Thesis Title: Development of a Theory and Evidence-based Public Health Weight Management Intervention for Female University Students in the Kingdom of Saudi Arabia

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Declaration

I, Aljohrah Aldubikhi declare that all the information included in this thesis "Development of a Theory and Evidence-based Public Health Weight Management Intervention for Female University Students in the Kingdom of Saudi Arabia" is my own work. I also declare that any information that has been taken from other sources has been mentioned in the thesis.

Acknowledgement

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Conflicts of interest: None.

Abstract

Saudi female university students are particularly vulnerable to weight gain, with 48% of this population being overweight or having obesity, contributing to non-communicable diseases. To address this public health issue, my current research aimed to develop a weight management intervention based on the Behaviour Change Wheel (BCW) framework, targeting female university students who are overweight in Kingdom of Saudi Arabia (KSA), using a theoretically-driven systematic approach.

The research comprised five stages. First, I conducted a systematic review to identify effective weight management interventions for female university students, including successful behaviour change techniques (BCTs) and programme lengths. Effective weight management interventions used a combination of interventions with the support of particular BCTs and lasted 12+ weeks.

Stage two involved conducting focus group discussions with 18 female university students to identify barriers and facilitators to healthy eating, physical activity and attending a weight management programme. The Theoretical Domains Framework (TDF) and the BCW were used to identify additional BCTs to incorporate into the programme. Findings pointed to multiple personal, social, and environmental factors influencing weight management, including several specific culture of KSA, such as food and hospitality norms.

In Stage three, these findings were combined with existing evidence to inform the design of the weight management programme entitled Better Healthy Lifestyle (BHL).

Stage four involved conducting a feasibility study with 15 female, overweight university students. The programme included 12 sessions focusing on nutrition and physical activity education and specific BCTs to promote weight loss. Overall, the study was feasible, but it highlighted the need to assess target behaviours and acceptability.

Finally, I interviewed 14 feasibility study participants to explore the effects of the BHL programme. Participants reported experiencing significant changes in self-perception and self-belief that facilitated behaviour change maintenance post-intervention and during the COVID-19 pandemic.

Impact Statement

I developed the first theoretically-driven and evidence-based multicomponent weight management intervention for female university students in Kingdom of Saudi Arabia (KSA). The intervention, the Better Healthy Lifestyle (BHL) programme, combines nutrition and physical activity education with behaviour change techniques (BCTs) to promote certain targeted behaviours to facilitate weight loss. The work addresses a number of research gaps and has potential impact in several areas. Key audiences are other public health researchers developing complex health interventions, and policy makers who make decisions about education and health initiatives for the KSA.

The key findings of the systematic review might help as set of recommendations for other researchers with the development of their intervention. In addition, it has identified some gaps in the literature about the population of interest that needs further investigations.

The focus group discussions addressed a gap in provision of effective weight loss programmes for female university students in KSA by obtaining first-hand accounts of lived experiences with weight management and healthy lifestyle behaviours. Data suggested that the cultural environment, including norms and customs, encourages or discourages students' food related and physical activity behaviours. Therefore, this study helped in addressing the needs of this target population to develop a customized weight loss intervention that suits them.

This thesis also illustrates a detailed step-by-step guide on how to develop an intervention in a systematic manner using the Medical Research Council (MRC) guidance, Theoretical Domains Framework (TDF) and Behaviour Change Wheel (BCW). This can help other researchers to utilise these in order to develop their own intervention.

Although the results of the feasibility trial were preliminary, they were promising, showing that most participants were able to maintain healthy food related and physical activity behaviours even under the government's strict measures in response to COVID-19. Furthermore, the information obtained from participants experiences' identified the potential BCTs that might help maintain weight loss. These BCTs and the targeted behaviours might be useful for other researchers to incorporate in their interventions.

A randomised controlled trial (RCT) is now needed to allow a more thorough assessment of the efficacy of the intervention. The penultimate chapter proposes updates to the BHL programme based on findings from the feasibility trial and the interviews. If the intervention is proven effective, I recommend dissemination of research results to the Saudi Ministry of Education and Ministry of Health for policy development at national scale. This could include implementing the BHL programme across university campuses in KSA, and/or developing policies to restructure the physical and social environments at universities to facilitate healthy eating and physical activity. Therefore, the careful reporting of the development and the procedures involved in the BHL programme provides a template for other researchers interested in developing complex interventions.

Moreover, the findings might assist policy-makers to consider incorporating the methods and BCTs for weight management among female university students into guidelines. Overall, if the potential RCT is proven successful and suited to the Arabic community, it could be presented to stakeholders across the Gulf and the Middle East region.

Abbreviations

Abbreviation	Full Term
ANCOVA	Analysis of Covariance
APEASE	Affordability, Practicality, Effectiveness and Cost-Effectiveness, Acceptability, Side-Effects/Safety, And Equity
BCTs	Behaviour Change Techniques
BCW	Behaviour Change Wheel
BHL	Better Healthy Lifestyle
BMI	Body Mass Index
CENTRAL	Cochrane Central Register of Controlled Trials
COM-B	Capability, Opportunity, Motivation – Behaviour
CONSORT	Consolidated Standards of Reporting Trials
COVID-19	2019 Novel Coronavirus (Disease caused by the novel coronavirus SARS-COV-2)
DEXA	Dual-Energy X-Ray Absorptiometry
EMBASE	Excerpta Medica Database
ERIC	Education Resources Information Centre
GDP	Gross Domestic Product
HBM	Health Belief Model
IRB	Institutional Review Board
ITT	Intention-To-Treat
MEDLINE	Medical Literature Analysis and Retrieval System Online
MeSH	Medical Subject Headings
MOH	Ministry of Health
MRC	Medical Research Council
NCD	Non-Communicable Disease
NICE	National Institute for Health and Care Excellence
PHCC	Primary Health Care Centres
PICOS	Population, Intervention, Comparison, Outcome, And Study Design
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSYCINFO	Psychological Information Database
REC	Research Ethics Committee
RoB 2	A Revised Cochrane Risk-Of-Bias Tool for Randomised Trials
ROBINS-I	A Risk of Bias In Non-Randomised Studies Of Interventions
SD	Standard Deviation
SES	Socio-Economic Status
SEU	Saudi Electronic University
SMART	Specific, Measurable, Achievable, Realistic, Time
SLT	Social Learning Theory
WMD	Weighted Mean Difference
SRQR	Standards for Reporting Qualitative Research
TDF	Theoretical Domains Framework
TPB	Theory of Planned Behaviour
TTM	Transtheoretical/Stages of Change Model
WMP	Weight Management Programme

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Chapter 1. Introduction

1.1 Introduction

This chapter discusses obesity aetiology, its determinative factors, its impacts and its prevalence globally and in the Kingdom of Saudi Arabia (KSA). It also provides a detailed overview of obesity among university students, internationally and in KSA. In addition, it discusses current international and local guidelines regarding obesity management and outlines theories of behaviour change, including the specific behaviour change models employed in this thesis. Finally, it describes the framework that I applied to develop the study’s weight management intervention.

1.2 Study Purpose

KSA has one of the highest obesity rates in the world, ranking second, at 35%, in 2020 (World Population Review, 2020). Obesity prevalence in KSA varies by demographic category, including age, gender, education, and region. For example, in KSA, women have higher obesity rates than men (Al-Ghamdi et al., 2018; Alqarni, 2016). Among female university students, overweight and obesity prevalence is as high as 48% (Al Qauhiz, 2010) compared with 22% in male students (Al-Rethaiaa et al., 2010). The high levels of obesity in this group is of concern, given the critical need to develop healthy behaviours in emerging adulthood (ages 19-25) to protect against poor health later in life (Reed & Phillips, 2005).

Despite disparities in obesity prevalence, there has been no prior weight management intervention focusing on female university students in KSA, as far as I am aware. It is thus vital to implement and test lifestyle modification programmes for this population to prevent and manage obesity. To address this need, the present study set out to develop a lifestyle intervention based on the best available evidence to promote weight loss among female university students in Riyadh, KSA.

1.3 Obesity

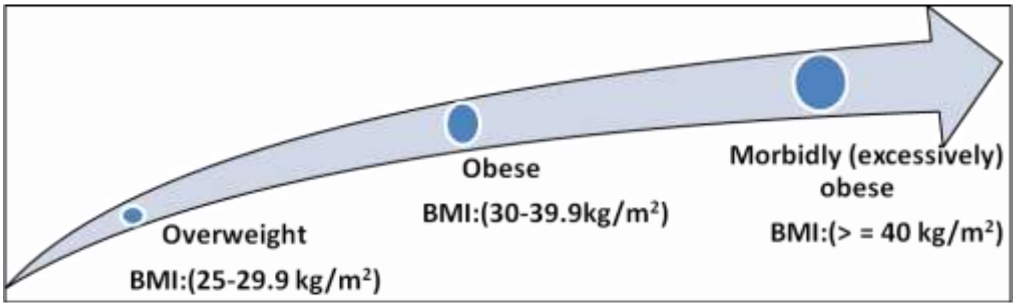
Obesity is defined as excessive fat accumulation in the body that has the potential to negatively impact health and well-being (WHO, 1995). Obesity is assessed using body mass index (BMI), which is a standard measure equal to weight in kilograms divided by height in metres squared (kg/m^2) (WHO, 1995). BMI is the most frequently used tool for anthropometric measurement to assess obesity levels in public health (WHO, 1995).

Over time, the World Health Organization (WHO) has expanded the number of BMI categories to reflect different degrees of obesity. Currently, BMI is subdivided into five categories: underweight, normal weight, overweight, obese and morbidly obese. The WHO (2018) classifies a BMI of 25-29.9kg/m^2 as overweight, and a BMI of 30-39.9kg/m^2 as obese. A BMI equal to or over 40kg/m^2 is considered morbidly obese (Figure 1.1).

BMI is a risk factor for various diseases, such as diabetes, hypertension, heart disease and some cancers, and its prevalence is used to establish domestic and global health policies. However, BMI does not always capture an individual's full risk profile (Nuttall, 2015). For example, it can be misleadingly high due to build-up of muscle or oedema or misleadingly low in older people (Wyatt, 2013). A recent meta-analysis of cohort studies suggests that people who are over age 65 may have BMI ranges that are linked to morbidity and mortality in different ways than younger people (Winter et al., 2014). For instance, the meta-analysis found that mortality risk was lowest at BMI 24 – 31kg/m^2 for people aged ≥ 65 (Winter et al., 2014).

Whilst BMI is the most common measure of body composition, there are other indices, including the skinfold thickness test, waist to hip ratio measurement, bioelectric impedance and dual-energy x-ray absorptiometry (DEXA) scan (Wells, 2006). Another measure of obesity is waist circumference, which gives a better indication for the amount of abdominal fat. Women and men with waist circumference ≥88 cm and ≥102 cm, respectively, are considered at high risk of obesity-related comorbidities (Saudi Guidelines on the Prevention and Management of Obesity, 2016). Many of these methods are more precise than BMI in assessing body composition but, like BMI, have limitations or are not practical to perform in clinical settings (Wyatt, 2013).

Figure 1.1: BMI as an indicator of overweight, obese or morbidly obese in adults, WHO, 2004



1.4 Obesity Aetiology and Associated Risk Factors

The aetiology of obesity is complex and multifactorial. Determinants are genetic, behavioural, environmental, physiological, socio-economic and cultural (Narciso et al., 2019). Direct drivers of obesity include poor diet and sedentary behaviour, each of which affect an individual's energy balance (WHO, 2002). Energy balance relates to calorie intake and level of physical activity. If caloric intake exceeds energy expenditure (physical activity), the outcome is weight gain (Butland et al., 2007).

The epidemiological rise in obesity over the last few decades is the result of broad socio-economic transformations and worldwide nutrition transitions (WHO, 2018). These international trends include economic growth and rising income levels, modernisation, urbanisation and the globalisation of food markets and "westernization" of diets (Fanzo & Davis, 2019; Kearney, 2010; WHO, 2018). These changes have contributed to unhealthy eating habits and sedentary lifestyles among much of the world's population. According to the WHO, globally, 42% of women and 32% of men are physically inactive (WHO, 2018).

Unhealthy dietary practices include insufficient intake of fruit and vegetables (Slavin & Lloyd, 2012; WHO, 2020a); whole grains and legumes (Fanzo & Davis, 2019; Frank et al., 2019; Popkin et al., 2012); and overconsumption of high fat foods, sugar-dense beverages (e.g., sodas) (Afshin et al., 2019), sugar, salt, (Afshin et al., 2019; WHO/FAO, 2003), fast foods, and foods outside the home (Fanzo & Davis, 2019; Popkin et al., 2012). To promote wellbeing, WHO provides nutrition guidelines for individuals, including advice to consume five servings of fruit and vegetables daily. Research suggests that adherence to these standards is associated with lower risk of death for all populations, regardless of age, gender or geographic location (Jankovic et al., 2014). Despite proven benefits, a wide gap remains between WHO's dietary recommendations and people's actual intake of food, including fruits and vegetables (Krebs-Smith et al., 2010; Serdula et al., 2004).

1.5 Negative Impacts of Obesity

There are various long-term detrimental health effects often associated with obesity, for instance, increasing the risk of extensive complications and chronic health problems (Hamdy, 2017). Obesity can result in premature atherosclerosis, as well as an increase in the likelihood of myocardial infarction and heart problems, and potential fatalities caused by cardiovascular complications (Apovian & Gokce, 2012). A study reported obesity related factors caused 11% of heart failure in men and 14% in women (Ebong et al., 2014). Other consequences include stroke, hypertension, type 2 diabetes mellitus (T2DM), depression, anxiety, respiratory issues, limitations in mobility and physical disabilities, osteoarthritis, sleep apnoea and some cancers (e.g. endometrial, breast and colon) (Abdelaal et al., 2017; Dixon, 2010; Zhang et al., 2014). Globally, more than half of T2DM, 21% of ischaemic heart disease, and 8-42% of certain cancers are associated with the BMI; the higher the BMI, the higher the risk of developing these diseases (WHO, 2002). Many of obesity's comorbidities put individuals at increased risk of premature mortality (Abdelaal et al., 2017). Together, overweight and obesity are the fifth leading risk for mortality worldwide and are responsible for 2.8 million deaths each year (The European Association for the Study of Obesity, 2020).

Obesity and related health problems place significant burdens on individuals, communities and economic, social and health care systems (Wang et al., 2011; Withrow & Alter, 2011). Studies globally demonstrate that obesity negatively affects people's productivity and work or school performance (Rissanen, 1996; Schmier et al., 2006; Seidell, 1998). A study conducted in a high income country (United States) showed that people with obesity visiting health providers increased 88% during a six-year period (Wolf and Colditz, 1994) and they are more likely to take extended sick or disability leave from work due to illness or doctor's appointments (Gates et al., 2008; Schmier et al., 2006).

Obesity-related morbidity and mortality produce significant healthcare and social welfare needs, draining society's economic resources. In 2014, the direct cost of obesity worldwide was estimated to be US $2.0 trillion, equivalent to 2.8% of the world's gross domestic product (GDP) (Dobbs et al., 2014; Tremmel et al., 2017). Recent studies and literature reviews suggest that there is a close relationship between BMI and healthcare expenditures: when BMI rises, healthcare expenditures also rise (Andreyeva et al., 2004; Dee et al., 2014; Finkelstein et al., 2009; Specchia et al., 2015). Beyond the healthcare sector, there are many indirect costs from obesity, including lost workplace productivity (and revenue) due to employees' absenteeism, on-the-job sickness and injuries and disability leave (Goettler et al., 2017).

Goettler et al. (2017) conducted a systematic review of research on productivity loss due to overweight and obesity, examining 50 studies from different countries, including the United Kingdom, North America, Europe, Korea, Australia and New Zealand. Several studies in the review focused on national (indirect) healthcare costs for one year, with sums ranging from $79 million in New Zealand (Lal, Moodie, & Ashton, 2012) to $41 billion for three states in the United States (Chenoweth & Leutzinger, 2006).

1.6 Epidemiology of Obesity

1.6.1 The Global Epidemiological Context of Obesity

Global obesity prevalence has almost tripled in the past 40 years (WHO, 2018). The WHO estimates that more than 1.9 billion adults aged 18 years and older are overweight (39% of the world's total population) (WHO, 2018). Amongst these, 650 million adults have obesity (13% of the world's population) (WHO, 2018). In 2015, the Global Burden of Disease study found that amongst the 20 most populated nations, the highest level of age-standardized adult obesity was in Egypt (35.3%) and the lowest was in Vietnam (1.6%). The overall global obesity rate was 12.0% among adults (GBD 2015 Obesity Collaborators, 2017).

Obesity is considered an international "epidemic" and a major contributor to the rise of chronic non-communicable diseases (NCDs) and disabilities. The prevalence of the four main NCDs - cardiovascular diseases, cancers, diabetes and chronic lung diseases - is rising disproportionately in low-and-middle income countries. In 2016, 75% of NCD deaths worldwide took place in developing and transitional economic countries (WHO, 2018).

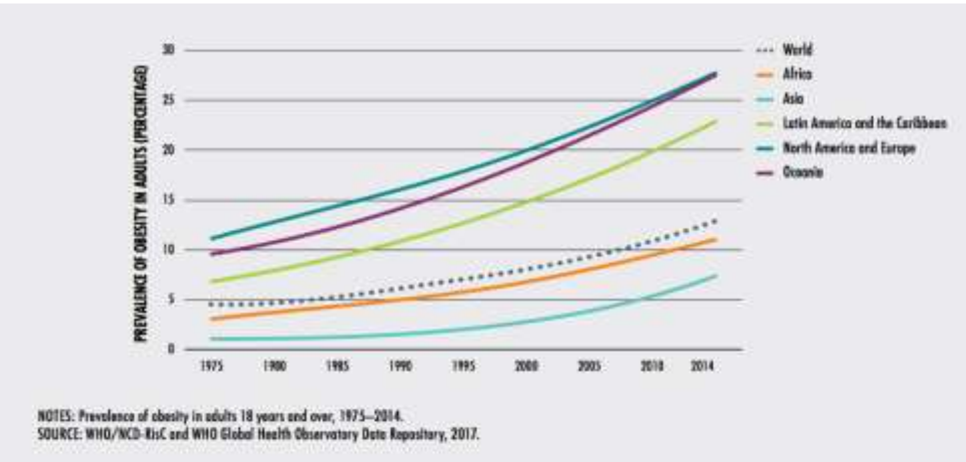
As previously noted, globally, at least 2.8 million deaths each year can be attributed to overweight or obesity. Moreover, an estimated 35.8 million global Disability-Adjusted Life Years (DALYs) (the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability) are the result of overweight or obesity (WHO, 2020b). Experts forecast that the obesity crisis will continue to grow. According to one study, over half of the global population will be affected by overweight or obesity by 2030 (Hruby & Hu, 2015). Another study projects that in absolute numbers, the overweight and obesity population in 2030 will be 2.16 billion and 1.12 billion worldwide, respectively (Kelly et al., 2008).

Obesity prevalence varies among populations and regions throughout the world, shaped by proximal and distal factors that interact to produce the condition. Distal factors are "upstream" determinants of health that indirectly affect proximal or "downstream" determinants that have a direct influence on health (Lakerveld & Mackenbach, 2017). Proximal determinants of obesity include people's social and physical environments, lifestyles, behaviours and physiological factors. Distal determinants are systemic and include legal, political, cultural and institutional factors (Swinburn et al., 2011).

Distal and proximal determinants work together to put certain demographic groups at greater risk of obesity. In general, people in urban areas have higher obesity rates than people in rural areas, due to diets of low-nutrient, high fat food and sedentary behaviour (Alqarni, 2016). Obesity has also been linked with socio-economic status (SES), although the direction of this relationship depends on a country's level of economic development. In low income countries, people with higher SES are more likely to suffer from obesity, whilst conversely, in high-income countries, people with higher SES are less likely to suffer from obesity (Cohen et al., 2013; Pampel et al., 2012). This reversal may reflect different patterns of consumption and physical activity among higher SES groups in low-income and high-income countries. In low-income countries, higher SES may lead individuals to consume high-calorie food and perform little physical activity, whilst in higher income countries, higher SES may prompt individuals to eat healthily and engage in regular exercise (Pampel et al., 2012). It may also reflect different patterns in low SES groups too. For instance, in low income countries, a higher proportion of low SES groups will suffer extreme undernutrition. Education's effect on obesity is mediated by gender and economic development: in higher income countries, education levels are inversely related to obesity, meaning that those who have more education are less likely to suffer from obesity. In lower income countries, however, a positive association exists between gender and education, and obesity is exacerbated by gender (Cohen et al., 2013). Understanding the relationships amongst obesity determinants is critical to developing programmes that address complex pathways to the disease and inequalities in the distribution across social groups (Devaux et al., 2011).

Global obesity rates disaggregated by demographic variables, including gender, age, education, country and region (Figure 1.2), are available from the WHO (WHO, 2020c). In terms of gender, in 2016, the global obesity rate was 11% for adult males, and 15% for adult females (WHO, 2020c). The highest mean BMI rate by geographic region was the Americas (27.6%), followed by Europe (26.4%) and the Eastern Mediterranean (26.1%) (WHO, 2017b). In addition, in some countries, obesity rates are rising sharply, especially in the high-income Arabian Gulf region, including KSA, Bahrain, Kuwait, Oman and Qatar (Samara et al., 2019).

Figure 1.2: Prevalence of obesity by region, Adapted from WHO, 2017

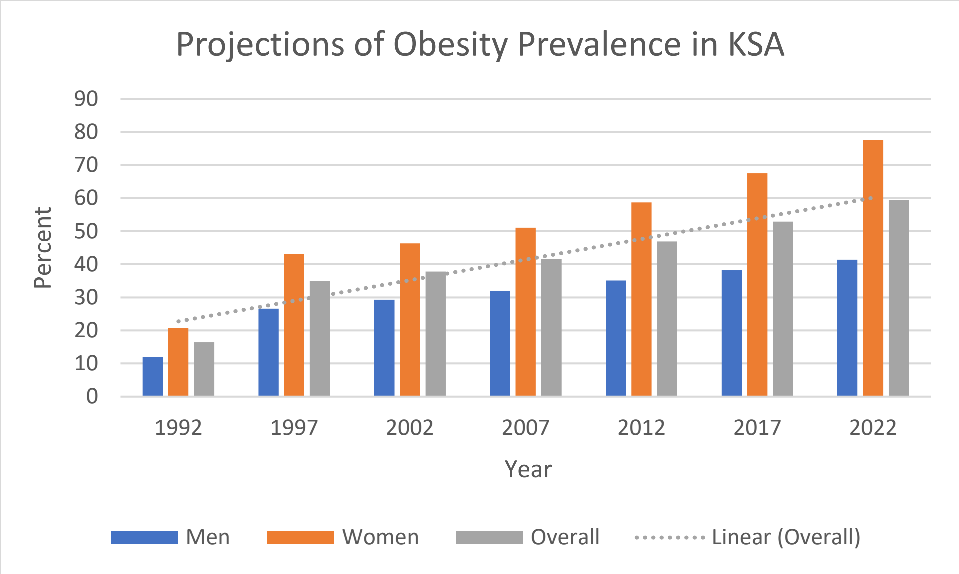


1.6.2 Epidemiological Context of Obesity in the Gulf Region

As noted in section 1.6.1, obesity in the Gulf region is rising at an alarming rate (Al-Saeed et al., 2007; Musaiger, 2011). The six Arab Gulf states - KSA, Bahrain, Kuwait, Oman, United Arab Emirates and Qatar - are some of the countries with the greatest share of people with overweight and obesity. In these countries, about 60% of the population are people with overweight and half of these (30%) have obesity (Samara et al., 2019). In KSA, the number of adults who are clinically overweight or obese has tripled over the past 30 years (WHO, 2019). Public health experts point to several possible factors that may contribute to this dramatic rise, including economic growth after the discovery of oil in the 1960s (Kelly et al., 2008). In particular, as in other countries, the rise in individual and national wealth has allowed Saudis a more sedentary lifestyle and access to westernized foods high in fat and sugar and sugary drinks (Alqarni, 2016).

Over the past 10-15 years, there have been several epidemiological studies in KSA documenting obesity prevalence and associated risk factors among adults (and children). These have largely been cross-sectional, focusing on rates nationally and among social groups and regions (Ahmed et al., 2014; Al-Ghamdi, 2018; Al-Nozha et al., 2005; Al-Nuaim, 2012; Al-Quwaidhi et al., 2014; Al Shehri et al., 2013; Elbadawi et al., 2015; El Nashar et al. 2017; Garawi et al., 2015; Horaib et al., 2013; Memish et al., 2014). Al-Quwaidhi et al. (2014) examined national surveys on adult obesity and reported that the prevalence of obesity increased from 22% in 1990-1993 to 36% in 2005. Extrapolating from existing secondary data, Al-Quwaidhi et al. (2014) projected that obesity would increase from 21% in 1992 to 78% in 2022 among Saudi women and from 12% to 41% among Saudi men (Figure 1.3). Memish et al. (2014) conducted a national survey to examine obesity (and risk factors) in KSA among a sample of 10,735 individuals ages 15 years and older. The results indicated that 28.7% of the sample had obesity, with higher prevalence among women (33.5%) than men (24.1%). Garawi et al. (2015) reported that in five national surveys undertaken between 1989 and 2005, obesity prevalence was significantly higher amongst Saudi women than amongst men.

Figure 1.3: Projection of Obesity Prevalence in KSA, Al Quwaidhi et al., 2014



Evidence suggests that obesity rates vary by geographic region in KSA. For instance, Al-Othaimeen et al. (2007) conducted a cross-sectional study evaluating the prevalence of obesity among 19,598 individuals in 2,837 households and reported findings by city. In Riyadh, the capital of KSA, 21.7% of adults were identified as having obesity, making it the sixth ranked city with obesity in the nation. In Hail, the city with the highest rate, 33.9% of adults were reported as having obesity. More recently, Ahmed et al. (2014) conducted a cross-sectional study of 5,000 Saudi adults in the Hail region, finding an obesity rate of 71% in women compared with about 56% in men. Regional differences in the prevalence of obesity have been reported in several other studies (Al-Qahtani, 2019; Al-Raddadi et al., 2019; Alzahrani et al., 2016; El Nashar et al., 2017; Sabra, 2014) with most finding higher obesity rates amongst women than men in their samples. Given this disparity in rates, there is a vital need for public health interventions that promote weight loss among Saudi females (De Nicola et al., 2015).

Multiple studies in KSA show a relationship between obesity and T2DM (Alqubali et al., 2017; Al-Shahrani & Al-Khaldi, 2013; Koura et al, 2012; Memish et al., 2014), cardiovascular disease (Garawi et al., 2015; Kalaf et al., 2016; Koura et al, 2012), breast cancer (Elkum et al., 2014) and hypertension in Saudi adults (Abolfotouh et al., 2012; Alanazi et al., 2018; Alqubali et al., 2017; Al-Shahrani & Al-Khaldi, 2013; Mehmood et al., 2016; Memish et al., 2014). These comorbidities have increased substantially over the past 20-25 years (Al-Nuaim et al., 1997;

Alzaman & Ali, 2016; Fatani et al., 1987). According to a report by the Saudi Arabian Ministry of Health (MOH), approximately 0.9 million people were newly diagnosed with diabetes (both types) in 1992, rising to 2.5 million people in 2010, an increase of more than 2.7 times in the incidence rate in just under two decades (The Ministry of Health Statistics Report, 2015). During this time, the cost of treatment and healthcare for diabetes rose by more than 500%. Estimates suggest the direct cost of diabetes is now close to 14% of the total health expenditure in KSA (Alhowaish, 2015; Alwin Robert et al., 2017).

A recent overview of diabetes studies found varying prevalence rates of T2DM across KSA regions. These ranged from 18.2% (in 2004–2005) in a study in the Eastern province (Al-Baghli, 2010) to 31.6% in 2011 in a study in Riyadh (Al-Daghri, 2011). Focusing on the Riyadh region only, Al-Daghri et al. (2011) concluded that the age-adjusted prevalence rate of T2DM between 1997 and 2011 increased from 14% to 29% among women and from 12% to 35% among men. Cardiovascular disease prevalence rates also grew, from 6.2% to 6.9% between 2000 and 2010.

Several researchers in KSA have explored the relationship between obesity and comorbidities in young adults. Abolfotouh et al. (2012) examined body composition and metabolic abnormalities in 501 Saudi university students (aged 18-26 years) and found that when the waist circumference and BMI increased, the risk of the most prevalent metabolic disorders increased, experienced by 42% of students. The authors also showed that obesity was associated with hypertension, high systolic blood pressure and high diastolic blood pressure. In a cross-sectional study of 405 medical students in Arar, Mehmood et al. (2016) found that 30% had obesity/overweight; among these, 11% had hypertension. Alanazi et al. (2018) conducted a cross sectional analysis of the association between obesity and pre-hypertension (not hypertension but it is a condition when the blood pressure of an individual is above the ideal level) and hypertension among young adults with overweight and obesity in Arar. Findings showed that 52% of females and 59% of males were pre-hypertensive. Moreover, 18% of participants with overweight and 41% of participants with obesity were pre-hypertensive or hypertensive compared with 3% of underweight/normal weight participants. Koura et al.'s (2012) cross-sectional study of 370 young female adults identified obesity as the second most prevalent risk factor for cardiovascular diseases (physical inactivity being the most prevalent). The same study showed that obesity and overweight were strong predictors of pre-hypertension.

Gender is often a key factor in the relationship between obesity and chronic diseases, which may result in distinct findings. To assess risk factors for breast cancer, Elkum et al. (2014) conducted an unmatched case-control study on 1,172 women in KSA, finding 76% of women with breast cancer had obesity/overweight, higher than the prevalence of 61% in the control group of women without breast cancer. Resistance to breast cancer screening among Saudi women further exacerbates this situation; despite the availability of free services, approximately 92% of Saudi women over 50 years old have never had a mammography and around 89% had not had a breast examination in the last year (El Bcheraoui et al., 2015).

1.7 Obesity Management

1.7.1 Obesity Management Through Lifestyle Change, Pharmacotherapies and Surgery

Behaviour change in diet and physical activity remains the most common weight loss strategy (MacLean et al., 2015) and the safest option among different obesity treatments (Montesi et al., 2016; Wadden et al., 2011). However, diet modification alone does not always produce significant or sustained weight loss (Dansinger et al., 2005). For instance, a successful weight loss is typically not less than 5–10% of bodyweight, as it may produce overall significant improvement in health (MacLean et al., 2015). For those who are unable to achieve durable change, there are alternative treatments, namely pharmaceutical or surgical interventions. However, in many cases, these procedures remain controversial due to safety and efficacy concerns (Bessesen & Van Gaal, 2018).

Patients with overweight are generally prescribed drug therapies only if they have attempted at least a 6-month lifestyle intervention without success, and have either BMI ≥28kg/m^2 with a comorbidity, e.g. T2DM, hypertension or high cholesterol, or BMI ≥30kg/m^2 (NICE, 2014; Saudi Guidelines on the Prevention and Management of Obesity, 2016; Wyatt, 2013). Thus, pharmacotherapies are not intended for unnecessary "cosmetic" weight loss (NICE, 2014; Wyatt, 2013) and may be prescribed only in combination with a healthy diet and exercise programme. Behavioural treatment and nutrition counselling are also highly recommended to complement behaviour modification and pharmacotherapy (Seagle et al., 1998).

Anti-obesity drugs have been approved in many countries, including the USA, European Union, Australia, and Japan. These drugs vary in effectiveness and side-effects but tend to promote greater weight loss than lifestyle changes alone (Bessesen & Van Gaal, 2018). For example, an American study found that when used as an adjunctive therapy to lifestyle intervention, obesity medications, namely lorcaserin, orlistat, and top-dose phentermine plus topiramate-ER, produce greater mean weight losses and greater likelihood of achieving clinically meaningful 1-year weight loss than placebo (Yanovski & Yanovski, 2014). Because of the potential risks of obesity drugs, clinicians should discontinue medication for patients who do not respond with weight loss ≥5% within a 12-week time period, thereby decreasing exposure to the potential harms of drug treatment when there is little likelihood of long-term benefit (Yanovski & Yanovski, 2014).

Patients with BMI greater than 35kg/m^2 and T2DM or cardiovascular disease may be considered for surgery when other treatments have not been successful (Mechanick et al., 2009; NICE, 2014; Saudi Guidelines on the Prevention and Management of Obesity, 2016). Sleeve gastrectomy, gastroplasty and gastric bypass are the most common surgical procedures performed for weight loss. Whilst some health benefits have been documented (e.g. resolution of diabetes, hypertension, obstructive sleep apnoea etc.), the literature does not consistently demonstrate long-term weight loss success from bariatric surgical procedures (Boeka et al., 2010; Buchwald et al., 2004; Livhits et al., 2010; Lynch, 2016; Ogden et al., 2005). Moreover, severe complications from these operations, such as gastric obstruction or infection, have been reported (Pandolfino et al., 2004). Surgical interventions are then only the first step in a long-term weight maintenance strategy that involves changes in dietary habits and levels of physical activity to maintain surgical results (Jumbe et al., 2016).

1.8 Behaviour Change

Human behaviours play a critical role in promoting or preventing morbidity and mortality (Danaei et al., 2009; Parkin et al., 2011) and despite medical advances, remain the largest source of variance in health-related outcomes (Schroeder, 2007). Understanding these behaviours and the environments in which they take place is crucial to developing effective evidence-based interventions and policies to minimize avoidable disease and death (Office of Behavioural and Social Sciences Research, 2006). Behavioural theories are a tool to undertake this type of analysis and develop effective behaviour change programmes. They help detect changes that have occurred, explain or describe change dynamics, and identify factors influencing intervention outcomes (Davis et al., 2015). Their application in intervention planning promotes understanding of the causal mechanisms of change and makes replication, modification, and the scaling up of effective interventions more probable (Michie & Johnston, 2012). Given these many benefits, the UK Medical Research Council's (MRC) guidance for developing and evaluating complex interventions advocates using theory in intervention design and evaluation (Campbell et al., 2000, 2007; Craig et al., 2008; Glanz & Bishop, 2010).

Theoretical approaches can be divided into two types. Explanatory behaviour theories help to describe a problem and explain why it occurs, allowing researchers to better predict behaviour and devise responses that target modifiable factors (Agar, 2008, Glanz & Rimer, 1997; Head & Noar, 2013). Behaviour change theories identify interactive and dynamic behaviour change processes (Agar, 2008; Head & Noar, 2013) and are used to inform intervention design and guide evaluation (ECDC, 2013). For instance some of the predictive theories of behaviour change are Health Belief Model (HBM) and Theory of Planned Behaviour (TPB). On the other hand, some of the dynamic theories of behaviour change are Transtheoretical/Stages of Change (TTM) and Social Cognitive Learning Theory (SCLT) (Michie et al., 2018). All of these theories are described in detail in section 1.8.1. Overall, behavioural models are typically based on more than one theory and may be informed by empirical findings (Ajzen, 1991).

1.8.1 Behavioural Theories and Models

A variety of health behaviour theories and models exist, however, the most commonly used are: The Health Belief Model, the Stages of Change (Transtheoretical) Model, and the Social Cognitive Learning Theory and the Theory of Planned Behaviour (Sallis & Owen 2008). Each incorporates a range of concepts and methods to explain relationships or causal pathways influencing behaviour (Michie et al., 2008). None of these theories were directly utilised in the current thesis. However, the Theoretical Domains Framework (TDF), the model I use to assess factors influencing food-related and physical activity behaviours among study participants, synthesizes these approaches and other psychological theories to create constructs/domains to explain behaviour change (Michie et al., 2005). It is therefore important to understand the rationale underpinning these central theories and therefore the Health Belief Model, the Stages of Change (Transtheoretical) Model, the Social Cognitive Learning Theory and the Theory of Planned Behaviour are described below.

Health Belief Model

The Health Belief Model (HBM) is derived from cognitive psychology and was developed in the 1950s to explain and predict health-related behaviours, particularly the uptake of health services. In the 1980s, the HBM was expanded to address limitations and increase its predictive capacity. Today, the model includes six central constructs that function to influence behaviours and decisions regarding disease prevention and management. These are: 1) perception of susceptibility, with individuals acting based on belief about vulnerability to disease; 2) perception of severity, with individuals acting on belief about the potential seriousness of contracting a disease or of failing to treat it; 3) perception of benefits, which is belief that taking action to reduce the threat of disease is beneficial; 4) perception of barriers, which is belief that there are impediments or costs to taking action; 5) cues for action, which are triggering mechanisms; and 6) self-efficacy, which is belief that one can successfully achieve an intended action (Champion & Skinner, 2008; Montano et al., 2008).

While the HBM attempts to predict health-related behaviours by accounting for differences in beliefs and attitude, it does not account for other factors that influence health behaviours. These include economic or environmental factors shaping health-related action (Hahm et al., 2008).

Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is an extension of the theory of reasoned action and addresses the latter's main shortcoming (Ajzen & Fishbein; 1975; Ajzen & Fishbein 1980). Unlike TRA, TPB recognizes that behaviour is not always voluntary and cannot always be controlled (Arafat & Ibrahim, 2018). Thus, in addition to considering attitudes, norms, and intentions, TPB takes perceived behavioural control (PBC) into account to explain behaviour. PBC can be likened to self-efficacy and is defined as the perceived ease or difficulty of successfully performing a behaviour. According to TPB, action is determined by three factors: behavioural beliefs (beliefs about a behaviour), subjective norms (beliefs about the expectations of other people) and PBC (Kagee & Freeman, 2017).

Supporters of TPB argue that it is able to predict all forms of behaviour. In contrast, opponents maintain that TPB is only able to predict deliberate behaviour and not automatic behaviour (Kan & Fabrigar, 2017).

Transtheoretical (Stages of Change) Model

The Transtheoretical/Stages of Change (TTM) model was developed in the late 1970s based on studies to understand behaviour related to smoking cessation (Prochaska & DiClemente, 1983). The model posits that health behaviour change is a process that contains five steps: pre-contemplation, contemplation, preparation, action, and maintenance (West, 2005). In pre-contemplation, an individual is not yet thinking about changing a behaviour. In the contemplation stage, an individual expresses intent to change a behaviour, while remaining unsure about changing. In the preparation stage, an individual intends to take steps to change, usually soon, and is less unsure about change. In the action stage, an individual makes clear, visible lifestyle modifications. Finally, in the maintenance stage, an individual works to manage temptations and prevent relapse (West, 2005).

The transtheoretical model can be defined as a 'circular' process, as it is possible to relapse to a previous stage; hence, a cycle form. Awareness of this cycle has helped in the development of 58 different health programmes based on people's tendency to return to prior behaviours. The model considers the role of time in the process, and groups are analysed to identify which demographics are most responsive to specific interventions; however, the model does not focus on the social context where change occurs.

Social Cognitive Learning Theory

Psychologist Albert Bandura based Social Cognitive Learning Theory (SCLT) on his earlier social learning theory (SLT), creating the new name to better reflect the role of cognition in the learning process (Bandura, 1999). SCLT develops a framework to help better understand, predict, and change people's behaviour (Green & Peil, 2009). According to SCLT, learning takes place in a social context with a reciprocal and dynamic interplay between personal factors, the environment, and behaviour. People learn through their own experiences as well as by observing the actions of others and the outcomes of those behaviours. SCLT holds those cognitive processes, based on past experiences, are mainly responsible for how behaviours are acquired and regulated, and it is these processes that determine how prior experiences are interpreted, whether they are retained and how they affect future action (McEwen & Wills, 2014).

A substantial amount of research has been conducted in relation to SCLT, exploring various theoretical issues, such as learning rewards and behaviour stability. However, SCLT is wide-ranging and complex, making it challenging to operate it entirely.

1.8.2 Intervention Development Models

Well-designed interventions are critical to addressing public health problems in a sustainable and effective manner. Increasingly, researchers and practitioners are seeking to identify and synthesise the various actions involved in developing complex interventions to create more comprehensive and systematic approaches to intervention design and evaluation (Croot et al., 2019). Despite this emphasis, many intervention development models remain focused on individual behaviour change and/or require technical ability, time and resources that are not available to most early researchers (Wight et al., 2015). Some of the more prominent intervention development frameworks are: The Precede-Proceed model (Green & Kreuter, 2005), the RE-AIM framework (Glasgow et al., 1999), Intervention Mapping (IM) (Bartholomew et al., 2016), and the Medical Research Council (Craig et al., 2008). These models are discussed below.

The Precede-Proceed (PPM) Planning Model

The Precede-Proceed planning model (PPM) encompasses both planning and evaluation phases. Precede, the planning part of the model, is composed of five phases. (PRECEDE stands for Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation). Each of the phases proceeds in a strict linear fashion and consists of pre-intervention assessments in the following community domains: social; epidemiological; behavioural and environmental; educational and ecological; and, administrative and policy.

The Proceed part of the model provides the structure for implementing and evaluating public health interventions. (The acronym stands for policy, regulatory, and organizational constructs in educational and environmental development.) The first step in Proceed is to design and implement a program. Next, and in sequential order, Proceed involves a process evaluation to determine if the program reached the desired population and goals; an impact evaluation to assess the change in behaviour; and an outcome evaluation to determine if there is a decrease or increase in the incidence or prevalence of the identified behaviour (Green & Kreuter, 2005).

The PPM takes an ecological approach to intervention development, implementation and evaluation. While it focuses on outcomes, the model does not provide any guidance on theories or intervention techniques to use.

RE-AIM Framework

The RE-AIM Framework is comprised of five indicators to assess the impact of interventions: Reach, efficacy/effectiveness, adoption, implementation and maintenance. Reach captures the percentage of people from a given population who participate in a programme and describes their characteristics. Effectiveness measures change in a variable of interest and the outcomes of the programme.

Adoption is the percent of possible settings (e.g., organizations) and staff that have agreed to participate in the programme. Implementation assesses the extent to which a programme is delivered consistently, and the time and costs of the programme. Finally, maintenance assesses long-term effects and attrition of individuals and organizations in the project (Glasgow et al., 1999).

The RE-AIM framework is contextual and practical and is applicable across a wide range of interventions, populations, settings and behaviours. However, rather than discussing specific intervention or policy techniques for changing behaviour, the model is focused on determining which programme elements will enable sustainable adoption and implementation of effective interventions (Michie et al., 2011).

Intervention Mapping

Another ecological approach to intervention development is Intervention Mapping (IM) (Bartholomew et al., 2016). IM follows six steps to develop health promotion programmes. Each of the six steps comprises several tasks that integrate theory and evidence, and the completion of tasks in one step produces a product that can be used as a guide for the next step. However, the steps making up the planning process are iterative rather than linear and planners can move back and forth between tasks and steps. The steps are: (1) conduct a needs assessment; (2) specify performance and change objectives (3) programme design, including choosing theory and evidence of change methods; (4) refine programme; (5) implementation; and (6) evaluation.

Intervention Mapping provides a comprehensive and prescriptive intervention development framework. However, it is extremely time-consuming, difficult for first time users, and requires extensive theoretical knowledge.

The Medical Research Council (MRC) Framework

The Medical Research Council (MRC) has published guidance for developing and evaluating complex interventions involving several interacting components (Craig et al., 2008). The MRC framework identifies four key phases in intervention development: development; feasibility/piloting; evaluation; and implementation. The MRC framework views intervention development as an iterative process, involving several passes through the different phases (Craig et al., 2008; O'Cathain et al., 2019).

1.8.3 Theories and frameworks used in this thesis

Many intervention development models do not offer any guidance on how to choose theories. This makes selecting an appropriate theory for intervention design difficult, especially as there are numerous options that share similar or overlapping concepts (Michie et al., 2005). There is also little information available on how to select a suitable theory for a particular task, with most researchers drawing from a small number of theories that are routinely used in the field (Painter et al., 2008). However, by using a "standard" theory rather than one better matched to the purposes of the intervention and the target population, studies may fail to make the most of a theory's advantages.

Even when a researcher choses one or more theories to guide an intervention, it may not consider the full range of possible influences on a behaviour, excluding potentially important variables. For example, the Health Belief Model and Transtheoretical (Stages of Change) Model do not address the broader social contexts in which behaviour takes place.

The Theoretical Domains Framework (TDF) (Michie et al., 2005) was specifically developed to address the multitude of existing theories and overlapping concepts as well as the lack of guidance concerning their application. It is also a framework that explicitly pays attention to cognitive, affective, social and environmental influences on behaviour. The TDF is discussed in next section.

Michie et al. (2011) reviewed 19 frameworks for behaviour change interventions (or intervention development frameworks) to assess their comprehensiveness, coherence, and link to an overarching theory of behaviour. Neither the Precede-Proceed model nor the RE-AIM model were included in the review, since they do not describe specific intervention techniques aimed at changing behaviour.
Michie et al. (2011) identified nine intervention functions and seven policy categories across the 19 frameworks but observed that no model covered the full range of the intervention functions or policies on its own. Only a handful of frameworks offered coherence and were linked to a model of behaviour change.

The authors also concluded that most intervention development frameworks do not provide a systematic approach to analysis of the target behaviour or to the 'theoretically predicted mechanisms of action' (p. 2). (Michie et al., 2011). They singled out intervention mapping (IM) as a uniquely systematic approach that maps behaviour to its theoretical determinants in order to identify pressure points for change. However, IM fails to take into consideration all of the possible influences on a behaviour that exist within a behaviour system. In addition, Michie et al. (2011) argued that none of the intervention frameworks followed a systematic process for selecting appropriate theories to guide the intervention. For example, although the Medical Research Council framework advises that intervention design should be based on theory, it does not discuss how to choose or apply theory. As I draw on the MRC Framework, along with the BCW, to develop this thesis' intervention, it will be discussed in more detail in section 1.13. This topic is also explored in more detail in Chapter 5. In brief, I developed the BHL programme using the MRC framework to structure the overall step-based approach, while specifically applying the BCW to understand the target behaviour and to identify mechanisms for behaviour modification.

Ultimately, Michie et al.'s critical analysis of existing frameworks prompted the development of a new framework that addresses existing limitations: The Behaviour Change Wheel (BCW). The BCW is coherent, grounded in a model of behaviour, and includes all possible intervention functions and policies. Like intervention mapping (IM), the BCW follows a step-by-step process to intervention design. Unlike intervention mapping (IM), which attempts to link behaviour directly to theoretic determinants, the BCW recognizes that behaviour may stem from a combination of components in a system. In fact, the BCW brings together 83 theories from disciplines such as sociology, psychology, and economics to allow for a comprehensive analysis of a target behaviour in context that accounts for the individual, social and environmental factors influencing behaviour. The BCW is introduced below.

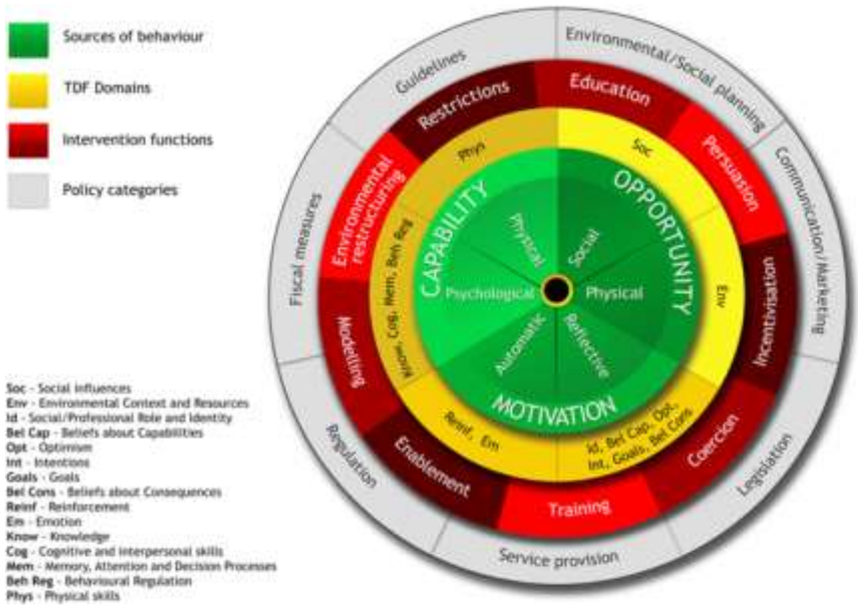
1.8.4 Behaviour Change Wheel and Theoretical Domain Framework

The current study combines two approaches, the BCW (Michie et al., 2011) and the TDF (Cane et al., 2012; Michie et al., 2005), to conduct a thorough assessment of the factors influencing weight management and identify intervention approaches.

Contents of Behaviour Change Wheel

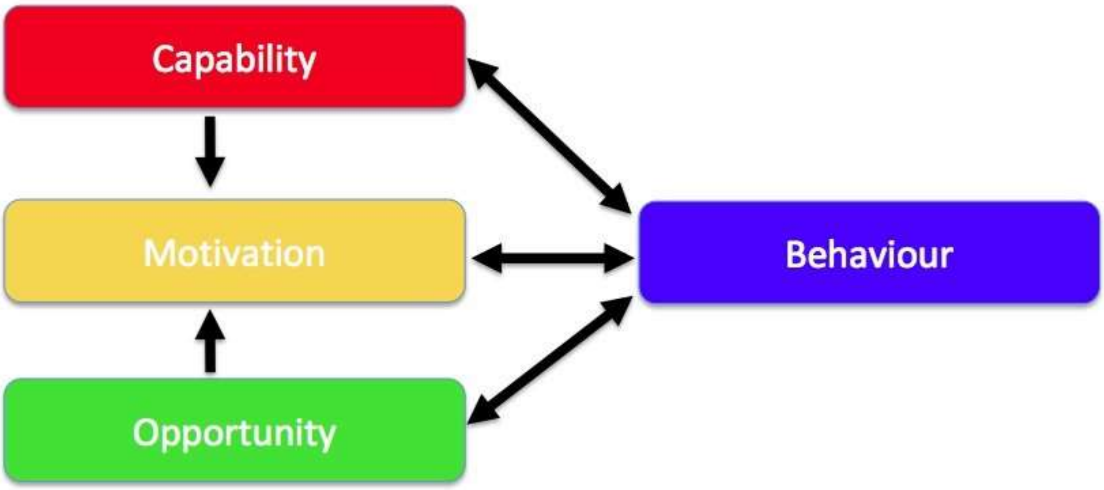
The BCW consists of three, interconnected layers (Figure 1.4). At its centre is the COM-B model which identifies influences on behaviour to inform future interventions. The COM-B is an interactive system, including capability (C), opportunity (O) and motivation (M), the three factors necessary for a behaviour change to occur (B). Figure 1.4 illustrates how the TDF domains are connected to the BCW.

Figure 1.4: Behavioural Change Wheel (adopted from Michie et al., 2014)



Capability is defined as the psychological or physical capacity to engage in a behaviour. For example, knowledge of nutrition – understanding how and why to follow nutrition guidelines – is a psychological capacity factor that may activate or inhibit healthy eating. Likewise, cooking skills – knowing how to prepare food - is a physical capacity that may activate or inhibit healthy eating. Opportunity includes factors external to the individual that discourage or encourage performing a behaviour. These include social opportunity (e.g. social pressures or cultural norms affecting physical activity or healthy eating) and physical opportunity (e.g. aspects of the physical environment such as time or access to facilities in which to cook and consume healthy meals or exercise). Finally, motivation may be reflective or automatic. Reflective motivation involves self-conscious processes, such as evaluation, that activate or inhibit performance of a behaviour. Automatic motivation reflects emotions, urges and reflexive/conditioned reactions that encourage or discourage performing a behaviour (Michie et al., 2011). For instance, an individual's engagement with a specific physical activity or healthy eating behaviour may be facilitated or inhibited by conscious intention or belief about whether an activity is good or bad or by existing habits and emotional states (e.g. guilt or shame) around food and exercise. Figure 1.5 demonstrates the contents of COM-B model.

Figure 1.5: COM-B Model (Michie et al., 2014)



Surrounding the hub of the BCW (Figure 1.4) is a second layer that includes the TDF, which is described below. The third layer consists of nine intervention functions (education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring and restrictions). These intervention functions are intended to create the conditions necessary to generate behaviour change. These intervention functions can then be linked to behaviour change techniques (BCTs) using the BCT Taxonomy v1 (BCTTv1) which includes 93 BCTs organized into 16 categories (Michie et al., 2013). A BCT is an intervention component that is designed to enable behaviour change by strengthening factors that facilitate behaviour change or improving factors that hinder behaviour change (Davis et al., 2015). For instance, it is possible to theorise that the BCT "Graded Tasks" may change one's behaviour through the increase in one's self-belief in their capabilities. The graded tasks have been shown to be simply applicable tasks that are achievable but difficult through behaviour performance (Michie et al., 2013). Comparatively, BCT "Restructuring the Social Environment" can be theorised to be the possible changes in the behaviour through decreases in negative social influences. The restructuring of the social environment has been noted as changes in the social environment that result in improved behaviour performance levels or the development of barriers to negative behavioural traits (Michie et al., 2013). Moreover, BCTs can be used alone or as part of a multi-component intervention (Michie et al., 2013). For example, behavioural practice/rehearsal is one of the BCTs that has been shown to effectively encourage increased physical activity (Howlett et al., 2018). Finally, the outer layer identifies seven policy categories that can be used to help implement intervention functions. For instance, education can be linked with communication/marketing policies as methods of delivery to affect behavioural change (Michie et al., 2011).

Rationale for Behaviour Change Wheel

The BCW is based on a synthesis of 19 existing behaviour change models across multiple academic disciplines (Michie et al., 2014). It provides researchers with a comprehensive and systematic approach to designing behavioural interventions based on understanding behaviours in context and identifying behavioural targets. Researchers are able to advance from an issue's behavioural diagnosis to an intervention through the development of the Behaviour Change Wheel (BCW) (Michie et al., 2014). This is strongly connected to behaviour change theory and correlates with respective data on intervention functions that are able to direct interventions to an environment or demographic. It also provides clear evidence in order to implement behaviour policy. The main positive aspects of the BCW and BCTs are that they enable intervention designers to take a systematic approach to implement the optimum behaviour change intervention (Atkins & Michie, 2015). This is achieved by selecting intervention components taking into account the specific population, resources available and context. The BCW has been beneficial in understanding behavioural developments in a variety of contexts, including physical activity (Webb et al., 2016) and diet (McEvoy et al., 2018). Moreover, the BCW provides researchers with step-by-step guidance for intervention development which can be clearly reported and more easily replicated.

Contents of Theoretical Domain Framework

To create the TDF framework, a collaboration of experts integrated 33 models of behaviour change, creating 128 concepts that were then grouped into 14 domains (Atkins et al., 2017; Cane et al., 2012). The 14 domains include: knowledge; skills; social/professional role and identity; beliefs about capabilities; beliefs about consequences; intentions; goals; optimism; memory, attention and decision processes; environmental context and resources; social influences; emotion; behavioural regulation; and reinforcement (Figure 1.4).

Rationale for Theoretical Domains Framework

The TDF provides a coherent frame to assess determinants of behaviour, making behaviour change theory easier to implement by researchers (Richardson et al., 2019). Mapping data to the TDF's domains allows researchers to systematically identify factors influencing behaviour and barriers and facilitators to behaviour change (Nilsen, 2015). Whilst many frameworks consider individual factors affecting behaviour, the TDF is broader in focus and includes social and environmental factors.

TDF is beneficial for various reasons, such as providing the potential for a theoretical base to implement research studies. Furthermore, it also covers possible reasons for the slow evidence/theory transition into practice by identifying the barriers to the behaviour change. Moreover, it is considered a method to progess from theory-based investigation into intervention (Atkins et al., 2017). Numerous factors prove potentially influential in this process, such as the development of an evidence-based intervention and the overall implementation being dependent on a clear evaluation of the enablers and barriers to the changes in behaviour. Accordingly, a theory-based assessment enables these specific factors to be systematically identified, which ultimately provide guidance to the implementation and evaluation strategy (French et al., 2012). Moreover, it is possible that better understanding of behaviour changes are developed through this process (Albarracin et al., 2005; Michie & Prestwich, 2010; Noar & Zimmerman, 2005).

Various theories and hypotheses have been proposed to explain different behaviours (Michie et al., 2014). Nevertheless, health professionals without a background in psychology normally find it challenging to fully comprehend these theoretical models (Michie et al., 2005). TDF supports the application of theoretical approaches to behaviour change interventions (Cane et al., 2012; Duncan et al., 2012; Francis et al., 2012), creating a process that is more accessible for these users. For example, a recent systematic review by Cowdell & Dyson (2019) indicates that the BCW seems to be sufficient for the development of health behaviour change interventions. Additionally, Richardson et al. (2019) showed that the TDF/BCW approach can be used to combine quantitative and qualitative evidence for a better understanding of behaviour change.

1.9 Effect of Health Intervention Programmes on Obesity

Obesity has traditionally been viewed as a personal problem requiring individuals to take responsibility for treatment. It was only with the global obesity epidemic that a shift to population-level preventative strategies to reach diverse groups of people occurred. However, results from large-scale studies indicate that promoting weight loss through health interventions is not straightforward. Rather, population-level change requires coordinated multi-level (individual, community and national) treatments to affect positive outcomes. Moreover, these strategies must align with the needs of targeted populations within different environments to be successful (Dyer, 1994, Sim et al., 2010).

Current National Institute for Health and Care Excellence (NICE) guidelines on the management and prevention of obesity in adults suggest that to be effective, an intervention should include multiple components, specifically a combination of nutrition education, physical activity and behavioural change (NICE, 2014). A meta-analysis of randomised controlled trials found that behavioural treatment interventions (e.g. relapse prevention, goal setting, cognitive restructuring) have a significant positive effect on adherence to weight loss programmes among adults with obesity (Burgess et al., 2016). Another systematic review of experimental studies showed that the most promising mediators for weight loss and physical activity in adults were psychological determinants such as self-efficacy, self-regulation and positive self-image (Teixeira et al., 2015).

1.10 Obesity and the Obesogenic Environment in KSA

An obesogenic environment refers to “the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations” (Swinburn & Eggar, 2002). Put more simply, an obesogenic environment promotes weight gain and inhibits weight loss. Within KSA, a complex mix of personal, socio-economic, cultural and environmental/physical design factors support or contribute to obesity. Many of these factors can be traced back to centuries old customs and religious beliefs, while others reflect more recent trends and behaviours (De Nicola et al., 2015).

Because of the complex nature of environments and the diversity of environments that people occupy, it is limiting to categorize environments as either wholly supportive of health or unsupportive of health (Stokols et al., 2003). While many dimensions of Saudi society promote unhealthful eating patterns and physical activity, this influence is not universal; however, the following discussion explicitly focuses on the environmental factors that encourage obesity.

1.10.1 The Geography and the Climate of KSA

As Figure 1.6 shows, KSA is in the Gulf region in southwest Asia. Most of the country experiences a desert climate except for the province of Asir on the southwest coast. The desert climate generates little rainfall and produces high temperatures; the summer is especially hot with an average temperature of about 45° C, although readings up to 54° C are not uncommon (Weather Online, 2020).

The country’s extreme hot weather affects people’s physical activities and habits. Outdoor physical activity is limited to relatively short seasons and activity at other times requires indoor facilities (Al-Nozha et al., 2007; AlQuaiz & Tayel, 2009). In times of hot weather, less strenuous endeavours, such as visiting malls or sitting in coffee shops, may be preferred over outdoor sports or recreation (Choguill, 2008).

1.10.2 Vision 2030 and Health Promoting Policies of KSA

KSA is considered one of the highest income countries in the world (World Bank, 2017). Despite this wealth, recent low oil prices have forced the government of KSA to implement drastic structural changes to improve the economy. For instance, crown prince Mohammed bin Salman and King Salman bin Abdul-Aziz, the rulers of KSA, developed a strategic plan called “the 2030 Vision” in order to improve the country’s status in multiple areas, such as health, education, tourism and infrastructure. In particular, the plan aims to diversify the economy by privatising health care and the education sectors (CIA, 2017). One of 2030 Vision’s major goals is to reduce the prevalence of obesity among citizens of KSA by 2030.

Several new initiatives to promote healthier lifestyles have been introduced in conjunction with the 2030 Vision plan. Some of these policies are: a) passage of a law to allow female fitness centres to open in Saudi Arabia in 2017 (Arabnews, 2017); b) introduction of physical activity classes in female public schools in 2017 (Reuters, 2017); c) government initiated quality of life programmes associated with the Vision 2030 plan that emphasize healthy lifestyle behaviours; d) a law requiring a printed notice of a meal’s calories on restaurant menus in 2019 (Arabiya Network, 2017); and e) the establishment of an excise tax of 50% on carbonated drinks and 100% on energy drinks in 2017 and the addition of a 50% excise tax on sugar sweetened beverages in 2019 (Alhareky et al., 2021, KPMG, 2019).

Whilst these policy changes may have a significant future effect on reducing obesity, it is still too early to assess their full impact. For example, studies evaluating the effect of the excise tax on sugar sweetened beverages, soft drinks and energy drinks show varying results, depending on their outcome variable. Two recent studies analysing the impact of the tax on sales volume reported a per capita reduction in purchases of soft drinks and energy drinks since the tax was implemented (Alsukait et al., 2020; Megally & Al-Jawaldeh , 2020). However, another study focusing on children’s consumption of energy drinks and soft drinks found no statistically significant change in the proportion of children consuming these beverages since the tax was implemented (Alhareky et al., 2021).

Figure 1.6: Map of KSA, adapted from CIA, 2017

1.10.3 The Religious and Cultural Characteristics of the KSA Community

The KSA is an Islamic country and religious law and custom dictate that females should be kept apart from males in all public (non-domestic) sectors. This is especially evident in the education sector. For example, private and public universities and schools are completely segregated. Female students are taught face-to-face by females alone, and male and female students are prohibited from entering one another's institutions. As employees, females and males work in separate buildings and can communicate only by virtual means or telephone, except in the medical field. Given strict sex-segregation regulations, the current study focuses on female university students only, since I am a female investigator.

Historically, sex-segregation has acted as a barrier to girls' and women's participation in physical activity. As noted previously, physical activity classes in female schools were introduced only in 2017. Moreover, until recently, there was a shortage of gender-segregated fitness facilities for women (Musaiger et al., 2013) and even today, the fees for female-only gyms are higher than for male-only gyms (as there are fewer in the marketplace). While women and girls have been granted more opportunities to participate in physical activity and sport, there are still obstacles that remain, due to longstanding gender norms that are grounded in law or social expectations (e.g., notions about acceptable dress).

1.10.4 The Built (Urban) Environment in KSA

The built environment and spatial arrangements, especially in urban areas, have played an important role in promoting obesity in KSA. Traditional urban design in Saudi cities emphasized narrow and shaded streets that supported pedestrian travel via walking and cycling as well as other community activities. However, with modernisation, cities became more crowded and densely populated. These areas expanded to include extensive road networks and separate zoning for residential and commercial areas, reducing greenery and public space for entertainment and exercise (Al-Hazzaa et al., 2007; Musaiger et al., 2013; Sidawi & Hariri, 2012). Large distances between homes and other establishments discouraged daily walking and reliance on automobiles significantly reduced physical activity levels. In recent years, municipalities around the country have begun to try and offset these conditions by creating parks, walking trails and community recreational spaces in the hope of encouraging physical activity and combating the obesity crisis.

1.10.5 Traditional Food and Physical Environments in KSA

As previously noted, KSA has experienced rapid economic growth and modernisation over the last four decades (Papandreou et al., 2008), resulting in rising standards of living and substantial changes to lifestyle factors and behaviours. Prior to modernisation, most people’s daily routines created very different experiences with food production and consumption and physical activity than exist today.

In 1950, just prior to the rapid transformation of Saudi society, approximately 20% of the country’s population resided in cities. Forty percent lived as Bedouin nomads, herding sheep, goats and camels in the desert terrain, while another 40% were widely scattered in agricultural settlements. The two groups worked together rearing livestock, and the nomads played a vital role transporting food and other goods between the agricultural areas. Whether nomads or farmers, people's daily regimens encouraged vigorous physical activity and promoted lean figures (Al Hazzaa, 2004) in both men and women (Bakhotmah, 2012).

The traditional Bedouin diet was dependent chiefly on the livestock they raised; fresh milk, butter, cheese and yoghurt were staples. In addition, wheat soups and porridge were common, and dates were a regular part of meals. Meat was eaten only on special occasions (such as feasts, weddings and visits from guests), and while families raised chickens, they were generally a source of eggs. *Hawayij* (a spice blend) was used to season food. Flat breads such as *fatir* and *kimaje* were dietary mainstays and were used at meals to scoop up other foods (Abu-Saad et al., 2001).

Today, many of the basic ingredients used in traditional Bedouin meals can be found in everyday Saudi dishes, which have grown more complex over time and have been influenced by other cultures (Heyer, 2012). Common foods include fava beans, wheat, rice, yoghurt, dates and chicken (Adam et al., 2014). Popular meals include *Kabsa*, the national dish, composed of rice cooked with lamb or chicken, vegetables and spices. Similar rice dishes include *bukhari*, *rozi*, *biryani*, or *mandi*. Wheat based foods include *harees,* a porridge-like dish cooked with meat, and *gerish*, *qorsan*, *marqooq*, and *marassia.* Dates, dried fruits and nuts, along with sweet tea or coffee, are often served as appetizers or snacks and sweet desserts finish meals.

From a nutrition standpoint, traditional Saudi food is healthful. Foods tend to be high in fibre and low or moderate in fat content. However, some dishes, especially rice-based meals such as Kabsa, are higher in carbohydrates, and desserts are often sugary and calorie dense (Al-Faris, 2017).

1.10.6 Nutrition Transitions in KSA: Fast and Processed Foods

In the past 20-30 years, food preferences have become more 'westernized' in KSA and have altered the nutritional content of diets. This 'nutrition transition' stems from socio-economic changes in Saudi society and the globalisation of food markets, which have altered consumption patterns (Adam et al., 2014; De Nicola et al., 2015). The transformation in Saudi food culture did not occur immediately but developed through the modernisation processes that followed the rise of the oil industry in the1960s.

Urbanisation spread quickly after the oil boom as new cities emerged and older ones grew in size. Demographic shifts drove this development as nomadic people and villagers left their rural communities and settled in cities for economic and occupational opportunities due to rising standards of living. While just 31% of the population in KSA lived in cities in 1960, this share rose to 49% in 1970 and 66% in 1980. Today, more than 84% of the population resides in metropolitan areas (The World Bank, 2021).

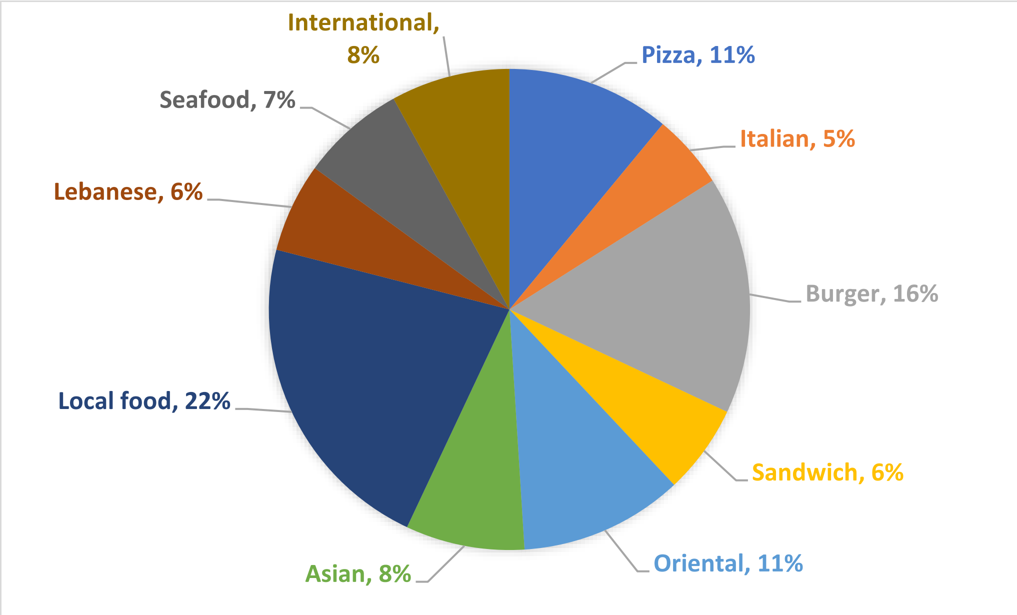
With national prosperity, the Saudi government invested significant funds in modern farming technology and irrigation systems, bringing about advances in food production, processing and distribution and increasing the country’s overall per capita food supply (Adam et al., 2014). However, even as KSA has achieved self-sufficiency in the production of some commodities, such as wheat, eggs, and milk, the country remains dependent on imports for the bulk of its food needs.

While outside food influences were present in KSA before the current period, largely due to expatriate oil workers, the Saudi population’s desire for western cuisine truly took off in the 1980s with the introduction of satellite TV and later, with the availability of the internet. Disposable income and foreign advertising joined to create an appetite for foreign products (Heyer, 2012).

As in other non-western countries, fast-food corporations successfully and rapidly penetrated the Saudi market and their advertising and influence prevailed over other restaurants and businesses (Heyer, 2012; Ritzer 1991). As of 2020, the Saudi fast-food market was dominated by US-based chains, including McDonald’s, Pizza Hut, Burger King, KFC, Starbucks, and Domino's Pizza. Successful local fast-food chains include Al Baik, Herfy, Kudu and Al Tazaj (Mordor Intelligence, 2021).

The popularity and availability of fast-food chains is evident in data collected from a KSA smartphone application used to identify local businesses. In 2013, more than a million Saudis used the application each month and the most frequent key word in searches was “restaurants” followed by “sweets,” “pizza,” and “Burger King.” Seventy-seven percent of users also searched for food establishments that delivered, reflecting a preference for dining at home in front of the television (De Nicola et al., 2015) Figure 1.7 provides an example of the most popular food searches in one month among Saudis using the application.

Figure 1.7: Top 10 Restaurants searched for using smartphone application in one month in KSA, 2013.



Source: Adapted from *Insights from Saudi Consumers* by Jeeran, 2013 in De Nicola et al., 2015. Data based on a sample of 80,000 active Saudi user of the smartphone app in October, 2013.

While food is plentiful, varied and affordable in contemporary KSA, the nutritional quality is often poor. Saudis are consuming more food that contains harmful fats, polyunsaturated fats, sugar, sodium and white flour and that has lower vitamin, protein and fibre content (Al Othaimeen et al., 2007; Naeem, 2012). The ultra-processed food that is prevalent is made from additives and industrial ingredients that are extracted or refined from whole foods. These substances include oils, hydrogenated oils and fats, flours and starches, variants of sugar, and cheap parts or remnants of animal foods (Monteiro, 2013). Ultra-processed food is harmless when consumption is limited or a part of a well-balanced diet, but its availability, low-cost and convenience coupled with pervasive and insistent advertising gives these products a commercial advantage over fresh or whole foods (Swinburn et al., 2011).

The increase in the number of international fast-food chains and the regular consumption of fatty, salty and highly processed food have contributed to KSA's current obesity epidemic (Al-Mahroos & Al-Roomi, 1999) and rise in chronic diseases, such as diabetes, hypertension, heart disease and some cancers. Other dietary changes, such as reduced intake of fruits (except for dates), vegetables and whole grains have aggravated the problem (Memish et al., 2014; Musaiger, 2017). In a study of obesity and dietary behaviours in KSA, Memish et al. (2014) found that 81% of 10,735 respondents reported eating less than three daily servings of fruits and vegetables, failing to meet WHO and the Food and Agriculture Organization's (FAO) recommendation to consume at least 400g (five portions) of fruits and vegetables per day to prevent chronic disease (Musaiger, 2017). A recent meta-analysis of nutrition studies found that eating twice the minimum recommendation of fruits and vegetables (10 servings or 800g per day) provided even greater protection against morbidity and mortality (Aune et al, 2017).

1.10.7 The Contemporary Physical Activity Environment and Physical Activity Behaviours in KSA

Besides dietary changes, there has been an increase in sedentary behaviour among the population of KSA. The change in physical activity behaviours was brought on by the same cultural and socio-economic shifts that altered the Saudi food system (De Nicola et al., 2015). While agricultural and nomadic lifestyles involved rigorous physical activity, urbanisation and mechanisation led to a marked reduction in physical activity, at work and during leisure time. For example, the widespread use of the automobile eliminated the need to expend significant energy walking to most destinations. As with change in the Saudi food system, the rise in sedentary behaviour has played a part in rising overweight/obesity and chronic disease rates (De Nicola et al., 2015).

The WHO (2020d) provides specific guidelines for weekly physical activity for adults (aged 18-64 years), including duration and intensity of exercise. However, studies indicate that many adults fail to meet these standards. El Bcheraoui et al. (2013) found that an estimated 4.5 million people (35% of the population) in KSA over 15 years of age were physically inactive, and an additional 3.4 million (26%) performed low levels of physical activity. Only 3.5 million (7%) achieved vigorous levels of physical activity, and 1.7 million (13%) met moderate levels of physical activity per week. Al Hazzaa's (2007) observational study showed that 72% of adults in KSA did not perform any form of vigorous physical activity that lasted more than 10 minutes per week. Overall, more than 40% of respondents were physically inactive, 34% were minimally active and 25% were physically active.

As noted previously, women and girls in KSA are less physically active than men due to a range of personal, social and environmental barriers (Albawardi et al., 2016; Al-Eisa & Al-Sobayel, 2012; Al-Hazzaa, 2018; Al-Mohaimeed & Elmannan, 2017; Alqout & Reynolds, 2014; Awadalla et al.; Khalaf et al., 2013; Majeed, 2015). Al-Eisa & Al-Sobayel (2012) conducted a cross-sectional study to examine the relationship between health beliefs of women of KSA (and associated psychological constructs) and physical activity. The authors found a high level of being insufficiently active (low active) among 161 respondents, with step counts in the range of 5000–7499 steps per day, a level of activity usually associated with adults 65 years of age or older (Chan et al.,2004; Miller & Brown, 2004).

Al-Eisa and Al-Sobayel (2012) also observed that women's health behaviours were associated with health beliefs, particularly health locus of control, which refers to one's beliefs about what controls health, and self-efficacy, which refers to one's ability to manage stressors and take action leading to a specific outcome. In specific, higher internal health locus of control (meaning a person believes positive health is a result of personal efforts) was positively associated with higher performance of physical activity, whilst external health locus of control (meaning a person believes that positive health is the result of outside forces) was negatively associated with it (Wallston et al., 1978). Al-Eisa and Al-Sobayel (2012) argue that these findings must be analysed within the context of the social system of KSA, which remains male-controlled, potentially leading to women's lower internal sense of control and lower self-confidence. To address this issue, the authors encouraged practitioners to empower women to take responsibility for maintaining personal and family health.

Using data from a representative national survey, Memish et al. (2014) also reported very low levels of physical activity among women, with 75% of respondents reporting little or no exercise weekly. The study further revealed differences in prevalence of obesity status (BMI) among women with different educational attainment: women with high school education had a lower prevalence of obesity than those with primary education or less. Memish et al. surmised that this difference did not reflect inconsistencies in physical activity performance between the two groups but represented healthier eating decisions made by high-school educated women of KSA, resulting in their lower obesity rates.

Elsoadaa’s (2013) study of 1,500 adult women in Makkah governorate in KSA found stark differences in obesity rates between women and women of other educational attainment. Surveys revealed that 93% of “illiterate” respondents had obesity compared with 58% of elementary/intermediate educated participants, 45% of secondary-university educated participants and 68% of post-graduate educated participants. The authors did not provide an explicit explanation for the relationship between education and obesity, although they did discuss the impact of socio-economic status on obesity, noting that less well-off people have lower access to “resources, knowledge of nutrition and health, food choices, and physical activity at work and in leisure time” (p. 861). However, Elsoadaa’s (2013) survey relied on convenience sampling, therefore some caution is required when interpreting the findings.

Albawardi et al. (2016) examined levels of physical activity and BMI of 420 female office workers of KSA. Most of the participants had obesity or overweight (58%) and were physically inactive (52%). The results showed a higher prevalence of obesity and overweight among older women, those with lower incomes and those working in the public sector. It should be noted that Albawardi et al.’s findings may not be generalizable since they were based on data from a cross-sectional study using purposive sampling.

Focusing on psychosocial determinants of obesity, Alqout and Reynolds (2014) interviewed seven women of KSA, aged 26 to 43, considering bariatric surgery. The women reported multiple barriers to weight loss, including distress, poor body image, failure to fulfil gender roles, feelings of stigmatisation, lack of social support in behaviour change efforts and obstacles accessing female-only facilities for exercise.

Collectively, these studies highlight that obesity is a critical public health concern in KSA. The evidence also shows that obesity is strongly associated with social, economic and cultural factors, impacting social groups, including women, differently. Creating programmes that effectively address these disparities will not only improve individuals’ lives but enhance community and national wellbeing.

1.11 Prevention and Management of Obesity in KSA

1.11.1 Health System Practices for Managing Obesity in KSA

In KSA, the private and public healthcare systems are under the supervision of the Ministry of Health. The public system provides close to 80% of health services, whilst the private system provides the rest (Almalki et al., 2011). Services are free for all citizens using the public health care system.

At the local level, primary health care centres (PHCC) oversee obesity management, serving as entry points into the wider healthcare system. This broader network includes secondary healthcare, specifically hospital treatment, and tertiary healthcare, which addresses obesity through surgical procedures. As mentioned earlier, Vision 2030 of KSA focuses on transforming healthcare delivery in KSA by reducing the role of the government and expanding the market-based (private) system (Al-Hanawi et al., 2019).

Approximately 14,000 individuals use the free services provided by PHCCs each year (MOH KSA, 2018). However, the centres’ physicians and nurses do not engage in obesity management (MOH KSA, 2017). Dieticians become available only after patients develop serious obesity complications, when patients are referred to secondary care centres (hospitals) for treatment (MOH KSA, 2017). Surgical interventions, such as gastric bypass, are available for patients with morbidly obesity and are managed under tertiary care. However, these procedures are not commonly performed since they are highly invasive and may result in adverse effects, such as severe malnutrition (Malinowski, 2006). Furthermore, even though medical workshops are now available to train PHCC physicians in obesity treatment (WHO, 2018), understaffing of personnel places significant pressure upon physicians, who are responsible for addressing weight problems. Al-Ghamdi et al. (2018) surveyed physicians, nurses, dieticians and health educators in five districts in Riyadh city. The study found multiple constraints to obesity treatment in PHCC, including lack of time, shortage of patient educational materials, low patient compliance and inadequate training and financial incentives for staff (Al-Ghamdi et al., 2018).

The approach countries take to treating obesity differs depending on the internal structure of their healthcare delivery systems. Figures 1.8 and 1.9 provide a contrast in how obesity is managed in KSA and the UK. In the UK, obesity management in primary care is part of a wider health management strategy (Maryon-Davis, 2005). PHCC practice nurses in the UK assume responsibility for a larger share of obesity management and treatment cases than in KSA, where GPs and PHCPs manage care (Maryon-Davis, 2005). Moreover, the health care system in the UK is centralised and better equipped to provide appropriate levels of care to the general population, in contrast to KSA. Even though obesity management in KSA is based on three tiers of care (primary, secondary and tertiary) like the UK system (MOH KSA, 2017), KSA has fewer non-medical professionals to provide support.

Figure 1.8: Weight management pathways in KSA (MOH, 2018)

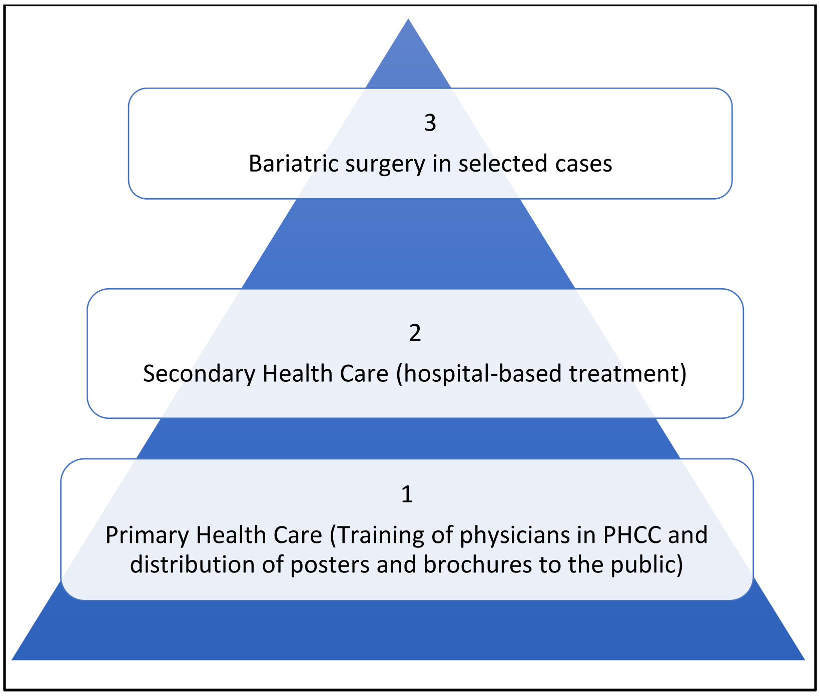
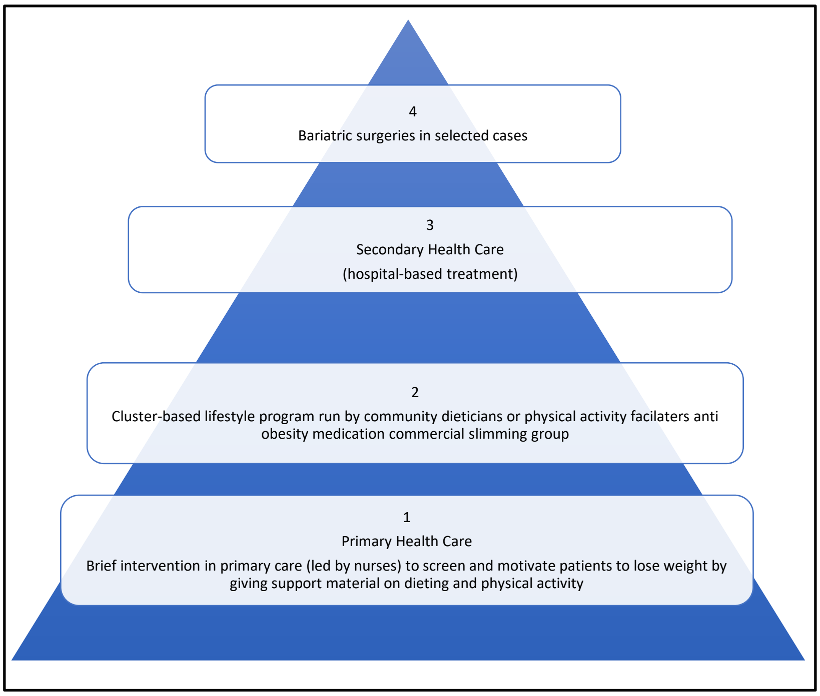


Figure 1.9: Weight management pathways in the UK, reproduced from Maryon-Davis, 2005



1.11.2 Responses to the Obesity Epidemic in KSA

In response to alarming levels of obesity, health experts and practitioners in KSA have called for strategic national action to address the crisis. Their recommendations include promoting obesity management at the primary healthcare level; building workforce capacity; and establishing public policies targeting food, healthcare and the built environment (Alghamdi et al., 2017; Al-Hazzaa et al., 2014; Al-Kadi et al, 2018; Al-Quwaidhi et al., 2014; Azzeh et al., 2017; Samara et al. 2019). Given the high rate of obesity among women, researchers have recommended creating programmes to specifically target this population. These include gender-specific health education (Al-Haramlah et al., 2015), work-based physical activity programmes (Albawardi et al., 2016), and interventions focused on self-efficacy and social support (Bajamal et al., 2017).

Despite these proposals, little attention has been paid to designing or evaluating weight interventions in the KSA weight management literature. In fact, a systematic review of the literature on physical activity in Gulf region countries

(Mabry et al., 2016) identified just six publications focusing on interventions, with two from KSA, including a quasi-experimental study focused solely on physical activity among female college students (Al-Eisa et al., 2016) and a cross-sectional study on patients in the primary health care centres in Qassim (Midhet & Sharaf, 2011). In the intervention in Qassim, practitioners were trained to educate patients on smoking, diet, and physical activity to modify behaviours, and a survey was distributed before and after the intervention to assess change in behaviour. Participants reported an increase in consumption of fruits and vegetables and a decrease in consumption of high calorie foods. Because the study did not measure patient weight but relied instead on self-reports, self-reporting bias may have affected results (Midhet & Sharaf, 2011).

Another systematic review on overweight and obesity among adults in the Gulf States (Balhareth et al., 2019) documented just seven interventions, with four in KSA (Albassam et al., 2007; Alghamdi, 2017; Midhet & Sharaf, 2011; Yar, 2008). Among these studies, one was an observational study focusing on weight management practices among females attending diet clinics in KSA (Albassam et al., 2007). Two others were conducted in primary health care centres (Alghamdi, 2017; Midhet & Sharaf, 2011), and one examined university medical students, but did not report anthropometric measurements (Yar, 2008).

Whilst the obesity crisis has required urgent response from health officials and related stakeholders (MOH KSA, 2017), it has only been in the last decade that KSA introduced national guidelines to monitor obesity management (Al-Majwal et al., 2009). In 2016, an education prevention programme was developed by the MOH to prevent child obesity in school settings. Initial efforts to address obesity among adults in KSA have involved the distribution of brochures on obesity management in hospitals and shopping malls. However, these initiatives are mainly focused on increasing knowledge rather than supporting behaviour change more broadly. As a result, they do not meet national guidelines on obesity treatment which specify that behaviour change strategies are necessary in the prevention and management of obesity long-term (NICE, 2014; MOH KSA, 2017).

Currently, there are no weight loss interventions targeting students with overweight/ obesity in KSA. Therefore, there is an urgent need to develop, implement, and evaluate obesity prevention and management programmes tailored for different stages of the life course, together with parental and/or family involvement if needed for a multifaceted approach (MOH KSA, 2017). As discussed previously, a sustainable multi-component programme should include physical activity and nutrition education components with support for behaviour change, which may positively impact obesity management (Chang et al., 2017; MOH KSA, 2017).

1.12 Obesity and Obesogenic Behaviours among University Students

Early adulthood is recognized as a vulnerable time for weight gain. This life stage, which primarily includes individuals 19-25 years old, is marked by a series of life transitions, such as graduating high school and starting college. Young adulthood involves rapid adjustment to unfamiliar physical and social environments. It also involves critical psychosocial development and identity formation, leading to greater independence, sense of self and autonomy in decision-making (Arnett, 2010; Gall et al., 2000; Nelson et al., 2008). For university students, newfound independence and academic demands (Silliman et al., 2004) combine to limit physical activity (Von Ah, 2004) and produce unhealthy eating habits (Anderson et al., 2003), such as skipping meals and overconsuming fast food (Niemeier et al., 2006; Von Ah, 2004).

Given that poor diets and sedentary behaviours are common, weight gain is an issue for up to two-thirds of university students (Vadeboncoeur et al., 2015), particularly during their first year at university (Crombie et al., 2009; Crombie et al., 2012; Economos et al., 2008; Gropper et al., 2009; Gropper, 2012; Gunes et al., 2012; Jung et al., 2008; Lloyd-Richardson et al., 2009; Pliner & Saunders, 2008; Smith-Jackson & Reel, 2012; Yakusheva et al., 2011). For example, studies show that first year university students' weight is typically higher at the end of the academic year than at the time of enrolment (Levitsky et al., 2004; Mihalopoulos et al., 2008). Overall, students tend to gain anywhere from 1.8 - 4.1 kilograms in their first 2 years of university (Anderson et al., 2003; Gillen & Lefkowitz, 2011; Lewis et al., 2000; Racette et al., 2005; Strong, 2008).Some research has also explored changes in BMI among university students. In general, findings are consistent with those for weight, showing small increases in

BMI as students transition to university life (Levitsky et al., 2004; Morrow et al., 2006; Provencher et al., 2009).

Emerging adulthood is a critical time for establishing healthy behaviours that persist over the life course (Reed & Philips, 2005). Consequently, students who engage in unhealthy behaviours and have overweight/obesity are more likely remain so into adulthood (Srinivasan et al., 1996) and develop lifestyle-related diseases, such as T2DM, cardiovascular disease, some cancers and hypertension (Field et al., 2001). In addition, weight gain appears to be more prevalent among young adults than other age groups (Nelson et al., 2008), making it crucial to create programmes that promote weight management for at-risk university students.

Despite the urgency, as noted earlier, very few international studies have focused on interventions for university students with obesity, compared with studies on children and older adults (Gary et al., 2006). Whilst prior research has focused on the causes and correlates of obesity among male and female university students in KSA, as far as I am aware, no studies have implemented and evaluated lifestyle behaviour interventions among this population.

1.12.1 Prevalence and Risk Factors for Obesity Among University Students

Overweight and obesity prevalence is high among university students in high-income countries (Peltzer et al., 2014). Whilst developed countries are focusing more on young adults as an at-risk population for obesity, in low-income countries, obesity among all age groups has only become a public health issue in the last 10-15 years. Studies among university students in low- and middle-income countries show significant obesity/overweight rates, with prevalence ranging from a low of 10% (Nigeria) to a high of 59.4% (Egypt) (Pengpid & Peltzer, 2014; Peltzer et al., 2014). Peltzer et al.'s (2014) cross-sectional study of students from 22 universities in 22 low and middle-income countries found that 22% had overweight or obesity.

The causes of obesity among university students in high, low- and-middle income societies are multifactorial. They include individual, social and environmental determinants of obesity such as: socioeconomic status, lack of social support, food beliefs, lifestyle behaviours such as poor diets and physical inactivity, time constraints, social media use, smoking and poor mental health (Deforche et al., 2015; Nelson et al., 2008; Pengpid & Peltzer, 2014; Radzi et al., 2019; Sparling, 2007; Stok et al., 2018). In Peltzer et al.’s (2014) a multi-country study, younger age, being born in a higher income country, physical inactivity, consciously avoiding fat and cholesterol, current tobacco use, and childhood physical abuse were positively associated with overweight or obesity in men. Among women, older age, being born in a higher income country, frequent organized religious activity, consciously avoiding fat and cholesterol, post-traumatic stress symptoms and physical childhood abuse were positively related with overweight or obesity. Peltzer et al. (2014) suggest that self-reporting of behaviours may explain the study’s unexpected positive association between obesity and students’ conscious effort to avoid fat and cholesterol, since actual diets may not correspond with survey answers. They also speculate that the finding may reflect the tendency of overweight or obese students to report adopting healthier food related behaviours for weight loss. Ultimately, Peltzer et al. concluded that causality between variables cannot be established since the study design was cross-sectional.

1.12.2 Factors Influencing Healthy Food Related and Physical Activity Behaviours at Universities: A Socio-ecological Approach

The socio-ecological model addresses behaviour change at multiple levels and considers the inter-relationship between people and their sociocultural, policy and physical environments. The model identifies five levels of influence on health behaviour and discusses the reciprocal relationships between them. The five levels in the socio-ecological model include: intrapersonal, interpersonal, organizational, community/environmental, and public policy (McLeroy et al.,1988; Stokols, 1996). These are detailed in Figure 1.10.

Figure 1.10: Socio-Ecological Model demonstrating the multiple levels of influences on behaviour

The socio-ecological model can be adapted to describe the relationship between the individual (student) and their environment within the university system (Deliens et al., 2014; Sogari et al., 2018). According to Sogari et al. (2018), there are three levels that directly influence behaviour in university systems: 1) intrapersonal factors – the personal, psychological characteristics specific to the individual student, 2) interpersonal processes — the student's social relationships with family, friends, peers, university staff and educators, 3) the university environment and student life, including formal and informal policies and rules, spatial arrangements and physical design and so on. While they are not explicitly a part of Sogari et al.'s model, it is reasonable to assume that external sources, including macro level public policies and radio and television marketing and advertising, impact on-campus behaviour.

The international literature lists multiple factors at the intrapersonal, interpersonal, and university environment and student life levels impeding or enabling students' healthy food related and physical activity behaviours. The broad range of factors clearly demonstrates the complexity of influences on health-related behaviour in this population. At the intrapersonal level, the main barriers affecting healthy eating behaviours include lack of motivation to prepare food, food preference (taste), differing conceptions of "healthy" foods, poor eating habits (e.g., irregular meals, snacking or consumption of junk food), lack of self-discipline, state of mind/stress eating, and lack of food preparation knowledge or skills (Allom & Mullan, 2014; Ashton et al., 2017; Deliens et al., 2014; LaCaille et al., 2011; Levitsky et al., 2004; Sogari et al., 2018; Van der Horst et al., 2011).

At the interpersonal level, lack of parental control over food habits, lack of social support, and pressure from friends and from the media to consume unhealthy foods are common barriers to healthy eating behaviours (Deliens et al., 2014; Sogari et al., 2018). Finally, at the university environment and student life level, barriers to healthy food related behaviours include: "all you can eat" dining halls that encourage overeating; lack of healthy food options at campus dining facilities or on campus meal plans; the cost of healthy food, lack of time to prepare nutritious meals due to academic and other college life demands, and living on and off campus (Ashton et al., 2017; Deliens et al., 2014; LaCaille et al., 2011; Levitsky et al., 2004; Sogari et al., 2018).

In terms of physical activity, intrapersonal level barriers include: lack of motivation, willpower and energy to exercise, not knowing how to use gym equipment and poor body image/not liking to exercise in front of others (Allison, et al., 2005; Daskapan, et al., 2006; LaCaille et al., 2011; Menon, 2008; Phillips et al., 2009). Social constraints on physical activity involve pressure from family to prioritise academic success over exercise and lack of social support from friends (Arzu et al., 2006; Gómez-López et al., 2010). Lastly, university environment and student life barriers include: lack of time to exercise due to school-related responsibilities (e.g., exams), cost of fitness equipment, classes and facilities and lack of campus fitness facilities (Allison, et al., 2005; Ashton et al., 2017; Daskapan, et al., 2006; Gómez-López et al., 2010; Menon, 2008; Phillips et al., 2009).

1.12.3 Eating Habits and Physical Activity Among University Students of KSA

In KSA, a number of studies have highlighted negative behaviours associated with diet and physical activity among university students (Alfhaid et al. 2017; Al-Otaibi et al., 2013; Khalaf et al., 2015). As in other countries, students are more likely to gain weight at university and increase their risk of developing disease (Al Qauhiz 2010; Al-Rethaia, 2010). Across studies, students have reported insufficient intakes of fruit and vegetables; excessive snacking; skipping meals; and consumption of high amounts of fat (Almutairi et al., 2018; Al-Otaibi, 2013;

Alqahtani, 2016; Alqahtani, et al., 2019; Al-Rethaiaa et al., 2010). In addition, studies report physical inactivity rates for male and female university students in KSA as high as 60% (Alfhaid et al. 2017).

Although studies are somewhat limited, existing evidence suggests that female young adults and university students have higher rates of physical inactivity than their male peers, as discussed in section 1.10.3. For example, the national prevalence of insufficient levels of physical activity in the population of KSA aged 15–24 years was 42% in males and 76% in females in 2013 (Moradi-Lakeh et al., 2016). However, as Alzamil et al. (2019) point out, only a few studies on physical activity among university students have used validated comprehensive physical activity questionnaires, raising concerns about the reliability of findings. Alzamil et al. (2019) conducted a cross-sectional study of 456 females attending health science colleges of King Saud University. Using a validated self-report instrument, the authors found that close to half of the university's females were physically inactive. When respondents were asked why they did not exercise regularly, the most popular answer was lack of time (71%). Moreover, most females exercised at home or alone at no set time during the day. In a cross-sectional study on lifestyle behaviours in health and non-health colleges of KSA, Almutairi et al. (2018) found that males were more likely than females to engage in physical activity. The authors attributed this difference to cultural norms, including restrictions on physical activity for females in KSA, such as bicycle riding, which is culturally not accepted for women.

Alhakbany et al (2018) used a validated and comprehensive physical activity questionnaire in their cross-sectional study and found that 50% of female university students were physically inactive (activity energy expenditure <600 metabolic equivalent minutes per week). Females who were physically active also had a significantly higher intake of vegetables and fruits and lower chocolate and candy consumption than physically inactive students. Whilst the study found that physical activity was positively associated with some of the lifestyle habits of university females, overweight/obesity was not associated with physical activity or dietary habits. Alhakbany et al. (2018) suggest that reverse causation is one explanation for these results, with females with overweight/obesity engaging in physical activity and consuming low-calorie diets as a means to lose weight.

Alqahtani et al. (2019) conducted a cross-sectional study with a sample of 200 female university students in Riyadh, creating two groups, with obesity and healthy weight (each with 100 students) to compare lifestyle behaviours and weight management. In contrast to Alhakbany et al (2018), the authors found significant differences in weight management behaviours between the two groups (Alqahtani et al. 2017). In terms of physical activity, females in the healthy weight group reported higher levels of moderate physical activity than females in the group with obesity (33% versus 19%, respectively). Results for dietary practices showed no difference in caloric intake between the two groups; however, fat intake was greater in the group with obesity. Snacking was also more common. In terms of food choice, daily consumption of dates and salad dressing, rich in fats, calories or sugar, were significantly higher in the with obesity group than in the healthy weight group.

Alqahtani et al. (2019) also identified different weight management practices among females. In their study, 93% of respondents with obesity reported engagement with methods to lose body weight. However, most of the practices reported by participants were unhealthy and less likely to be effective long-term, including skipping meals (59%) or fasting for long periods of time (37%). These findings suggest weight management interventions providing nutrition education and healthy behaviour modification could be helpful in addressing obesity among university students.

The conflicting results from these studies suggest that more information is needed concerning the complex relationships between obesity/overweight and lifestyle risk factors among female university students in KSA. Once again, given some differences in risk factors, these findings suggest that gender considerations should inform university-based health promotion programmes.

1.12.4 Obesity Intervention Studies Targeting University Students

Despite several epidemiological studies with university students in KSA (Al-Rethaiaa et al., 2010; El-Qudah et al., 2012; Hamam et al., 2017), there have been no intervention studies on weight loss promotion for university students (Willeboordse et al., 2016) and adults (Alghamdi, 2017). A recent meta-analysis assessing the effectiveness of lifestyle-related interventions for weight management among adults found only six studies conducted in Arab countries and judged them ineffective. The authors attributed the limited impact of lifestyle-modification programmes to poor methodologies and the absence of expert clinical supervision during the interventions (Kreidieh et al., 2018).

In contrast, accumulating evidence from intervention studies outside of KSA indicate that weight loss programmes have been successful for students attending universities and colleges, particularly multimodal strategies (Grim et al., 2011; Plotnikoff et al., 2015). For example, Grim et al. (2011) conducted a quasi-experimental, three arm study to compare a 10-week web-based physical activity course with an in-person physical activity course and a health course. The goal of the web-based intervention was to promote vigorous physical activity and change outcome expectancies (anticipated consequences of a behaviour) and behavioural constructs, such as self-regulation (ability to manage behaviours to achieve goals) and self-efficacy (confidence in performing a behaviour). The authors found that the intervention, which included lectures and three exercise sessions per week, increased physical activity and positively impacted self-regulation and outcome expectancy.

Belogianni & Baldwin (2019) conducted a “systematic review of systematic reviews” to evaluate their methodological quality and overall effect. The authors undertook a more rigorous assessment to address previous difficulties synthesizing and interpreting the results of health promotion interventions, given differences in design, measures and outcomes. After evaluating eight systematic reviews and meta analyses, comprising 122 individual studies, Belogianni & Baldwin determined that combining different modes of interventions (e.g. online, face-to-face, environmental) may be a promising strategy for weight management. They also stressed that interventions incorporating behavioural theory techniques appeared to have a greater effect on behaviour change than interventions without these techniques, strengthening support for combining behaviour change with other modalities in weight loss promotion.

Based on this evidence (and supplementary evidence discussed previously) as well as the high prevalence of obesity among university students, especially females, it is important to target this population by designing and implementing lifestyle-modification programmes that incorporate diet, physical activity and behaviour change components.

1.13 Medical Research Council (MRC) Framework

Complex interventions consist of multiple components interacting with one another and are commonly used in public health interventions to address weight management and other public health issues. Given the dynamic nature of complex interventions, researchers should take numerous factors into account when conducting them, including the range of interacting components between the intervention and control group; the range of behaviours that are essential for the researcher who delivers the intervention and for the participants who receive the intervention; number of targeted groups; variability of outcomes; and problems in the implementation of the intervention (Craig et al., 2008).

There are several methods to develop complex interventions that address these factors (as discussed in section 1.8.4). A recent 'framework of actions for intervention development' to improve health considers is based on a review of many of these methods/frameworks (O'Cathain et al., 2019). This approach views intervention development as an ongoing and engaged process and consists of eight categories of approach to developing an intervention. These include: 1) creating an equal partnership with the people who will use the intervention to inform decision-making throughout the development process; 2) centring the intervention around the experiences of the target population; 3) basing the intervention on published research evidence and existing theories; 4) ensuring that the intervention can be implemented and used in the real world; 5) testing intervention components to select those that are most efficient; 6) establishing a phased and systematic approach to intervention development; 7) constructing an approach to fit the specific intervention; and 8) combining existing approaches to intervention development.

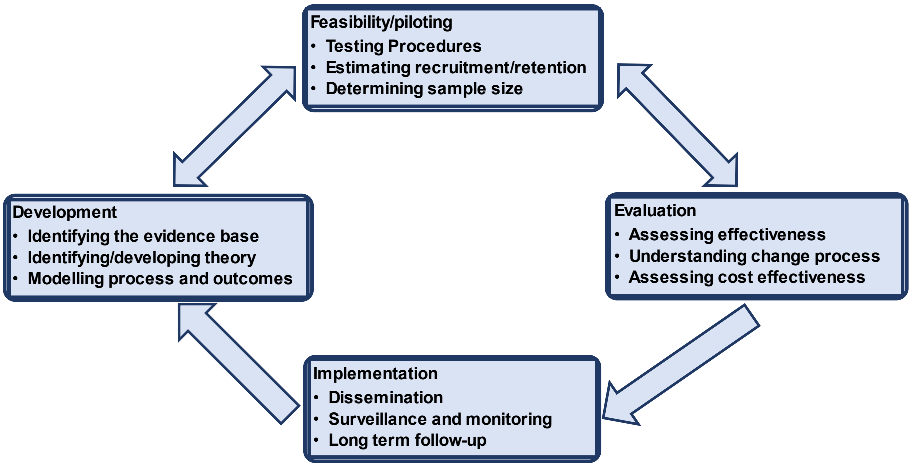
A previous section (1.8.5) compared generic intervention development frameworks to the Behaviour Change Wheel (BCW) which was designed to address their omissions and limitations (Michie et al., 2011). For my research, I used one of the frameworks mentioned in the comparative discussion and commonly employed by investigators developing and evaluating complex interventions: The Medical Research Council (MRC) framework (Craig et al., 2008). In this approach, interventions must be developed following a systematic approach, drawing on the existing literature and related theory and then cautiously tested using a step-by-step method.

Intervention development models can be combined to produce more effective results, and in this thesis, the design and implementation of the intervention is derived from the MRC Framework and the Behaviour Change Wheel. In general, the MRC framework provided the broad scaffolding to develop the intervention (i.e. what steps to follow), and the BCW pointed to the specific mechanisms required to drive behaviour change. The interplay between the MRC Framework and BCW in developing the BHL programme is discussed in Chapter 5.

The MRC framework for complex interventions describes the four main stages of the development and evaluation process. These are: 1) development, 2) feasibility/piloting, 3) evaluation and 4) implementation.

Each stage is shown in figure 1.11 (Craig, et al., 2008).

Figure 1.11: Stages of MRC framework (Craig et al., 2008)



Stage One: Development

The first stage of the MRC framework focuses on developing the complex intervention and involves three steps. The three steps are as follows:

***Step 1: Identifying the available evidence base*: ** The first step in developing a complex intervention is to identify existing literature on similar interventions as well as the methods used to assess them. If there is not a current systematic review available, then such a review must be conducted and updated as the assessment moves forward. This step is important because there must be the anticipation of a positive result before the intervention is undertaken (Craig et al., 2008).

Step 2: The Identification and Development of Appropriate Theory

At the start of development, a complex intervention's rationale, expected outcomes and means of change may be unclear. Thus, an important preliminary task is to gain theoretical knowledge of the possible change process by making use of existing evidence and theory together with new primary research, if needed. This step should be followed when developing an intervention or evaluating an existing intervention (Craig et al., 2008).

Step 3: A Demonstration of the Process and Outcomes

Useful information concerning the design of a complex intervention and evaluation can be attained by modelling the intervention before performing a large-scale evaluation. This may require a series of studies to improve the design before undertaking a thorough evaluation. Another helpful approach is to conduct an economic evaluation before a thorough evaluation, which may uncover potential weaknesses or indicate that a large-scale evaluation is not necessary (Craig et al., 2008).

Stage Two: Feasibility/Piloting

Evaluations are regularly facing many challenges, including problems of acceptability, compliance, intervention implementation; recruitment and retention, and smaller than anticipated effect sizes that could have been predicted using pilot tests. To address these issues, the second stage of the MRC framework includes three steps: testing the methods; estimating the retention rate; and determining the sample size. This is accomplished by implementing a pilot. However, the pilot does not need to be a full-scale model of the final evaluation; it merely needs to analyse issues recognized during the development stage.

Findings from a pilot study should be considered carefully when deciding the numbers necessary for scaling up the evaluation. Indeed, effects and response rates may differ when an intervention is implemented across a multiple setting (Craig et al., 2008).

Stage Three: Evaluation

The third stage of the MRC framework is evaluation. Evaluation approaches differ depending on the specific conditions and concerns of a study. The researcher should be aware of the range of designs for interventions and choose one based on the study's characteristics, anticipated effects and potential bias (MRC, 2007). Randomisation is the best method for preventing selection bias (Higgins & Green, 2008).

Stage Four: Implementation

The final stage includes full scale implementation of the intervention (Craig et al., 2008). Researchers should decide which outcomes are key and which are less important and consider how they will manage various outcomes in the analysis. One primary outcome and a handful of secondary outcomes are best suited to statistical analysis, although these may not reflect the most appropriate use of the data or provide a fitting assessment of the success of an intervention with effects across multiple domains. It is also vital to determine which sources of variation in outcomes are important and to prepare for analysis of the relevant subgroups. After the study's completion, long-term follow up may be desirable to determine whether short-term changes are maintained.

1.14 Conclusion

This chapter has presented contextual information on the prevalence and aetiology of obesity in general, in KSA and among female and male university students. The next chapter will discuss the rationale, aims and methodology of this thesis.

Chapter 2: Rationale, Aims and Methodology

2.1 Introduction

This chapter provides an overview of the rationale, aims and methodology of this thesis. It also describes the circumstances that prompted a change in direction for my thesis in 2020. This shift involved substituting semi-structured interviews exploring the impact of a piloted programme to replace the planned randomised controlled trial (RCT) to assess the effectiveness of a weight management programme (based on previous research contained in this thesis). Because the early version of the weight management intervention was assessed via a feasibility study, this thesis includes a protocol for the RCT based on evidence from this research and the methods for conducting the planned RCT.

2.2 Rationale for Research among Female University Students

As discussed in the previous chapter, early adulthood (19-25 years) is a life stage that gives rise to circumstances and challenges that make weight gain more likely (Fedewa et al., 2014; Gropper et al., 2012; Nelson et al., 2008). It is a transition period to developmental growth and lifestyle change, including reduced physical activity (Gordon-Larsen et al., 2004), increased independence and heightened autonomy in decision-making (Nelson et al., 2008). During this phase, university students often struggle to maintain a healthy diet and regular physical activity (Cluskey & Grope, 2009). Targeting university students for health promotion is therefore essential to address these challenges, particularly since emerging adulthood is a critical period for developing life skills and cognitive beliefs, such as self-efficacy. Students who adopt healthy lifestyle habits during university years are more likely to maintain these behaviours long-term (Nelson et al., 2008). However, there are limited weight management studies on this vulnerable age group compared to research on children and older adults with obesity (Gary et al., 2006). In the Kingdom of Saudi Arabia (KSA), no evaluation of lifestyle modification interventions for university students has been conducted (Kreidieh et al., 2018). Given the high levels of obesity among college students, especially female students, with obesity rates up to 48% (Al Qauhiz, 2010), there is an urgent need to design and assess weight management programmes targeting this population.

2.3 Significance of the Research

This research study fills the gap in existing literature on obesity management to promote weight loss and healthier lifestyles among female university students in KSA. The research provides preliminary evidence on the use of a multicomponent approach which integrates diet and physical activity with the support of behaviour change techniques (BCTs). The design and assessment of this research recognizes factors related to Saudi culture, religion and language. This information helped to develop, pilot and refine a weight management programme titled Better Healthy Lifestyle (BHL) to reflect eating and physical activity patterns shaped by social norms and culture of KSA.

2.4 Main Research Question

The original intent of this thesis was to develop and design a weight management programme titled Better Healthy Lifestyle (BHL) targeting female university students in a manner consistent with the culture and norms of KSA. Development of the programme was based on the Medical Research Council (MRC) framework applying a systematic eight step approach and using the Behaviour Change Wheel (BCW), Theoretical Domains Framework (TDF) and specific Behaviour Change Techniques (BCTs) to promote healthy food related and physical activity behaviours. The final research step was to going to assess the programme's effectiveness in a large-scale randomised controlled trial (RCT). Based on this agenda, my original research question was:

1. Does a multicomponent weight management intervention, conducted at a university in Riyadh, KSA, increase weight loss among female participants who are overweight (BMI ≥25kg/m^2) or obese (BMI ≥30kg/m^2) compared with a control group of students who did not participate in the intervention?

Unfortunately, the final stage of the original plan became impracticable after the COVID-19 pandemic in spring 2020 and the decision of the government of KSA to impose a lockdown in March 2020. Under the government's COVID restrictions, schools, shops, restaurants and other facilities were closed and inessential travel was banned, effectively confining residents to their homes for most or all of the day. At the time of the lockdown, I had completed all the research stages of this thesis except implementation of the multicomponent RCT. These earlier research stages included: 1) a systematic review of the effectiveness of weight management interventions for female university students, 2) a focus group study on barriers and facilitators to healthy eating and physical activity for female university students, 3) design of the intervention and 4) a feasibility study of the proposed intervention.

As an alternative to the RCT, I made the decision to explore the impact of the intervention in the feasibility study using phone interviews with the pilot's participants. The additional questions for this thesis thus became:

2. What are participants' perceptions of changes in their dietary or physical activity since the intervention?
3. What do participants perceive as barriers and facilitators to maintaining healthy food related and physical activity behaviours after the intervention?
4. What do participants perceive as barriers and facilitators to maintaining healthy food related and physical activity behaviours during the COVID-19 lockdown?
5. What do participants perceive as the most and least valuable aspects of the intervention?

2.5 Research Aim

The original aim of this research study was to develop and implement a theory- and evidence-based public health weight management intervention for female university students in KSA and assess its effectiveness via an RCT. However, as mentioned above, the COVID-19 pandemic made this impossible and instead, after developing and piloting the intervention, I conducted one-year follow-up interviews with participants of the feasibility trial to investigate their experiences maintaining healthy food related and physical activity behaviours. As a result, the main aim of the modified study became to develop, pilot and refine a theory- and evidence-based public health weight management intervention for female university students in KSA. I plan to conduct an RCT of the refined intervention at a future date.

2.6 Objectives and Scope of Research

This thesis comprises six stages that provide comprehensive information to develop a suitable weight management intervention (BHL) for female university students in KSA. Each stage matches the phases of the MRC framework. These stages, their objectives, and the chapters in which they are discussed are described below:

The first two stages of my study (systematic review, focus group discussions) were conducted to inform the development of the BHL programme (stage three of my study) and followed the MRC framework, particularly the development stage. The fourth (feasibility trial) and fifth (semi-structured interviews) stages of my study assessed the feasibility and the effectiveness of the intervention and explored the long-term impact of the intervention to meet the second (feasibility) and third (evaluation) stages of the MRC framework (Figure 2.1). Originally, I planned to meet the implementation stage of the MRC framework (stage 6 of my planned study), but this was not possible due to the COVID-19. However, the methods for full scale implementation of the intervention are described in this thesis (Chapter 9).

Each research stage and its aims are described below:

1. **Stage One: Systematic Review (Chapter 3)**
   To identify and evaluate available evidence in the literature on the effectiveness of weight management interventions for female university students.

2. **Stage Two: Focus Group Discussions (Chapter 4)**
   To identify the barriers and facilitators to healthy lifestyle behaviours (healthy food related and physical activity) and enablers and barriers to

attending sessions of a proposed weight loss programme among female university students in KSA. These insights helped to devise the BHL intervention that was built on existing knowledge about lifestyle modification programmes for female university students, whilst focusing on specific cultural influences of KSA on weight loss for this population.

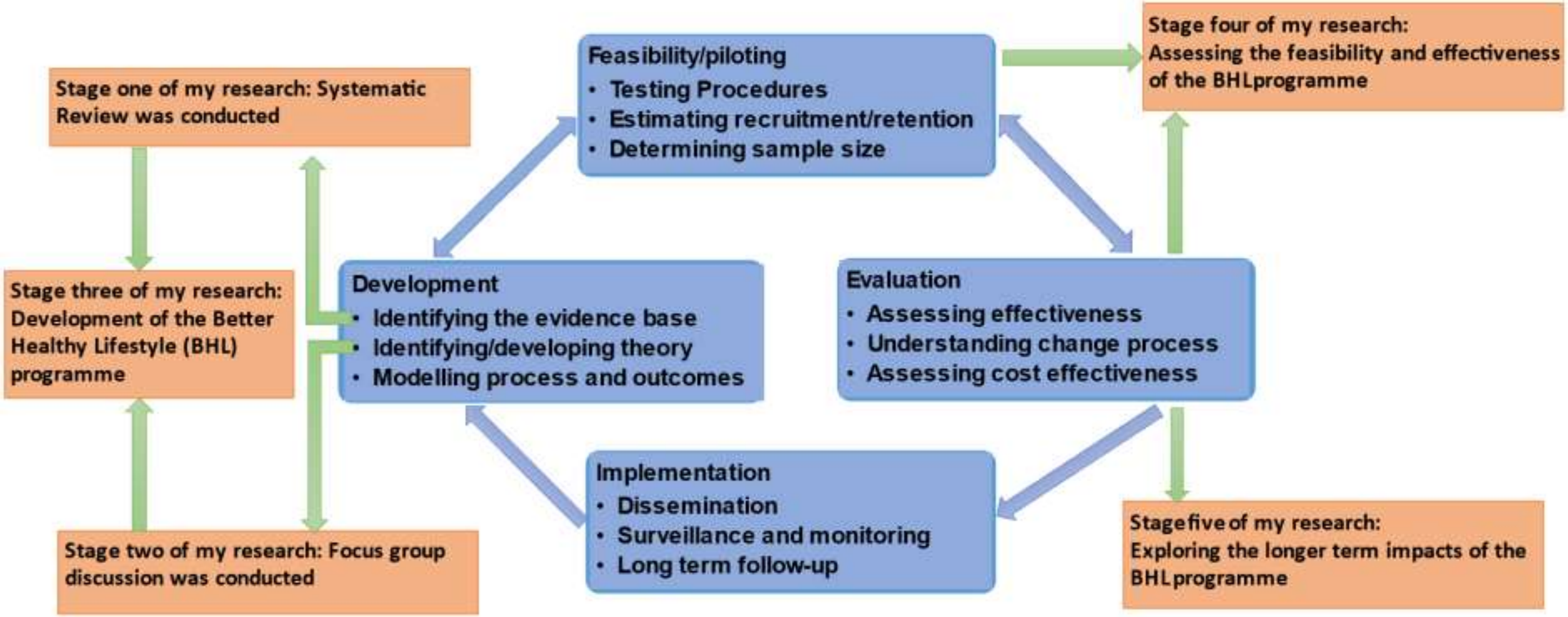
3. **Stage Three: Design a multi-component programme (Chapter 5)**
   To identify and incorporate findings from the above two stages to design a multidimensional weight loss programme that included nutrition education, physical activity and behaviour modifications tailored to female university students in KSA and based on the Medical Research Council (MRC) framework, using the Theoretical Domains Framework (Cane et al., 2012; Michie, et al., 2005) and the Behaviour Change Wheel approach (Michie et al., 2011).

4. **Stage Four: Feasibility trial of the intervention (Chapter 6)**
   i) To evaluate the time needed to deliver the weight loss sessions in order to determine an appropriate timeframe for the intervention before implementing a full-scale programme.
   ii) To assess the feasibility of the methods used in the trial.
   iii) To evaluate the acceptability of and compliance with the weight loss intervention among a sample resembling the planned target population.

5. **Stage Five (modified): Telephone interviews (Chapter 8)**
   i) To evaluate the acceptability of the weight loss intervention implemented in the feasibility trial, focusing on facilitators and barriers to weigh loss maintenance.
   ii) To assess how the COVID-19 lockdown impacted weight loss maintenance behaviours.
   iii) To determine the most and least helpful aspects of the programme.

6. **Stage Six: Modification of the BHL programme and methods for the implementation of potential RCT (Chapter 9)**
    i) To further enhance the BHL programme using findings from the feasibility trial and interviews.
    ii) To detail methods for the implementation of the RCT.

Figure 2.1: Stages of development of a theory and evidence-based public health weight management intervention for female university students in the Kingdom of Saudi Arabia based on the MRC framework (Craig et al., 2008)



2.7 Summary of Research Methods

This is a mixed method research that consists of both qualitative and quantitative methods. These methods are discussed in the sections that follow.

2.7.1 Qualitative Methods

Qualitative research involves the study of phenomena in their natural settings in order to obtain a rich understanding of how people make sense of social problems or relations (Denzin et al., 2006; Esterberg, 2002). This emphasis on context and detail generates a holistic account that emphasizes the thoughts, feelings, and experiences of research participants, often revealing diverse perspectives (Tong et al., 2007). According to Braun and Clarke (2013) the qualitative research paradigm rejects the opinion that there is one true version of reality but maintains that there are multiple constructed realities that are situationally dependent. Consequently, knowledge is produced within the research context, including the context of data generation, as well as the broader socio-political, cultural, and economic environment.

In qualitative research, the investigator is considered the instrument of data collection (Denzin & Lincoln, 2003), gathering information via interviews, participant observation, focus groups and other engaged methods. This approach contrasts with quantitative research in which data are collected through surveys or other instruments which distance the investigator from research participants. Due to close involvement with participants, the qualitative researcher gains an insider perspective on the research question, allowing her to identify issues or themes overlooked in positivist research and permitting a multidimensional description of research findings. This subjective role requires reflexivity and constant questioning of findings rather than taking results at face value (Braun & Clarke, 2013). Despite this awareness, the qualitative investigator's deep engagement in the research experience can complicate data interpretation due to researcher bias, an issue that will be discussed later in this thesis.

This thesis includes two qualitative studies: 1) focus group discussions with female university students on barriers and enablers to healthy lifestyle behaviours and to healthy lifestyle programmes (Chapter 4); and 2) semi-structured interviews with Better Healthy Lifestyle (BHL) programme participants focusing on post-intervention weight loss maintenance experiences (Chapter 8). In both cases, the qualitative approach was critical to gaining valuable insights for effective intervention planning. To date, there has been minimal research on healthy lifestyle behaviours among female university students in KSA and what exists is exclusively quantitative in nature. The current qualitative studies explore this topic in-depth, yielding rich first-person insights from the target population to complement limited quantitative work. Moreover, the focus group discussions and interviews produce narratives that highlight the social dimensions of food and physical activity behaviours. Understanding how these practices are shaped by social relations and social processes is essential to designing interventions that are sensitive to local cultures and contexts.

Each qualitative method has its advantages and disadvantages and is appropriate for certain research questions or purposes. To explore enablers and barriers to healthy lifestyles and healthy lifestyle programmes, I used focus groups; these typically involve semi-structured and/or open-ended group discussions among four to 12 individuals exploring certain topics (Tong et al., 2007). In general, they are facilitated by an engaged researcher who manages the discussion to collect data (Morgan, 1996). Focus groups are appealing because they are a quick and convenient way to explore multiple opinions on a topic (Denscombe, 2007) so that an intervention can be better tailored to a target population. More important, focus groups offer unique value compared to other methods because they foster interaction between group members, creating a synergistic process that encourages discussion and debate. This back and forth may yield greater breadth of information than other methods (Wilkinson, 1998), improve data quality (McLafferty, 2004), and provide a good fit for guiding intervention design (Ayala & Elder, 2011).

To assess the impact of the BHL programme, I used semi-structured interviews to generate accounts highlighting individual differences in the weight loss maintenance experience in order to identify factors facilitating or hindering behaviour change (Penn et al., 2008). I selected the semi-structured format, rather than unstructured or structured, because it is guided by an interview protocol, which incorporates research questions, but remains flexible, allowing follow-ups and probes to more deeply explore participant thoughts, feelings and beliefs (DeJonckheere & Vaughn, 2019). The semi-structured interview is often used in qualitative research in the public health field (Trigueros et al., 2017).

2.7.2 Trustworthiness and Rigour

Quality and rigor of the qualitative research (focus groups and semi-structured interviews) was assessed using Lincoln & Guba's (1985) notion of trustworthiness. Trustworthiness comprises four criteria: 1) credibility, referring to confidence in the a study's findings; 2) transferability, referring to the findings applicability in other contexts; 3) dependability, referring to whether the research process and findings can be repeated; and 4) Confirmability, which refers to the extent of researcher bias. For a detailed discussion about the trustworthiness of this thesis's qualitative data, please see Chapter 4.

2.7.3 Quantitative Methods

Quantitative research stresses a positivist approach to data collection and interpretation, holding that objective knowledge is knowable using observation and measurement. Findings in this kind of research are usually quantifiable and based on mathematical/statistical analysis of primary or existing data. In quantitative studies, the researcher remains independent from the study to keep the research "value-free" (Onwuegbuzie & Leech, 2005, p. 271). To collect data, the researcher uses instruments such as questionnaires, tests, and experiments. Later, the data are analysed to generalize findings to particular (sub)populations to explain specific phenomena (Babbie, 2010; Muijs, 2010). Positivist research generally takes a deductive approach to research, generating and testing hypotheses, as opposed to qualitative work which tends to adopt an inductive method (Crowther & Lancaster, 2008).

Feasibility studies are conducted to prepare for a future comprehensive randomised controlled trial (RCT). They aim to generate insight into several aspects of an intervention, including acceptability of procedures, participant recruitment and retention rate and calculation of suitable sample sizes. The UK Medical Research Council (MRC) framework for designing and evaluating complex interventions explicitly recommends feasibility and pilot studies to pinpoint problems before they occur during the RCT stage of a complex intervention (Craig et al., 2008). These studies do not need to be at full scale, but should address significant uncertainties identified in development of the intervention (Eldridge et al., 2016). This feasibility study is described in Chapter 6.

2.8 Thesis Outline

This thesis includes four successive investigations: a systematic literature review (first investigation) identifying the research base on successful weight management strategies for female university students (Chapter 3); qualitative research (focus groups: second investigation) exploring female university students' attitudes toward healthy eating and physical activity (Chapter 4); the development of the Better Healthy Lifestyle (BHL) intervention programme using the MRC and BCW framework (Chapter 5); and an uncontrolled pre-post-test trial to assess the feasibility of the (potential) BHL weight management intervention (third investigation) based on findings from the first two studies (Chapter 6). Next, I present the COVID-19 contexts and possible impacts on dietary and physical activity behaviours (Chapter 7) and the semi-structured interviews (fourth investigation) to explore the perceived effects of the feasibility trial (Chapter 8). I then outline the modifications I would make to the BHL programme and the method for its implementation on a larger scale (Chapter 9), and end with the research implications, strengths and limitations of this thesis and recommendations for future study (Chapter 10).

2.9 Conclusion

This chapter has summarised the rationale, aim and objectives and methodology of this thesis. Having provided this overview, the next chapter will detail the process and findings of a systematic review of weight management interventions targeting female university students.

Chapter 3: Lifestyle Interventions for Weight Loss Targeting Female University Students: A Systematic Review

3.1 Introduction

This chapter describes a systematic review of weight loss interventions targeting female university students. The review was conducted to meet step one in the development stage of the Medical Research Council (MRC) framework (Craig et al., 2008) in anticipation of developing a weight management intervention as part of this thesis (see Figure 1.9).

3.2 Background

The obesity epidemic has become a global problem contributing to escalating mortality and morbidity from chronic conditions such as diabetes and cardiovascular disease (Whitlock et al. 2009). Despite public health efforts to manage this rise, obesity remains a serious economic burden on global health systems. In the Arabian Gulf region and KSA in particular, the prevalence of obesity and associated comorbidities continues to increase with relatively limited public health response or national intervention programmes to address the issue. In KSA, the obesity rate is higher among females than males (Al Qauhiz, 2010) and this situation, combined with segregation of the sexes in public, demands that effective weight management interventions for women be identified in order to implement sustainable measures towards good practices. Currently, there is no empirical evidence on effective interventions for female students in KSA, which led me to focus my review on female university students. The findings from this systematic review helped me to develop my intervention and can guide future practice and research in this area.

3.2.1 Rationale for conducting a systematic review on female university students

To date, researchers have focused mainly on developing weight loss interventions targeting adults and young children, meaning that other vulnerable age groups have been less studied. Research has found that students are at high risk of weight gain during their time at university (Fedewa et al., 2014; Gropper et al., 2012; Nelson et al., 2008) due to poor dietary choices and lack of physical activity (Von Ah, 2004). During university years, students experience a transition from adolescence to adulthood that is critical to developing sustainable and healthy lifestyle habits (Nelson et al. 2008). University students have greater independence and exert more control over their lives during this transition period, increasing the likelihood that they will adopt unhealthy behaviours. In fact, this demographic experience a rise in risk-taking behaviours at this time (Butler, 2004).

University students are ideal candidates for lifestyle interventions for several reasons (Plotnikoff et al., 2015). For instance, adoption of healthy lifestyle behaviours is readily achievable and cost-effective due to the availability of existing facilities and resources on university campuses, thus eliminating the economic constraints common to other health promotion programmes (Plotnikoff et al., 2015). If students in a university learning environment adopt healthy lifestyle habits, they are more likely to maintain such behaviours long-term (Nelson et al., 2008). Thus, implementation of lifestyle interventions in university settings is essential to improving students' overall well-being (Plotnikoff et al., 2015).

There are multiple factors influencing the effectiveness of weight management interventions for university students. For example, interventions implemented as university courses and involving frequent face-to-face contact with facilitators have been shown to be more effective strategies for health promotion than distribution of audios and leaflets (Abu-Moghli et al, 2010; Plotnikoff et al., 2015). Evidence suggests that regular contact with professionals providing encouragement and support promotes positive health outcomes (Elfhag & Rössner, 2005).

In recent years, several systematic reviews have assessed studies focusing on weight management interventions globally (Hutchesson et al., 2013; Johns et al., 2014; Kreidieh et al., 2018; Plotnikoff et al., 2015; Poobalan et al., 2010). However, only one of these reviews looked at diet and physical activity interventions as well as weight loss interventions (Plotnikoff et al. 2015). The majority of studies in this review included male and female participants; moreover, the studies with single sex (female) samples were cross-sectional or did not measure weight. Only four studies out of 12 assessing weight were effective in promoting weight loss, and just two studies addressed weight loss alone (Plotnikoff et al. 2015).

Another systematic review focusing on young adults ages 18-25 was unable to identify the most effective weight loss intervention due to the heterogeneity of studies being assessed (Poobalan et al., 2009) A third review found that men and women respond differently to weight loss strategies, prompting the authors to recommend that future studies focus on sex-specific interventions (Stroebele-Benschop et al., 2013). A reason for the difference in response between the sexes could be explained by results from the previous review (Poobalan et al., 2009) showing that men and women prefer different types of weight loss interventions. A final systematic review examined weight loss in young women (Hutchesson et al., 2013). However, to date, there is no systematic review focusing exclusively on weight loss strategies for female university students.

A number of studies have found that women in Arabic countries are particularly vulnerable to obesity due to cultural barriers to developing healthier lifestyles (Badran & Laher 2011; Donnelly et al., 2012). However, a recent systematic review on weight modification strategies in Arabic countries included only one study targeting females exclusively, although they were not university students (Kreidieh et al., 2018). The current focus on males is surprising, given that females have higher obesity prevalence rates in Arabic countries. For example, more than half of females in KSA have overweight or obesity (Alqarni 2016; Elsoadaa 2013) and over 48% of female university students reported being overweight (Al Quahiz, 2010). For these reasons, intervention studies targeting female students in a university setting were included in the current systematic review.

Evidence indicates that just 5% weight loss significantly reduces risk factors for disease in people with obesity who are at risk of disease (Douketis et al., 2005). Moreover, 5% weight loss is considered suitable for determining whether weight loss interventions are clinically significant (Williamson et al., 2015). The findings from my systematic review on the effectiveness of weight loss interventions for female students also assisted in refining the design of my weight management intervention for this target group.

3.2.2 Systematic Review Objectives

The objectives for this systematic review were developed using the population, intervention, comparison, outcome, and study design (PICOS) approach (Miller & Forrest, 2001). PICOS is a systematic framework and the most commonly used approach to frame relevant clinical research questions. The review's overall aim was to assess the effectiveness of controlled trials of physical activity, dietary or behavioural change interventions promoting weight loss among female university students compared with a control group.

The specific objectives of this review were:

i) To determine whether controlled trials of physical activity, dietary or behavioural change interventions to promote weight loss are effective in reducing weight among female university students compared to a control group.

ii) To determine whether complex interventions are more effective than a single modality intervention in promoting weight loss among female university students.

iii) To identify the minimum duration required to implement an effective weight management intervention to promote weight loss among female university students compared to a control group.

iv) To identify the most common behaviour change techniques (BCTs) associated with effective weight management interventions targeting female university students.

3.3 Methods

3.3.1 Inclusion criteria

Eligibility criteria were developed using the PICOS framework (Table 3.1). The rationale for using this approach includes three parts: first, PICOS helps the researcher to concentrate on what patients, clients or target groups view as their most significant problem and outcome. Secondly, the framework helps in the digital search process by providing researchers with the language or key words to use in the search. Thirdly, PICOS enables the researcher to identify the problem, results and outcome associated with a particular intervention or treatment (Miller & Forrest, 2001).

Types of Participants

Participants were female university or college students aged 18 years and above. Participants were included if they were in good health and not experiencing an eating disorder or chronic disease such as diabetes or hypertension.

Types of Intervention

Studies were included if they reported on the impact of integrated weight management interventions where one or more components of nutrition education, physical activity or behaviour change were implemented in a university setting. Studies involving interventions of any length were included. Only randomised controlled trials (RCTs) or controlled trials were deemed eligible for inclusion.

Types of Comparators

The review included studies reporting comparisons with no intervention, usual care, alternative approach, or placebo.

Types of Outcomes

The review included studies measuring the impact of weight management interventions incorporating one or more components of weight reduction, such as nutrition education, physical activity or BCTs for female students with overweight or obesity. Quantitative measures included changes in weight, BMI, percentage of weight change and/or mean weight change compared to baseline and/or between the intervention group and the control group.

Types of Study design

This review included all controlled studies comprising of either randomised or non-randomised controlled studies. Uncontrolled, observational and case studies were excluded.

Table 3.1: PICOS framework for Systematic Review

PICOS	Inclusion criteria	Exclusion criteria
Population	Female university/college students	Males, anyone suffering from chronic diseases or eating disorders
Intervention	Weight management intervention that includes one of or any combination of diet, nutrition education, physical activity or any behavioural change technique conducted at a university setting	Any intervention not relevant to the study (such as supplementation, bariatric surgery, etc).
Comparator	No intervention Usual care Alternative approach	Uncontrolled studies
Outcomes	Weight/ % weight change/ BMI	Any study that did not measure weight/ % weight change/ BMI
Study Design	Randomised Controlled Trials / controlled trials	Uncontrolled, observational, and case studies

3.3.2 Exclusion Criteria

Studies were excluded if participants were not university students, were males or were experiencing chronic disease or an eating disorder. Studies were also excluded if they reported pharmacological interventions, herbal or complementary treatments (e.g., acupuncture), surgical interventions, gene-based trials, or any nutrient supplementation. Studies without an intervention or comparator group, cross-sectional studies, case reports, case series or pre-post studies with no comparison group were excluded. Moreover, interventions that did not measure weight or change in weight or BMI as an outcome were omitted. Interventions in any setting other than universities (e.g., hospital, workplace, community, and/or family interventions) were similarly excluded. And finally, dissertations or conference/book abstracts were excluded.

3.3.3 Information Sources: Electronic Databases

The search was carried out using general international health care electronic bibliographic databases. These included five electronic databases: Cochrane Central Register of Controlled Trials (CENTRAL); Medical Literature Analysis and Retrieval System Online (MEDLARS Online or MEDLINE), Excerpta Medica Database EMBASE; Education Resources Information Centre (ERIC); and Psychological Information Database (PSYCINFO). In addition, I performed a manual search of references in relevant studies in my review and other systematic reviews (Kreidieh et al., 2018; Plotnikoff et al., 2015; Poobalan et al., 2010). I conducted the electronic and manual searches in March 2018 and then updated the search strategy and performed the search again during the first week of May 2019. MEDLINE thesaurus Medical Subject Headings (MeSH) terms were adapted for each database (see Appendix 1A).

3.3.4 Search Strategy for Identification of Relevant Studies

I determined the relevant search terms using the PICOS framework (see Appendix 1A). The category 'study design' was added to the framework to reduce the number of irrelevant studies produced by the search. Next, I searched databases without language restrictions, using combinations of key words and MeSH words. The initial search was conducted manually to pilot the electronic database search strategy. Subsequently, a search strategy was developed using the PICOS framework (Table 3.1). Search terms are summarised in Appendix 1B.

Boolean operators 'AND' and 'OR' were used in the search. The word 'AND' was used to combine search terms so that each term/keyword was included in the search results. I used 'AND' to combine all of the PICOS terms except for the 'comparator' words which often did not apply to the search. For example, the search (university students 'AND' health promotion) produced titles/abstracts containing both university students and health promotion. On the other hand, I used the word 'OR' to combine search terms so that search results contained at least one of the search terms/keywords. For example, the search (university students 'OR' college students) produced either university or college or both terms in the list of titles/abstracts. I separated the terms in each of the PICOS categories by the Boolean operator ‘OR’ and then each category was combined using the operator ‘AND’. For example, the final search was done by combining all population terms ‘AND’ intervention terms ‘AND’ outcome terms ‘AND’ study design.

To ensure the results included words spelled differently in British English and American English, I used both forms of spelling in my search (for example, ‘behaviour’ and ‘behavior’). In addition, I used the positional operator ‘adjn’ and Truncation ‘*’ to enhance the efficacy of the search. ‘Adjn’ is a positional operator that helps to retrieve records that contain search terms in any order within a certain number of words from each other. For example, I used the ‘adj5’ operator to find terms having four or fewer words between them in any order. The endings of words were symbolised by an asterisk (*) so that all variations from the root of a word could be located, e.g., a search for ‘los*’ resulted in the words ‘losing’ ‘loss’ lost’ or ‘lose.’ These techniques were used to capture all relevant studies. Furthermore, a built-in search filter was applied to increase the sensitivity of the search while retrieving relevant articles (King’s College, 2018) (see Appendix 1B).

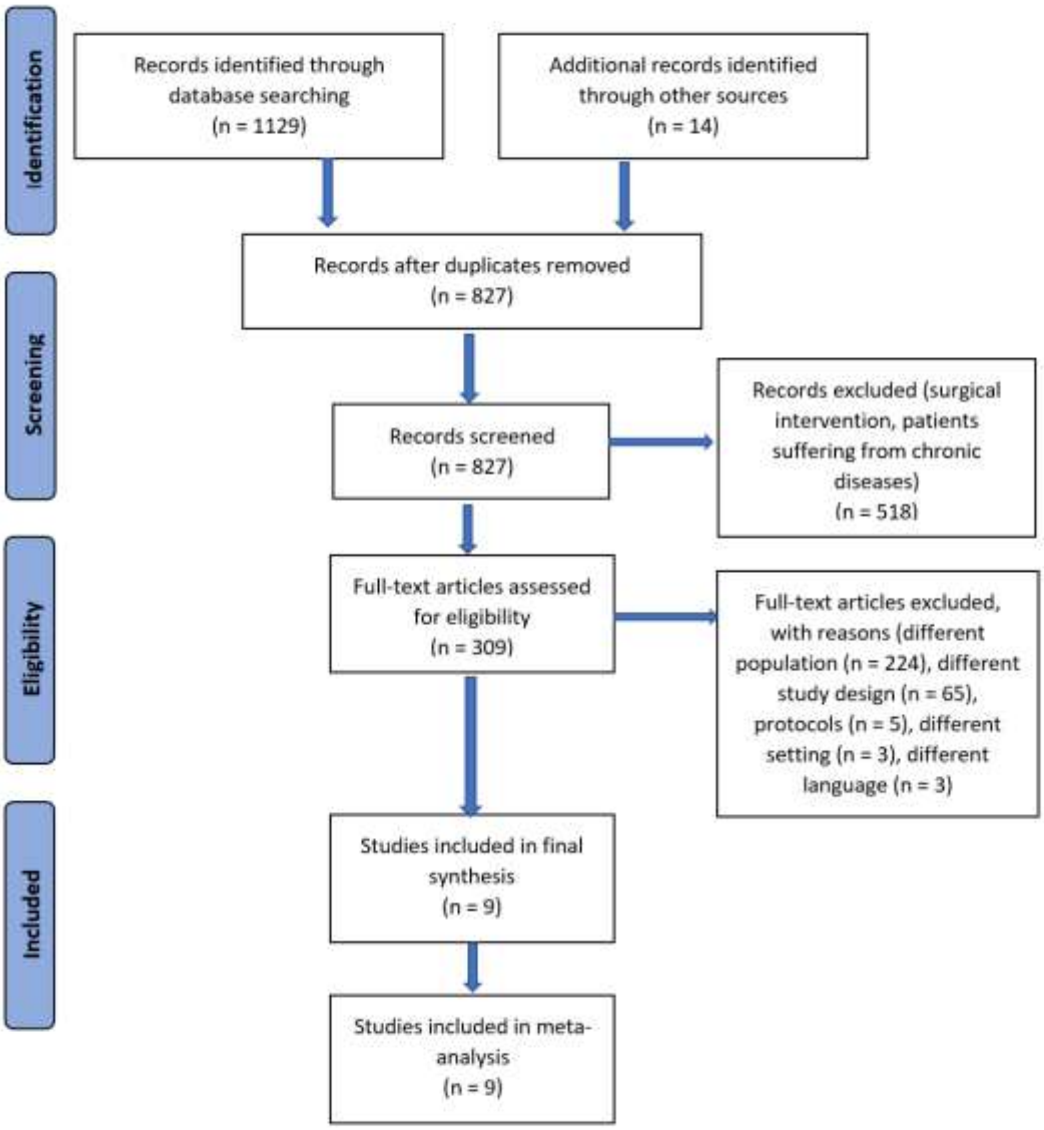
3.3.5 Study Selection and Data Extraction

After running the search, I exported all citations into the reference manager EndNote X8, removing duplicates articles. I then screened titles and abstracts of potential studies according to the eligibility criteria. Next, I screened the full-text articles using the same criteria. I managed the review in EndNote X8 and Excel. I made note of excluded studies on an Excel sheet, providing justification for their elimination. Later, I documented the study process, illustrating the search, screening, and selection of results according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart (Figure 3.1).

To make sure I identified all relevant studies, I reviewed the bibliographies of relevant published systematic reviews as well as the studies produced by my search (Kreidieh et al., 2018; Plotnikoff et al., 2015; Poobalan et al., 2010). Even though most studies included university students, only a handful focused solely on female participants. Of those, some did not measure the weight of the participants, and for that reason, they were excluded, as the main outcome of the current study relates to weight loss.

For the purposes of this review, I extracted only descriptive data related to the study design, the country in which the study was conducted, and the intervention content, including BCTs. In terms of quantitative data, I extracted outcomes such as sample size, duration of the study, age, BMI, weight and statistical significance. It was not necessary to contact authors as most of this information was available in the published articles. The data extracted from the eligible studies was analysed using narrative or descriptive analysis as well as meta-analysis.

Figure 3.1: PRISMA flow chart of the Systematic Review: Lifestyle Interventions for Weight Loss Targeting Female University Students



3.3.6 BCT Coding and Risk of Bias

I reviewed each eligible study entirely to determine whether BCTs were part of the intervention. If BCTs were present, I labelled the intervention and control groups' BCTs using the Behaviour Change Techniques Taxonomy v1 (BCTTv1) (Michie et al., 2013) (Table 3.4), having taken the BCTTv1 training. For example, if a passage discussed establishing goals for participants, I classified this as 'goal setting'. Quotes were extracted and placed in a table along with corresponding BCTs using BCTTv1 (Michie et al. 2013). My supervisor Dr. Emma Norris then double-coded it.

Risk of bias was assessed using the RoB 2: A revised Cochrane risk-of-bias tool for randomised trials (Sterne et al., 2019) and ROBINS-I: A risk of bias in non-randomised studies of interventions (Higgins & Green, 2011; Sterne et al., 2016). The review's randomised controlled trials (RCTs) were evaluated using five criteria from RoB2: 1) bias arising from the randomisation process, 2) bias due to deviations from intended interventions, 3) bias due to missing outcome data, 4) bias in measurement of the outcome, and 5) bias in selection of the reported result. The controlled trials were assessed using seven criteria from ROBINS-I: 1) bias by confounding, 2) selection bias, 3) bias due to classification of interventions, 4) bias due to deviations from intended interventions, 5) bias due to missing data, 6) bias in measurement of outcomes and 7) bias in selection of reported re

According to the RoB 2 (for randomised controlled trials), it is necessary to reach an overall risk-of-bias judgement for a particular outcome, which fall into three categories: low risk; some concerns; high risk. In regards to the low risk of bias, this is applicable when the study's full domain is judged to represent a minimal risk, while some concerns are deemed relevant when at least a single domain presents potential bias. Comparatively, high risk of bias is found when numerous domains are judged to be at risk, which reduces the levels of accuracy in the results (Sterne et al., 2019).

According to the ROBINS-I (for non-randomised controlled studies), it is important to reach an overall risk-of-bias judgement for a particular outcome, which can fall into five different categories. Firstly, the low risk is when no domain represents potential risk, which compares to a randomised trial. Secondly, the moderate risk level is where all domains present minimal risk, which provides clear evidence for non-randomised studies, although not to be compared to high quality randomised trials. Thirdly, the serious risk level is when at least one domain presents with risk, although not critically. Fourthly, the critical risk level is when in excess of one domain presents risk to a more severe level, and thus, the evidence needs to be re-analysed. Fifth, “no information” is shown when certain key domains fail to present important information (Sterne et al., 2016).

3.3.7 Meta-Analysis

Data were extracted and tabulated using Excel software. Data retrieved from nine studies were meta-analysed. The outcome of interest for the meta-analyses was weight loss. Sample size, mean, and standard deviations (SDs) for both experimental groups and controls groups were extracted. Studies were categorized based on the type of intervention implemented in the study group. Also, studies were included in the analysis, if it reported the mean, and SD of weight loss as a primary or secondary outcome. I did not need to calculate the SD for the weight loss outcome. It was available clearly in the text of each included article without trying to contact the original authors for providing more information beyond the published data. All the studies were included in the meta-analysis. Statistical analysis was performed using STATA Version 16.0. Change in weight loss was calculated as weighted mean difference (WMD) with 95% confidence intervals between the different interventions in comparison with the controls. Four meta-analysis were conducted. Studies were categorized based on the type of intervention implemented in the study group to increase the homogeneity of included studies. The comparison subgroups included BCT versus controls, diet + BCT versus controls, diet + physical activity + BCT versus controls, and physical activity + BCT versus controls. A random effects model was applied to report the overall estimate based on the weighted difference between studies. The heterogeneity of the quantitative analysis was assessed visually and using a Chi-square test. I also used I^2 to test heterogeneity. I^2 describes the percentage of variability across studies (Higgins et al., 2011). Sensitivity analyses (excluding one study at a time) were conducted to assess the heterogeneity and robustness of the pooled results. I assessed potential publication bias using a funnel plot. Z-values represent Egger's test (Egger et al., 1997) for overall effect, and a $p < 0.05$ was considered statistically significant.

3.4 Results

3.4.1 Study Selection

A total of 1,143 studies were initially identified based on database and manual searches. After removing duplicate articles, I screened 827 articles by title and abstract. 518 articles were removed; most of these included patients with chronic disease although some included surgical interventions. Then the remaining 309 articles were screened on full text, 300 were excluded because they contained either a different population, different setting, or different study design. Ultimately, data were extracted from nine studies that met the inclusion criteria.

3.4.2 Study Characteristics

Of the nine studies, four were conducted in the United States (Ames et al., 2005; Logel & Cohen, 2012; Roach et al., 2003; Schmidt et al., 2001), two in Japan (Hazama et al., 1994; Kondo et al., 2006), one in China (Siqiang, 2018), one in Pakistan (Memon et al., 2018) and one in Korea (Lee et al., 2017). One study was a non-randomised controlled trial (Schmidt et al., 2001), three studies did not report the method of randomisation (Hazama et al., 1994; Kondo et al., 2006; Siqiang, 2018), and five studies had RCT research designs, including three that were randomised pilot trials (Ames et al., 2005; Lee et al., 2017; Memon et al., 2018) and two that were not pilot trials (Logel & Cohen, 2012; Roach et al., 2003). The duration of the interventions ranged from ten days to seven months. The main characteristics of these studies are summarised in Table 3.2. The outcomes assessed across the studies were weight and BMI.

Table 3.2: Summary of characteristics of identified studies on weight management intervention among university female students

Study (year)	**Study design**	**Country**	**Study Participants**			**Intervention**		**Comparator/ Control**	**Outcomes (both groups)**
			Total no.*	**Age (years)**	**Baseline BMI (kg/m2) or Weight****	**Treatment plan**	**Duration**		
Ames et al. (2005)	Randomised controlled trial (pilot)	United States	26	21.5±2.2	31.1±2.9	SB intervention 10 sessions + restricted **diet** (1200-1500 Kcal/day) & **exercise** + 10 sessions of RCB intervention	6 months Follow-up 6 months	SB intervention 10 sessions+ restricted **diet** (1200-1500 Kcal/day) & **exercise**	Weight
Hazama et al. (1994)	Controlled trial	Japan	16	I: 20.7 ± 1.4 C: 20.9 ± 1.7	I: 25.5 ± 2.7 C: 26.8 ± 3.4	**Diet** 1500-1700 Kcal/day; 10-15 min diet meeting weekly; Instructions were given on low energy food **Exercise** 40-50 min of continuous cycling; 5 min warm up	15 weeks	Control (no intervention)	Weight
Kondo et al. (2006)	Controlled trial	Japan	16	18.0± 1.5 years	I: 29.5± 2.7 C: 21.9± 3.2	**Diet** (400-500 Kcal/day) **Exercise** 30-60 min endurance exercise 4-5days/week; Intensity monitored by heart rate wrist-watch	28 weeks	Control (no intervention)	Weight BMI

Study (year)	Study design	Country	Study Participants			Intervention		Comparator/ Control	Outcomes (both groups)
			Total no.*	Age (years)	Baseline BMI (kg/m2) or Weight**	Treatment plan	Duration		
Lee et al. (2017)	Randomised controlled trial (pilot)	Korea	30	20.0±1.1	21.5±4.0	**Diet** lectures on nutrition; healthy cooking sessions for a total of 8 hrs over the 10-day period; food at a scheduled time and place; vegetarian meals planned by nutritionist (VDiet); 1.5 litres of water daily. 10-RHPDP **Exercise** Received lectures on exercise's role in health; Exercised for a total of 23 hours over the 10-day period; a light walk for 1 hr every morning; aerobic, conditioning and strength exercises for 2 hrs every afternoon. **Stress Relieving**	10 days	Control group (normal diet, no exercise)	Weight BMI
Logel & Cohen (2012)	Randomised controlled trial	United States	45	NR	26.38± 3.07	Value-affirmation	10 weeks	Control group wrote an essay on why ninth ranked might be important to someone else.	Weight BMI (some of the participants self reported their measurements)

Study (year)	Study design	Country	Study Participants			Intervention		Comparator/ Control	Outcomes (both groups)
			Total no.*	Age (years)	Baseline BMI (kg/m2) or Weight**	Treatment plan	Duration		
Memon et al. (2018)	Randomised controlled trial (pilot)	Pakistan	56	20.63±1.54	I: 68.67 ± 7.46 kg C:72.13 ± 8.77 kg	Step count measured weekly via Moves app; Participants downloaded app and left it playing in the background during activity (self-monitoring) Financial Incentive	5 weeks	Control group (Moves App + self-monitoring)	Weight
Roach et al. (2003)	Randomised controlled trial	United States	66	18-23	I: 83.7 ± 19.4 kg C: 82.3 ± 17.0 kg	**Diet** Nutrition education; Food diary Self-efficacy promotion (12 weekly sessions of 1 hour each to promote increase in self- efficacy)	12 weeks	Control (diet)	Weight

Study (year)	Study design	Country	Study Participants			Intervention		Comparator/ Control	Outcomes (both groups)
			Total no.*	Age (years)	Baseline BMI (kg/m2) or Weight**	Treatment plan	Duration		
Schmidt et al. (2001)	Non-randomised controlled trial	United States	48	20.8 ± 1.6	31.4 ± 2.5	**Diet** Classes about: Accurate serving sizes; Sample menus; Food caloric values; 80% of REE (Resting Energy Expenditure); Self-monitored calorie restricted diet **Exercise** Continuous daily exercise (1 x 30 min) group; Accumulated daily exercise (2 x 15 min) group; Accumulated daily exercise group (3 x 10 min); Each group exercised 5 days per week.	12 weeks	Control (no exercising)	Weight BMI
Siqiang (2018)	Controlled trial	China	100	I: 20.5±1.5 C: 20.5±2.5	I: 25.5 ± 2.7 C: 26.8 ± 3.4	**Exercise** Exercise for 60 min; 30 min AM, and 30 min PM; 4 sessions weekly	12 weeks	Control group (oral calcium pyruvate)	Weight BMI

***** Number of female students who completed the study

****** Baseline BMI or weight measurements

Abbreviations BMI: Body Mass Index; **C**: Control; **I**: Intervention, **NR:** Not Reported; **RCB:** Reformulated Cognitive–Behavioural Treatment; **SB:** Standard Behavioural Treatment; **TMS:** Tissue Monitoring System; **VDiet:** Vegetarian Diet; **10-RHPDP:** 10-day health promotion programme combining diet and physical activity.

3.4.3 Weight Outcomes

Diet, physical activity, and BCTs

The meta-analysis model includes five studies with 202 participants and reports the effect sizes of weight loss from diet, physical activity, and BCTs in comparison with control groups. However, Schmidt et al. (2001) included three different arms that were separately included in the meta-analysis as Schmidt et al 2001a, Schmidt et al 2001b and Schmidt et al 2001c. The pooled effect estimates of weight loss in this model revealed WMD of 3.21 (95% CI 0.45 – 5.98), favouring the intervention approach. There was a substantial heterogeneity in this model: I^2= 98% and P<0.001 (Figure 3.2). Removal of each study one by one did not reveal any significant effect on the weight loss findings. A funnel plot showed evidence of asymmetry (Figure 3.3). Egger's linear regression test showed statistical significance of imprecise study effects (P = 0.001). Subgroup analysis by study design revealed that the pooled estimate of weight loss in controlled studies was WMD 4.52 (95% CI 0.50 – 8.53), favouring the intervention approach. There was a substantial heterogeneity in this model: I^2= 98% and P<0.001 (Figure 3.4). After sensitivity analysis removed Kondo et al. (2006), heterogeneity was resolved into I^2= 0% and P = 0.74 with a pooled estimate of WMD 2.41 (95% CI 1.89 – 2.98), favouring the intervention approach (Figure 3.4). The pilot RCTs yielded a pooled effect estimate of WMD 0.65 (95% CI -0.63 – 1.92) with no significant difference between intervention and control approaches (Figure 3.5).

Figure 3.2: Forest plot of weight loss for the different interventions in comparison to control.

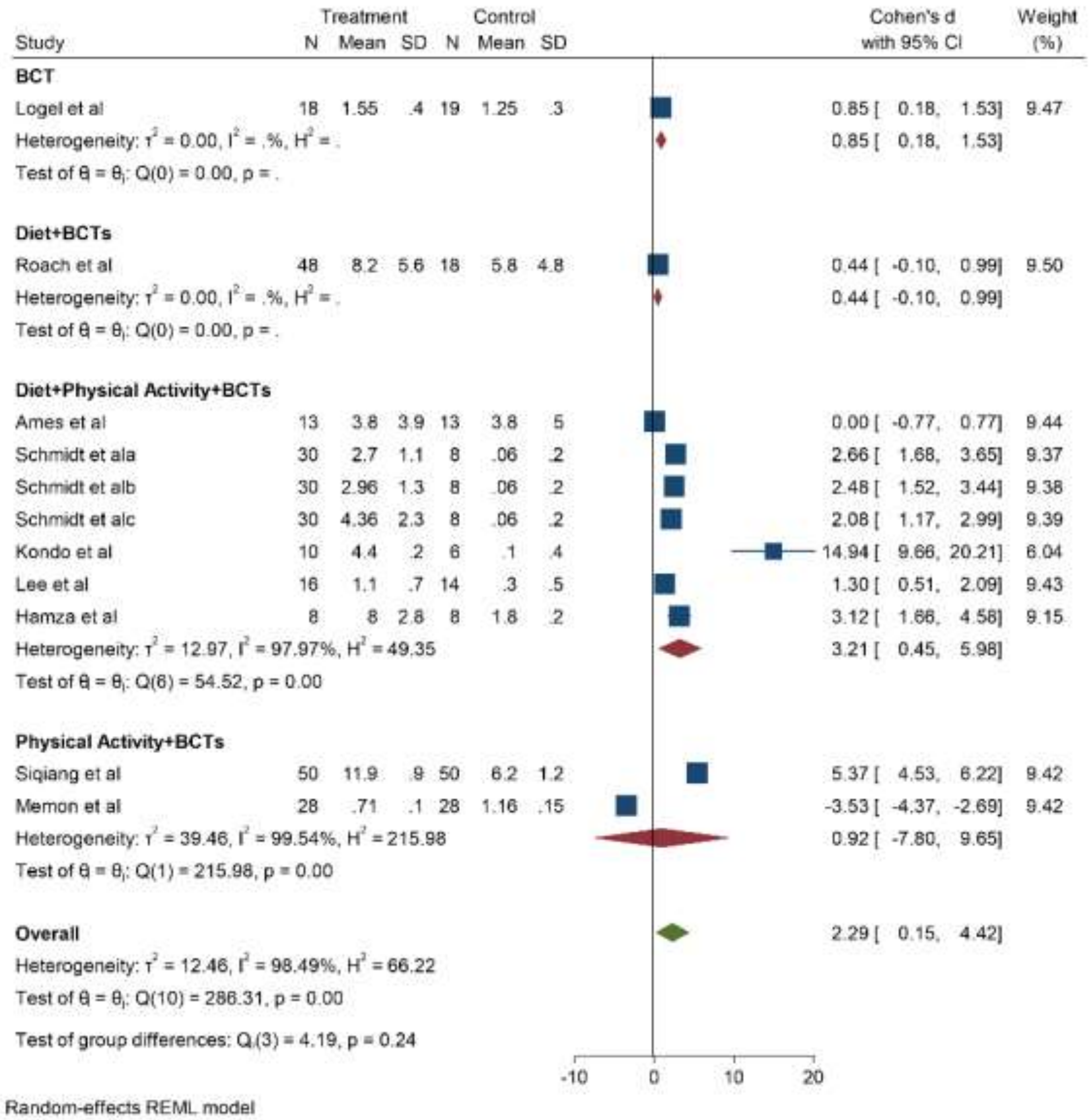


Figure 3.3: Funnel plot representing publication bias of weight loss outcome for diet, physical activity, and BCTs intervention in comparison to control.

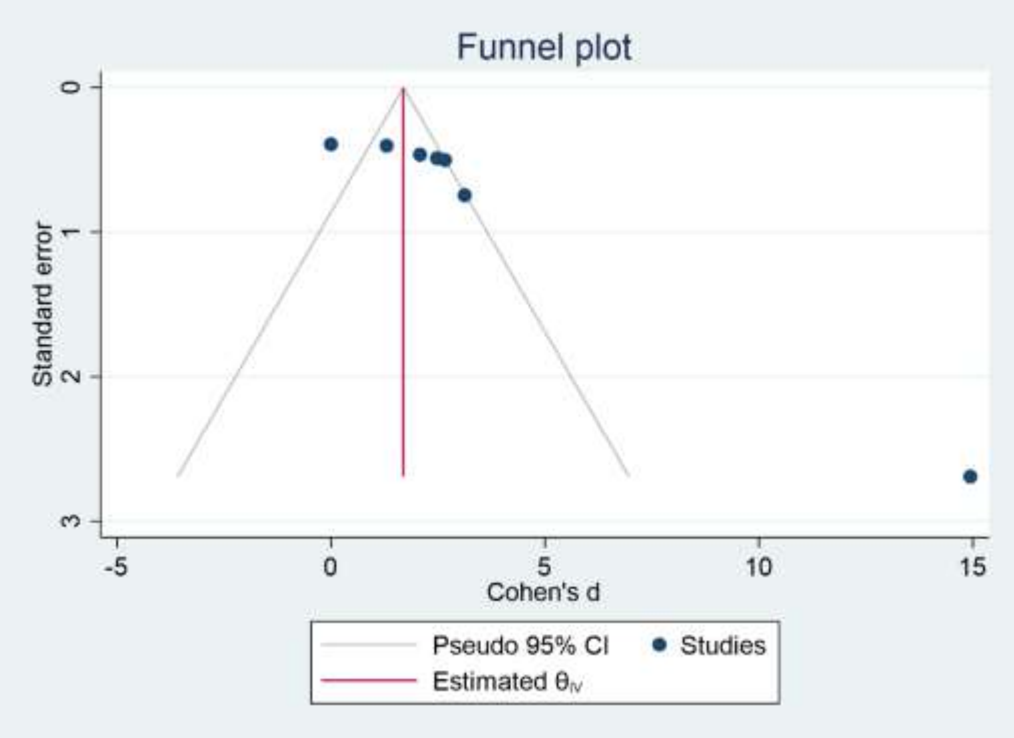


Figure 3.4: Forest plot of weight loss for diet, physical activity, and BCTs intervention in comparison to control grouped by study design.

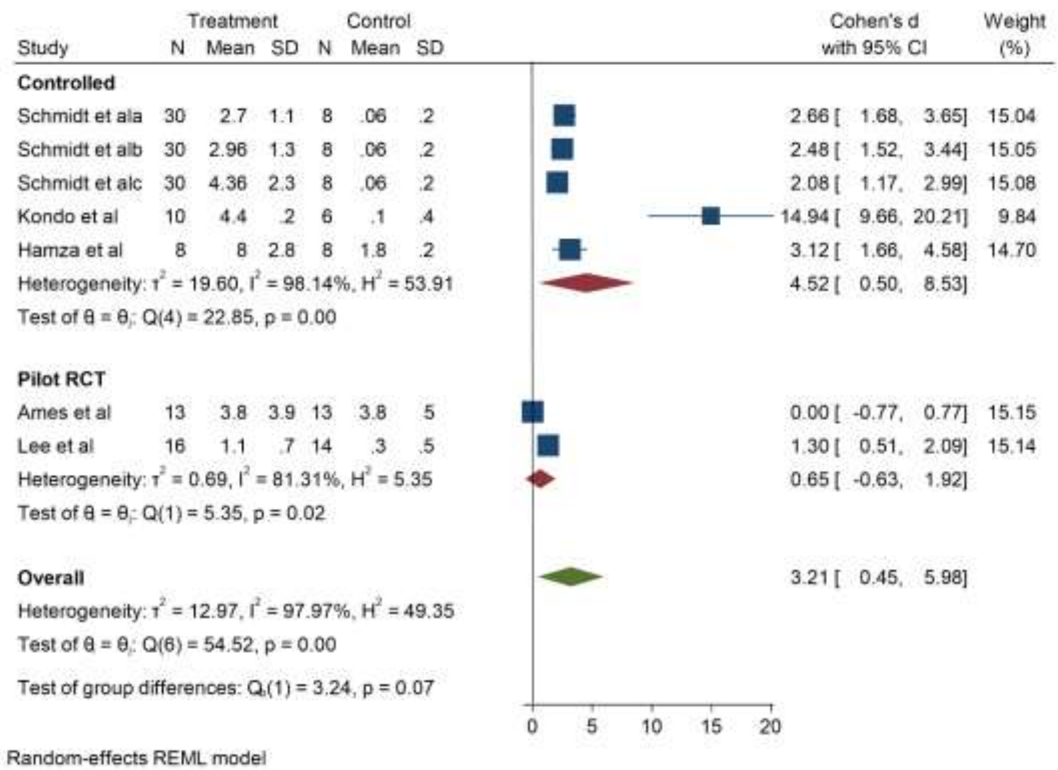
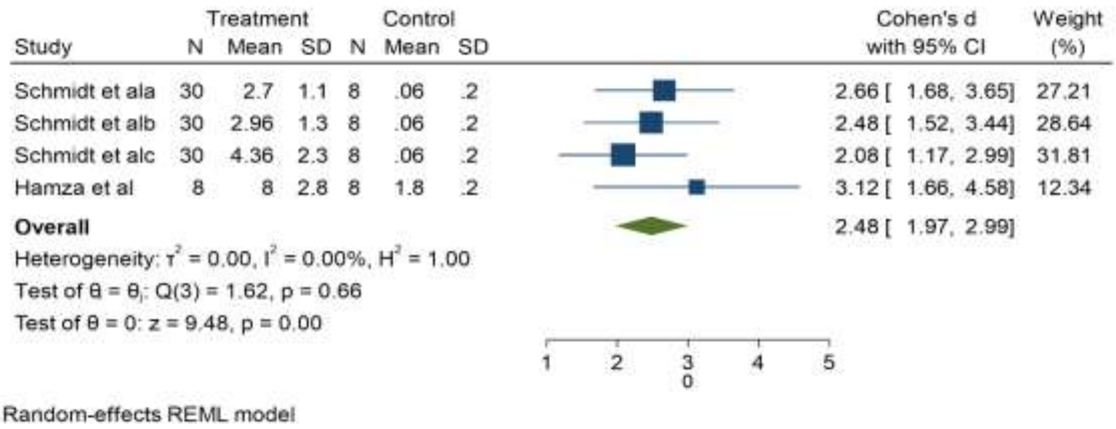


Figure 3.5: Forest plot of weight loss for Diet, physical activity, and BCTs intervention compared with control grouped by controlled study without Kondo et al. (2006) study.



BCT

Just one study containing 37 participants examined BCT as an intervention (valued self-identity) for weight loss in comparison with the control. The pooled effect estimates of weight loss in this model revealed that a weighted mean difference (WMD) of 0.85 (95% CI 0.18 – 1.53) favoured the intervention approach (Figure 3.2).

Diet and BCTs

Only one study with 66 participants investigated diet and BCT as a combined intervention for weight loss in comparison with a control group. The pooled effect estimate of weight loss in this model revealed a weighted mean difference (WMD) of 0.44 (95% CI -0.10 – 0.99) with no significant difference between intervention and control approaches. (Figure 3.2).

Physical activity and BCTs

Two studies with 156 participants investigated physical activity and BCTs as a combined intervention for weight loss compared with a control arm. The pooled effect estimates of weight loss in this model revealed a weighted mean difference (WMD) of 0.92 (95% CI -7.80 – 9.65), indicating no difference between the intervention and the control group (Figure 3.2).

Clinical Significant Weight Loss

Most (six out of nine) of the studies showed statistically significant weight loss ranging from 0.7kg ($p<0.0001$) to 11.9kg ($p<0.05$). One study did not find statistically significant weight loss result, reporting $p>0.05$ (Memon et al., 2018). A final study did not report on statistical significance between groups (Hazama et al., 1994).

All but three (Lee et al., 2017; Logel & Cohen, 2012; Memon et al., 2018) of the nine studies were clinically significant (see Table 3.3). This is due to the fact that 5% weight loss from baseline level is considered sufficient for finding clinically significant weight loss (Williamson et al., 2015). Participants in the intervention groups of the relevant studies experienced weight loss ranging from 2% (Lee et al., 2017) to 17% (Siqiang, 2018) after the intervention. In contrast, the weight loss for participants in control groups ranged from 0% (Hazama et al., 1994) to 9% (Siqiang, 2018), comparatively less than participants in the intervention groups. Only one study included a follow-up which took place six months post-intervention. The study found significant weight loss of 6.2kg ($p<0.08$) immediately after the intervention but weight gain of 2.5kg ($p<0.05$) at follow up (Ames et al., 2005)

Table 3.3: Effective weight management interventions with clinically significant outcomes.[a]

Study (Year)	Control group		Intervention group		Weight management components of the intervention group			Duration
	Weight change[b] (kg)	**Weight loss (%)**	**Weight change[b] (kg)**	**Weight loss (%)**	**Diet**	**PA**	**BCT**	
Ames et al. (2005)	-4.1*	5%	-3.9*	5%	✓	✓	✓	24 weeks
Hazama et al. (1994)	+0.1	0%	-4.4*	7%	✓	✓	✓	15 weeks
Kondo et al. (2006)	-1.8	3%	-8.0*	11%	✓	✓	✓	28 weeks
Schmidt et al. (2001)	-0.7	<1%	E1:-2.7* E2:-2.9* E3:-4.4*	3% 4% 5%	✓	✓	✓	12 weeks
Siqiang (2018)	-6.2*	9 %	-11.9*	17%		✓	✓	12 weeks
Roach (2003)	-2.6	3%	-3.7*	5%	✓		✓	12 weeks

[a] Clinically significant is considered 5% or more weight loss (Williamson et al., 2015)
[b] Weight loss/gain changes from baseline
* Statistically significant (p<0.05); **PA:** Physical Activity; **BCT:** Behaviour Change Technique

3.4.4 Intervention Content

The nine eligible studies were stratified based on the type of weight loss approach used in the trials. Five trials integrated all weight reduction components: diet, physical activity with these embedded using identifiable behaviour change techniques (BCTs) (Ames et al., 2005; Hazama et al., 1994; Kondo et al., 2006; Lee et al., 2017; Schmidt et al., 2001). Two studies focused on physical activity with the support of BCTs (Memon et al., 2018; Siqiang, 2018) and another one included dietary approach supported with BCTs (Roach et al., 2003). A final study included a single intervention approach (behavioural change) using the BCT 'valued self-identity' (n=1) (Logel & Cohen, 2012) (see Table 3.4). I coded all the studies that included BCTs in their research design: the BCTs used across the studies is explained in section 3.4.5.

Combined weight loss approaches

Diet and Physical Activity

Five of the nine studies used complex weight loss approaches, incorporating nutrition education and physical activity with the support of BCTs. There was no diet consistently recommended across the five studies: four studies involved diets with restricted calorie intake (Ames et al., 2005; Hazama et al., 1994; Kondo et al., 2006; Schmidt et al., 2001), while one involved vegetarian meals with no calorie restriction (Lee et al., 2017). Calorie intake was not consistent across the four studies with restricted calorie diets. The study with the lowest calorie intake was based on an extremely restricted energy diet around 400-500 Kcal/day (Kondo et al., 2006). The calorie intake for the other three studies was 1200-1500 Kcal/day (Ames et al., 2005), 1500-1700 Kcal/day (Hazama et al., 1994) and 80% of resting energy expenditure (Schmidt et al., 2001).

In terms of physical activity, four of the five studies incorporated exercise lasting 30-60 minutes approximately five days a week. One study included roughly three hours of exercise daily (Lee et al., 2017). Three studies involved moderate intensity exercise, with two of these also promoting vigorous exercise (Ames et al., 2005; Lee et al., 2017). Four of the five studies had an intervention running three to seven months, while one intervention was conducted over just 10 days (Lee et al., 2017).

All five studies employed ‘behavioural practice/rehearsal’ as a BCT. Four studies, excluding Schmidt et al. (2001), applied ‘goal setting (behaviour)’, and three studies applied ‘self-monitoring of behaviour’ (Ames et al., 2005; Hazama et al., 1994; Schmidt et al., 2001) (Table 3.4) Two studies incorporated the BCT ‘instructions on how to perform a behaviour’ (Hazama et al., 1994; Lee et al., 2017).

Diet

Only one study focused on diet with the support of BCTs (Roach et al., 2003). This study examined a weight loss program for university women (aged 18-23 years) monitoring improvements in self-efficacy for weight loss while encouraging healthy food-related behaviours. The authors compared the efficacy of a behaviour-based approach to the more traditional weight loss approach. In addition to basic nutrition information, the intervention group was provided a diary to record food intake. After 12 weeks, the intervention group experienced a greater mean weight loss (2.4kg, $p<0.01$) than the control group; they also showed improvement in self-efficacy while the control group did not.

Physical Activity

Two studies focused on physical activity using BCTs (Memon et al., 2018; Siqiang, 2018). One, a randomised controlled study, assessed the effectiveness of a five week pilot combining financial incentives with a smartphone application to promote physical activity and weight loss (Memon et al. 2018). At the beginning of the intervention, participants were randomly allocated to incentivised and non-incentivised groups. Both groups used a validated Moves application (an application that was downloaded to their smartphones) (Evenson & Furberg, 2017; Case et al., 2015) to count their steps, with the incentivized group receiving money every week for five weeks based on level of physical activity. Though there was no significant difference between the two groups in weight loss or physical activity level, both groups lost nearly one kilogram from pre to post-test with a significant difference ($p<0.05$). The authors concluded that the effect in weight loss was likely due to the use of the Moves application alone and not the combined use of financial incentives and the Moves app (Memon et al. 2018).

Another randomised controlled study by Siqiang (2018) sought to determine the impact of aerobic exercise on weight loss for female university students with obesity. The study's physical activity intervention consisted of 60 minutes of exercise, 4 times a week, divided equally into morning and afternoon sessions; this approach was supported with the use of BCTs. The intervention was administered to 100 female university students in China for 12 weeks. The experimental group engaged in aerobic exercise while the control group was administered an oral placebo (calcium pyruvate) for weight loss. Overall, the group receiving the intervention showed clinically significant improvement in weight loss compared to the control group. Although both groups lost a statistically significant amount of weight, the exercise group lost nearly twice as much weight (17%) as the control group (9%).

In terms of BCTs, the two studies used different approaches (Memon et al., 2018; Siqiang, 2018). While Memon et al. (2018) used 'self-monitoring of behaviour' and 'material incentive (behaviour)' Siqiang (2018) used 'goal setting (behaviour)', 'action planning' and 'behavioural practice/rehearsal'.

Single modality weight loss approaches

A study that only included one BCT

Logel and Cohen (2012) identified the role of value affirmation, known as self-affirmation, as a behavioural modification strategy in improving physical health and promoting weight loss among female university students. In this intervention, participants were randomised into an affirmation group and a non-affirmation group. Those in the affirmation group were instructed to write about their self-defining values, such as relationships and religious beliefs. Outcome measures included changes in weight and BMI after a 10-week period. The study findings revealed a significantly lower weight and BMI in the intervention group compared with the control. Whereas the intervention group's weight loss was 2%, the control group's weight gain was 2%, a statistically significant difference between the two groups (Logel & Cohen, 2012).

3.4.5 Common BCTs across interventions

In order to identify the BCTs most and least often used in effective interventions, I coded all the studies that included BCTs in their research design. The BCT most commonly used, which was identified in six studies, was ‘behavioural practice/rehearsal (Ames et al., 2005; Hazama et al., 1994; Kondo et al., 2006; Lee et al., 2017; Schmidt et al., 2001; Siqiang, 2018). This was followed by “goal setting (behaviour)” (Ames et al., 2005; Hazama et al., 1994; Kondo et al., 2006; Lee et al., 2017; Siqiang, 2018) and self-monitoring of behaviour” (Ames et al., 2005; Hazama et al., 1994; Memon et al., 2018; Roach et al., 2003; Schmidt et al., 2001), each appearing in five studies. The BCT “instruction on how to perform a behaviour” was present in two studies (Table 3.4) (Hazama et al., 1994; Lee et al., 2017).

The BCTs appearing alone in individual studies with weight loss effects were “valued self-identity”, “problem solving”, “goal setting (outcomes)”, “social support (unspecified)”, “framing/reframing”, “feedback on behaviour”, “graded tasks”, “monitoring of behaviour by others without feedback”, “biofeedback”, “information about health consequences”, “material incentive (behaviour)”, “action planning” and “self-monitoring of outcome behaviours”. Table 3.4 presents an extract of text (“quotes”) describing how BCTs were applied in each study.

Table 3.4: BCTs present in identified studies (n=9) for each group along with an example of quotes from each study

Study ID	Intervention Group BCTs	Quotes	Control Group BCTs	Quotes
Ames et al. (2005)	1.1: Goal setting (behaviour)	“instructed to follow a low-calorie intake (e.g., 1200–1500 kcal/day)” “received training in self-monitoring, goal setting” (diet)	1.1: Goal setting (behaviour)	“instructed to follow a low-calorie intake (e.g., 1200–1500 kcal/day)” “received training in self-monitoring, goal setting” (diet)
	1.2: Problem Solving	“relapse prevention strategies” (diet and physical activity)	1.2 Problem Solving	“relapse prevention strategies” (diet and physical activity)
	1.3: Goal setting (outcomes)	“produce a target weight loss of 0.4kg per week” (diet and physical activity)	1.3: Goal setting (outcomes)	“produce a target weight loss of 0.4 kg per week” (diet and physical activity)
	2.3: Self-monitoring of behaviour	“received training in self-monitoring” (diet and physical activity)	2.3: Self-monitoring of behaviour	“received training in self-monitoring” (diet and physical activity)
	3.1: Social support (unspecified)	“received training in self-monitoring, goal setting, stimulus control, social support” (diet and physical activity)	3.1: Social support (unspecified)	“received training in self-monitoring, goal setting, stimulus control, social support” (diet and physical activity)
	8.1: Behavioural practice/rehearsal	“they were provided with the opportunity for supervised exercise on 2 days per week.” (physical activity)	8.1 Behavioural practice/rehearsal	“they were provided with the opportunity for supervised exercise on 2 days per week.” (physical activity)
	13.2: Framing/reframing	“correcting faulty assumptions about appearance” (diet and physical activity)	–	–

Study ID	Intervention Group BCTs	Quotes	Control Group BCTs	Quotes
Hazama et al. (1994)	1.1: Goal setting (behaviour)	“were advised to initiate attempts at energy restriction of 25kcal/kg/d that corresponded to approximately 1500-1700 kcal/d” (diet)	–	–
	2.3: Self-monitoring of behaviour	“The subjects were given oral and written instructions and a sample dietary record to enable them to be as explicit as possible with regard to quantities” (diet)	–	–
	2.7: Feedback on outcome of behaviour	“weight and/or skinfold thickness were individually measured and their progress was discussed” (diet and physical activity)	–	–
	4.1: Instructions on how to perform a behaviour	“detailed instructions on the selection of relatively low energy foods, on the avoidance of high energy foods, on the restriction of palatable foods, on the prevention of exercise-induced (or iron-deficient) anaemia, and/or on the consumption of necessary quantities of vitamins, minerals and protein” (diet)		
	8.1: Behavioural practice/rehearsal	“40-50 min of continuous cycling” (physical activity)	–	–
	8.7: Graded Tasks	“The intensity of cycling exercise was gradually increased from the beginning to the end of the study on the basis of changes in exercise HR at the individual LT” (physical activity)	–	–
Kondo et al. (2006)	1.1: Goal setting (behaviour)	“30 min four to five times per week” (physical activity) “The estimated energy consumption was 400-500 kcal.” (diet)	–	–
	2.3: Self-monitoring of behaviour	“participants had a wrist watch type heart rate monitor” (physical activity)		
	2.5: Monitoring of outcome(s) of behaviour without feedback	“While the participants participated in training, the authors carried out medical check-ups to confirm that all subjects are in good health” (physical activity)	–	–
	2.6: Biofeedback	“participants had a wrist watch type heart rate monitor” (physical activity)	–	–

Study ID	Intervention Group BCTs	Quotes	Control Group BCTs	Quotes
	2.2: Feedback on behaviour	"If a reduction of daily training activity was noted, subjects were advised to increase their daily training activity" (physical activity)	–	–
	8.1: Behavioural practice/rehearsal	"The exercise regimen combined fast slope walking, slope jogging, dumbbells, stretching, leg cycling and jumping ropes with the preferred exercise for each subject" (physical activity)	–	–
Lee et al. (2017)	1.1: Goal setting (behaviour)	"had to drink water frequently throughout the day (a daily total of 1.5 L of water)" (diet)	–	–
	4.1: Instruction on how to perform the behaviour	"…lectures relating to healthy lifestyle were also included" (diet and physical activity)	–	–
	8.1: Behavioural practice/rehearsal	"To ensure the long-lasting effects of the program, healthy diet, exercise, massage practice, cooking practice and various lectures relating to healthy lifestyle were also included." (diet and physical activity)	–	–
Logel & Cohen (2012)	13.4: Valued self-identity	"select the most important value and write about why it was important to them."	–	–
Memon et al. (2018)	2.3: Self-monitoring of behaviour	"weekly financial incentive based on the following schedule: a) PKR100 (0.95 American dollar [USD]) for logging 7500-9999 steps for >4 days per week; b) PKR200 (1.9 USD) for logging >10000 steps for >4 days per week; and c) PKR300 (2.85 USD) for logging >12000 steps for >4 days per week" (physical activity)	2.3: Self-monitoring of behaviour	"PA, in the form of step count, was measured each week for five weeks by the Moves application" (physical activity)
	10.1: Material incentive (behaviour)	"weekly financial incentive based on the following schedule: a) PKR100 (0.95 American dollar [USD]) for logging 7500-9999 steps for >4 days per week; b) PKR200 (1.9 USD) for logging >10000 steps for >4 days per week; and c) PKR300 (2.85 USD) for logging >12000 steps for >4 days per week" (physical activity)	–	–

Study ID	Intervention Group BCTs	Quotes	Control Group BCTs	Quotes
Roach et al. (2003)	2.3: Self-monitoring of behaviour	“Such activities included keeping a food diary” (diet)	2.3: Self-monitoring of behaviour	“Such activities included keeping a food diary” (diet)
	5.1: Information about health consequences	“nutrition education on a topic related to healthy eating patterns and one or more activities” (diet)	5.1: Information about health consequences	“nutrition education on a topic related to healthy eating patterns and one or more activities” (diet)
Schmidt et al. (2001)	2.3: Self-monitoring of behaviour	“a self-monitored calorie restricted diet” (diet) “Subjects were asked to wear the pedometer for the duration of the study during all waking hours when they were not involved in the study-related exercise sessions and the number of miles accumulated was recorded weekly” (physical activity)	–	–
	2.4: Self-monitoring of outcome(s) of behaviour	“to monitor their own resting heartrate with measurement taking” (physical activity)	–	–
	8.1 Behavioural practice/rehearsal	“daily continuous exercise group with one bout lasting 30 minutes (1 x 30), a 30 minutes daily accumulated exercise group with two bouts, each lasting 15 minutes (2 x15), and a second 30 minutes daily accumulated exercise group with three bouts, each lasting 10 minutes” (physical activity)	–	–
Siqiang (2018)	1.1: Goal setting (behaviour)	“60 minutes each time, and 4 times per week” (physical activity)	–	–
	1.4: Action planning	“The exercise was divided into two: one in the morning for half an hour. Students could do rope skipping lasting 10 minutes for three times; another in the afternoon” (physical activity)	–	–
	8.1: Behavioural practice/rehearsal	“Students could do rope skipping lasting 10 minutes for three times” (physical activity)	–	–

3.4.6 Risk of Bias within Studies

The nine studies in this review are of uniformly low quality and at high risk of bias. Because I used two assessment tools to assess randomised and non-randomised studies, the risk of bias assessment is presented separately for each type of study. Detailed risk of bias assessments using Rob-2 are displayed in Appendix 1C, and assessments using ROBINS-I are shown in Appendix 1D.

Randomised Studies

A risk of bias summary assessment for all included randomised studies using RoB-2 is summarised in Table 3.5.

The assessments for the randomised studies indicated that three studies had a high risk of bias (Ames et al., 2005; Logel & Cohen, 2012; Memon et al., 2018). The two remaining studies (Lee et al., 2017; Roach et al., 2003) had some concerns (unclear).

Randomisation of some form was undertaken in all studies; however, the approach was frequently inadequate, with no study explicitly detailing appropriate concealment methods. For example, in Memon et al. (2018), significant and considerable baseline differences between the intervention and control groups existed, indicating that there was a problem with the randomisation process, possibly due to non-concealed random allocation increasing selection bias.

Due to the nature of the interventions (typically physical activity), it was not possible to blind participants and researchers/assessors in any of the randomised studies. This is a limitation in study design and introduces a significant risk of bias, since placebo effect is likely. The problem was especially acute in Ames et al. (2005) and Logel & Cohen (2012) where some outcome measures were self-reported. In fact, the participants in Logel & Cohen (2012) were able to self-report weight, further adding to the risk of bias due to stigma concerning overweight. It is probable that the effects of these interventions (Ames et al. 2005; Logel & Cohen, 2012) were overstated.

Table 3.5: Risk of bias assessment for randomised studies using Rob-2 tool.

Study	Randomisation process	Deviations from intended interventions	Missing outcome data	Measurement of the outcome	Selection of the reported result	Overall Bias
Ames et al. (2005)	Some concerns	Some concerns	High	High	Low	**High**
Lee et al. (2017)	Some concerns	Some concerns	Low	Low	Low	**Some concerns**
Logel & Cohen (2012)	Some concerns	Some concerns	Low	High	High	**High**
Memon et al. (2018)	High	Some concerns	Low	Low	Low	**High**
Roach et al. (2003)	Some concerns	Some Concerns	Some concerns	Low	Low	**Some concerns**

Table 3.6: Risk of bias assessment for non-randomised studies using ROBINS-I tool.

Study	Confounding	Selection Bias	Classification of interventions	Deviations from intended interventions	Missing Data	Measurement of outcomes	Selection of reported result	Overall Bias
Hazama et al. (1994)	Serious	Low	Low	Moderate	Moderate	Low	Low	**Serious**
Kondo et al. (2006)	Moderate	Low	Low	Low	Low	Low	Low	**Moderate**
Schmidt et al. (2001)	Serious	Low	Low	Low	Low	Low	Low	**Serious**
Siqiang 2018	Serious	Low	Low	Low	Low	Low	Low	**Serious**

The randomised studies generally did not show bias caused by missing data, except for Ames et al. (2005), in which less than 50% of participants assigned to the intervention completed it. Moreover, most non-completers were non-white. It is likely that failure to complete the study was related to the outcome itself, in this case weight loss, likely biasing the results and again, leading to overstatement of the intervention’s impact.

Selection of outcome results and outcome analyses were generally appropriate, other than in the case of Logel & Cohen (2012), who report that other data was collected but not reported on, therefore putting the study at high risk of reporting bias.

Non-randomised studies

A summary of the risk of bias assessment for all non-randomised studies is displayed above in Table 3.6.

Among the four non-randomised studies, Kondo et al. (2006) was assessed at moderate risk of bias and the three remaining studies were assessed at high risk of bias (Hamaza et al., 1994; Schmidt et al., 2001; Siqiang, 2018).

The process of randomisation distributes confounding variables evenly into control and intervention groups. Confounding variables are those that may affect both the outcome and the intervention, and the presence of bias by confounding can significantly impact the internal validity of a study. Confounding is therefore the most significant risk facing non-randomised studies. Although all four non-randomised studies in this review were experimental by design, the researchers decided against randomisation in each case for unknown reasons, therefore increasing the risk of confounding. Furthermore, none of the studies adequately controlled for confounding in study design or analytic technique (such as multi-variant regression). Prognostic factors for weight loss or exercise, such as age, ethnicity, smoking status, socioeconomic status, mental health status, medication history etc., could likely confound non-randomised studies and this risk exists for the nonrandomised studies in this review. For example, while Kondo et al. (2006) controlled for age, smoking status, previous medications, history of cardiovascular disease and, possibly, ethnicity, they did not use an appropriate analytic technique, such as multiple linear regression.

The four non-randomised trials were well designed in all other aspects, demonstrating low risk of selection bias, classification bias, bias due to deviations from intended outcome, bias due to missing data, measurement bias and reporting bias.

3.5 Discussion

3.5.1 Summary of Evidence

Effectiveness

This is the first systematic review to examine the effectiveness of lifestyle interventions for weight loss targeting female university students. Findings show that most of the review's nine studies were effective at promoting weight loss among this population. Seven out of nine studies reported statistically significant weight loss in the intervention group in comparison to the control group. Most of the studies (67%) were clinically significant, meaning that participants lost 5% or more of their baseline weight which is considered to be beneficial in improving health (Douketis et al., 2005). The meta-analysis revealed that weight loss was greater in the intervention group comprised of diet and physical activity with the support of BCTs than in the control group. For instance, the pooled effect estimates of weight loss in this model revealed a weighted mean difference of 3.21 (95% CI 0.45 – 5.98), favouring the intervention approach. Alternatively, there was no significant difference between the control groups and intervention groups with a BCT modality and diet with support of BCTs and physical activity with the support of BCTs.

Complex or Single modality intervention

Most studies containing dietary and physical activity components with the support of BCTs were clinically significant with a pooled effect estimate of 3.21 (95% CI 0.45 – 5.98), favouring the combination of diet and physical activity with the support of BCTs. However, the single modality intervention in this review was not clinically significant. These findings highlight the important role of BCTs in increasing physical activity and improving dietary habits to promote weight loss. Consistent with these findings, a recent systematic review (Johns et al., 2014) showed that combined and complex intervention strategies had a greater impact on weight loss among adults than single modality approaches. For instance, physical activity alone was found to be less effective than a combination of physical activity with behaviour weight management programmes (BWMPs) (Johns et al., 2014). Similarly, a previous meta-analysis comparing interventions based solely on diet to change of behaviour related to diet or change of behaviour related to physical activity among adults with obesity found a greater mean effect size for the latter strategy (Avenell et al. 2004). The authors also reported a significantly greater weight loss percentage when BMWPs and diet combinations were implemented for longer periods. Moreover, another systematic review demonstrated that most BMWPs have positive effects on weight loss with as much as 8kg weight loss achievable within a year among adults being overweight and having obesity (Hartmann-Boyce et al. 2014). Collectively, these findings show the importance of combined intervention programmes (i.e., diet, physical activity with the support of BCTs) in the management of weight gain among female university students.

Duration

In terms of duration, most study designs involved interventions lasting 12 weeks, with three studies conducted for shorter periods of time (Lee et al. 2017; Logel & Cohen 2012; Memon et al. 2018). Only studies conducted for 12 weeks or more demonstrated clinically significant weight loss (Table 3.3). Conversely, the three studies conducted for less than 12 weeks were not clinically significant, possibly due to the short duration of their interventions. For instance, the study with the shortest programme length, which included physical activity and dietary modifications over a 10-day period, reported statistically significant weight loss among students but was not clinically significant (Lee et al., 2017). Physical activity in this study persisted for hours on a daily basis, and participants reported feeling fatigued after engaging in 23 hours of exercise in 10 days, raising concerns about the long-term sustainability of the programme.

A recent systematic review by Plotnikoff et al. (2015) recommended that interventions for weight loss targeting university students have a duration of 12 weeks or less. The authors noted that interventions spanning this length, roughly equivalent to a university semester, generally yielded a greater number of significant outcomes (physical activity level, diet intake and weight) than interventions running for longer periods (Plotnikoff et al., 2015). This review was primarily concerned with physical activity and nutrition outcomes (rather than weight outcomes) which may have contributed to the '12 weeks or less' result. In addition, the review's two studies with weight loss as the main outcome were assessed at high risk of bias, (Musgrave & Thornbury, 1976; Harvey-Berino et al., 2012). Also, only one of these studies had significant results and was implemented for 12 weeks; the other study was conducted for less time and did not produce significant results (Plotnikoff et al., 2015). Alternatively, another systematic review by Johns et al. (2014) reported that combined behavioural change interventions are more effective at a duration of 12-24 weeks. These contrasting findings may be due to different sample sizes, study designs and outcome selections in the two systematic reviews. Results from my systematic review support previous findings showing that a duration at least 12 weeks produces the greatest weight loss. Given these mixed results, further research is necessary to develop the duration according to the type of weight loss intervention strategy.

BCTs

Reducing the prevalence of obesity requires changes in the surrounding environment, lifestyle combined with behaviour modifications that would support sustainable eating and exercising habits for long-term well-being. Clearly BCTs are a key approach to promoting long-term weight loss and wellbeing (Michie et al., 2009). This review identifies behavioural practice/rehearsal, self-monitoring, and goal setting (behaviour) as the most used BCTs in the studies comprising the current review. The most common BCT used in interventions was behavioural practice/rehearsal. Five of the six studies using behavioural practice/rehearsal to modify behaviour were clinically significant (Ames et al., 2005; Hazama et al., 1994; Kondo et al., 2006; Schmidt et al., 2001; Siqiang, 2018), while five of the six studies using behavioural practice/rehearsal were statistically significant (Hazama et al., 1994; Kondo et al., 2006; Lee et al., 2017; Schmidt et al., 2001; Siqiang, 2018). These findings suggest that 'behavioural practice/rehearsal' was an important component of effective interventions included in this review. This corresponds with results in another review that identified behavioural practice/rehearsal as effective at increasing physical activity (Bull et al., 2018).

Findings from five studies highlight the importance of using the BCT ‘self-monitoring’ in weight loss interventions. These studies included exercise (Memon et al., 2018) or diet (Roach et al., 2003) or both exercise and diet with ‘self-monitoring’ to promote weight loss (Ames et al., 2005; Hazama et al., 1994; Schmidt et al., 2001). Four of the five studies using this BCT presented clinically significant weight loss, except for Memon et al. (2018). In Memon et al. (2018) both the intervention and control groups lost weight but there was no statistically significant difference between the two groups. This could be due to the fact that both groups engaged in self-monitoring, although the intervention group received material incentivisation and the control group did not.

Five studies in this review used ‘goal setting’ (behaviour) to promote weight loss, with four showing clinically significant weight loss; Lee et al. (2017) was the only study using this BCT that did not demonstrate clinically significant weight loss. As mentioned previously, this result may be due to the short duration of the intervention (only 10 days).

Evidence from previous research indicates that goal setting (behaviour), self-monitoring of behaviour and behavioural practice/rehearsal are among the most effective BCTS for weight loss. Self-monitoring, in particular, has been identified as one of the five principal BCTs of self-regulation, which is considered an effective tool in promoting healthy eating and increasing physical activity when accompanied with one of the four remaining self-regulatory behaviours such as goal setting, feedback on performance and review previously set goals (Bull et al., 2018; Michie et al., 2009; Samdal et al., 2017). The process of self-monitoring not only influences weight loss, but also encourages long-term weight loss maintenance (Varkevisser et al., 2019). A recent review also found that goal setting is an effective BCT to promote weight loss (Teixeira et al., 2017). These findings suggest that I should include self-regulation BCTs, such as goal setting (behaviour) and self-monitoring of behaviour, in the design of my future clinical study.

Overall, due to the poor to moderate quality of the studies included in this review, I was unable to come to a definitive conclusion about BCTs and optimal duration for an effective weight management intervention. The variation in the timeline of interventions and weight loss approaches (either single or complex) made this a challenging task. As a result, results of this review should be considered exploratory since correlations between BCTs/intervention characteristics and clinically significant reductions in weight do not reflect causality (only association). The strict eligibility criteria limited this review to nine studies, and high heterogeneity decreased the power of the meta-analysis and the robustness of results in interpreting weight loss estimates. However, after assessing heterogeneity, it was attributed mostly to Kondo et al. (2006). In this study, the authors reported a difference between weight loss interventions (diet, physical activity and BCTs) of 14.94. This estimate was far larger than in the other eight studies in which the difference in weight loss was around 2.5. Indeed, Kondo et al.'s design had several limitations, such as a small sample size of students compared to the other studies. Therefore, it is necessary to explore the effect of prolonged moderate intensity exercise combined with diet and BCTs on weight loss in a larger study of students with obesity to confirm these findings and to settle variations in effect sizes. The findings of this review should be interpreted cautiously due to the limited number (9) of studies.

3.5.2 Strengths and Limitations

This systematic review has several strengths and limitations. In terms of strengths, this is the first review to assess the evidence on weight loss strategies among female university students. To date, there has been little research on weight loss interventions targeting female students as most of the available primary prevention studies have included both female and male participants (Plotnikoff et al., 2015). Targeting the female population alone is a significant contribution to existing research and of interest to future studies, given the prevalence of obesity among this group, particularly in Arabian countries (Badran & Laher, 2011). Furthermore, all the studies assessed in this review were controlled trials/RCTs, which strengthens the findings. In addition, I used a systematic approach to describe the components of the interventions, based on the BCTTv1 (Michie et al., 2013). In performing this systematic review, I strictly adhered to the PRISMA guidelines for conducting systematic reviews and assessed the quality of studies using the updated Cochrane Quality Assessment Tools RoB 2 and ROBINS-I. Moreover, this review was registered in PROSPERO (CRD42020133332).

There were several limitations to the systematic review that may impact the generalisability and validity of findings. The PICOS framework may have caused missing of number of related studies while conducting the search as the search was limited by study design. Moreover, the majority of studies were conducted in the United States, and these findings cannot be generalised to my population of interest, which is female university students in KSA. In fact, none of the studies in this review were undertaken in Arabic countries. The small number of studies, small sample sizes, diversity in methodological approaches, and poor to moderate quality of the studies restricted my ability to reach definitive conclusions. In addition, this review was limited to female students and therefore cannot be generalised to the general population. Nevertheless, the strategies identified in this review have been also effective in other interventions involving males and other age groups in the general population (Harvey-Berino et al. 2012; Khambalia et al., 2012). Overall, the results of this systematic review should be interpreted with caution in terms of generalisability.

This review also includes studies that were conducted more than 10 years ago. Due to significant advances in health and lifestyle awareness over the past decade, some of the findings in this review may be less relevant to current female university students than in the past. In addition, because this review only included published studies, publication bias is a possible concern. Moreover, the screening, data extraction and assessment of quality in the review's papers was performed by just one coder. However, the coding of the BCTs was double coded by my supervisor, Dr. Emma Norris. There is a risk of potential publication bias in the included studies, as asymmetry was detected in the funnel plot. Also, it should be taken into account that the review included only peer-reviewed journal papers, excluding grey literature, such as theses or unpublished observations. Since the review included controlled trials only, real world studies might have been missed. In addition, I did not contact the authors of any included studies for more information.

3.5.3 Research Implications

The main implication of this review is that there is limited evidence due to the low to moderate quality of the studies, and the conclusions drawn from them. BCTs were not clearly reported in the studies in this review, therefore, it was difficult to identify the relevant information to code the BCTs and I may have missed some in the process. In addition, none of the studies in this review used a standardised approach for dietary and physical activity components. For instance, dietary advice, duration of the programme, and intensity of physical activity varied across the studies. On the other hand, one finding stands out as useful for intervention development, specifically the importance of creating an obesity management intervention that lasts for at least 12 weeks for successful weight reduction. Also, the review suggested my intervention should be designed to focus on modifying behaviour related to diet and physical activity with the support of BCTs, including goal setting, self-monitoring and behavioural practice/rehearsal to motivate participants to adopt sustainable healthier lifestyles. Based on the findings from this systematic review, recommendations for future direction in obesity management interventions are presented below and displayed in Figure 3.2. These include:

- Development of a lifestyle modification program that includes diet and physical activity components supported by BCTs for female university students with overweight that lasts for a minimum of 12 weeks.
- Regular performance of physical activity should be encouraged.
- Students should be encouraged to adapt several healthy behaviours to promote healthier lifestyles that can be successfully maintained long-term instead of requiring students to follow strict diets that may not be sustained over time.

3.6 Conclusions

This chapter described a systematic review identifying effective weight management-controlled trials for female university students. The review found nine studies of low to moderate quality that are highly relevant to my research. Most of the studies were effective at reducing weight. The review’s findings indicate that a combination of interventions, rather than a single modality intervention, is potentially more effective at promoting weight loss among female university students. With regard to BCTs, I identified goal setting, self-monitoring and behavioural practice/rehearsal as BCTs that may support participants to adopt a healthier lifestyle. With respect to intervention duration, weight loss programmes of 12 weeks or more were shown to result in clinically significant weight reduction. These findings will assist me in designing my obesity management intervention for female university students in KSA.

Chapter 4: Perceptions of barriers and enablers to adopting a healthy lifestyle among female university students: Focus group discussion

4.1 Introduction

This chapter provides insights into female university students' perceptions of barriers and enablers to adopting a healthy lifestyle in Kingdom of Saudi Arabia (KSA). It builds on knowledge from the systematic review (Chapter 3), which focused mainly on studies from Western countries, by considering my target population's views on healthy food-related and physical activity behaviours within the context of KSA.

4.2 Rationale

Multiple multi-level factors in the university ecosystem affect weight gain among university students (Sogari et al., 2018), including time constraints, stress eating, late night snacking, poor access to healthy food and lack of motivation (Smith-Jackson & Reel, 2012). Research on female university students in KSA has found similar barriers to weight loss as well as factors specific to the culture of KSA, such as gender norms and limited availability of sex-segregated leisure facilities (Awadalla et al., 2014; Khalaf et al., 2013; Majeed 2015). While research in KSA has recognized barriers to weight loss among female university students, no intervention targeting this population has been documented (Balhareth et al., 2019; Mabry et al., 2016).

The existing weight management literature sheds some light on barriers and facilitators to weight management among women in KSA (Alqout & Reynolds, 2014; Al-Hazzaa, 2018; Al-Mohaimeed & Elmannan, 2017; Rasheed, 1998) and female university students, in particular (Awadalla et al., 2014; Khalaf et al., 2013; Majeed, 2015; Sabra, 2014). Barriers to adopting a healthy lifestyle include lack of self-motivation and self-efficacy, sedentary behaviour, time constraints, lack of social support, limited availability of gender-segregated entertainment/fitness facilities, gender norms, preference for "unhealthy foods," and snacking during studying and social activities. Studies from other Gulf region countries provide greater insight into the personal, social, environmental and structural factors affecting weight management among women, although they did not include university students in their samples (Ali et al., 2010; Donnelly et al., 2011). This suggests that comparative research on the attitudes of female university students in KSA toward diet, healthy eating and physical activity would fill an important knowledge gap.

To date, most studies on obesity and weight management among women in KSA have involved cross-sectional, quantitative research, limiting insight into subjective experiences of these issues that could be used to inform future interventions. Moreover, there has been no qualitative research on female university students' perceptions of weight management programmes, particularly their most or least engaging aspects. Therefore, qualitative approaches like focus groups are useful for exploring the perceptions of target groups. They provide a space where group norms/customs, opinions, and attitudes can be explored by participants, leading to analysis of common behaviours and experiences that may help in understanding behavioural motivations (Kitzinger, 1995; Krueger 1994).

To the extent that specific cultural and/or environmental factors in KSA (e.g. sex-segregation in public space) influence obesity, a culturally sensitive approach to weight management is also important. Existing obesity research has shown that understandings about body weight, healthy food and weight control are culturally distinct (Barroso et al., 2010). Thus, weight loss interventions that incorporate these understandings may improve uptake and increase the potential for positive outcomes (Ard et al., 2000; Barroso et al., 2010; Lindberg et al., 2013).

As mentioned in Chapter 3, none of the studies included in my systematic review were conducted in KSA. I conducted focus group discussions to look at cultural factors that may have an impact on students' behaviour. This allowed me to address issues of relevance to my target population (female university students in KSA) regarding weight loss promotion.

4.3 Theoretical underpinning

Weight management interventions typically target modifications in individual behaviour related to diet and physical activity. Evidence suggests that theory-driven approaches to evaluate the determinants of behaviour can increase the effectiveness of interventions (Craig et al., 2008; Michie et al., 2008). While there are many change theories in the literature, this study is informed by the Theoretical Domain Framework (TDF) (Cane et al., 2012; Michie et al., 2005) and the Behavioural Change Wheel (BCW)/COM-B model (Michie et al., 2011) which together provide the tools to categorize barriers and enablers and match potential behavioural change techniques (BCTs) with these issues (see Section 1.8.3). Therefore, I conducted this qualitative study (focus group discussions) to provide a foundation for my intervention by exploring factors influencing behaviour. This helped me to determine BCTs likely to promote weight loss by encouraging healthier eating habits and increased physical activity among participants.

4.4 Goals and Objectives

The goal of this study was to provide insight into perceptions of barriers and enablers to physical activity and healthy eating of female students of KSA. It was also to use these insights to devise a weight management intervention that integrates participant perceptions with evidence-based practices for weight management.

The specific objectives of this qualitative study were:

i) to explore perceptions of barriers and facilitators to a healthy diet and physical activity of female university students of KSA, and

ii) to examine students' perceptions of enablers and barriers to attending a weight loss programme.

4.5 Method

This qualitative study used convenience sampling to recruit participants for focus groups at the Saudi Electronic University (SEU) located in Riyadh, KSA.

Convenience sampling is a widely used method in clinical research and is a nonprobability approach. In convenience sampling, the researcher selects respondents based on proximity and availability, making the process quick and economical (Elfil & Negida, 2017). The main drawback of convenience sampling is that results are not generalizable. This is not necessarily a concern in qualitative work, however, where the emphasis is on rich description and interpretation of phenomena rather than assessing whether results are extendable to the target population as a whole.

Participants were recruited using three methods. First, posters and leaflets were distributed at the SEU campus to undergraduates and graduate students (Appendix 2A). Participants were also recruited via word-of-mouth from others who had read the advertisements about the study. Finally, announcements were made at university events. To be eligible for the study, participants had to be female students who had previously attempted to lose weight. This criterion produced participants who were able to directly draw on weight loss experiences to discuss enablers and barriers to losing and managing weight. Prior to participating in group discussions, students were informed about the study and if interested, were asked to sign a consent form (Appendix 2B).

Each focus group comprised six female students. Data saturation was achieved after the third focus group discussion, as no new themes emerged during this session (Saunders et al., 2017). According to Guest et al. (2006), saturation is *'the gold standard by which to determine sample sizes in health science research'*. Therefore, three focus group discussions were conducted. Thus, the study's total sample size was 18, which proved adequate. Focus groups took place in January and February 2019 at SEU and lasted approximately 60 minutes each. The focus groups were facilitated in English (by me), since all participants were proficient in the language. Proficiency in English was not a criterion for focus group participation but was an unintentional, though beneficial, recruitment outcome. During the focus group discussion, I tried to give all participants sufficient time to think and express ideas. There were no difficulties communicating in English at any of the focus group discussions. None of the participants objected to using English or stated that they would prefer to use Arabic. Focus group sessions were recorded using phone recorders.

4.5.1 Ethical Considerations

This study was approved by the Institutional Review Board (IRB) of King Fahad Medical City (reference number: 18-674E) (Appendix 2C) and Saudi Electronic University (Appendix 2D). Participation was voluntary and participants could withdraw from the study at any time. Participants were informed that their names would be kept confidential and all responses would remain anonymous. Any identifiable data were removed from the audio recordings and transcripts. The audio recordings were destroyed after data analysis, and the transcripts (hard and soft copies) were kept in a locked cabinet in my locked office.

4.5.2 Trustworthiness and Rigour

There is a debate surrounding evaluation of qualitative research. Some researchers suggest that qualitative research should be assessed using the same standards applied to quantitative research, such as internal and external validity and reliability (Payton, 1979; Morse et al., 2002). In contrast, others argue that these criteria are not suitable to qualitative work, given philosophical differences between the two methods (Guba, 1981; Leininger, 1985; Rolfe, 2006; Sandelowski, 1986). For example, external validity, which refers to the ability to generalize from the research sample to the population, is a critical component of good quantitative research. However, generalizability is not emphasized in qualitative research; instead, as noted previously, qualitative work focuses on providing in-depth description of a social problem through naturalistic inquiry that emphasizes subjective meaning (Krefting, 1990; Schmid, 1981).

To address these issues, Lincoln & Guba (1985) developed a model to assess the rigour of qualitative research, centred on the notion of trustworthiness. The aim of trustworthiness is to provide evidence that *'the findings of an inquiry are worth paying attention to [and] worth taking account of'* (Lincoln & Guba, 1985, p. 290). Lincoln & Guba's (1985) framework includes four criteria by which to assess trustworthiness: *credibility*, *transferability*, *confirmability*, and *dependability*.

Credibility is concerned with whether research findings represent a "credible" conceptual interpretation of the data (Lincoln & Guba, 1985, p. 296). To strengthen credibility, I discussed the focus group discussions with my supervisors, particularly my emerging interpretations of the data (Merriam, 2002).

I also used ‘triangulation’ of data sources to improve credibility. Triangulation refers to the search for ‘regularities’ across different data sources (or methods, theories and researchers) (Denzin, 2006; O'Donoghue and Punch, 2003) in order to identify themes, confirm findings and enhance interpretation (Creswell & Miller, 2010; Rutherford et al., 2010). For example, in the present study, I drew on a systematic review, focus group discussions and expert guidance (supervisors) – a cross section of data sources and methods - to generate a credible knowledge base to develop the potential intervention. As will discussed in future chapters, my feasibility study and semi-structured interviews provided additional approaches and data that helped to validate prior results and improve data understanding critical to refining the intervention.

Transferability, the qualitative equivalent of “external validity,” is concerned with whether a study’s findings extend to other contexts (Merriam, 1997; Shenton, 2004). To enhance transferability, I have provided in-depth descriptions of participants’ accounts so that readers can judge the transferability of the findings using their own frames of reference (Lincoln & Guba, 1985).

Dependability, which resembles reliability, indicates whether results are consistent and repeatable, requiring a logical, traceable, and clearly documented research path (Tobin & Begley, 2004).. This chapter lays out my decisions concerning research design and data collection related to the focus groups as well as efforts to manage, analyse, and report the data. Transcripts are available.

Confirmability is concerned with making sure interpretations and findings are clearly derived from the data and researcher biases are minimized or explained (Lincoln & Guba, 1985). The final chapter of this thesis includes a reflexivity/positionality statement, which acknowledges potential biases on my part and outlines the efforts I made to understand how they may have (unintentionally) shaped interactions with the research process (Cohen & Crabtree, 2008).

4.5.3 Data Collection

At the beginning of each focus group, I introduced myself and briefly described the ground rules for the discussion based on the focus group guide (Appendix 2E). I emphasized that there were no “right or wrong” answers and that each response was valuable to the study. Participants were also asked to be respectful of one another and not to interrupt others during the discussion. The fact that all participants were female may have helped to create an environment that was comfortable and respectful for open conversation. Participants were assured that their answers were confidential and informed that they could refuse to answer a question at any point during the focus group session.

After the introductory period, participants were asked a standard set of nine open-ended questions I developed for the focus group guide (Appendix 2E). The questions focused on participants’ knowledge of three broad areas: 1) weight management (healthy diet/nutrition and physical activity); 2) barriers and facilitators to a healthy lifestyle (healthy eating and physical activity); and 3) enablers and barriers to attending sessions of a proposed weight loss programme.

4.5.4 Data Analysis

I transcribed the audio recordings of the focus groups verbatim, except for introductory comments which I excluded from the transcript. I analysed the data using Braun and Clarke’s (2006) thematic analysis. Thematic analysis is a methodical means of qualitative data analysis widely used by researchers (Howitt & Cramer, 2008) to identify meanings in texts (Joffe, 2012; Pollio & Ursiak, 2006). Thematic analysis is not underpinned by a specific epistemology, such as positivist or constructionist. While some authors have criticised the framework for this reason, Braun and Clarke (2006) argue that this strengthens the approach by making it more theoretically flexible and adaptable to different research studies, yielding rich and complex accounts (Braun & Clarke, 2006; King, 2004). Since thematic analysis does not necessitate comprehensive knowledge of other qualitative methods, its analytic approach is user-friendly, especially for beginner researchers (Braun & Clarke, 2006). Researchers who are comparatively unfamiliar with qualitative approaches may be able to quickly understand thematic analysis, as there are few rules and courses of action (Braun & Clarke, 2006; King, 2004). Thematic analysis is also beneficial when exploring the viewpoints of different research participants, highlighting similar and dissimilar attitudes and producing unexpected findings (Braun & Clarke, 2006; King, 2004). Finally, thematic analysis offers an advantage in summarising important aspects of a dataset, as it involves an organized approach to working with data, resulting in a clear and well-ordered written product (King, 2004).

Although thematic analysis is beneficial in many ways, it also has disadvantages compared with other qualitative research methods. For instance, the literature on thematic analysis is underdeveloped in contrast to grounded theory, ethnography, and phenomenology. This may leave early career researchers uncertain about how to perform a comprehensive thematic analysis. In contrast to other methods, basic thematic analysis does not enable the researcher to make claims about language use (Braun & Clarke, 2006). Furthermore, while thematic analysis is flexible, this flexibility can make the process of developing themes inconsistent and incoherent (Holloway & Todres, 2003). However, greater coherence can be achieved by taking an epistemological stance to strengthen empirical arguments (Holloway & Todres, 2003).

In Braun and Clark's framework, analysis takes place in six stages: becoming familiar with the data, coding the data, identifying themes, reviewing themes, defining themes and writing up the results. For this study, I followed the first three of Braun and Clark's (2006) steps to extract themes and subthemes from the data. However, I then used the Theoretical Domains Framework (TDF) (Cane et al., 2012) and Behaviour Change Wheel (Michie et al., 2011) to interpret data, meaning Braun and Clarke's later steps were replaced by or matched with aspects of the TDF/BCW model.

In the earliest stage of analysis, I read the transcripts multiple times to familiarise myself with the data. Next, I set out to closely code the transcripts to begin organising my data in a meaningful way. In qualitative analysis, coding schemes develop inductively through a data-driven process or deductively based on pre-existing frameworks, concerns in the literature or the researcher's subject knowledge (Seale, 2004). My initial approach to coding was inductive, as I allowed subthemes to emerge from the data without the constraints of a top-down theory (Thomas, 2003). I focused on the semantic level or surface level meanings of the data rather than the latent level (underlying assumptions, ideas, and concepts). I shifted to a more deductive approach when using the TDF as the main themes and BCW in later stages of data analysis. I manually coded hard copies of the transcripts using open coding which permits “you [to] work intensively with your data, line by line, identifying themes and categories that seem of interest” (Esterberg, 2002, p. 158). I also kept notes, writing down early impressions of the data. I used pens and highlighters to accentuate and mark relevant text. Later, I created different colour schemes to associate with the codes.

Once the codes were established, I began searching for themes. According to Braun and Clark (2006), a theme captures the main ideas about data in relation to the research question(s) and reflects patterned responses or meanings in the dataset that are significant. Themes should be present across the data set, but more examples do not essentially mean that the theme is more vital. However, the themes were the TDF domains themselves. Nonetheless, to extract subthemes, I combined codes that were similar or related to a common aspect of the data. These subthemes were generally descriptive, showing patterns in the data that were relevant to the research questions. Names for the subthemes reflected participant attitudes or thoughts on a barrier or facilitator, such as “already possess sound nutrition knowledge.” (See Table 4.3 for a description of the themes.) These subthemes were ultimately associated with relevant TDF domains as the main themes and then the BCW/COM-B categories.

Two points are central to explaining data analysis at this stage. First, the act of coding and identifying subthemes was not entirely a linear process, but involved some moving back and forth between data categories to make sure the codes (and later themes) adequately reflected the descriptive meanings in the data. Second, the relatively small size of the data set made distinguishing between codes and subthemes challenging at times. Still, as Braun & Clarke (2006) explain, there are no rigid rules to describe what a theme requires. In their view, a theme simply characterizes significance within a data set and offers explanatory power; as a result, there is always the possibility of overlap between themes and codes.

The next step in data analysis involved mapping the 22 subthemes identified using Braun and Clarke's (2006) framework onto the Theoretical Domains Framework (TDF) (Cane et al., 2012). This process involved narrowing down the 22 sub themes that corresponded with 10 of the 14 TDF domains (themes): "knowledge", "behavioural regulation", "goals", "environmental context and resources", "social influences", "beliefs about consequences", "reinforcement", "beliefs about capability", "intentions", and "emotion" (See Table 4.1 for definitions and constructs of the 14 TDF domains).

After using the TDF for analytic purposes, the findings were mapped on to the Behaviour Change Wheel (BCW), specifically its hub - the COM-B model using the table *"Links between COM-B, TDF and intervention functions"* (Michie et al., 2014, pp.113-115). Next, based on the Behaviour Change Wheel guide (Michie et al., 2014), I linked each COM-B component to the intervention function (Michie et al., 2014, pp.113-115). During the final analytic phase, I again referred to the Behaviour Change Wheel guide (Michie et al., 2014) as well as to BCT Taxonomy (v1): 93 hierarchically-clustered techniques (BCTTv1) (Michie et al., 2013) to compare intervention functions against BCTs using the table *"Linking intervention functions to BCTs" (*Michie et al., 2014, pp. 151-155). Each intervention function was linked to one or two BCTs. This process became cyclical when I mapped the BCTs back to the intervention functions to determine how they aligned with the TDF domains. Further details are explained in Chapter 5.

Table 4.1: Theoretic Domains Framework (TDF) Domains

TDF Domain	Definition	Associated Constructs
Knowledge	An awareness of the existence of something	Knowledge (including knowledge of condition/scientific rationale) Procedural knowledge Knowledge of task environment
Skills	An ability or proficiency acquired through practice	Skills Skill development Competence Ability Interpersonal skills Practice Skill assessment
Social/professional role and identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting	Professional identity/role Social identity Identity Professional boundaries Professional confidence Group identity Leadership Organisational commitment
Beliefs about capabilities	Acceptance of the truth, reality or validity about an ability, talent, or facility that a person can put to constructive use	Self-confidence Perceived competence Self-efficacy Beliefs Self-esteem Empowerment Professional confidence

TDF Domain	Definition	Associated Constructs
Optimism	The confidence that things will happen for the best or that desired goals will be attained	Optimism Pessimism Identity Unrealistic optimism
Beliefs about consequences	Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation	Beliefs Outcome expectancies Characteristics of outcome expectancies Anticipated regret Consequents
Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus	Rewards (proximal/distal, valued/not valued, probable/improbable) Incentives Punishment Consequents Reinforcement Contingencies Sanctions
Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way	Stability of intentions Stages of change model Transtheoretical model and stages of change
Goals	Mental representations of outcomes or end states that an individual wants to achieve	Goals (distal/proximal) Goal priority Goal/target setting Goals (autonomous/controlled) Action planning Implementation intention

TDF Domain	Definition	Associated Constructs
Memory, attention, and decision processes	The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives	Memory Attention Cognitive overload/tiredness Decision making Attention control
Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence and adaptive behaviour	Environmental stressors Resources/material resources Organisational culture/climate Salient events/critical incidents Person × environment interaction Barriers and facilitators
Social influences	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours	Social pressure Social norms Group conformity Social comparisons Group norms Social support Power Intergroup conflict Alienation Group identity Modelling

TDF Domain	Definition	Associated Constructs
Emotion	A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event	Fear Anxiety Affect Stress Depression Positive/negative affect Burn-out
Behavioural regulation	Anything aimed at managing or changing objectively observed or measured actions	Self-monitoring Breaking habit Action planning

Source: adapted from Atkins et al., 2017

4.6 Results

4.6.1 Sample characteristics

Most students ranged from 20 to 30 years (n = 14). There were two participants aged 31 to 40 years old and two participants aged 40 to 50 years. Of the eighteen participants, five were married, one was divorced and 12 were single. All four of the participants over age 30 were married.

Six participants were employed, and 12 were not employed. All four of the participants over age 30 were employed. Fifteen of the participants were Saudi nationals of KSA, and three were citizens from other Arab countries studying at SEU. Table 4.2 provides a description of focus group participants' characteristics.

In the preceding chapters, I explained that my rationale for sampling university students was to address a gap in the weight management research targeting this population. I also noted that this group typically includes individuals 19-25 years old at a life stage involving "critical psychosocial development and identity formation, leading to greater independence, sense of self and autonomy in decision-making" (p. 50). As students navigate the university environment on their own, often whilst handling competing demands, they may find it challenging to adopt healthy lifestyle behaviours.

As noted, the majority of my sample fits or falls just outside the 19-25 age range. While four participants are over 30 years old, I propose that including these "mature" students does not compromise my study's premise or results since many aspects of university life apply equally to traditional and mature students. Some common elements of the student lifestyle (Sogari et al., 2018) include: time constraints, financial constraints, academic pressure, and the need to balance competing demands (e.g., work and school, school and family, or school and extracurricular activities).

Moreover, the literature suggests that mature students also undergo a process of identity (re)formation when they attend university. Resuming learning may have significant implications for family relationships and self-conceptions and may open up new possibilities for higher learning and occupational advancement (Baxter & Britton, 2001). In addition, the decision to attend university as an older student is often provoked by key life transitions, whether situational events (e.g., divorce) or “dispositional aspects of personal satisfaction” (Gill et al., 2015).

In addition, both younger and mature students spend time on university campuses and are part of the ecological system identified in Chapter 1 that gives rise to university-specific environmental facilitators and barriers to healthy eating and physical activity, such as limited access to nutritious food or to fitness facilities on campus. Keeping this in mind, I have identified any differences in students’ viewpoints based on age in this chapter’s results and discussion sections. In addition, I have pointed to any differences based on marital status or employment, since these variables are associated with age in my sample.

Table 4.2: Demographic Description of Focus Group Participants

Demographic characteristics		No. of students	Percentage
Age	**21 to 30 years**	14	78%
	31 to 40 years	2	11%
	41 to 50 years	2	11%
Nationality	**Saudi**	15	83%
	Non-Saudi	3	17%
Employment	**Employed**	6	33%
	Not Employed	12	67%
Marital Status	**Married**	5	28%
	Single	12	67%
	Divorced	1	5%

4.6.2 Summary of the TDF and COM-B model: Barriers and enablers to physical activity

I identified 22 subthemes via thematic analysis that were mapped directly onto 10 of the 14 TDF domains (themes) and the six COM-B components. The 10 TDF domains included “knowledge”, “behavioural regulation”, “goals”, “environmental context and resources”, “social influences”, “beliefs about consequences”, “reinforcement”, “beliefs about capability”, “intentions”, and “emotion”. The TDF domains not relevant to the context of healthy eating and physical activity among female university students in KSA were “optimism”, “memory”, “skills” and “social/professional role and identity”. The 22 subthemes are categorised below according to associated TDF domains and are discussed within the context of barriers and facilitators to weight loss. Table 4.3 provides an overview of the study’s themes (and subthemes) as well as associated transcript extracts. Table 4.4 links the TDF domains to the BCW, including COM-B framework, intervention functions and potential BCTs.

4.6.3 Study Themes and Associated TDF Domains

Theme 1 (TDF Domain): Knowledge

Three subthemes related to “knowledge” emerged from the focus group discussions. These largely focused on personal food or nutrition knowledge as opposed to knowledge about physical activity/fitness.

Sub-theme 1: *Already possess sound nutrition knowledge*

During group discussions, most participants stated that they already possessed comprehensive nutrition knowledge. In fact, several mentioned that information about healthy eating so saturated the media that it was impossible to be unaware of these issues:

> *Awareness campaigns in general and now even in social media, so everywhere you go there are some people raising awareness about health and nutrition…*- P17, age 23

In response to “What do you think is healthy food?” participants’ answers centred on types of food, food composition/nutrients, food preparation methods and food portion size. These answers broadly aligned with nutrition guidelines endorsed by professional dieticians and public health agencies and represented basic familiarity with the subject. Foods mentioned as healthy included “vegetables,” “fruits,” “green tea,” “salads,” “water,” “yoghurt,” “chicken,” “dark chocolate” and “fish.” During discussions, some participants displayed more complex understandings of nutrition, emphasizing the importance of distinguishing between types of carbohydrates (simple and complex) and fats when choosing what to eat:

Carbs, complex carbs, fats, protein…, healthy fats, fats that are found in food, avocado, omega 3, like in salmon, sea food and stuff like that, healthy fats, what else like the ones in nuts and stuffs like almonds and other nuts. - P15, age 24

Others pointed to the need to limit sugar and salt in their diets:

You should get away from the three whites, the sugar, the salt and the flour. - P7, age 46

Students indicated that they were familiar with healthier cooking methods, agreeing that it was best to select “grilled or steamed” food over “fried” as part of a healthy diet. There were also a few participants who commented on the method of production or composition of food, arguing that that food “without preservatives or chemicals” or “organic food” were healthier options.

Not surprisingly, participants’ belief that they already possessed comprehensive nutrition knowledge created resistance to attending weight loss programmes emphasizing nutrition education. In general, participants viewed lectures on healthy eating as outdated and uninteresting and preferred more unusual and engaging approaches instead:

Regular information, any information about our body and carbohydrate and protein and their benefits, calories, I think it is so old. Also, about traditional diets program, also old. If I see something new, new diet program such as Keto and some new, I will get interested, and I may, I think it is Keto and a French diet programme, a lot of new diet programme and it’s useful in this time. But yes new, not in the old, so I think it’s interesting. - P3, age 22

Sessions are as I always see on TV and even You-Tube is lectures and information via slides…they might bring somebody who shared his experience that was a special experience. Nothing new! A lecture. You just listen and listen...you want movement. To make travel, to make climb in the mountains. - P2, 22

Sub-theme 2: ***Diets should be balanced and not overly rigid***

Many participants insisted that balance was important to healthy eating. By balance, participants meant three things: portion size, types of food (e.g. food plate) and customized diets. Here, participants acknowledged the importance of nutrition but were cautious of strict dietary regimes, which they felt were unproductive to weight management. For example, some participants talked about the importance of eating across the five food groups, a standard nutrition recommendation, but also insisted that "unhealthy" foods not included in these categories were acceptable, as long as portions were reasonable:

> *No, it's a 70% -30% or 80%-20% like, you can have during the day, let's say 80% healthy food and 20% something sweet or anything, like you can have an ice cream scoop if you want, or you don't have to eat healthy. - P15, age 24*

Another participant made a similar comment, insisting that it was not "right" to restrict diets to certain foods, such as fruits and vegetables, while excluding others, suggesting such standards were unfair:

> *It depends on, like, what she said, it depends on the portion, on how much you eat each of them. Each and every food is healthy, but there is a portion of how much you should eat each of them, not like only fruits and vegetables are healthy. It's not right. I feel it's not right. - P16, age 33*

Participants felt that diets included in the weight management programmes should be balanced and flexible. They further argued that rigid or unrealistic dietary goals (e.g. extreme calorie counts) were discouraging and would reduce enthusiasm for programme participation:

> *In the programme, if it's too strict, and you can't eat anything you want and not little bit flexible, I wouldn't want to. Flexible means like maybe start with like not a very low calorie intake, you know what I mean, like if I am eating let's say I am a person who eats 3000 calories per day, I don't want to go to a programme where you will give me 1200 calories a day. It's a huge gap, huge shift from what I eat usually and what you are giving me…that won't make me want to go. - P15, age 24*

Finally, some participants felt that balanced diets should reflect each person's food needs. In other words, diets should be personally customized. As before, students acknowledged nutrition's importance but insisted on considering personal metabolism when determining healthy eating habits:

> *Healthy means what your body needs or what your body likes. Some people are more in need of proteins, or iron. Some bodies they cannot, you know, digest the carbs. That's why you might get obese, if you consume a lot of carbs. Some bodies it's not good to eat sugar for them. They cannot tolerate sugar. Others, as she has said, her husband eats a lot and my husband, they eat…, they don't gain any…, they lose weight, so different bodies need different things, and so you should know what your body needs, you should give what it needs. - P7, age 46*

Table 4.3: Study themes and subthemes and associated transcript extracts

Themes (TDF Domains)	**Subthemes**	**Examples**
Knowledge	1. Already possess sound nutrition knowledge	*Awareness campaigns in general and now even in social media, so everywhere you go there are some people raising awareness about health and nutrition and yah…* - P17, age 23
	2. Diets should be balanced and not overly rigid	*In the programme, if it's too strict, and you can't eat anything you want and not little bit flexible, I wouldn't want to, flexible means like maybe start with like not a very low calorie intake, you know what I mean, like if I am eating let's say I am a person who eats 3000 calories per day, I don't want to go to a programme where you will give me 1200 calories a day, it's a…huge shift from what I eat usually and what you are giving me…that won't make me want to go. - P15, age 24*
	3. Need nutrition knowledge to make healthy eating decisions	*I get confused with this because every programme have its own healthy food, some of them never allow meat because it's lot of cholesterol and some programme don't allow never milk and yoghurt, some… I get confused… - P3, age 22*
Beliefs about capabilities	4. Successful weight loss in the past means it is possible again	*I already lose my weight, I was fat before, I lose weight. It changed all my life…even my family, it is very nice when you lose weight. - P14, age 40*
Beliefs about Consequences	5. My appearance will improve with health eating and physical activity	*To become beautiful. – P13, age 26*
	6. A healthy lifestyle will promote and protect physical wellbeing	*I think when I have a good weight in my age now I will keep my health good … also after 50 years old, or later… I have a good, also health cause my weight, my blood pressure… my blood sugar will be good… if I have a good weight and can I avoid a lot of disease like the diabetes and also some pains like knee pains, leg pains. - P2, age 22*
	7. A healthy lifestyle will promote mental wellbeing	*May be it [losing weight] increases even our self-confidence, when we are little, you know when we are not so fat you know you can stand in front of everyone, but when you are fat you feel a little bit shy, yes,…we feel insecure being fat, may be this. - P16, age 33*
	8. A healthy lifestyle will enhance personal freedom	*If you are skinny, I think you can wear whatever you want, you can eat whatever you want, you don't have to guard anything, but if you are fat, you can't, you can't dress whatever you want, you have to be careful with everything, I think. – P14, age 40*
Reinforcement	9. Competitions and rewards incentivize weight loss	*I think competitions maybe with having a winner, giving something to that winner, I think stars or something, this might me motivation…yes. – P8, age 25*

Themes (TDF Domains)	Subthemes	Examples
Intentions	10. Willpower is essential to weight loss	*I feel like anything you want to if you are determined like if you are motivated, no matter what it is, like I know some people do that, and they wake up six in the morning, they exercise and they go to work or school, whatever, it's all up in your hand, no matter how difficult it is in the beginning, but you need motivation. – P15, age 24*
Emotion	11. Stress is a barrier to weight loss	*Looking in the mirror sometimes effects your mental phase, you might go under stress, and depression, you will eat more…negative feedback. – P14, age 40* *Sometimes the marriage and your husband also affect your body, I don't like to eat, I am a healthy person, but you know the stresses over you, this will make you even, so be careful. – P8, age 25*
Goals	12. Setting goals is important to achieving weight loss	*Maybe if we have different goal every month, so one month we focus on lowering our fat percentage, the other month we focus on gaining more muscle so every month we have a different goal that would leave us to lead a healthier life. - P17, age 23*
Behavioural Regulation	13. Monitoring lifestyle behaviours is important to achieving weight loss exercise facilities (distance and amount)	*Get us experienced people to monitor our diet, and monitor our weight, this will also motivate us…somebody should keep pushing us you know…– P10, age 25*
Environmental Context and Resources	14. Time pressures impede healthy eating and physical activity	*We do not have enough time to because our studies is pressure, and many homework. – P1, age 28* *We must always put something important than others, because if we didn't make the time management for us good, we not have time for walking, time for eating, time for spending - P14, age 40*
	15. The high cost of healthful food impedes healthy eating	*They are expensive too, usually the healthy food is expensive than the unhealthy food. – P16, age 33*
	16. The city's environment impedes physical activity	*We are in the huge city, because we are in the centre, the destination is so far, if I want to…we have gym, but it is far from my house, so because we are in huge city, not in the small...when we travel to another country we walk, so we lose weight, when I travel to my country I lose weight, because we don't use cars… P3, age 22*

Themes (TDF Domains)	Subthemes	Examples
	17. The campus' environment impedes healthy eating and exercise	*And also the lack of the availability of the tasty food, you can't,… like hunger station you can take any food, but healthy food is very limited and you can't, and also it is over price and not tasty…, it is not tasty. - P12, age 24* *Why not have a fitness centre here, yes…, instead of sitting in the cafeteria and eating, we can you know, exercise waiting for our lectures, we should have the facilities. - P11, age 35*
	18. Lack of shops selling healthful food hinders healthy eating	*There should be more shops outside to sell the good food, the healthy food, for working females, if you don't have time, just pass by when you are getting home, you will buy the healthy food before we get home, but if you get home, and you will see the things around you, you will eat you know something that is fast and yes…and reachable… you don't have time to cook so we will bring anything that save money…and anything that will fill the stomach. – P13, age 26*
	19. Lack of calorie counts for restaurant meals impedes healthy eating	*At every restaurant in the Saudi Arabia, every menu should have calories, have to write it, I think people see that maybe effect their opinion from eating. - P4, age 23*
Social Influences	20. Social support is important to promote weight loss	*Emotionally sharing stories for example obesity problems and they work together on this to lose weight, this is motivational, …make it emotional classes, two people or ladies maybe if they are obese, put them together and make them work hard, because they have the same feeling, same suffering, but if you bring somebody who is fit and somebody who is obese and put them together, for sure the class will not be…, classify people. – P9, age 24*
	21. Peer pressure is an obstacle to healthy eating	*And the people it's my major, when I was in, with my family, I was very healthy person, they eat like vegetables all the time, and when I married, he is very like burger, what I will do? Burger… breakfast to lunch to dinner and Pepsi and Pepsi and he is very thin, I get fat, he is still in the same weight, so it is very hard I promise…I am tired… - P8, age 25*
	22. Cultural norms of KSA impede healthy eating	*And also, the social system here, the families eat together, and so you can't have a separate meal and the traditional cuisine are filled with oil… - P2, age 22*

Table 4.4: Mapping TDF Domains to the BCW, Including Intervention's Potential BCTs

TDF Domains	COM-B	BCW Intervention function	(Potential) BCTs based on BCW
Knowledge	Psychological capability	Education	Information about health consequences
		Training	Instruction on how to perform behaviour Demonstration of the behaviour
Beliefs about capabilities	Reflective motivation	Persuasion	Verbal persuasion about capabilities
Beliefs about consequences	Reflective motivation	Persuasion	Information about health consequences
		Education	Information about health consequences
Reinforcement	Automatic motivation	Incentivisation	Social Reward
Intentions	Reflective motivation	Persuasion	Verbal persuasion about capabilities
		Incentivisation	Commitment
Goals	Reflective Motivation	Persuasion	Goal setting (behaviour)
		Incentivisation	Self-monitoring of behaviour
Environmental context and resources	Physical opportunity	Enablement	Behavioural substitution
		Environment Restructuring	Restructuring the physical environment
Social influences	Social opportunity	Enablement	Problem Solving
Emotion	Automatic motivation	Persuasion	Framing/reframing
		Incentivisation	Self-monitoring of behaviour
		Enablement	Social Support (unspecified)
Behavioural regulation	Psychological capability	Training	Self-monitoring of behaviour
		Enablement	Goal setting (behaviour) Adding objects to the environment Action Planning

Sub-theme 3: ***Need nutrition knowledge to make healthy eating decisions***

While most participants believed they were familiar with nutrition fundamentals, this sense was not universal; a small minority confessed to some uncertainty concerning healthy eating. For example, one participant admitted that she was unsure how to differentiate foods, given what she viewed as competing expert information about healthy eating:

> *I get confused with this because every programme have its own healthy food. Some of them never allow meat because it's lot of cholesterol, and some programme don't allow never milk and yoghurt, some… I get confused until this moment, so…no… no healthy food. - P3, age 22*

Another student shared that while she was aware of the importance of a nutritious diet, she was less clear on how to prepare and cook healthy meals:

> *Maybe we can't make meal… healthy meals… we don't know how to make… delicious healthy meals…all the time we know unhealthy meals. - P5, age 23*

Not surprisingly, these participants were far more interested in a weight management programme that included nutrition education in their curriculum:

> *Understanding also and learning, and we go back to understanding and learning about how important of healthy food to your body… -P16, age 33*

> *[Classes could include] sharing facts of our daily basis if like a bar of chocolates, how many sugar it contains and attach it with sugar bars, and maybe…Like a Kit-Kat bar, showing you how many sugar it contains. – P18, age 23*

Theme 2 (TDF Domain): Beliefs about Capabilities

Sub-theme 4: *Successful weight loss in the past means it is possible again*

In terms of "belief about capability," several participants referred to previous attempts to lose weight, whether via diet, exercise, or surgery, as a key reason for their current interest in losing weight. They also interpreted past success losing weight as a sign that they could achieve similar results again, suggesting a sense of self-efficacy. One participant who had recently gained back weight after a successful weight loss experience, regularly looked at a photo of her slimmer self to feel motivated to exercise or manage her food intake:

> *Me… me before, this is my biggest motivator… like from one year I was 55 kilo and now I am 64, my biggest motivator is me, my picture in the last year. I put, put it in front of my…, no enough, when I want to eat, look at yourself, you can do it. - P8, age 25*

Others pointed to the great changes that occurred in their lives after losing weight, including improvements in personal health, work performance and relationships. Knowing that these outcomes were possible, as they had been experienced before, was a strong motivator to start losing weight again:

> I *already lose my weight, I was fat before, I did surgery to reduce my weight, before I can't carry my children, I can't go to my apartment, third floor easily, I choose this one because I try to make and do diet, unfortunately I didn't get it. Now thank God I lose weight. It changed all my life…, even my family, it is very nice when you lose weight. - P14, age 40*

Theme 3 (TDF Domain): Beliefs about Consequences

Participants' beliefs about the consequences of healthy eating and exercise were wholly positive and operated as facilitators to healthy lifestyle change. These beliefs centred on four broad areas: appearance, physical well-being, mental well-being and freedom.

Sub-theme 5: ***My appearance will improve with healthy eating and physical activity***

In terms of appearance, participants mentioned several ways in which losing weight would enhance self-presentation, including beauty, youth and thinness. Participants used phrases such as "to become beautiful," "skinnier," and "I will look younger" to express this theme.

Sub-theme 6: A healthy lifestyle will promote and protect physical wellbeing

Physical wellbeing included three elements: to "become fit," "to sleep better" and "to avoid chronic disease". Chronic disease was the most popular of these, and participants cited two benefits to preventing these conditions, remaining healthy in the present and protection against poor health later in life. A few participants framed chronic disease as a potential threat and emphasized that fear was a strong motivator to eat healthily:

> *I fear of any disease that may come, like cholesterol, diabetic, all of the diseases that may come or you may be affected by if you eat unhealthy food. This fear makes you to eat healthy. - P14, age 40*

Others saw managing their weight now as a wise investment for good health in later years:

> *And also, I think when I have a good weight in my age now…, I will keep my health good … also after 50 years old, or later… I have a good, also health cause my weight, my blood pressure… my blood sugar will be good… if I have a good weight and I can avoid a lot of disease like the diabetes and also some pains like knee pains, leg pains. - P2, age 22*

In some instances, participants pointed to a history of disease in their family as a reason to exercise and maintain healthy diets as young adults:

> *Also, I saw my mom she fat. She has like back pain, knee pain, hypertension, diabetic, all that because she is high…, so we have to look about our self, our self specially if we have our family with these diseases. - P9, age 24*

Sub-theme 7: A healthy lifestyle will promote mental wellbeing

Participants suggested that physical activity and weight loss provided emotional benefits, including happiness or "feeling better," (i.e. a general improvement in well-being) as well as greater self-confidence and stress reduction:

> *Sometimes it takes the stress away, whenever you walk a lot or make some exercise like cardio... - P14, age 40*

> *Maybe it [losing weight] increases even our self-confidence. When we are little, you know, when we are not so fat, you know, you can stand in front of everyone, but when you are fat you feel a little bit shy. Yes, we feel insecure being fat, maybe this. - P16, age 33*

One participant compared the positive mindset resulting from weight loss with the negative outlook associated with weight gain, using exaggerated language to describe the difference:

> *The happiness also, the satisfaction, self-confidence that she talks about, everything, everything. Gaining weight is the worst thing in life. – P7, age 46*

Sub-theme 8: *A healthy lifestyle will enhance personal freedom*

Weight loss was associated with two types of freedom: freedom of choice and freedom of movement. Participants described losing weight (and obtaining a slimmer body) as a process that broadened social and personal options and increased autonomy. The freedom to wear whatever one liked and to choose among self-presentation styles was seen as especially beneficial:

> *If you are skinny, I think you can wear whatever you want. You can eat whatever you want. You don't have to guard anything, but if you are fat, you can't. You can't dress whatever you want. You have to be careful with everything, I think. – P14, age 40*

Other participants mentioned that weight loss produced greater freedom of movement and a feeling of comfort in one's own body:

> *You can do whatever you like, you can jump, you can run, you can …- P7, age 46*

> *Even the movement of your body, you can walk a lot, you will feel lighter. - P13, age 26*

Theme 4 (TDF Domain): Reinforcement

Sub-theme 9: ***Competitions and rewards incentivize weight loss***

Several participants suggested that weight management programmes should include competitive challenges and prizes as weight loss incentives. They described competitions involving both healthy eating and physical activity goals:

> *A drinking water challenge. How many litres they are drinking by the end of the week? - P18, age 23*

> *I think competitions maybe with having a winner, giving something to that winner. I think stars or something. This might me motivation…yes. – P8, age 25*

While most participants saw competitions and rewards as straightforward weight loss enablers, a few had a more layered perception and were interested in competitive activities to relieve daily pressures. Given the extra burden of household and childcare responsibilities, married/older women were especially keen to engage in weight loss competitions that provided a feeling of joy. In this sense, competing became its own reward and reinforced commitment to the weight loss process:

> *Making walking competitions in the university. Walk around the university like five times, and there is a winner…we want fun. Give us the moons, for example, something to motivate us. We need colours; we need music. We need to live. We need to feel what we are humans, to get away from this stress. - P7, age 46*

Theme 5 (TDF Domain): Intentions

Sub-theme 10: Willpower is essential to weight loss

Willpower was a concept that several participants highlighted as critical to weight management. They viewed it as an intrinsic motivator that a person either did or did not possess. However, without this determination or self-control, efforts to increase physical activity or change eating habits would always fail no matter how many extrinsic factors were altered:

> *Laziness, I think, because if you don't have determination, because it is easy to do exercise one day, then it's hard to commit for rest of your life…I feel like it's your mind that stops you from doing these things, and the one that pushes you to do these things. That's the only barrier I feel like I have. – P15, age 24*

Theme 6 (TDF Domain): Emotion

Sub-theme 11: Stress is as a barrier to weight loss

A few participants directly tied their emotional states to an inability to eat healthily. Stress' impact on food intake was described in two ways. Mainly, stress was presented as a result of negative body image due to excessive eating. As one participant explained, negative self-perceptions damaged self-esteem, producing stress and leading to renewed over-eating, creating a negative feedback loop:

> *Looking in the mirror sometimes effects your mental phase. You might go under stress and depression, you will eat more…negative feedback. – P14, age 40*

Alternatively, one participant, a married student, blamed her poor eating habits on stress, which she attributed to the pressures and responsibilities of marriage:

> *Sometimes the marriage and your husband also affect your body. I don't like to eat. I am a healthy person, but you know the stresses over you, this will make you even, so be careful. – P8, age 25*

Theme 7 (TDF Domains): Goals

Sub-theme 12: Setting goals is important to achieving weight loss

When asked what would motivate them to attend a weight management programme, participants emphasized setting individual or collective goals:

> *If I have a goal, I want to do that one. Maybe I look for this session to have it. – P1, age 28*

In terms of how to set goals, participants suggested creating different target areas throughout the intervention to keep participants engaged and motivated:

> *Maybe if we have different goal every month, so one month we focus on lowering our fat percentage, and the other month we focus on gaining more muscle, so every month we have a different goal. That would leave us to lead a healthier life. - P17, age 23*

Theme 8 (TDF Domain): Behavioural Regulation

Sub-theme 13: Monitoring lifestyle behaviours is important to achieving weight loss

In terms of "behavioural regulation," participants frequently referred to monitoring, whether this involved self-monitoring of target behaviours or weight or monitoring by other people, preferably a course instructor or facilitator:

> *Get us experienced people to monitor our diet and monitor our weight. This will also motivate us…somebody should keep pushing us, you know, maybe a push along with it… they are following up with us. This might even motivate me to attend. – P10, age 25*

Some participants felt that pedometer watches or fitness phone apps with the ability to track steps would help motivate them to meet weight loss goals:

Maybe checking people's steps. If you tell them to buy a watch and see how, or on their phones, you can see how many steps they walked, and the one who walked the most wins something. – P9, 26

Using social media for self-monitoring of behaviour was a popular idea among the participants. Some suggested creating WhatsApp groups in weight management programmes so participants could keep track of one another's progress and remain engaged in the weight loss process:

Or like you have a WhatsApp group or something. Okay, like did you write down what… how much you exercised, or what did you eat or things like this. May be that will keep us all throughout. - P16, age 33

Alternatively, one student suggested accessing an online service that assessed food related and physical activity behaviours throughout the weight loss process:

Like the, you know, the healthy monitors the people that you can, you know, share with them monthly and pay for them, and they track what you are eating on daily basis and you talk to them… they will track you on the social media like Instagram, Facebook. They will communicate I think through WhatsApp on daily basis. You will send them what did you eat. She will tell you, no don't eat, please eat, and she will tell you… - P7, age 46

Theme 9 (TDF Domain): Environmental Context and Resources

Participants discussed the environment in which they negotiated food related and physical activity behaviours, including specific contextual and resource-related factors facilitating or inhibiting healthy lifestyle behaviours. These factors were related to time pressures; cost; the city environment, especially its massive size; the campus food and fitness environment; access to fresh, healthful food in the community; and lack of calorie guidance on restaurant menus.

Sub-theme 14: Time pressures impede healthy eating and physical activity

By far, the most common obstacle to healthy eating and exercise was time. As university students, participants felt that they were constantly managing competing demands and simply did not have enough free hours to engage in healthy lifestyle behaviours:

> *The major barrier is limit of time; we don't have time. We like to cook healthy food at home, but we don't have time. As university student, we are studying like 18 hours out of 24. We just sleep four hours or sometime six hours. When do you want me to cook healthy food? – P1, age 28*

The thought of adding another commitment to already busy schedules felt overwhelming for participants, especially for those who were older/married, and acted as a barrier to weight loss:

> *I am waiting until I graduate in order to lose weight. Actually, during university I gained, gained a lot of weight, but I cannot do anything. You study, you feel hungry, you have to eat, you have no time to exercise. Even the university doesn't help us to move and physically be active, lot of homework, as if stuffing you, killing you. – P14, age 40*

For one participant, a health science major, difficulty finding time to cook after a long day at university was especially frustrating, given her deep knowledge of nutrition. However, academic obligations meant she had no flexibility with her schedule:

> *I like cooking healthy food, that's what motivate me, cooking for myself healthy and eating and in addition, to stay away from diseases. We are health sciences graduates; we all know this. We want to do it, but you know, it's the time, and lot of bad things, but we know healthy food is very delicious, and we like it, and we like cooking it even*. *- P12, age 24*

When discussing time constraints on exercise or healthy eating, several of the older participants attributed this issue to their multiple responsibilities as mothers/wives, employees, and graduate students, framing this tension as a dilemma of "the modern working women." In this way, they compared current gender roles with those of previous generations, noting that while social changes had created greater opportunities for women outside the home, normative expectations concerning responsibility for the domestic domain remained the same:

> *Females now have huge responsibilities other than the previous, in the previous our mothers used to sit at home, they don't work and look for us, what we are doing? We are working. We have to get pregnant. We have to bring up children. We have to study, why? You have a lot of responsibilities; men they don't have these responsibilities. So, we should have somebody to cook for us at work and at home. - P7, age 46*

Sub-theme 15: The high cost of healthful food impedes healthy eating

Price was also a barrier mentioned frequently by participants. A few focused on food costs in stores or markets, but far and away, the greatest concern was the price of restaurant meals. While fast food and other less healthy foods were inexpensive, participants felt that the nutritious food was too costly:

> *Like in the restaurant, they provide unhealthy food, but healthy food… usually high price. -P12, age 24*

Sub-theme 16: The city environment impedes physical activity

Another concern focused on the environmental context of the city (Riyadh), especially its layout and massive size. Participants explained that given the city's expanse, gyms were often far from home or campus, hindering efforts to exercise. In addition, wide distances between places made cars essential for travel in the city, preventing them from walking:

> *We are in the huge city, because we are in the centre, the destination is so far, if I want to…we have gym, but it is far from my house, so because we are in huge city, not in the small...when we travel to another country we walk, so we lose weight. When I travel to my country, I lose weight, because we don't use cars. I am from Syria. I am living in village and don't*

use cars. Here city we use cars, also in huge cities, we use cars. - P3, age 22

Also, we use car all the time, that's a reason, in another country they run or walk more than use the car. – P5, age 23

Some participants commented on the lack of walking spaces in the city, including the university campus, although others countered that walking was possible in the malls. One participant specifically linked limitation on female mobility with the poor access to walking spaces:

If there is campus, we could walk, no campus and so no place to walk,.. see green things, beautiful place to walk to enjoy…and I think this is the main issue in Saudi Arabia, no place for females to walk. -P7, age 46

Sub-theme 17: The campus environment impedes healthy eating and exercise

Several students argued that the university campus' food environment operated as a barrier to healthy food related behaviours. They specifically criticised the campus cafeteria, observing that it offered few nutritious snacks or meal options:

Here in my university, it is not healthy food, here… it is not healthy, yes… chocolate and … all of sugar… - P7, age 46

They also observed that the healthy food on offer at the cafeteria was expensive and unpleasant, adding that they were far more likely to consume the "delicious" and "tasty" fast food options made available:

And also the lack of the availability of the tasty food, you can't,… like hunger station, you can take any food, but healthy food is very limited and you can't, and also it is over price and not tasty…, it is not tasty. - P12, age 24

Ultimately, participants felt stuck eating cafeteria food, since time pressures prevented preparing food at home and bringing it to the university:

Don't have time to prepare healthy food. You cannot eat anything you want. It needs to be prepared earlier, so I still think it is because of the time management, I don't have time to prepare for me, so when I go to the university, I eat whatever is served, like fast food. - P17, age 23

Finally, participants noted that the lack of a gym or fitness centre at the university restricted their ability to exercise, particularly since they spent so much time on campus. One participant suggested that access to such a facility would allow students to make use of free time between classes to exercise:

Why not have a fitness centre here, yes…, instead of sitting in the cafeteria and eating, we can, you know, exercise waiting for our lectures. We should have the facilities. - P11, age 35

Sub-theme 18: Lack of shops selling healthy food hinders healthy eating

An inability to shop for food on the way home from university was also identified as a barrier to healthy eating. Participants noted that there were few shops selling fresh products and other healthy food on their routes to and from campus, meaning that that another route was necessary to purchase these items. However, time constraints made taking an alternative path challenging:

There should be more shops outside to sell the good food, the healthy food, for working females. If you don't have time, just pass by when you are getting home, you will buy the healthy food before we get home, but if you get home, and you will see the things around you, you will eat you, know, something that is fast and yes…and reachable... You don't have time to cook, so we will bring anything that save money and stomach, and anything that will fill the stomach. – P13, age 26

Sub-theme 19: Lack of calorie counts for restaurant meals impedes healthy eating

Finally, participants believed that maintaining a healthy diet would be easier if restaurants provided customers with information detailing the number of calories in their meals:

> *At every restaurant in the Saudi Arabia, every menu should have calories, have to write it. I think people see that maybe effect their opinion from eating.* - P4, age 23 (Note: An initiative went into effect in KSA in January 2019 mandating restaurants to display calorie counts for each item on their menus.)

Theme 10 (TDF Domain): Social Influences

Participants mentioned multiple social factors influencing their ability to manage weight, including social support for exercising, pressure to eat like others and the culture and tradition of KSA.

Sub-theme 20: Social support is important to promote weight loss

In terms of social support, participants felt that having a group of friends or peers to exercise with was an important facilitator of weight loss; several clearly expressed their unwillingness to keep fit without this support:

> *We need someone to support us. There is no one to support me. I want someone who will do with me the exercises, so I don't like to do the exercises alone. I will not do it… - P12, age 24*

Similarly, having encouragement from friends and family to engage in healthy eating was identified as key to weight management through diet:

> *In general, surrounding environment, it can encourage you to be healthy, like your family can help you, your friend can help you,…with just eat, eat, eat, open day, making open day. -P3, age 22*

Others made it clear that they had no interest in participating in a weight loss programme that did not provide a strong social support system. For example, emotional warmth and social encouragement were characteristics that participants found attractive in an instructor or group facilitator:

> *They [the instructor] should stay close to us, not give us diet and leave you alone. We need support, it could be emotional and physical. -P9, age 24*

One student commented that support groups comprised only of students with overweight and obesity might help to motivate students to achieve healthy food related and physical activity behaviours. Specifically, she felt that weight loss might be more likely if people with a shared understanding of weight issues worked together to meet weight loss goals:

> *Emotionally sharing stories, for example, obesity problems, and they work together on this to lose weight, this is motivational, …make it emotional classes with two people or ladies. Maybe if they are obese, put them together and make them work hard, because they have the same feeling, same suffering. But if you bring somebody who is fit and somebody who is obese and put them together, for sure the class will not be…, classify people. – P9, age 24*

Several participants compared positive social support of healthy lifestyle behaviours (e.g. praise or encouragement) in weight loss programmes with coercion or enforcement of behaviours to argue that the former approach was a far more effective motivator:

> *The people there, how they interact with me, are they supportive, motivational? When you want to lose weight, you don't want someone to…, you don't want to feel enforced. You want someone to support you and be nice to you, so it's their behaviour. - P2, age 22*

Judgmental environments in weight management classes were also deemed discouraging to weight loss:

> *The people with you in your group, if they are judgemental, I won't complete in the programme. You won't be comfortable sharing whatever you do with them. For example, if you are sitting and talking about yourself*

or talking about what you have did in the last days, you may look at some people, and they will maybe stare at you, or give you looks that you feel they are judging you, so you won't or you can't complete sharing your life with them, so you will just quit the programme. -P17, age 23

Sub-theme 21: Peer pressure can be an obstacle to healthy eating

A number of participants mentioned that weight loss was difficult because of pressure they received from friends or family to maintain unhealthy eating habits. One domain where this pressure occurred was in the home, where family members expected participants to conform to their dietary behaviours. Two of the married women observed that their weight troubles developed or increased because their husbands expected them to eat the same food they did:

> *When I was in, with my family, I was very healthy person. They eat like vegetables all the time. When I married, he is very like burger, what I will do? Burger… breakfast to lunch to dinner and Pepsi and Pepsi and he is very thin. I get fat, he is still in the same weight, so it is very hard, I promise…I am tired… - P8, age 25*

> *You are reminding me of myself, 30 years ago when I got married, like I was 50s like 57kgs, and my husband is like this* (she raised her finger up to show that he is thin), *and you know what happened after 30 years? I gained a lot of weight because he likes to eat and he never gets fat, God bless, and all the time I have to feed him, and when you feed him, you have to eat. - P7, age 46*

Social gatherings were settings where group pressure made it especially hard to moderate food intake:

When you go to gathering or when you go out with your friends, you are all eating like unhealthy food. -P17, age 23

Sub-theme 22: Cultural norms of KSA impede healthy eating

Finally, food culture of KSA was identified as a barrier to eating in a healthy manner. One obstacle the participants discussed was the nature of the local diet which they felt was comprised of ingredients that were calorie dense and low in nutrients or likely to encourage weight gain:

> *The culture in the country, like drinking Arabic coffee plus sweets, all the time sweets, sweets, sweets around you. - P8, age 25*

Some participants pointed to the culture of KSA around food that encouraged eating food together by sharing the same meals, compromising diets as well as weight management:

> *And also, the social system here, the families eat together, and so you can't have a separate meal and the traditional cuisine are filled with oil… - P2, age 22*

4.7 Discussion

4.7.1 Summary of Evidence

The present study explored perceptions of weight management and healthy lifestyle behaviours among female university students in KSA. Unlike most studies, which have focused on the prevalence rates of obesity in KSA, this study used a qualitative approach to better understand female students' perspectives on barriers and enablers of diet and physical activity as well as attendance at a proposed weight management programme. Analysis of the data allowed for identification of emotional, social, and environmental factors affecting students' behaviours in these areas and determination of whether these factors were part of a university system or whether they stemmed from sources outside this setting. The process of mapping study themes to the Theoretical Domains Framework (TDF) and COM-B model highlighted relevant BCTs to apply to my weight management intervention targeting this population.

In the present study, participants generally felt that they were well-informed about weight management issues, specifically healthy eating, and physical activity. They viewed both weight management approaches as important to maintaining health, controlling weight and preventing chronic disease. Despite these beliefs, most admitted that they were not regularly exercising or engaging in healthy eating habits and that they found it difficult to integrate these behaviours into their daily lives. For example, students acknowledged overeating, consuming significant amounts of fast food and not meeting international dietary guidelines (WHO, 2018). These behaviours have also been noted in previous studies on the eating habits of university students in the Kingdom of Saudi Arabia (KSA) (Abdel-Megeid et al., 2011; Al-Qahtani, 2016; Al Qauhiz, 2010; Al-Rethaiaa et al., 2010). For example, one study focusing on female nursing students found that participants routinely engaged in unhealthy eating practices, such as watching television during meals or consuming large amounts of soft drinks and junk food (Sabra, 2014).

The participants' contention that they were knowledgeable about healthy eating corresponds with international research showing that consumer understandings of nutrition are largely accurate (Paquette, 2005; Povey et al., 1998) and that insufficient knowledge about nutrition is infrequently mentioned as a barrier to healthy eating (De Ridder et al., 2017). This has led some researchers to suggest that the challenge facing consumers is not so much lack of information about nutrition but how to apply dietary guidelines at an individual level (Lappalainen et al., 1998).

Having an awareness of this gap (between abstract nutritional knowledge and practical application) is useful when designing effective weight management interventions. In fact, in discussions, some participants stated that they would be uninterested in attending weight management programmes that spent considerable time on already familiar nutrition education. This view suggests that interventions establishing a balance between an applied education strategy (e.g. tools to engage in healthy eating in everyday life) and other approaches to weight management may be more likely to motivate and retain individuals. Indeed, balance was a theme that was brought up regularly by participants, particularly its importance to diet as well as to weight management programmes. For participants, programmes incorporating "realistic" expectations for weight management, such as flexible dietary rules, were considered more favourably. This finding coincides with previous research showing that weight loss approaches emphasizing incremental change and realistic goal setting are more effective long-term (Greaves et al., 2017; Hindle & Carpenter, 2011; Kozica et al., 2015; Penn et al., 2013).

Participants in the current study discussed a number of emotional and behavioural barriers to healthy eating and/or physical activity. Stress was frequently mentioned as a barrier to weight management, since eating was used to cope with emotional pressure. Students associated stress with home, work and university pressures and negative self-perception about body size and attractiveness, a finding that supports previous research on barriers to weight management among women of KSA (Al-Mohaimeed & Elmannan, 2017; Rasheed, 1998), including female university students (Awadalla et al., 2014). Another emotional/behavioural barrier to weight management highlighted by participants was lack of willpower or what was seen as poor self-control, a finding which again corresponds with existing research on female university students in KSA (Awadalla et al., 2014).

The issue of willpower was brought up during discussions about enablers to attending weight management interventions. Many participants commented that they were likely to find weight management programmes interesting if they included means to monitor progress toward individual goals, whether via pedometers, weight loss apps or face-to face sessions with course facilitators. Participants suggested that these types of strategies would promote self-control and motivate them to continue with their weight loss efforts. In fact, devices such as accelerometers, pedometers and mobile phones are increasingly being used in weight loss interventions, particularly to compensate for long standing issues with unreliable self-report measures, and are typically recommended by researchers (Freedson et al., 2012; Hallal et al., 2012; Silfee et al., 2018).

In general, the literature offers support for interventions that incorporate various forms of monitoring. Both meta-analyses and individual studies have found that self-monitoring positively influences health-related behaviours that are being targeted for change as well as intervention outcomes (such as weight loss), either alone or in combination with another BCT (Bird et al., 2013; Greaves, et al., 2011;

Martin et al., 2013; Michie, et al., 2009; Olander et al., 2013; Samdal et al., 2017). Similarly, evidence exists showing that monitoring on the performance of behaviours, whether online, one-on-one or in a group environment, positively impacts these behaviours and/or intervention results (Celis-Morales et al., 2014; Olander et al., 2013; Samdal et al., 2017; and Sherrington et al., 2016).

A considerable amount of the focus group discussions centred on environmental and social barriers to weight management, both inside and outside the university. Environmental barriers mentioned by participants included lack of time (due to academic, work and household demands); city size and dependence on driving; the high cost of healthy food on and off campus; and lack of access to nutritious food in the campus cafeteria and in community stores and restaurants. Many of these constraints have been discussed in previous research on weight management in KSA (Al-Mohaimeed & Elmannan, 2017; Awadalla et al., 2014).

While a university-based intervention would clearly not be capable of changing the built environment to help individuals lose weight, an alternative involves incorporating problem-solving as a BCT. In this approach, participants analyse and identify strategies to overcome environmental barriers, a method that has positively affected outcomes in previous weight management interventions (Avery et al., 2013; Celis-Morales et al., 2014; Hankonen et al., 2014; Martin et al. 2013; Olander et al., 2013; Samdal et al., 2017).

Lack of access to leisure facilities as well as places for walking on campus or in the city were also mentioned as barriers to physical activity. In some cases, participants directly linked poor access with cultural customs about gender-segregation that have restricted development of infrastructure for women's athletic and leisure activities. This issue has been discussed in previous research on obesity in KSA and other Middle Eastern nations (Albassam et al., 2007; Ali et al., 2017; Alqout & Reynolds, 2014; Al-Mohaimeed & Elmannan, 2017; Badran & Laher, 2011). The implications of this barrier to exercise are extreme. According to one systematic review, prevalence of physical activity is up to 40 percentage points greater for males of KSA than for females of KSA (Mabry et al., 2016).

In a recent study on women of KSA with obesity planning bariatric surgery (Alqout & Reynolds, 2014), the authors found that many respondents were considering medical intervention for weight loss because of a perceived lack of exercise options. However, the authors cautioned that there is some uncertainty as to whether participants were actually unable to access exercise spaces; whether they lived in family circumstances that were especially restrictive; or whether they were disabled due to their obesity. Regardless of the reasons, the fact that multiple studies have indicated that this is a barrier to physical activity for some women of KSA suggests that an intervention which promotes exercise in an accessible location for female students would help address this issue.

In terms of social barriers, participants focused on three key factors preventing them from healthy eating or physical activity. First, some participants stated that lack of social support from friends (or family) kept them from exercising, particularly because they felt that they could not sustain exercise without involving a group of peers in the activity. Lack of support for physical activity has been discussed in previous research on university students of KSA (male and female) (Al-Hazzaa, 2018; Awadalla et al., 2014). Given similar findings in other Middle Eastern countries (Musaiger et al., 2013), it is likely that there are regional-specific factors that contribute to this issue, including parents who appear to favour educational and religious activities over physical activities for their children (Sharara et al., 2018).

In discussions about potential weight management programs, many participants suggested that social (and emotional) support would facilitate commitment to behavioural change. They specifically focused on non-judgemental group discussions and support sessions as vital components of promising weight management programmes. Within the literature, social support has been identified as a BCT that significantly affects intervention outcomes (Avery et al., 2013; Hankonen et al., 2014; Martin et al., 2013; Olander et al., 2013; Samdal et al., 2017.) When implemented, this approach may include providing group discussions, helping individuals to locate self-help support groups or advising people to call a friend when they feel like avoiding performance of a behaviour (e.g. physical activity) so that he/she motivates him/her to perform the behaviour.

Social pressure to follow friends' or the family's eating patterns was also a subject among focus group participants. This pressure existed during peer group events or during mealtimes with family members (particularly husbands) who preferred fattier, less nutritious foods. These concerns were linked with comments about traditional calorie-dense foods of KSA (e.g. sugary desserts or chocolate) present at many social occasions as well as hospitality customs, which dictate offering chocolates as gifts at social gatherings. This theme has been noted in other studies on barriers to weight loss among women of KSA (Alqout & Reynolds, 2014; Al-Mohaimeed & Elmannan, 2017) and among women in other Middle-Eastern cultures, including the United Arab Emirates (Ali et al., 2008; Benjamin & Donnelly, 2013). Researchers have also noted that many of these social gatherings occur in the evening (Al-Mohaimeed & Elmannan, 2017), increasing the likelihood of weight gain due to night-time eating (Katayose et al., 2009; Kinsey & Ormsbee, 2015).

Research suggests that the ability to modifying eating customs is limited regardless of the culture in which efforts take place (Hammarström et al., 2014). Based on this understanding, developing an intervention to successfully address cultural eating patterns poses a significant challenge, with problem-solving once again offering a way to help participants plan and strategize about changing their behaviours in problematic situations.

Some participants in this study mentioned that they were not able to exercise or prepare or eat healthy meals due to time constraints stemming from their responsibilities as wives and mothers. Past studies on women of KSA and obesity have pointed to women’s tendency to overlook their own health out of a sense of duty to other family members. In specific, gender roles have been found to affect weight loss for women who have difficulties taking personal time to exercise in the face of household demands or cultural disapproval of women’s involvement in activities outside of the home (Donnelly et al., 2011; Alqout & Reynolds, 2014).

In the present study, several older and married participants cited challenges to exercising or eating nutritious meals within a discussion that emphasized their roles as “modern working females.” While participants still perceived gender roles as barriers to weight management, they acknowledged that these roles have evolved from previous generations, creating the expectation that modern women of KSA simultaneously work and assume responsibilities for domestic matters (Al-Asfour et al., 2017). A weight management intervention that frames its approach within this discussion is perhaps more likely to attract and keep participants. To this end, programmes might emphasize how weight loss could enhance the ability to meet gender responsibilities and/or offer practical instruction on means to manage time constraints (e.g. providing ideas on how to cook quick and easy healthy meals).

Despite the weight management barriers mentioned above, participants discussed several important enablers to exercise and healthy eating that could be incorporated into the potential weight management intervention, including the desire to enhance physical appearance, mental and physical well-being and personal agency. One of the strongest enablers for weight loss among the participants was the desire to prevent chronic disease. While research suggests that existing medical conditions motivate weight loss and promote higher levels of weight loss and maintenance (Gorin et al., 2004), there is less evidence to show that a relationship exists between the desire to prevent chronic conditions and adherence to weight loss regimes. However, research does indicate that people motivated to lose weight in order to improve their health may have characteristics that make them more likely to succeed in managing their weight than those who choose to lose weight based on body-image (Thome & Espelage, 2007).

Providing social rewards depending on successful performance of behaviour was proposed by some participants as an incentive to meet weight loss goals. Prior literature reviews and meta-analyses examining the effectiveness of this BCT, alone or in combination with other methods, have found mixed results for weight loss (adults and children) (Celis-Morales, Martin et al., 2013; Olander et al., 2013; Samdal et al., 2017; Van Genugten, 2016). Given the existence of positive results (Celis-Morales, Olander et al., 2013; Samdal et al., 2017) and participants' interest in this approach, it may be useful to incorporate this BCT into the potential intervention.

Another motivator mentioned by participants is what this study terms "freedom." In this context, freedom refers to a sense of agency that some participants felt would be realized by losing weight, as this change (re)oriented their relationship with their bodies, the environment, and other people. The theme of freedom/autonomy was discussed in a prior study on women of KSA with obesity (Alqout & Reynolds, 2014) which found similar thoughts about weight loss and physical freedom and comfort. Efforts to frame discussions about the benefits of weight loss around the concept of freedom/agency may improve the effectiveness of the potential intervention.

4.7.2 Strengths

This is the first study to explore the preferences and dislikes of female university students with regard to attending a weight management programme. It is also the first study to identify personal, socio-cultural and environmental barriers and facilitators to weight management, including those specific to culture of KSA, drawing on the TDF and BCW as guides. Using the TDF and BCW in data analysis provided a systematic approach to facilitate identification of BCTs to incorporate into the potential weight management intervention.

4.7.3 Limitations

This study used convenience sampling to explore the views of 18 female university students of KSA on weight management barriers and facilitators, thus limiting the ability to generalize the findings to the larger population. Another limitation may be researcher bias, which has implications for the study's trustworthiness/confirmability (Lincoln & Guba, 1985). As the sole investigator, I attempted to reduce bias by employing strategies to increase rigour in qualitative work (Lincoln & Guba, 1985; Padgett, 1998) but these were not exhaustive. For example, when coding the data, I did not use any element of multiple coding, such as cross-checking coding strategies with another researcher. As a result, I may have limited the interrogation of the data and potentially eliminated alternative interpretations.

While I approached moderating the focus group discussions in as objective a manner as possible, there is the possibility that I had some influence on the type of information that was produced. While the focus group discussions offered an ideal format for participants to discuss and develop ideas together, it is possible that some 'groupthink' occurred and participants' answers conformed to narrow lines of thought (Janis, 1982). However, as moderator, I tried at all times to encourage input and diversity of opinion and recall multiple instances when participants voiced differing opinions.

While the focus groups were conducted in English, which was not the first language of the participants, this does not appear to have been a significant problem. No one objected to conversing in English before the discussions began and there was no time when students struggled to express themselves in English. However, it is always possible that conducting the sessions in English may have prevented some students from conveying more nuanced opinions. For example, two sentences from one student were translated from Arabic to English, which might have caused some slight difference in meaning, so nuances may have been lost in this process.

4.7.4 Implications for Intervention Development

The results of this study will inform the development of my weight management intervention intended to modify participants' food related and physical activity behaviours. Table 4.4 provides a full list of promising BCTs to incorporate into the intervention. Examples of intervention functions include:

a) Education
b) Training
c) Persuasion
d) Incentivisation
e) Enablement
f) Environment restructuring

Examples of BCTs include:

a) (2.3) Self-monitoring of behaviour and (1.1) goal setting (behaviour) (including use of pedometers or smart apps)
b) (6.1) Demonstration of the behaviour and (3.1) social support (unspecified) (including groups discussions and support sessions)
c) (1.2) Problem-solving (to negotiate environmental and cultural barriers and integrate healthy eating into daily life)
d) (13.2) Framing/reframing
e) (4.1) Instruction on how to perform the behaviour

4.8 Conclusion

This chapter described focus group discussions to identify barriers and enablers of weight management for female university students in KSA. It identified important aspects of personal, social and environmental barriers and facilitators and placed these findings within the TDF and the BCW model to help identify appropriate intervention approaches and potential BCTs. It is clear from the study that this sample of female university students (those responding to advertisements to participate in the research) were interested in healthy eating and physical activity and were keen to apply strategies that will enable them to manage their weight, as long as these strategies are consistent with their preferences. Findings from the study indicate that it is critical to understand the cultural environment in which eating and exercise take place. A deeper understanding of the factors motivating or discouraging people from making behaviour changes to support weight loss in KSA is essential to developing targeted interventions that help reduce the burden of obesity among the country's various populations.

Chapter 5: Development of the Better Healthy Lifestyle Programme

5.1 Introduction

This chapter describes the development of the Better Healthy Lifestyle (BHL) programme based on the Medical Research Council (MRC) framework and the Behaviour Change Wheel (BCW) as discussed in previous chapters.

5.2 Better Healthy Lifestyle: A Complex Intervention

As described in Chapter 1, the Medical Research Council (MRC) offers guidance to develop and evaluate randomised controlled trials (RCTs) for complex interventions. A complex intervention involves multiple, often interacting, components as well as other dimensions of complexity, such as the range of behaviours required for intervention participants, difficulty of implementation, the number of target groups, and the variability of outcomes (Craig et al., 2008). Complex interventions use education or psychosocial strategies to change health-related knowledge, behaviours, or beliefs (Redfern et al. 2006).

Based on the above definition, the BHL programme can be considered a complex intervention for the following reasons:

(i) BHL is a multicomponent intervention that was developed based on existing evidence from similar settings and previous literature reviews in the field of weight management and behaviour change.

(ii) Students will demonstrate a diversity of responses to the same intervention during the delivery of the sessions.

(iii) BHL is an intervention that includes educational sessions designed to improve physical activity and dietary habits with the support of BCTs.

5.3 MRC framework: Development of the intervention

As mentioned previously, the BHL programme was developed using the MRC and BCW frameworks shown in Figure 1.9 and discussed in detail below:

Step 1 (MRC): Identifying the available evidence-base

Before designing the BHL intervention, I thoroughly assessed relevant behaviour change theories as well as the literature supporting obesity management among female university students. I conducted a systematic literature review (Chapter 3) to identify and evaluate the existing evidence on weight management interventions targeting female university students. I also conducted a qualitative study (focus group discussions, Chapter 4) to explore female university students' perceptions of barriers and facilitators to a healthy lifestyle as well as preferences for attending a weight management programme. The findings from these two studies informed the design of the BHL programme.

Step 2 (MRC): Identifying/developing theory

The BHL programme includes educational sessions to facilitate changes in dietary and physical activity behaviours to promote healthier lifestyles and long-term weight loss. The BHL programme's approach was shaped by the Theoretical Domains Framework (TDF) (Cane et al., 2012; Michie et al., 2005) and the BCW, including the COM-B model (Michie et al., 2011). (The TDF, BCW, and COM-B are described in detail in Chapter 4.) The BCW's intervention development process (Michie et al., 2013) involves three stages and eight steps. The three stages include:

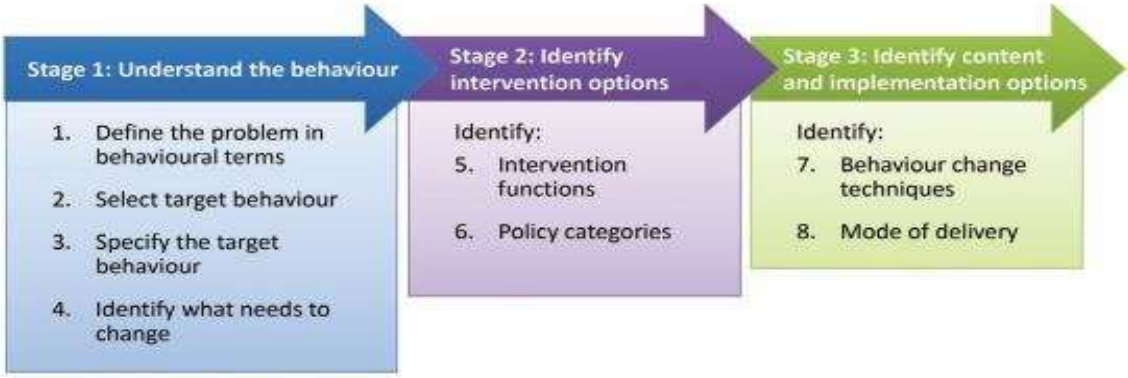
1. Understanding the target behaviour

2. Identifying the intervention options

3. Identifying content and implementation options

Each stage is shown in Figure 5.1 (Michie et al., 2013).

Figure 5.1: BCW Intervention Development Process

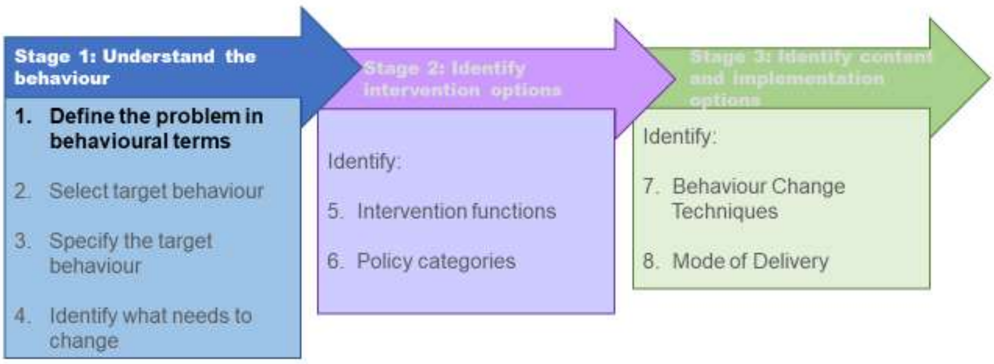


Stage 1 (BCW): Understand the target behaviour

The first stage, which focuses on understanding the target behaviour, consists of four steps.

Step 1 (BCW): Define the problem in behavioural terms

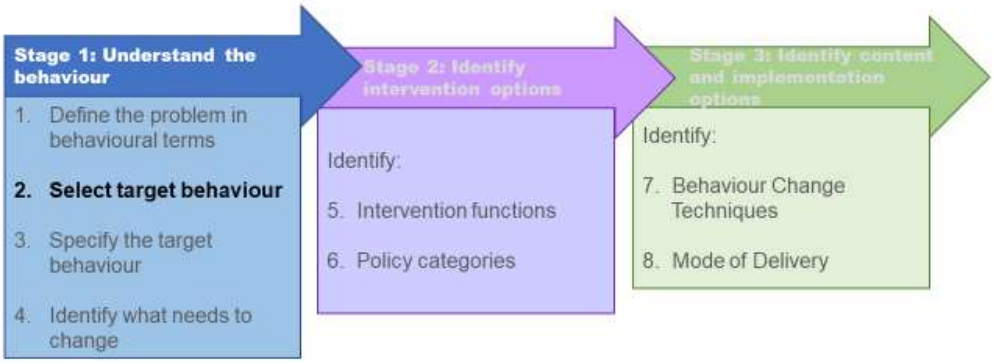
Figure 5.2: Step one: Define the problem in behavioural terms



The first step (Figure 5.2) in the BCW's intervention development process involves describing the "behaviour in behavioural terms" (Michie et al., 2013, p. 6). This includes recognizing the behaviours that need to be changed, the target population and the setting. In terms of the BHL intervention, the literature has identified unhealthy consumption patterns and lifestyle behaviours as major factors for obesity risk among the population of KSA (Almutairi et. al, 2018; Alqarni, 2016). According to the literature, the unhealthy dietary habits that are associated with the weight gain of the population in KSA are high energy intake due to the consumption of high calorie food items (Al-Hazzaa & Musaiger, 2010) and high calorie beverages (Alqarni, 2016), low consumption of fruits and vegetable intake, consumption of snacks as their main meals, frequent snacking or over snacking, (Alqarni, 2016; Al-Rethaiaa, 2010), skipping of breakfast, and high frequency of eating outside the home (Memish et al., 2013). The physical activity behaviours that are linked to weight gain include a sedentary lifestyle (Alqarni, 2016) due to a lack, or low levels, of physical activity among the population of KSA (Alqahtani et al., 2020). Obesity is especially common among female university students in KSA, with almost half (48%) of the target population experiencing high rates of obesity (Al Qauhiz, 2010).

Step 2* (BCW)*: Select the target behaviour

Figure 5.3: Step two: Select target behaviour



Step two (Figure 5.3) first involves listing all relevant behaviours that may have an impact on the health problem that needs to be addressed. Therefore, several potential dietary and physical activity behaviours for weight management were considered and are listed in Table 5.1.

Table 5.1: Outline of relevant behaviours for weight management

Potential dietary behaviours	Potential physical activity behaviours
1. Reduce consumption of high calorie beverages	1. Reduce sedentary behaviours
2. Reduce consumption of high fat foods	2. Increase moderate physical activity to 150 minutes per week
3. Reduce frequency of unhealthy snacking	3. Increase step count
4. Reduce portion size	
5. Reduce amount of fat and sugar in food	
6. Increase fruit and vegetable consumption	
7. Replace high calorie beverages with water	
8. Make healthier food choices[1]	
9. Reduce the frequency of eating from outside home	

This list should be narrowed down to include prioritized target behaviours, using a systematic technique that considers the following criteria (Michie et al., 2013):

1. The target behaviour(s) that has more influence on resolving the problem (reducing the risk of obesity).

2. The target behaviour(s) that is more easily changed in contrast to more difficult ones.

3. The effect of the target behaviour(s) on other relevant behaviours (that are considered central to behaviour in the system). In other words, this includes the behaviours that are more likely to help in changing related behaviour to achieve the required change.

4. The target behaviour(s) that is more easily measured.

Diet

Based on the literature, a consistent negative energy balance is required to achieve weight loss. As such, it is necessary to modify an individual's food intake to reach this goal. In the literature, most weight management studies include a change in diet to help participants lose weight. In my systematic review (Chapter 3) on weight management interventions for female university students, the majority of studies incorporated a dietary change component. Similarly, in

[1] I am now aware that this was not a specific behaviour and it has been mentioned in detail in section 6.8.4.

another systematic review on weight management interventions for university students by Plotnikoff et al. (2015), the bulk of studies included changes in food intake.

While dietary change components are common, the literature does not specify which dietary method is most effective (e.g., low fats or low carbohydrates). For instance, a recent 12-month weight loss RCT that compared a healthy low-fat diet with a healthy low carbohydrate diet showed no significant difference in weight change (Gardner et al., 2018). Due to inconclusive findings, students who participate in the BHL intervention will not be prescribed a specific diet. Instead, they will be taught how to make better food-related choices to adopt a healthier lifestyle.

Recent research on obesity recommends moving from a strict diet-based approach to weight loss to an emphasis on small, manageable changes in healthy eating and exercise (Gibson & Sainsbury, 2017). Evidence suggests that this more moderate or balanced approach to change has longer-term adherence, since it allows participants to set more realistic goals for eating and exercise (Gibson & Sainsbury, 2017). BHL's approach to weight loss reflects these findings. The programme will encourage healthy lifestyle awareness and lifestyle behaviours for students that can be sustained throughout their lives, regardless of weight. Restrictive diets will be discouraged due to their potential harm to psychological well-being and emphasis will be placed on healthy eating and physical activity behaviours instead of concentrating entirely on weight loss (Bacon et al., 2002).

Physical Activity

Physical activity is a significant component of weight management interventions that help to reduce weight. Physical activity results in energy expenditure, and this must exceed energy intake for weight loss to occur. In general, there are many health benefits associated with increased physical activity levels, such as weight reduction, improved mental health and lower cholesterol (Sharma et al., 2016). Moreover, physical activity helps in reducing the incidence of heart disease, stroke, cancers, dementia, hypertension, cognitive decline, osteoporosis etc. (Ryan et al., 2017). Overall, increased physical activity not only reduces weight but helps to maintain a healthy weight (Magosso, et al. 2017).

Moderate intensity physical activity provides most of the disease prevention and health promotion advantages of exercise in adults (NHS, 2007). In fact, research shows that small amounts of moderate exercise significantly diminish the risk for all-cause mortality. For example, the Harvard Alumni study demonstrated that simply moving from the least active category to the next more active category provides the greatest risk reduction in mortality (Paffenbarger et al, 1986; Rhodes et al., 2017). Physical activity levels can be increased gradually by changing behaviours, such as decreasing sedentary behaviours or engaging in activities like walking. According to the WHO (2011), adults should perform at least 150 minutes of moderate-intensity activity per week or 75 minutes of vigorous-intensity activity per week.

The potential behaviours (Table 5.1) were narrowed down based on the literature and the criteria mentioned above to the following target behaviours, to use in the BHL intervention based on the literature showing them as promising weight loss strategies:

1. Modify diet to adopt healthier eating habits

BHL's objective is to help students reduce their overall calorie consumption by replacing high calorie beverages with water, increasing fruit and vegetable intake and making healthier food choices.

(i) Replacement of high calorie beverages with water

In regards to the drinks' market, KSA provides the largest consumer base in the Middle East (Benajiba & Mahboub, 2019, Islam et al., 2020). Research conducted in KSA has indicated that 85.8% of adults of KSA consume sweetened soft drinks (Nada et al., 2019) leading to weight gain (Alqarni, 2016). Other research shows that the replacement of high calorie beverages with water is an effective way to reduce weight (Daniels & Popkin, 2010; Tate et al., 2012).Therefore, this target behaviour was chosen.

(ii) Increase fruit and vegetable consumption: Eat at least 400g or five portions of fruit and vegetables per day (WHO, 2018)

Existing evidence supports increasing intake of vegetables and fruits to promote weight management and health. For example, a systematic review of RCTs indicated that an increase in the consumption of fruits and vegetables decreases the intake of other energy sources, which may lead to weight loss and maintenance (Mytton et al., 2014). In addition, the WHO states that eating more fruits and vegetables reduces the risk of obesity and non-communicable diseases, while helping to prevent weight gain and improving overall health. 78% of university students in KSA fail to consume the recommended five fruit or vegetable servings each day (Al-Otaibi, 2013). According to the WHO (2020), increasing the intake of fruits and vegetables can help in replacing high energy dense foods. Therefore, this goal will help in decreasing the consumption of unhealthy food, which may contribute to weight loss (Mytton et al., 2014).

(iii). Making healthier food choices

Making healthier food choices will help in preventing weight gain (Wardle et al., 2006). Therefore, I chose this behaviour.

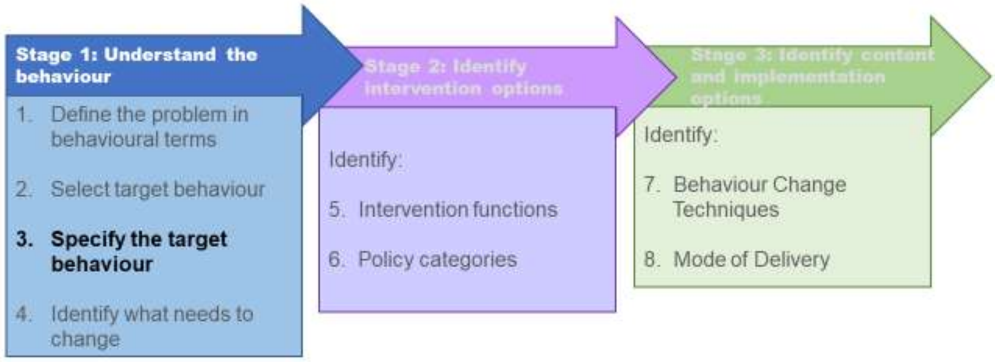
2. Increase Physical Activity

Increase walking to reach a minimum 10,000 steps daily

I chose a 10,000-step count per day based on the National Health Service's (NHS) recommendation and a systematic review on physical activity (Wattanapisit & Thanamee, 2017) demonstrating that physical activity facilitates weight loss (NHS, 2007). The 10,000 steps per day would help people burn 500 calories per day (NHS, 2007). Although this approach is an alternative to the World Health Organization's (WHO) recommendation (2011) of 150 minutes of moderate physical activity per week, a minimum of 10,000 steps was chosen as it is more easily achieved and measured. There are several methods to measure physical activity levels such as questionnaires (International Physical Activity Questionnaire) and pedometers (Sylvia et al., 2014). Pedometers do not assess the intensity of physical activity (Sylvia et al., 2014) and it is not possible to state if a low score indicates that the participant was not active or the participant has removed the pedometer (Sallis, 2010). Despite these disadvantage, there are many advantages for pedometers. For instance, I chose to use pedometers as they more easily measure step count and are affordable (Turner et al., 2012). Moreover, pedometers are often used in weight loss and physical activity interventions as the participants can track their physical activity levels (Sallis, 2010). During the intervention, pedometers will help students to self-monitor to ascertain whether they have achieved target behaviours. As an alternative, students will track their physical activity using step count related phone applications.

Step 3* (BCW)*: Specify the target behaviour

Figure 5.4: Step three: Specify the target behaviour



The third step (Figure 5.4) is to specify target behaviours in more detail. This can be accomplished by answering the following six questions about the target behaviour:

1) Who needs to perform the behaviour?

2) What needs to be done differently to realize change?

3) When does a person perform the behaviour?

4) Where will they perform it?

5) How often will they perform it?

6) With whom will they perform it? (Michie et al., 2013).

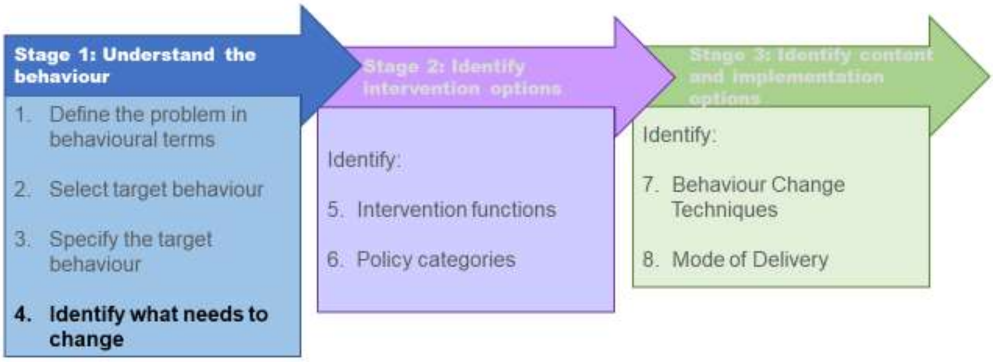
The answer to each question is summarised in Table 5.2.

Table 5.2: Describe the target behaviour

Target behaviour	**1. Replace high calorie beverages with water** **2. Increase fruit and vegetable consumption** **3. Make healthier food choices** **4. Increase walking to reach minimum 10,000 steps daily**
Who needs to perform the behaviour?	Female university students
What do they need to do differently to achieve the desired change?	Replace high calorie beverages with water; increase fruit and vegetable consumption; make healthier food choices; and walk a minimum of 10,000 steps daily.
When do they need to do it?	When they are thirsty or consume beverages (drinking water) At each meal (fruit and vegetable consumption) When they buy, cook, or eat food (inside or outside the home) When walking throughout the day to reach a minimum of 10,000 steps wearing a pedometer
Where do they need to do it?	Wherever they eat, drink and/or find time to walk (i.e. most places, including university and home).
How often do they need to do it?	Whenever they buy, cook, and consume food or drinks Any time suitable to achieve the required 10,000 steps
With whom do they need to do it?	Alone, with peers or family members (based on preference)

Step 4* (BCW)*: Identify what needs to change

Figure 5.5: Step four: Identify what needs to change



The final step in the first stage is to recognize what must be altered in a target group member or environment to achieve the intervention's intended behavioural change (Figure 5.5). Some recommended methods to attain this information include focus group discussions, interviews or questionnaires (Drew et al., 2008). To accomplish this step, I held focus group discussions (Chapter 4) to investigate food-related and physical activity behaviours among female university students of KSA. I analysed the data using the TDF and COM-B. As suggested by Michie et al. (2013), the focus group questions were open-ended and focused on exploring facilitators and barriers to adopting a healthier lifestyle (physical activity and food related habits).

For more information on the TDF and COM-B driven analysis of the dietary and physical activity behaviours are summarised in table 5.3 and 5.4 respectively.

Table 5.3: TDF and COM-B Analysis linked to the dietary behaviours

COM-B	TDF Domains	What needs to happen for dietary target behaviour to occur	Evidence to support the need for change (Quotes from focus group)
Psychological capability	Knowledge	Able to differentiate healthy and unhealthy food	*I get confused with this because every programme has its own healthy food, some of them never allow meat because it's lot of cholesterol and some programme don't allow never milk and yoghurt, some… I get confused*
		Know how to cook and prepare healthy meals	*Maybe we can't make meal… healthy meals… we don't know how to make… delicious healthy meals…all the time we know unhealthy meals.*
	Behavioural regulation	Monitoring the healthy eating behaviour	*"Get us experienced people to monitor our diet, and monitor our weight, this will also motivate us"*
Physical opportunity	Environmental context & resources	Managing time to cook and prepare healthy food	*We do not have enough time to because our studies is pressure, and many homework.*
Social opportunity	Social influences	Having encouragement from friends	*In general, surrounding environment, it can encourage you to be healthy…your friend can help you…*
Reflective motivation	Beliefs about capabilities	Have a strong will that you can eat healthy	*I feel like it's your mind that stops you from doing these things, and the one that pushes you to do these things.*
	Beliefs about consequences	Understand the health consequences of unhealthy eating	*I fear of any disease that may come, like cholesterol, diabetic, all of the diseases that may come or you may be affected by if you eat unhealthy food. This fear makes you to eat healthy.*
		Understand the benefits of eating healthy	*Maybe it [losing weight] increases even our self-confidence.*
	Intentions	Have the will power to eat healthy	*I feel like it's your mind that stops you from doing these things, and the one that pushes you to do these things.*
	Goals	Have a goal to achieve the targeted behaviour	*If I have a goal, I want to do that one.*
Automatic motivation	Reinforcement	Make goals and rewards to motivate healthy eating	*A drinking water challenges. How many litres they are drinking by the end of the week?* *I think competitions maybe with having a winner, giving something to that winner. I think stars or something.*
	Emotion	Discuss the impacts of emotions and mood that are associated with unhealthy eating	*Looking in the mirror sometimes effects your mental phase. You might go under stress and depression; you will eat more…negative feedback.*

Table 5.4: TDF and COM-B Analysis linked to the physical activity behaviours

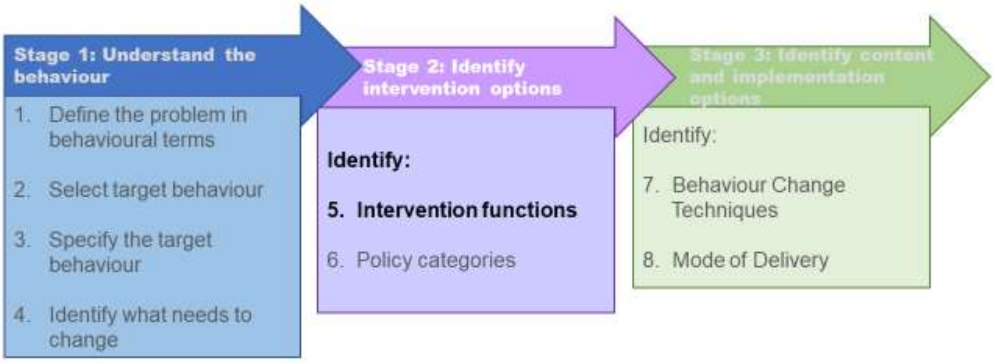
COM-B	TDF Domains	What needs to happen for physical activity target behaviour to occur	Evidence to support the need for change (Quotes from Interviews)
Psychological capability	Behavioural regulation	Monitoring for physical activity (step count)	*Maybe checking people's steps. If you tell them to buy a watch and see how, or on their phones, you can see how many steps they walked, and the one who walked the most wins something.*
Physical opportunity	Environmental context and resources	Utilising any environment to engage in physical activity (walking)	*Why not have a fitness centre here, yes…, instead of sitting in the cafeteria and eating, we can, you know, exercise waiting for our lectures. We should have the facilities.*
		Understand how to integrate physical activity (walking) into daily life	*We must always put something important than others, because if we didn't make the time management for us good, we not have time for walking, time for eating, time for spending*
Social opportunity	Social influences	Having encouragement from friends	*We need someone to support us. There is no one to support me. I want someone who will do with me the exercises, so I don't like to do the exercises alone. I will not do it*
Reflective motivation	Beliefs about capabilities	Have a strong will that do physical activity (walking)	*I feel like it's your mind that stops you from doing these things, and the one that pushes you to do these things.*
	Beliefs about consequences	Understand the health consequences of not being physically active	*Even the movement of your body, you can walk a lot, you will feel lighter.*
		Understand the benefits of physical activity (walking)	*Sometimes it takes the stress away, whenever you walk a lot or make some exercise like cardio...*
	Intentions	Have the will power to do physical activity (walking)	*Laziness, I think, because if you don't have determination, because it is easy to do exercise one day, then it's hard to commit for rest of your life*
	Goals	Have a goal to achieve the targeted behaviour	*If I have a goal, I want to do that one.*
Automatic motivation	Reinforcement	Make rewards for achieving the targeted behaviour	*Making walking competitions in the university. Walk around the university like five times, and there is a winner*

Stage 2 (BCW): Identifying the intervention options

The second stage, which identifies the intervention options, consists of two steps.

Step 5* (BCW)*: Identify intervention functions

Figure 5.6: Step five: Identify intervention functions



The first step of stage two involves identifying intervention functions (Figure 5.6) by drawing on the BCW for analysis. This also requires a thorough understanding of the context in which an intervention will take place to maximize its effectiveness. Toward this end, Michie et al. (2013) recommend using the APEASE criteria (affordability, practicality, effectiveness and cost-effectiveness, acceptability, side-effects/safety, and equity) to determine intervention functions (and other aspects of the intervention as well as BCTs etc.).

Analysis of the focus group data (Chapter 4) identified six (out of nine) intervention functions in the BCW applicable to the intervention (Table 5.5). The six intervention functions and examples of their delivery are listed below:

Education: Provide information (e.g. nutrition education) to promote healthy lifestyles.

Training: Impart skills to promote healthy lifestyles, such as label reading skills to make healthier choices.

Persuasion: Use PowerPoint presentations (imagery) to motivate healthy eating and physical activity behaviours.

Incentivisation: Praise students who achieve the target behaviour.

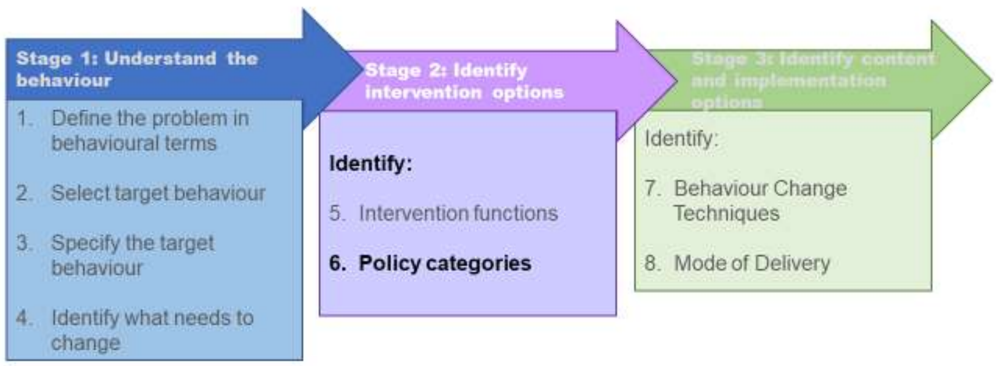
Enablement: Provide behavioural support to motivate weight loss.

Environment restructuring: Introducing phone apps to measure/increase student step counts.

The three intervention functions that were not chosen were coercion, restriction, and modelling. Coercion, which relies on force or pressure to gain desired outcomes, seemed inconsistent with students' expressed desire for less rigid and more flexible weight loss programmes in the focus group discussions. Modelling, which provides examples for people to aspire to or imitate, was not considered in this research context as the BHL programme has not been applied before. Therefore, there was no university student who they can aspire to or imitate. In addition restriction, which requires rules to limit certain (unhealthy) behaviours, was rejected as too harsh by students during the focus group discussions.

Step 6 (BCW)_: Identify policy categories_

Figure 5.7: Step six: Identify policy categories



Step two involves identifying policies (Figure 5.7) that can be instituted by authorities to support the delivery of intervention functions. Data analysis of the focus group discussions (Chapter 4) revealed four out of seven BCW policy categories to possibly pursue (Table 5.5). These categories, and examples of how they might be operationalised, include the following:

Communication/marketing: Provide PowerPoints, discussions, activities, and self-monitoring sheets to promote healthier lifestyles.

Guidelines: Provide guidelines explaining how to adopt healthier lifestyles via target behaviours (dietary and physical activity behaviours) and goal setting.

Environmental/Social Planning: Design or control the physical environment (restructuring the physical environment) or social environment (such as healthy eating at gatherings).

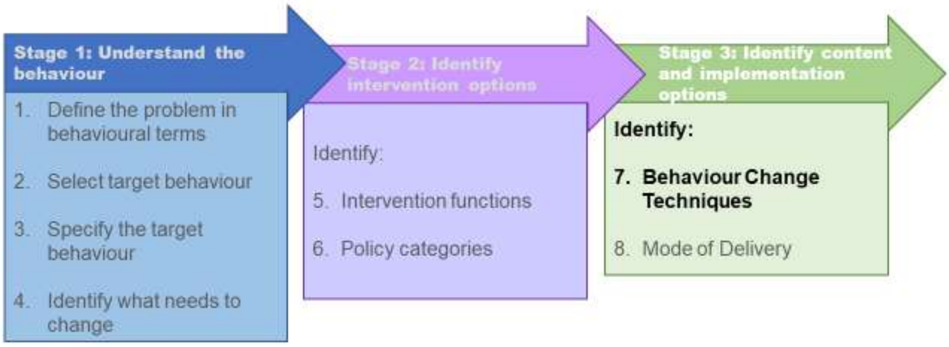
Service Provision: Deliver face-to-face sessions.

Stage 3 (BCW): Identifying content and implementation options

The third stage, which identifies content and implementation options, involves two steps.

Step 7* (BCW)*: Identify behaviour change BCTs

Figure 5.8: Step seven: Identify behaviour change techniques



The intervention functions identified from the focus group data were linked to behavioural change techniques (BCTs) according to the following steps (Figure 5.8). Firstly, according to the table 3.3 (Michie et al., 2013, pp. 151-155) the BCTs that were frequently used were considered more than the less frequently used that are listed within each intervention function (Michie et al., 2013). Since the intervention function was linked to the TDF domains, the BCTs that were related to make a change in those TDF domain were chosen (table 5.5). Second, I narrowed down the BCTs based on findings from my systematic review and existing evidence on BCTs used in effective weight management interventions. Finally, only BCTs that met the APEASE criteria were selected for the intervention (Michie et al., 2013).

The focus group results (Chapter 4) and a contextual literature review identified several BCTs to incorporate into the BHL intervention (table 5.6). Moreover, the systematic review (Chapter 3) detected four BCTs commonly used in effective weight management interventions for female university students: Behavioural practice/rehearsal, goal setting (behaviour), self-monitoring of behaviour and instruction on how to perform a behaviour. The finalised BCTs included in the BHL programme are summarised in Table 5.5 and more details are described in section 5.5.2.

Table 5.5: BCW Intervention functions linked to Policy categories

TDF Domains	COM-B	BCW Intervention function	Policy Categories	(Potential) BCTs based on BCW
Knowledge	Psychological capability	Education	Communication/ marketing	Information about health consequences
		Training	Guidelines	Instruction on how to perform behaviour Demonstration of the behaviour
Beliefs about capabilities	Reflective motivation	Persuasion	Service provision Communication/ marketing	Verbal persuasion about capabilities
Beliefs about consequences	Reflective motivation	Persuasion	Service provision	Information about health consequences
		Education	Communication/ marketing	Information about health consequences
Reinforcement	Automatic motivation	Incentivisation	Communication/ marketing	Social Reward
Intentions	Reflective motivation	Persuasion	Communication/ marketing	Verbal persuasion about capabilities
		Incentivisation	Communication/ marketing	Commitment
Goals	Reflective motivation	Persuasion	Guidelines	Goal setting (behaviour)
		Incentivisation	Guidelines	Self-monitoring of behaviour
Environmental context and resources	Physical opportunity	Enablement	Communication/ marketing	Behavioural substitution
		Environment Restructuring	Communication/ marketing	Restructuring the physical environment
Social influences	Social opportunity	Enablement	Communication/ marketing	Problem solving
Emotion	Automatic motivation	Persuasion	Communication/ marketing Service provision	Framing/ reframing
		Incentivisation	Guidelines	Self-monitoring of behaviour
		Enablement	Communication/ marketing	Social support (unspecified)
Behavioural regulation	Psychological capability	Training	Guidelines	Self-monitoring (behaviour)
		Enablement	Environmental/ social planning	Goal setting (behaviour) Adding objects to the environment

Table 5.6: Support for Behavioural Change Techniques

BCT No.	Label	Definition (Michie et al., 2013)	Support in the Literature Review (combined weight loss approaches)	Support in Text of the Focus Group Study	Participant Quotes	BCTs incorporated into the Feasibility Study
1.1	Goal Setting (Behaviour)	*"This BCT refers to establishing or mutually agreeing upon a defined goal with regard to the behaviour to be achieved"*	Ames et al., 2005 Avery et al., 2012 Hankonen et al., 2015 Hazama et al., 1994 Kondo et al., 2006 Lee et al., 2017 Olander et al., 2013 Samdal et al., 2017 Siqiang, 2018	When discussing positive features of weight management programmes, participants pointed to monitoring of target behaviour, goal setting, emotional/social support, diversity in weight loss strategies and instruction on the benefits of weight management and costs of obesity.	*"If I have a goal, I want to do that one, maybe I look for this session to have it…"*	Students mutually agreed to i) increase their steps to 10,000 per day; ii) increase their consumption of fruits and vegetables; and iii) replace sweet, high caloric drinks with water
1.2	Problem Solving	*"This BCT involves encouraging participants to analyse ways (strategies) to overcome barriers to performing a targeted behaviour"*	Ames et al., 2005 Celis-Morales, Lara & Mathers, 2015 Hankonen et al., 2014 Olander et al., 2013 Samdal et al., 2017	Participants identified multiple environmental barriers to weight management, including time, lack of access to resources and cost (of food). Social pressure to follow other people's eating patterns was also a barrier to weight loss, especially during mealtimes or social occasions when high calorie food was served and participants felt that eating was compulsory (social custom).	*"I have no time to exercise, I like exercise, but I don't have time, I don't have time to cook healthy food to eat, yes… this is the problem…"* *"And also, the social system here, the families eat together, and so you can't have a separate meal and the traditional cuisine are filled with oil…"*	Helped students to think about barriers to daily physical activity and healthy eating. Worked with students to devise possible solutions.
1.4	Action planning	*"Prompt detailed planning of performance*	Siqiang, 2018			Participants agreed to increase walking to reach a minimum 10,000 steps per day.

BCT No.	Label	Definition (Michie et al., 2013)	Support in the Literature Review (combined weight loss approaches)	Support in Text of the Focus Group Study	Participant Quotes	BCTs incorporated into the Feasibility Study
		of the behaviour (must include at least one of context, frequency, duration and intensity)"				
1.9	Commitment	*"This BCT involves asking the person to affirm or reaffirm statements indicating commitment to change the behaviour"*	Coupe et al., 2019			When the goals were discussed, the students were asked to affirm statements that they would achieve the targeted behaviour.
2.3	Self-Monitoring of Behaviour	*"This BCT involves establishing means for an individual to monitor and record his/her activities to affect change"*	Ames et al., 2005 Hankonen et al., 2015 Hazama et al., (1994) Kondo et al., 2006 Memon et al., 2018 Michie et al., 2009 Roach et al., 2003 Samdal et al., 2017 Schmidt et al., 2001	Many participants commented that they would be motivated to attend a weight management programme that allowed them to monitor their progress toward individual goals, whether via smart apps or face-to face sessions with course facilitators.	*"Someone who track me…by sending a lot of message, like alarms and keep tracking me everywhere, like any advertisements app now."*	The students used a phone app to count their daily steps. In addition, tick sheets were provided for each targeted behaviour. For instance, increasing consumption of fruits and vegetables to five portions per day.
3.1	Social Support (unspecified)	*"This BCT involves helping to establish support from friends, family, colleagues, etc. for the performance of the behaviour as well as providing noncontingent praise or reward for performing the behaviour"*	Ames et al., 2005 Hankonen et al., 2015 Olander et al., 2013 Samdal et al., 2013	Many participants observed that lack of social support from friends or family was a barrier to exercising. They suggested that social support would enhance their commitment to behavioural change, particularly if group support sessions were part of a weight management programme.	*"Maybe like catching you through phone, maybe an App or something, or like you have a WhatsApp group or something, okay like did you write down what… how much you exercised, or what did you eat or things like this, may be*	I encouraged the students to perform the behaviour and students shared their experiences to motivate one another to perform (in the problem-solving session) the behaviour during the programme.

BCT No.	Label	Definition (Michie et al., 2013)	Support in the Literature Review (combined weight loss approaches)	Support in Text of the Focus Group Study	Participant Quotes	BCTs incorporated into the Feasibility Study
					that will keep us all throughout" *"…when you want to lose weight, you don't want someone to…you don't want to feel enforced, you want someone to support you and be nice to you…"*	
4.1	Instruction on How to Perform a Behaviour	*"This BCT involves advising how to perform the behaviour (includes 'Skills training')"*	Hartmann-Boyce et al., 2014 Hazama et al., 1994 Lee et al., 2017	Participants indicated that they did not know how to "cook healthy meals" and would be interested in learning.	*"Maybe we can't make meal… healthy meals… we don't know how to make… delicious healthy meals…all the time we know unhealthy meals"*	I provided guidance on how to cook healthy meals.
5.1	Information about Health Consequences	*"This BCT involves providing information about health consequences of performing the behaviour"*	Roach et al., 2003			Health consequences were discussed in the first session (Obesity, its causes and its impacts) and the third session (Physical activity: types and benefits, making it a part of a daily routine, and inexpensive and fun activities to perform with the family).
6.1	Demonstration of Behaviour	*"This BCT involves providing an example of the performance of the behaviour*	Hartmann-Boyce et al., 2014 Howlett et al., 2018	Participants indicated that they did not know how to "cook healthy meals" and would be interested in learning.	*"Maybe we can't make meal… healthy meals… we don't know how to make…*	I provided students with videos on physical activity and fitness.

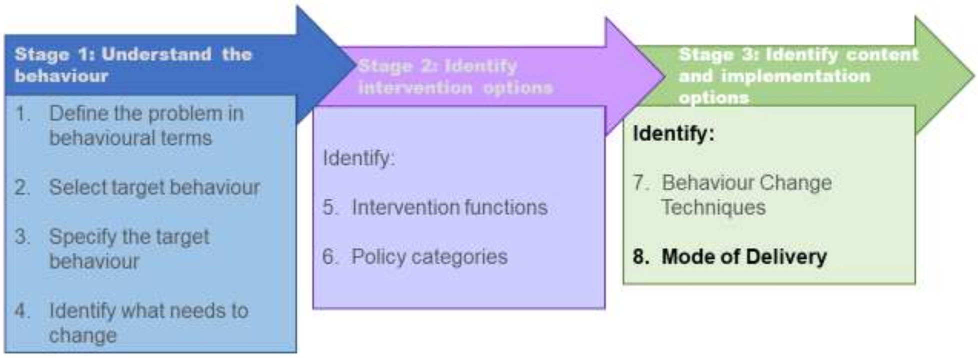
BCT No.	Label	Definition (Michie et al., 2013)	Support in the Literature Review (combined weight loss approaches)	Support in Text of the Focus Group Study	Participant Quotes	BCTs incorporated into the Feasibility Study
		indirectly or indirectly (e.g. films, photos etc.) for the person to aspire to or emulate"			*delicious healthy meals…all the time we know unhealthy meals"*	I provided healthy recipes by sending videos (such as preparing salad with fruit and vegetables), through the WhatsApp group. I conducted activities/exercises on (diet and physical activity) these topics during sessions.
8.1	Behavioural Practice/Rehearsal	*"This BCT involves encouraging practice or rehearsal of the performance of the behaviour in order to increase skills and likelihood of performing the behaviour"*	Ames et al., 2005 Hartmann-Boyce et. al, 2014 Hazama et al., 1994 Howlett et. al, 2018 Kondo et al., 2006 Lee et al., 2017 Olander et al., 2013 Schmidt et al., 2001			The students were asked to download the phone App and they were shown how their step counts were recorded by the App while walking around in the campus with the researcher.
8.2	Behaviour Substitution	*"This BCT involves prompting the substitution of an unwanted behaviour with a wanted or neutral behaviour"*				Students were advised to replace high calorie beverages with water.
10.4	Social Reward	*"This BCT involves providing a verbal or non-verbal reward if there has been effort and/or progress in performing the behaviour"*	Olander et. al, 2013	Participants suggested that competitions and announcement of winners would motivate them to achieve a targeted behaviour	*"Group diet, I think competitions maybe with having a winner, giving something to that winner."*	I congratulated students who shared their experience achieving the targeted behaviour successfully.

BCT No.	Label	Definition (Michie et al., 2013)	Support in the Literature Review (combined weight loss approaches)	Support in Text of the Focus Group Study	Participant Quotes	BCTs incorporated into the Feasibility Study
12.1	Restructuring the Physical Environment	*"This BCT involves altering or advising altering the physical environment in order to facilitate performance of the wanted behaviour or create barriers to performance of the unwanted behaviour"*				I instructed students to replace chips and chocolates with fruits and vegetables in their surroundings to create a healthier environment.
12.5	Adding Objects to the Environment	*"This BCT involves adding objects to the environment in order to enable performance of the behaviour"*	Samdal et al., 2017	Participants expressed an interest in using smart apps etc.to help them (self) monitor and receive feedback on their behaviour (e.g. step count).	*"Maybe checking people's steps, if you tell them to buy a watch and see how, or on their phones, you can see how many steps they walked…"*	I introduced a new app, changing the use of the phone and making it a different device.
13.2	Framing/reframing	*This BCT suggest the deliberate adoption of a perspective or new perspective on behaviour (e.g. its purpose) in order to change cognitions or emotions about performing the behaviour*	Ames et al., 2005			I suggested that students integrate physical activity into their daily routines and /or play sports or games (instead of just thinking about gyms).
15.1	Verbal Persuasion about Capability	*"This BCT involves telling the person that they can successfully perform the wanted behaviour, arguing*				I assured students that they could successfully increase their physical activity by walking and reaching 10,000 steps per day.

BCT No.	Label	Definition (Michie et al., 2013)	Support in the Literature Review (combined weight loss approaches)	Support in Text of the Focus Group Study	Participant Quotes	BCTs incorporated into the Feasibility Study
		against self-doubts and asserting that they can and will succeed"				

Step 8* (BCW)*: Identify the mode of delivery

Figure 5.9: Step eight: Identify mode of delivery



Decisions concerning mode of delivery (Figure 5.9) should be based on the population and setting of an intervention as well as the APEASE criteria (Michie et al., 2013). Using these criteria as a guide, I identified face-to-face group sessions as the most appropriate mode of delivery for the implementation of the intervention. I chose this approach for practical reasons such as the availability of communal spaces on campus to facilitate face to face sessions. During the intervention, the target goals and the self-monitoring tick sheet will help with the delivery of the intervention.

Step 3 (MRC): Modelling Process and Outcomes

According to the MRC framework, the final step of the development stage involves demonstrating process and outcomes. However, I have not included this step as modelling involves complex statistical analysis and is not required for feasibility and RCT assessments. The BHL programme will be further refined based on findings from this research.

5.4 Goals of the BHL Programme

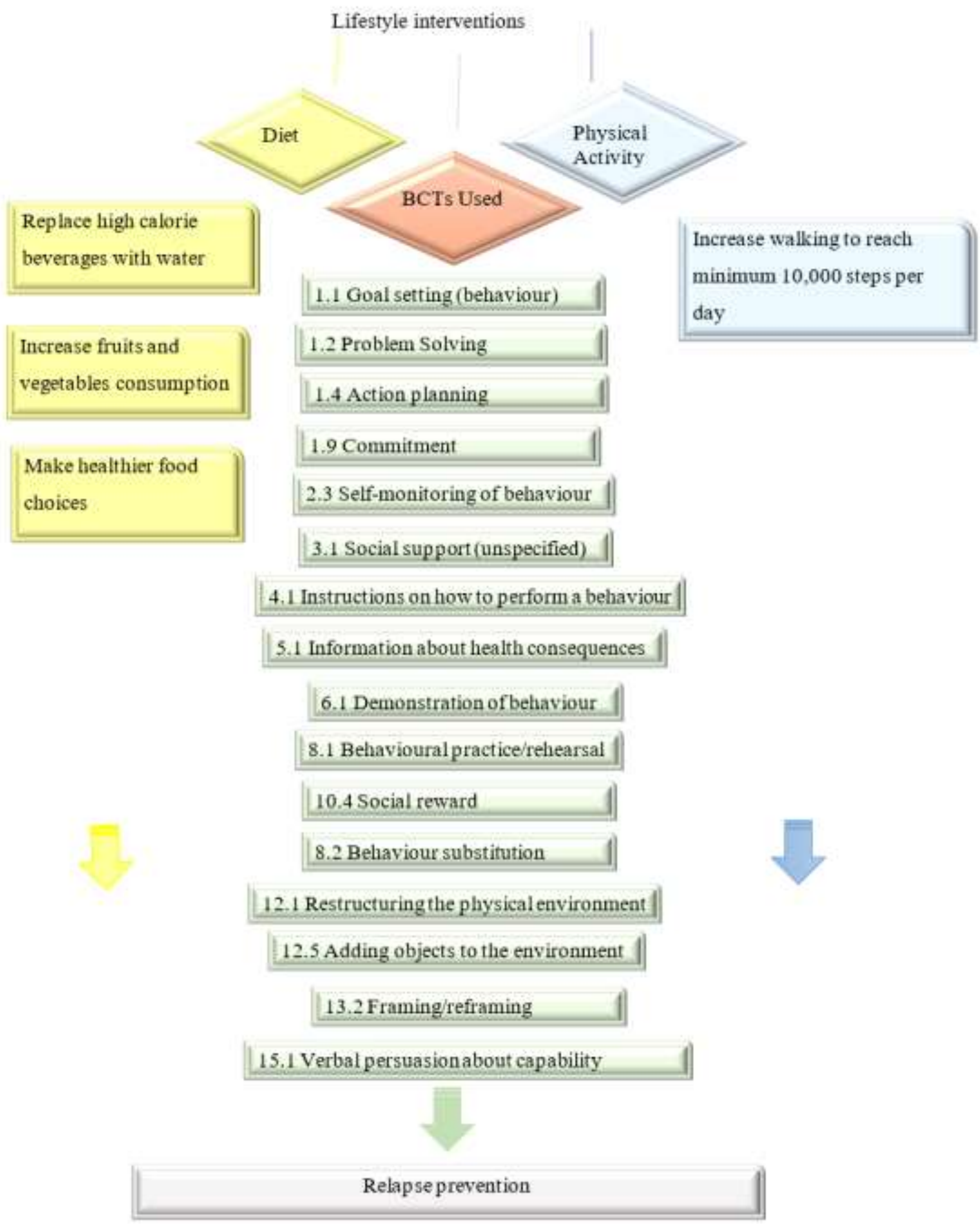
The aim of the BHL programme is to promote long-term weight loss among female university students with the support of BCTs by promoting a healthy lifestyle that reduces food intake and increases physical activity.

5.5 BHL Intervention Content

The intervention's curriculum is based on insights from two prior studies that were conducted for my thesis: the systematic literature review of weight loss interventions for female university students (Chapter 3), and the qualitative study (focus group discussions) exploring the perceptions of barriers and enablers to diet, physical activity and weight loss programmes among female university students in KSA (Chapter 4). By combining these findings, I designed an intervention that integrates participant's culturally specific viewpoints with evidence-based practices for weight management. The main strategies included in the BHL programme are summarised in Figure 5.10.

The BHL programme was designed by me, a dietician, under the guidance of my supervisors Prof. Jennifer Mindell, Prof. Nicola Shelton, Dr. Emma Norris, and Dr. Helen Croker. The programme consisted of 12 sessions, including one introductory session, one physical activity session, four behaviour modification sessions and six nutrition sessions (Appendix 3A). The introductory session included student and instructor introductions and information on the causes and impact of obesity. It is often recommended to use co-production in designing an intervention, in which the population of interest are engaged in designing the intervention (Kickbusch & Gleicher, 2012; Needham, 2008). However, due to the time issues, I relied on the findings from my systematic review and focus group discussions to design my intervention.

Figure 5.10: Strategies included in the BHL Programme



5.5.1 Specifying BHL's intervention content: Dietary Components

Dietary guidelines are often established by governments to improve nutrition awareness and overall health. Therefore, there are a number of healthy eating guidelines that describe daily servings of food groups, such as the Eatwell Guide (NHS, 2019) and the healthy food palm of KSA (MOH, 2013). I chose the healthy food palm (Appendix 3B) for the BHL programme, since it was developed to suit the dietary needs of the population of KSA. The programme will use the healthy food palm as a guide to illustrate to students their daily consumption needs of carbohydrates (e.g. rice and bread), vegetables, fruits, milk and dairy products, proteins (meats and legumes), fats (oils) and water. I chose the target of eating five servings of fruits and vegetables daily as it is part of the healthy food palm, shown in Appendix 3B, and the minimum number of daily servings prescribed by the WHO. I decided that during the BHL programme, I would explain the recommended daily servings of food groups using the healthy food palm (MOH, 2013).

The BHL programme uses the healthy plate (Appendix 3C) as a model to illustrate how to make healthy meals to enable participants to make healthier food-related choices (Harvard, 2011). I chose the healthy plate model with the five food groups as it is a simpler illustration making it easier to use and to plan meals. In this model, fruits and vegetables (except for potatoes as they are considered starchy foods) make up 50% of the plate size helping participants to achieve the goal of increasing intake of fruits and vegetables. The remaining 50% of the plate comprises wholegrains (25%), such as wheat, barley etc., and protein foods (25%), such as fish, poultry, etc. The healthy plate also recommends using only healthy plant oils, such as olive oil, rapeseed oil etc. (and avoiding unhealthy trans-fat), drinking water, coffee or tea (and avoiding sugary drinks), and limiting dairy products such as milk, yoghurt, etc. (to one to two servings per day) and juice (to a small glass per day). The healthy plate applies to individuals aged six months and older. A pie chart is used to represent the portion of the plate made up by each food group.

The programme was also designed to teach participants many healthy food-related skills during sessions, including assessing portion size and servings, label reading, healthy shopping and cooking, and how to eat (more) healthily at restaurants and gatherings. These skills would be discussed to increase the students' dietary knowledge to help them make healthier food choices.

It is challenging to create a nutrition foundation that reflects the suitable distribution of all foods and drinks throughout the day. Therefore, I devised dietary sessions to increase nutrition awareness and to encourage students to adopt healthier eating habits. Thus, as discussed above, the BHL programme focused on the healthy plate which promotes high consumption of fruits and vegetables during main meals, skills to make healthier food choices and replacement of high calorie drinks with water. These guidelines were designed to be practical and accessible for participants to modify their behaviour. The manner in which the programme's targeted food related behaviours was introduced to participants is described below.

Replacement of high calorie beverages with water

Participants would be advised to adopt this strategy at the start of the BHL programme. During the sessions, students would be engaged in an informative discussion about obesity and overweight, particularly their causes and negative health impacts. Moreover, students would be educated on the sugar content and calories of different types of drinks as well as the benefits of drinking water. The programme's approach to instruction and behaviour change was designed to make the replacement of high calorie beverages easy to understand and implement in daily life. During the sessions, students would be introduced to each target behaviour in the form of a goal to achieve. They would be encouraged to self-monitor to assess whether they met this behavioural goal by using tick sheets to keep track of their performance.

Increase fruit and vegetable consumption

The programme was designed to instruct students on the benefits of increasing fruit and vegetable intake. The programme's approach was developed to help students easily integrate these behaviours into their daily life.

Making healthier food choices

The nutrition sessions focus on teaching students about the fundamentals of dietary topics, such as food servings and portion size, types of healthy and unhealthy food and the healthy plate. They also provide skills to promote weight loss, such as how to read food labels, how to cook and shop for healthy meals, how to choose healthy fast-food options and how to eat healthily at restaurants and gatherings. These sessions are intended to help participants to identify and make healthy food choices.

5.5.2 Specifying BHL's intervention content: Behaviour Change Techniques

The programme incorporates multiple BCTs, but goal setting and self-monitoring of behaviour are the only ones that will be explained in detail to participants so that they can understand and achieve the target behaviours. The goals have been established through the golden rule of goal setting, specifically the SMART (Specific, Measurable, Achievable, Realistic, Time) goals, which help people to meet target behaviour (healthier eating and physical activity behaviours). As noted previously, participants would monitor their behaviours using tick sheets (placing a check mark on a tracking paper if they achieve the dietary target behaviour) and phone apps (to monitor their step count). The programme includes four behavioural sessions focusing on: internal and external cues; goal setting; self-monitoring of behaviour; and problem solving.

The behaviour change sessions include the following BCTs: goal setting (behaviour), problem solving, commitment, self-monitoring of behaviour, social support (unspecified), instruction on how to perform a behaviour, information about health consequences, demonstration of behaviour, behavioural practice/rehearsal, behaviour substitution, social reward, restructuring the physical environment, adding objects to the environment, framing/reframing and verbal persuasion about capability (Table 5.6). The programme utilises the BCT 'goal setting (behaviour)' by asking students to set personal goals based on the four target behaviours previously mentioned. The BCT 'self-monitoring of behaviour' would be introduced to allow students to track performance of their target behaviours by using self-monitoring tick sheets. Students can mark a check on the sheet if they meet the targeted behaviour and mark a cross if they do not.

The programme uses the 'framing/reframing' BCT by suggesting that students change their perspective on physical activity. Students would be asked to shift from seeing physical activity as something performed solely in gyms to something that can be integrated into daily routines and accomplished playing sports or games. To implement the BCT ‘verbal persuasion,’ I would assure students that they can successfully increase their physical activity by walking up to 10,000 steps per day. The BCTs ‘social support’ (unspecified) and ‘social reward’ would be employed during programme sessions to allow students to share their experiences with one another.

The programme incorporates the BCTs ‘instruction on how to perform a behaviour’ and ‘information about health consequences’ into the students’ dietary and physical activity education. I decided I would explain the ‘restructuring the physical environment’ BCT to the students during the internal and external cues session to help them overcome external cues. Students would be advised to restructure their environment by keeping only fruits and vegetables around (at home) instead of crisps and chocolate to create healthier surroundings. (If students must keep chocolates or chips in their homes, they would be told to keep them out of sight and reach). The BCT ‘problem-solving’ would be discussed during a brainstorming session on students’ barriers and enablers to achieving the targeted behaviour.

5.5.3 Specifying BHL’s intervention content: Physical Activity Component

As noted previously, the BHL programme uses walking 10,000 steps daily as an alternative to 150 minutes per week of moderate physical activity (Wattanapisit & Thanamee, 2017), making behavioural change easier because it is a more measurable behaviour. This session would introduce the WHO guidelines for physical activity and provide students with examples on how to increase their step count. For instance, students would be advised to walk on campus; park their car 1km away and walk to the university etc. The programme is restricted to only one session on physical activity due to student time demands and the need for more experts (personal physical activity trainers) to provide suitable supervision and support. Furthermore, students would be asked to use a pedometer or download a step count related phone app on their phone and will be shown how to track their step count in the app by walking around the campus with me. An example of one of the lesson plans is provided in table 5.7.

Table 5.7: Example Lesson Plan

Types of Physical Activity and Integration into Daily Routines
1. Information about the WHO recommendations on physical activity.
2. Talk about how to integrate physical activity into daily routine. For example, climb the stairs rather than take lifts.
3. Benefits of increasing step count to 10,000 per day.
4. Brainstorm and consider inexpensive exercises for the entire family.

5.6 Conclusion

This chapter has described the development of the BHL programme. The feasibility trial of the BHL programme is presented in the next chapter.

Chapter 6: Feasibility Trial of the BHL Programme

6.1 Introduction

This chapter describes the feasibility trial of the Better Healthy Lifestyle (BHL) Programme and reports on the feasibility, acceptability, fidelity, and effectiveness of the intervention.

6.2 Rationale and objectives for the feasibility study

According to the Medical Research Council (MRC) framework for complex interventions (discussed in the previous chapter), feasibility or piloting is the second stage in the development, evaluation and implementation process and is performed after the development stage's objectives are met. The feasibility stage involves the following three steps:

a) Examining the methods
b) Assessing the retention rate
c) Determining the sample size

In addition to the three steps above, this study also provides a preliminary evaluation of the effectiveness of the intervention (Figure 6.1).

In accordance with the MRC framework, after developing the intervention, I conducted a study to evaluate feasibility, acceptability, fidelity, and effectiveness of the BHL programme. The study also assessed the time needed to deliver the sessions to identify a suitable time frame for the intervention before performing it at scale. I also recalculated the required sample size for a future randomised controlled trial (RCT).

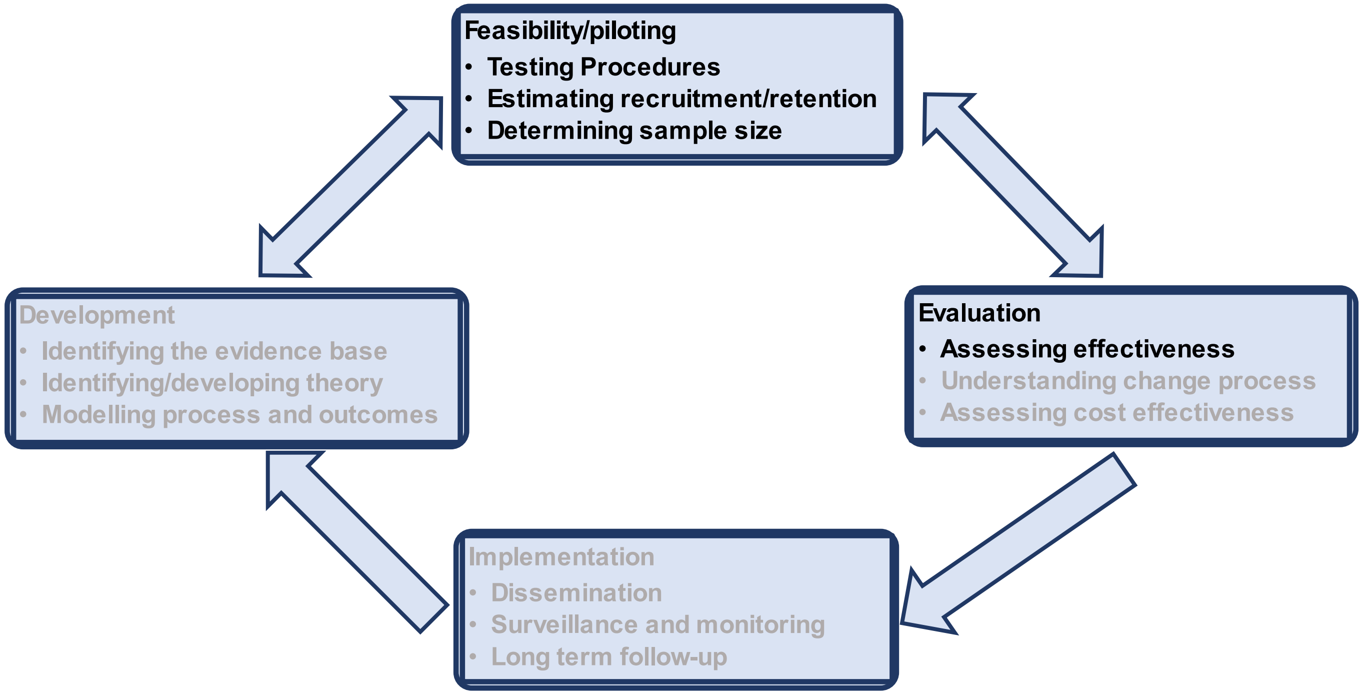


Figure 6.1: Stage two and three: Feasibility and Evaluation (MRC framework) (Craig et al., 2008)

6.3 Objectives for the feasibility trial

The feasibility trial's objectives were as follows:

1. To assess the feasibility of the intervention and implementation (the content of the intervention, its clarity and recruitment and retention rates).

2. To assess the acceptability of the intervention (attendance and adherence rates).

3. To assess the effectiveness of the BHL programme and to recalculate the sample size for a future RCT.

4. To assess the appropriate duration of programme sessions and to identify a suitable time frame for the intervention (number of sessions).

5. To assess the fidelity of the delivery of the intervention (planned versus delivered BCTs).

6.4 Step 1 (MRC): Methods

6.4.1 Study Design

The feasibility study was an uncontrolled feasibility trial design to assess the feasibility of the BHL programme (a complex weight loss intervention for female university students in KSA) before conducting it on a larger scale (RCT). Though uncontrolled studies provide limited reliable evidence on the effectiveness of interventions, these studies are frequently used for practical purposes and for feasibility of interventions. Thus, the study's design is appropriate for the purposes of this research. Insights from the feasibility trial will be used to inform a larger-scale RCT evaluation in the future.

6.4.2 Participants

Inclusion/Exclusion Criteria

To be eligible for the study, participants had to be: enrolled at Saudi Electronic University (SEU); female with overweight or obesity; and at least 19 years old.

Students who were pregnant or had a chronic disease were excluded from the study. The feasibility study was conducted at SEU to avoid contamination of information, because the potential RCT is planned to be conducted in King Saud University in Riyadh.

Recruitment

Participants for the feasibility study were recruited using convenience sampling at SEU. Convenience sampling is often used in feasibility trials and offers both advantages and disadvantages. I chose this sampling method because it makes reaching and recruiting participants easy and yields a sample that resembles the main population of interest (Bornstein et al., 2013). Another advantage of convenience sampling is its low cost.

In terms of drawbacks, convenience sampling is a non-probability method, potentially increasing the risk of selection bias; limiting generalizability to the larger population; and resulting in low external validity of the research (Bornstein et al., 2013). However, these issues are not relevant to the feasibility study as it was concerned with the feasibility, acceptance, fidelity and effectiveness of the intervention before it is implemented in a RCT with a larger sample size.

Recruitment emails were sent to SEU students (Appendix 4A) in January and screening took place in February. Participants were recruited using three means: distribution of flyers about the study among SEU students (see Appendix 4B); an advertisement in all campus email (using the same flyer); and brief announcements about the nature of study during university events. Potential participants were asked to contact the study researcher (me) for more information. Once I heard from interested students, they were provided with an information leaflet describing the trial and its purpose and benefits (see Appendix 4C). The leaflet also informed students of their right to withdraw from the study at any time and let them know that their information would be kept confidential. For any queries, the participants were again asked to contact me. If still interested, potential participants were encouraged to visit the SEU clinic for pre-intervention assessment and eligibility screening. This involved taking students' height, weight, and waist circumference measurements and asking about pregnancy status and medical history (presence of chronic disease). Students who met one or both criteria were excluded from the study. Moreover, I advised any student who was pregnant or presented with a chronic disease (such as diabetes) to make an appointment with the clinic's doctor. Students who were interested and met the eligibility criteria were provided with a consent form highlighting their rights and were required to sign it before joining the study (see Appendix 4D). All sessions of the weight management intervention took place in a SEU campus classroom.

6.4.3 Ethical Consideration

This feasibility study was approved by the Institution Review Board (reference number: 18-674E) (Appendix 2C) of King Fahad Medical City and the Saudi Electronic University, Kingdom of Saudi Arabia (Appendix 2D). Participation was voluntary, and only participants who provided consent were included in the study. Participants had the right to withdraw their data at any time during the study until post anthropometric measurements were taken. No participant was identified by name (except on a list of names and ID codes, which were kept securely in a locked cabinet in my locked office) to maintain anonymity. Participants' names were coded (numbered) to ensure confidentiality. The participants' data (height and weight) were stored electronically on a password-protected flash drive in a locked cabinet located in a locked room that only I could access.

This study was considered low risk, as it was an educational intervention and participants were not given supplements, medicines, or clinical care. However, to reduce the risk of stress for participants failing to lose weight during or after the intervention, I delivered sessions aimed at enabling participants to make small, positive behavioural changes to promote healthier lifestyles. Thus, even if weight loss did not occur, behaviour modification could help participants to improve their health.

6.4.4 Intervention

The 12-week weight loss intervention was designed to include: (a) once weekly 90-minute weight management sessions facilitated by me and (b) multi component weight loss strategies, including nutrition education, physical activity education and behavioural modification. The sessions were delivered face-to-face at the SEU campus from March-May 2019.

The intervention consisted of 12 sessions (see Appendix 3A for a detailed overview of the content of the weekly sessions). All sessions were conducted in Arabic, as some participants were first year students and did not speak English. Attendance was recorded at the start of each session to encourage weekly participation. The 12 sessions included one introductory session, six nutrition sessions, one physical activity session and four behaviour change sessions (Chapter 5). The BCTs I planned to include in this study were discussed in Chapter 5. During the trial, I added two additional BCTs, ‘distraction’ and ‘self-talk’, to a session on ‘problem solving’ to help participants overcome barriers. For example, I instructed students to use ‘distraction’ to ignore the urge to over-snack by engaging in another activity, such as calling a friend. I advised students to use ‘self-talk’ to talk positively to themselves about healthy eating and physical activity to overcome negative thoughts. These BCTs helped students to achieve solutions to the barriers they identified in the brainstorming session (see Table 6.1 for examples of BCTs used with problem solving).

Another aspect of the programme involved supplemental activities for each session. For instance, one of the supplemental activities involved walking around the campus with students to reinforce instructional content, increase step count, and encourage weight loss. Four of the sessions were combined with interactive activities to engage and entertain the students. However, it was not possible to introduce supplemental activities during some weeks due to time constraints (week 1, week 5, week 6, week 8 and week 9) and Ramadan (week 10 and week 11). (Appendix 3A).

Table 6.1: BCTs Linked with Problem Solving Session

BCTs Linked with Problem Solving Session			
12.4	Distraction	Advise or arrange to use an alternative focus for attention to avoid triggers for unwanted behaviour	I advised the students to avoid snacking and to focus on another activity such as calling a friend.
15.1	Self-talk	Prompt positive self-talk (aloud or silently) before and during the behaviour	I advised students to talk positively to themselves about healthy eating and physical activity.

6.5 Outcomes

6.5.1 Study Measures/Assessment

To evaluate the feasibility and acceptability of the intervention and implementation, I calculated recruitment, retention, attendance, and adherence rates. Furthermore, I used descriptive analysis to describe demographics, such as age and nationality, and pre- (baseline) and post- (12 weeks) intervention anthropometric measurements (height and weight).

Feasibility: Recruitment and Retention Rates

Pre-intervention quantitative measures included height, weight, and waist circumference. Weight was measured in kilograms using a portable electronic weighing scale , with participants wearing indoor clothing and no shoes. Height was assessed using a stadiometer and waist circumference was assessed using a measuring standardized measuring tape (constant tension tape). Participants' Body Mass Index (BMI) was calculated using height and weight data. In keeping with WHO standards, overweight was defined as BMI 25 to 29.9kg/m^2 and obesity was defined as BMI ≥30kg/m^2 (WHO, 2019). Pre-intervention measurements were taken in the university clinic by the nurses and me. Before the pre-intervention assessment, I trained the nurses to measure height according to *The Procedure for Measuring Adult Height* (NHS 2014) guidelines and weight and waist circumference according to the *WHO STEPS Surveillance Manual* protocols (World Health Organization, 2016) (Appendix 4E). I also informed the (trained) nurses about the eligibility criteria. Lastly, I recorded the number of eligible participants and the number of ineligible participants to calculate the study's recruitment rate.

The retention rate was calculated by dividing the number of participants who attended the final session (n=12) by the total number of participants (n=15) and then multiplying the quotient by 100. Targeted behaviours were not assessed.

Acceptability: Attendance and Adherence Rates

To assess the attendance rate, I tracked attendance during weekly weight management sessions. I calculated the attendance percentage for each session. This was done by dividing the number of participants attending each session by the total number of participants recruited for the study (n=15) and then the quotient was multiplied by 100. An overall attendance rate was calculated by adding the number of participants who attended each session and dividing by 150 (the number of participants recruited for the study times 10 sessions), multiplied by 100.

The average (mean) number of participants was calculated by dividing the sum of the attendance at each session by the number of sessions conducted (n=10, as two sessions were combined with another session making the total number of sessions delivered to the students 10 rather than 12 as originally planned). The median number of sessions attended by the participants was calculated in three steps. First, I noted the number of sessions attended by each participant. Second, these numbers were arranged in ascending order. Third, I identified the median, the central number of the arranged data. I identified the mode of the number of sessions attended by the participants by finding the most repeated number in the data set.

The adherence rate was determined by the number of sessions attended by all the participants. I also recorded the number of sessions that were not completed by all the participants, noting the reason for each participant's absence.

Effectiveness and Sample Size Calculation

The primary outcome was change in weight and the secondary outcome was BMI. However, all recruited participants were included for intention-to-treat (ITT) analysis. The pre-intervention measurements were used for missing post-intervention measurements (drop outs). In addition to that, a complete analysis was also conducted with removing the dropouts and including the participants who were considered as the completers of the programme. For any participants to be considered as a completer of the programme she has to attend a 50% of the sessions (six sessions). Of those six sessions three sessions were considered as the core of the programme which was a must to be attended along with any other three sessions. The core sessions were session three, four and the final session, as sessions three and four involved the description of the targeted behaviours and the final session included the final measurements. In order to identify any significant differences before and after the intervention (the BHL programme) in primary (the body weight) and secondary (BMI) outcomes, paired sample t-test was used.

Timeframe

I assessed the suitability of the weekly sessions' timeframe (90 minutes planned for each session) and the programme length (12 weeks) via informal feedback from students.

Fidelity of the intervention

Intervention fidelity involves determining the extent to which an intervention was delivered as originally conceived and planned. Both the CONSORT Statement for reporting randomised controlled trials and the MRC framework for developing and evaluating complex interventions recommend investigating and reporting on fidelity (Michie et al., 2013). This is true especially if the intervention is shown to be effective but was not conducted as planned, making it difficult to determine what is being evaluated and suggesting that the final results may be spurious. Therefore, to ensure precise evaluation of the feasibility of the intervention, I assessed fidelity to obtain a clear sense about the delivery of the contents and the use of BCTs in the trial. I accomplished this by first reviewing the intervention's contents, time duration and the BCTs planned for the intervention (as detailed in the protocol). Then, I investigated whether the entire content of the intervention was delivered as planned and how many BCTs were used in the feasibility trial. Finally, I coded each of the BCTs used in the feasibility trial. For that, first of all, I checked whether the planned BCTs were delivered or not. Then I went through the BCT Taxonomy v1 (BCTTv1) which includes 93 BCTs, to check if I had used any of those BCTs or not (Michie et al., 2013).

6.5.2 Sample size and Demographic Data

When conducting any clinical trial, sample size calculation is required to avoid bias in interpreting outcomes (Kadam & Bhalerao, 2010). The sample size for the feasibility trial was 15 students. I chose this number to reflect 10% of the sample size which was originally calculated for the proposed RCT (Appendix 4F) (Conelly, 2008). (Section 6.7 below re-examines the sample size for the proposed RCT in light of the findings from the feasibility study).

Students ranged in age from 19 to 42 years old. 20% of the sample were aged 19-20 years old; 27% were 21-23 years old; 13% were 24-26 years old; and 40% were aged 27 years or older. Ten of the students were Saudi nationals, and five were non-Saudi nationals. The mean age of the participants was 27.5 years.

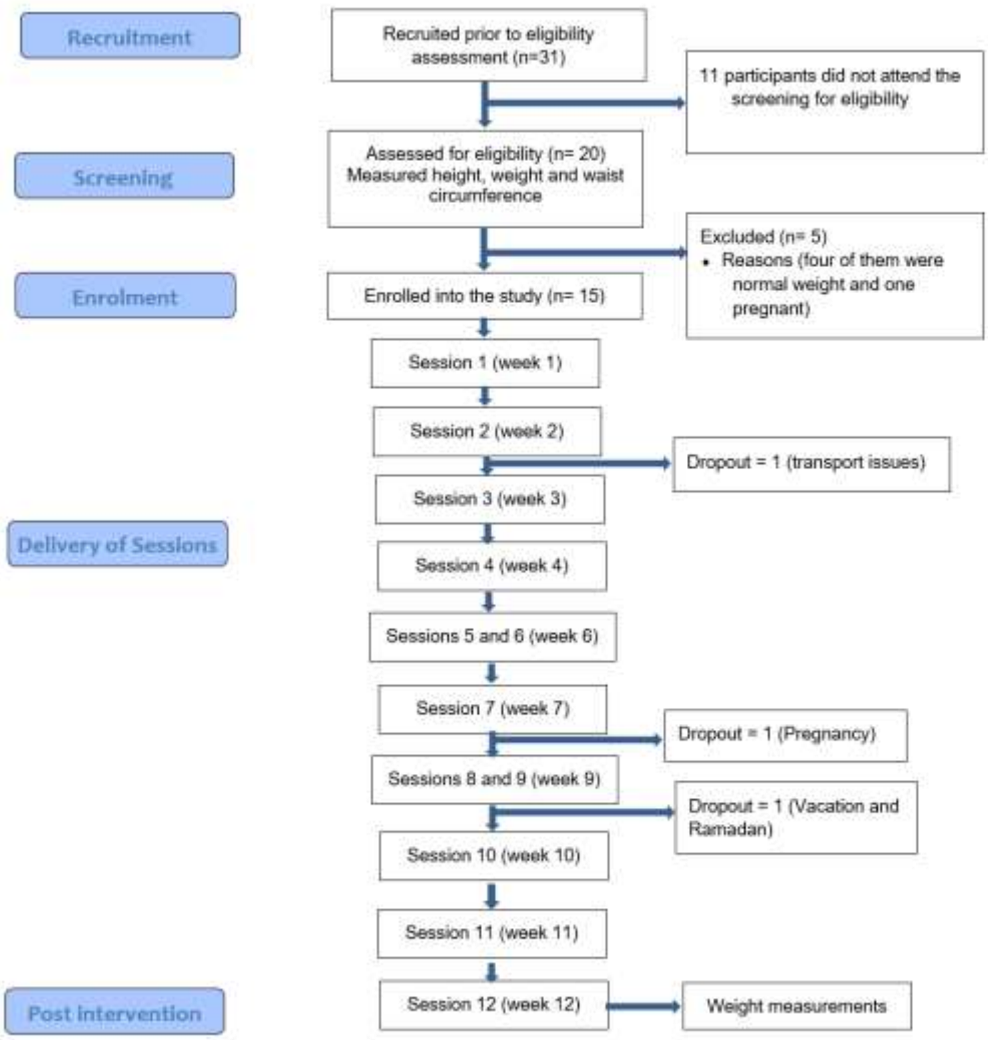
6.6 Step 2 (MRC): Results

Feasibility: Recruitment and Retention Rates

Thirty-one students expressed interested in the study and called me to enquire about the intervention. However, 11 students did not show up for baseline measurements, leaving a total of 20 potential participants. Of the 20 students, five (25%) did not meet the inclusion criteria as one was pregnant and the remaining four were normal weight. As a result, only 15 participants (75%) met the inclusion criteria, signed the consent form, and entered the programme. As the target sample size was achieved, further recruitment was not necessary. Of the 31 students who were initially interested in the study, 15 were made aware of the programme via university events, nine via emails, three via flyers and the remaining via word of mouth.

Not all of the 15 participants completed the programme as three (20%) dropped out during the programme for personal reasons or because a change in status made them ineligible for the study. Of these three, one student participated in two sessions before leaving the programme due to transportation difficulties. Another student attended nine sessions but, after becoming pregnant, no longer met the study's inclusion criteria. The third student attended nine sessions but quit the programme once university vacation started. As a result, the intervention's retention rate was 80%, with only 12 out of 15 students completing the programme (attending the final session). Figure 6.2 illustrates the flow chart for the feasibility study.

Figure 6. 2: Flow chart for the feasibility study



Acceptability: Attendance and Adherence Rates

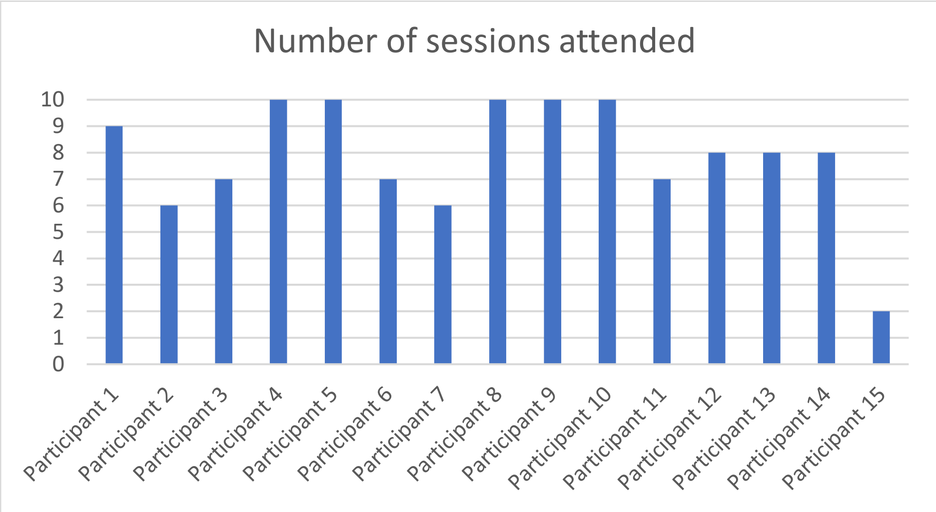
The programme's overall attendance rate was 79%, with a 96% attendance rate during the first 6 weeks (5 sessions), falling to 61% during weeks 7-12 (5 sessions) (Table 6.2). The mean number of participants attending each weight management session was 11.8. Among the 15 participants recruited for the study, the median and modal number of sessions they attended were eight and 10, respectively.

Only two of the 10 sessions were attended by all 15 participants. Among the 15 participants, five attended all the sessions (100%), one attended nine sessions (90%), three attended eight sessions (80%), three attended seven sessions (70%), two attended six sessions (60%) and one attended two sessions (20%). Figure 6.3 illustrates the number of sessions attended by each participant.

Table 6.2: Attendance of the participants

Title of the sessions	Attendance (N=15)	Percent Attending (N=15)
Introduction: Obesity, its causes and its impacts	Session 1: 15 students	100%
Types of foods: healthy and unhealthy	Session 2: 15 students	100%
Physical activity: types, benefits, incorporating into daily routine, and performing with the family	Session 3: 14 students (1 student dropped out due to transportation issues.)	93%
Identifying healthy and unhealthy dietary habits: food portions, servings, and the healthy plate	Session 4: 14 students	93%
Autonomous motivation and stimulus control (internal and external cues)	Session 5: Session postponed and combined with next week.	N/A
Autonomous motivation and stimulus control (internal and external cues) + Goal setting	Session 5 + 6: 14 students	93%
Self-monitoring of behaviour	Session 7: 7 students	47%
Problem solving	Session 8: Session postponed and combined with the next session due to exams	N/A
Problem solving + Label reading skills	Session 8 + 9: 13 students (1 student left the study due to becoming pregnant.)	87%
Healthy Shopping	Session 10: 7 students (Session overlapped with Ramadhan and school closed for summer holidays)	47%
Cooking and preparing healthy meals and healthy fast-food options	Session 11: 7 students	47%
Eating healthy meals at restaurants and social gatherings	Session 12: Final Session. Class included presentation of achievement certificates (12 students).	80%

Figure 6.3: Number of sessions attended by each participant



Effectiveness of the programme

I conducted an Intention-to-Treat (ITT) analysis to assess the effectiveness of the intervention on the primary outcome (body weight). ITT analysis included all 15 recruited participants, including those who subsequently withdrew from the programme. The pre-intervention mean weight was 79.97kg ± 12.67 Standard Deviation (SD). The post intervention mean weight was 77.35kg with SD of 12.27 (the three dropout students' pre-intervention weight were used as the post-intervention weight). The observed mean differences between pre-post intervention was 2.62kg, showing highly statistically significant difference pre-post intervention ($t=4.764$ with 14 degree of freedom, $p <0.001$) (Table 6.3).

Another Intention-to-Treat (ITT) analysis was conducted to assess the effectiveness of the intervention on the secondary outcome (BMI). The ITT analysis included all 15 original participants (three drop out students' pre-intervention BMI were used as the post-intervention BMI). The pre-intervention mean BMI was 30.37kg/m^2 ± 4.19 (SD). The post intervention mean BMI was 29.87kg/m^2 with SD of 4.09. The observed mean differences between pre and post intervention BMI was 1.00, showing statistical significance pre and post intervention at 5% significance level ($t= 4.74$with 14 degree of freedom and $p <0.001$) (Table 6.3). I also conducted a secondary efficacy analysis to determine the effectiveness of the intervention on the primary outcome (body weight). Only

12 participants were included, those who dropped out were excluded from the analysis. The pre-intervention mean weight was 79.15kg ± 13.81 (SD). The post intervention mean weight was 75.87kg with SD 13.02. The observed mean difference between pre and post intervention weight was 3.27kg, showing statistical significance pre and post intervention at 5% significance level ($t= 6.12$ with 11 degree of freedom and $p <0.001$) (Table 6.4).

In addition, I performed an analysis to determine the effectiveness of the intervention on the secondary outcome (BMI). The pre-intervention mean BMI was 30.57kg/m^2 ± 4.627 (SD). The post intervention mean BMI was 29.30kg/m^2 with SD of 4.358. The observed mean differences between pre and post intervention BMI was 1.27, showing statistical significance pre- and post-intervention at 5% significance level ($t= 6.26$ with 11 degree of freedom and $p<0.001$) (Table 6.4).

Table 6.3: ITT analysis – Primary and Secondary Outcomes

Variable	Mean	SD	n	SE of mean	Mean difference	SD of mean difference	t	P value
Pre-intervention weight (kg)	79.97	12.67	15	3.270	2.62	2.13	4.764	<0.001
Post-intervention weight (kg)	77.35	12.27	15	3.168				
Pre-intervention BMI (kg/m^2)	30.87	4.19	15	1.084	1.007	0.822	4.74	<0.001
Post-intervention BMI (kg/m^2)	29.87	4.088	15	1.055				

SD: standard deviation; n: Sample size; SE: Standard Error; t (14, 0.05) at 5% significance level

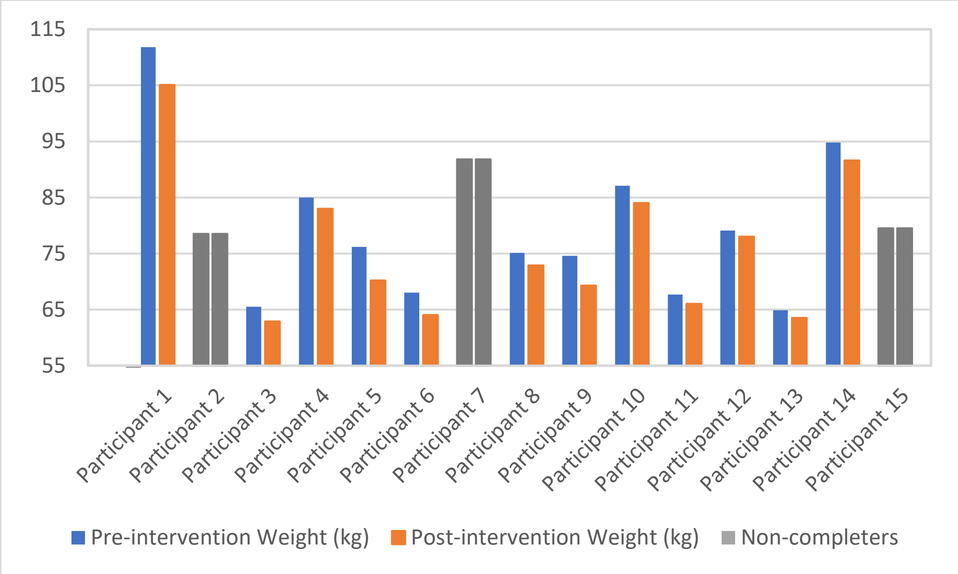
Table 6.4: Efficacy Analysis – Primary and Secondary Outcomes (Dropouts removed)

Variable	Mean	SD	n	SE of mean	Mean difference	SD of mean difference	t	P value
Pre-intervention weight (kg)	79.15	13.81	12	3.98	3.27kg	1.853	6.12	<0.001
Post-intervention weight (kg)	75.87	13.02	12	3.76				
Pre-intervention BMI (kg/m^2)	30.50	4.627	12	1.33	1.267	0.701	6.26	<0.001
Post-intervention BMI (kg/m^2)	29.30	4.358	12	1.25				

SD: standard deviation; n: Sample size; SE: Standard Error; t (11,0.05) at 5% significance level

As figure 6.4 demonstrates, all participants who completed the programme lost weight.

Figure 6.4: Pre- and post- intervention weight measurements of each participant



Time frame

Although the sessions were planned to last for 90 minutes, students reported difficulties incorporating sessions into their busy schedules. Therefore, the sessions were shortened to 60 minutes after the first session. Due to time constraints, session 5 and 6 were combined into one meeting and sessions 8 and 9 were also merged. Students were asked to provide their informal feedback about the session at the end of each session, in order to improve the BHL programme.

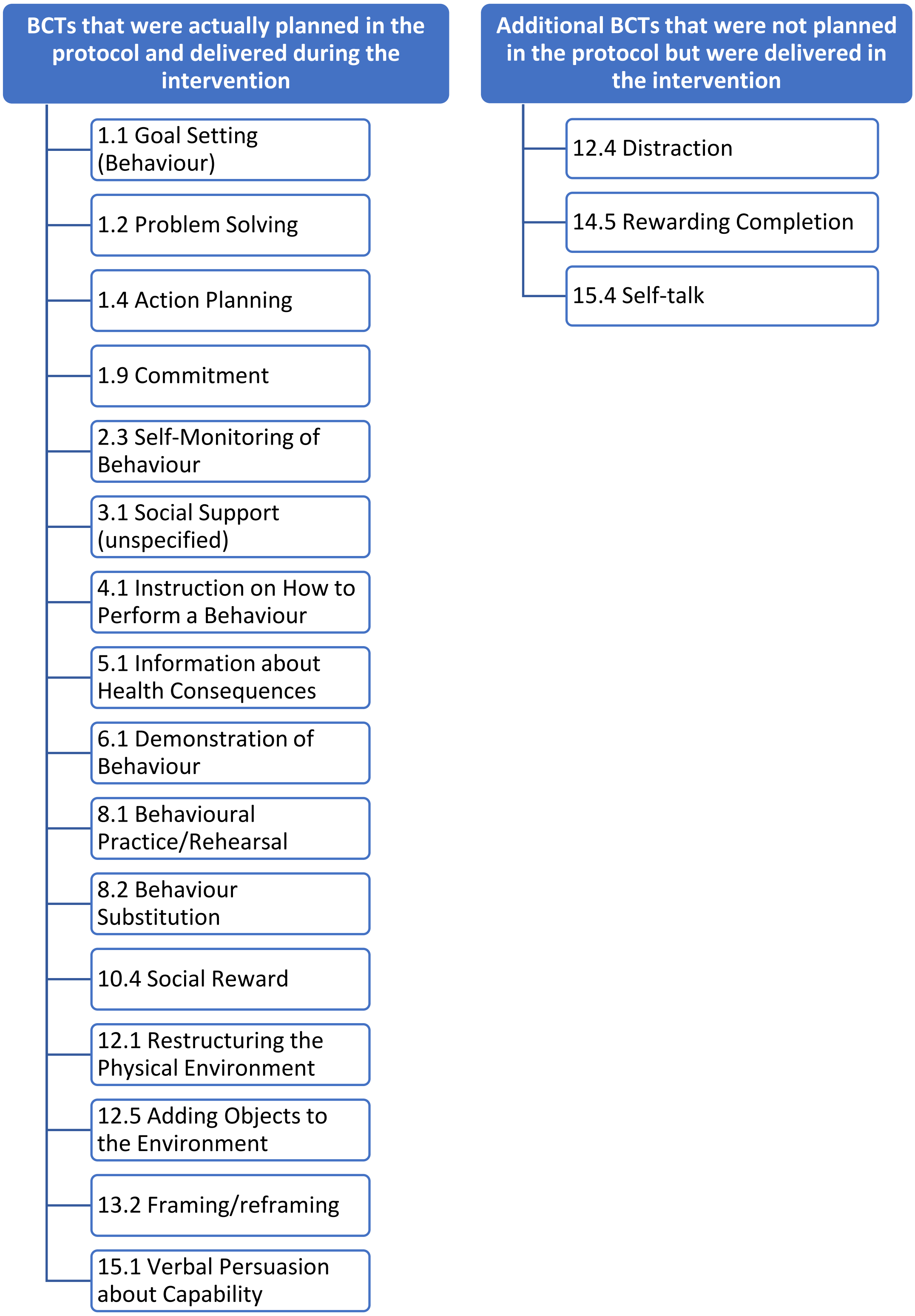
Assessing the fidelity of delivery of the intervention

I made five changes to the original curriculum during the intervention, based on student input. First, after the initial session, students objected to the programme's 90-minute length, arguing that it interfered with other school obligations like studying and attending class. As a result, I shortened the sessions to a maximum of 60 minutes per week by including only the most important content. Secondly, students complained that some of the sessions conflicted with exam taking, Ramadan or the summer holidays. As a result, I combined sessions five and six together and sessions eight and nine together, making the programme ten sessions rather than the proposed 12 sessions. Thirdly, one of the students created a WhatsApp group that I incorporated into the intervention as a social media component. The WhatsApp group provided peer support and motivation to students during the week. It also allowed me to send out reminders about upcoming sessions to boost attendance.

The BCTs ‘social support’ (unspecified) and ‘social reward’ were employed during programme sessions and via a WhatsApp group allowing students to share their experiences with one another. (Amendments to the study were sent to the IRB and were approved.) In addition, I incorporated ‘social reward’ when congratulating students who sent pictures of their healthy plate or evidence of their step count (10,000 or above) via the WhatsApp group. ‘Demonstration of the behaviour’ was achieved by showing videos on physical activity and fitness (such as light and moderate intensity exercises) and preparing healthy meals (such as fruit and vegetable salads) during the sessions and via the WhatsApp group. Fourthly, while I originally asked students to buy a pedometer to monitor their step count, most students could not afford to purchase this instrument. As an alternative, I advised them to use an application on their phones to self-monitor their step count. Finally, the original design of the study included post-intervention measures of height and waist circumference. However, an unexpected barrier to accessing the university’s clinic and nurses prevented assessment of height and waist circumference on the final day of the intervention. As an alternative, I measured the weight of the participants with the same scale I used for baseline measurements, since the scale was kept outside the clinic. Without access to the clinic, I was not able to measure waist circumference.

With regard to fidelity of the BCTs, I found that all the BCTs planned for the intervention were used in delivery of the intervention. However, I also used three new BCTs that were not included in the protocol. Of these BCTs, two were introduced during the problem-solving session and one was introduced during the final session. Figure 6.5 illustrates the BCTs that were planned and in the protocol, and those actually delivered during the sessions. It also shows the BCTs that were not planned and absent from the protocol but used during the sessions. Ultimately, 100% of the BCTs in the protocol were used in the feasibility trial, indicating that all planned content was delivered. In addition, around 16% of the BCTs the programme delivered were not specified in the protocol. The three additional BCTs were not planned earlier. Thus, all the sessions were delivered as planned except the problem-solving session.

Figure 6.5: Assessment of the fidelity of BCTs



6.7 Step 3 (MRC): Sample size calculation based on the feasibility trial

I used the feasibility study results above to recalculate the sample size for the future RCT. I did the calculation manually, using the formula titled ‘sample size estimating for means for pre-post intervention’ (Danel & Cross, 2013, p. 189), as follows:

$n = (z_{1-\alpha/2})^2 s^2 / d^2$

Where:

Expected standard deviation of the variable in group = s

Expected absolute allowable error in the mean =d (eg : 20% $\bar{x}$), where expected mean of the variable in the study group = $\bar{x}$

Value of normal deviate at considered level of confidence = $z_{1-\alpha/2}$

Hence, assuming the variable values based on the feasibility trial:

Intervention group mean change in weight ($\bar{x}$) was 2.62kg ± 2.13kg (s) (based on ITT analysis)

Putting values in the formula: $n = (z_{1-\alpha/2})^2 s^2 / d^2$

Calculating the same

s = 2.13

α = probability of type I error (5% = 0.05)

$z_{1-\alpha/2} = 1.96$

d = 20% of $\bar{x}$

= 20/100 *2.62

=0.2X2.62

=0.524

$n = (1.96)^2 (2.13)^2 / (0.524)2$

= 3.841x4.53/0.274

=17.39/0.274

= 63.46

= 64 for each group

If we consider

n 1: n2 = 64x2 = 128

Based on the preliminary feasibility study, drop out % is 20

Considering a drop-out rate of 20%= 0.2(128) = 25.6

$$\approx 26$$

Therefore, the required sample size = 128 + 26 = 154

So, 154 participants are needed for the potential RCT.

In my feasibility study, change in weight was 2.62 ± 2.13 kg. However, in the initial calculation of the sample size (Appendix 4F), the mean weight change which was used was 5.58 ± 5.6 kg. Therefore, I assume that the sample size determined from the feasibility study which resembles my population of interest (154 participants to be recruited) is more accurate than my initial calculation (137 participants) which was based on another study (Alghamdi, 2017) conducted in KSA among a different population and setting.

6.8 Discussion

The objective of this study was to evaluate feasibility, acceptability, fidelity, and effectiveness of a multi component weight loss programme, combining nutrition education, physical activity and BCTs, before implementing it at a larger scale. A secondary aim was to determine the suitability of the intervention's overall time frame. The high recruitment and retention rates showed that the BHL programme was feasible among female university students.

Feasibility

Findings support the feasibility of the BHL programme. First, the study recruited the required sample size indicating the willingness of university students to participate in the weight management programme. Second, the programme's retention rate was high suggesting student's continued interest in the sessions and commitment to weight loss. Third, the contents were delivered as planned to the participants, further indicating feasibility of the programme. Only minor changes were made to the content, as mentioned earlier.

Acceptability

Attendance rates differed at the start and near the end of the programme. The first half of the intervention had over a 90% attendance rate. However, participation dropped dramatically the week before university examinations and during Ramadhan and the university's summer vacation period. I was able to motivate all the remaining 12 students to attend the final session by handing out certificates of achievement for completers of the programme. This technique, which involved rewarding behaviour (14.5: Rewarding Completion) (Michie et al., 2013), will be incorporated into the future intervention and participants will be provided an appreciation certificate upon completion of the study.

Overall, the attendance rate of the programme was high, indicating that it was acceptable to the participants. In addition, to further assess acceptability, I conducted follow-up interviews with participants to identify facilitators and barriers to the programme and its content (targeted behaviours) (Chapter 8).

Effectiveness

The non-randomised feasibility study design may provide evidence of potential effectiveness but compared with the RCT, has less statistical power to detect a clinically and statistically significant difference between weight pre- and post-intervention. Keeping this limitation in mind, students in the present non-randomised study obtained a mean weight loss of 2.62kg after 12 weeks; and completers had a mean weight loss of 3.27kg.

Time Frame

The trial highlighted barriers to attending a weight loss programme, which included transportation issues and conflicts with significant dates and holidays. For example, I held the last three sessions of the programme during the summer vacation and the holy month of Ramadan, which prevented many students from attending. While the study began with a sample of 15 students, these challenges reduced the number of participants to 12 by the programme's end. However, two of the students who left the intervention for personal reasons requested an opportunity to continue at an alternative or future date, suggesting that their interest in the programme remained high. Therefore, the potential intervention should be modified to reduce the number of sessions and be more flexible to suit the schedule of the university students.

Fidelity

The use of a pedometer, whether as part of a watch or phone, to track daily steps was well-received by students, who, in conversations during sessions, commented on its usefulness in reaching targeted behaviours and intervention goals.

The study successfully took baseline anthropometric measurements, including weight, height, and waist circumference. Due to confusion concerning clinic hours (at the time of the scheduled post-intervention measurement, the clinic was closed), I was not able to measure waist circumference post-intervention. The future intervention will secure a location and ensure that staff are ready to assist with all measurements before and after the programme is completed.

Based on the outcomes discussed above, the study proved largely successful in terms of feasibility and acceptability with the intervention design. After making several adjustments to the intervention, it should be ready to implement at a larger scale. These changes will help to improve programme attendance and modify the curriculum to include new BCTs identified as helpful in promoting weight loss during implementation.

6.8.1 Strengths

This feasibility study has several strengths. The trial used evidence based BCTs drawn from a systematic review of the literature on weight management interventions. It also incorporated data from a qualitative study on healthy eating and physical activity among female university students in KSA. The focus group data were analysed using two theoretical models, the Theoretical Domains Framework (Michie et al., 2005) and the Behaviour Change Wheel (Michie et al., 2011). These frames facilitated linkage of the study’s culturally specific themes with potential BCTs for weight loss, providing further basis for the trial. The study was also enhanced by my experience as a registered dietician, who is familiar with nutrition and the provision of dietary advice, and I was able to use this knowledge to help students meet their targeted behaviours and outcomes.

Furthermore, as far as I am aware, this is the first feasibility study of a weight loss programme for female university students in KSA.

6.8.2 Limitations

This study had several limitations. First, it was a non-randomised trial with a small sample size (n=15) and no control group. The small sample was composed of self-selected volunteers who were recruited using convenience sampling. While there was no control, this approach is consistent with feasibility trial design and my intention to assess feasibility of the intervention and its implementation, acceptance, and effectiveness on a small scale. Nevertheless, the small sample size and lack of control group means that results should be interpreted with caution. Secondly, the intervention was not co-produced and thus critical information from student stakeholders that could have improved programme design was not obtained before implementation. For example, input from students as part of a collaborative design process could have prevented issues with the length of sessions and the timeframe for the programme. Thirdly, participants used different phone apps to assess their step counts during the study, which prevented comparison of standardized results. Fourthly, no data on goals or their achievement were collected from the students. Subsequently, this study did not assess targeted behaviours. Fifthly, the trial's initial design also lacked potential strategies to assess or enhance feasibility and compliance. Finally, it was difficult to assess fidelity myself, as I was delivering the intervention.

6.8.3 Generalisability

The generalisability of this feasibility trial was limited compared with an RCT design. However, the trial offered useful insight into promoting weight loss among its target population.

6.8.4 Reflection from the feasibility study for the potential intervention

Reflection on the implementation of the feasibility study suggests several areas where the potential trial could be changed and improved to successfully bring it to scale at a later date. The main obstacle I faced as a researcher during the implementation of the trial was scheduling sessions of the weight management programme. Similarly, exam week, summer holidays and fasting (which typically involves not eating or drinking in the daytime) during the holy month of Ramadan created barriers to student attendance.

To address barriers during exam periods, I chose to cancel the weekly meetings and then combine topics at the next scheduled session. Also, at the suggestion of students, I decided not to meet during the summer vacation and Ramadan, further condensing the number of sessions. Ultimately, I reduced the number of sessions from 12 to ten during the programme's implementation. The future RCT's sessions will be further shortened to six sessions carried out across 12 weeks, to accommodate student needs better during exams or when other conflicts (e.g. events or project deadlines) arise.

Another scheduling challenge prevented post-intervention assessment of height and waist circumference. I had to weigh the participants on a scale in another location, potentially introducing bias to the results. In the future RCT I will make all necessary arrangements to ensure post-intervention anthropometric measurements are taken by the nurses in the university clinic, to ensure blinding of outcome assessment and prevent outcome bias.

A second barrier to implementation was students' lack of access to pedometers. Many students were unable to afford these instruments to measure their daily step count. As a result, I encouraged students to keep track of their daily step counts on phone apps. However, given the different apps used by students, results were not standardized. To eliminate bias, the future intervention will require students to use a pedometer provided by the programme to ensure standardized data (step counts).

In its original design, the study overlooked the use of social media, especially as a form of social support. Fortunately, one of the students created a WhatsApp group for the students to keep them motivated and updated on each other's performance and progress. The WhatsApp group also helped to remind students about upcoming sessions, times, and locations. The future RCT will incorporate social media from the beginning of the study.

Finally, making healthier food choices was not specific as at the time of the initial development of the BHL programme, my knowledge was limited regarding the behaviour change. However, after I took the CBC course after the feasibility trial of the BHL programme, my understanding of the models improved and changes were made. After my upgrade viva, I decided to modify the programme's curriculum and to strengthen its focus on the targeted dietary related behaviours in the future intervention. Accordingly, specific behaviours were targeted, One of the targeted behaviours ('increase the consumption of fruits and vegetables') was replaced with a new target behaviour ('reduce the number of snacks to two or less per day') to highlight the main behaviours leading to weight loss. And the other behaviour ('making healthier food choices') was modified to a new target behaviour ('making healthier main meal choices) to make the behaviour more specific. Overall, the targeted behaviours were modified as follows:

- Replace high calorie beverages with water
- Reduce the number of snacks to two or less per day
- Making healthier main meal choices
- Increase walking to reach minimum 10,000 steps daily

Despite several modifications, the future intervention will remain similar to the original design. The intervention will include modest changes to the curriculum, the number of sessions and the targeted behaviours and related activities. For instance, the behaviours will be assessed in the future RCT.

6.9 Conclusion

This feasibility study helped to identify potential obstacles to successfully conducting an evaluation of a weight loss intervention. These obstacles included timing and scheduling conflicts; barriers to taking anthropometric measurements; and insufficient means to evaluate targeted behaviours. In particular, the challenges in post-intervention assessment and participant attendance indicate that the curriculum should be adapted to meet the needs of female university students of KSA and the timeframe of the study should be more accommodating to student needs. Despite these challenges, attendance at the intervention sessions was high during the first half of the programme, indicating interest in the session topics and a desire to meet outcome goals. The students appreciated using a social media app to motivate themselves and each other and responded positively to a reward-based behaviour change technique (10.4: Social Reward) by attending their final session. The assessment of fidelity of the session content and BCTs indicated that 100% of BCTs in the protocol were used in the trial, showing that all planned content was delivered. ITT analysis and complete analysis found that the effectiveness of the intervention on the primary outcome (weight) was statistically significant. Moreover, the sample size (n=154) for the potential RCT was successfully calculated. Overall, these various results provide a promising foundation for designing an effective larger-scale evaluation.

Having investigated the feasibility trial, the next chapter considers COVID-19 in the KSA context as well as the existing literature on public health quarantines and food related and physical activity behaviours. This information provides relevant background knowledge for the discussion of the interviews in Chapter 8.

Chapter 7: COVID-19

7.1 Introduction

This chapter discusses the novel Coronavirus disease outbreak in 2019 (COVID-19) and associated government restrictions to minimize the outbreak in 2020. It then explores existing empirical knowledge on the impact of pandemics and quarantines on psychological health, food related behaviours and physical activity. The chapter ends with a rationale for conducting phone interviews with participants of the BHL programme.

7.2 Background

In spring 2020, the government of KSA imposed a nationwide curfew (“lockdown”) to control the COVID-19 pandemic. With universities closed and travel restricted, I was forced to alter the research design of this thesis, which originally called for an in-person randomised controlled trial (RCT) of a weight management intervention for female university students which was under ethical review by UCL at the time of the lockdown. As an alternative, I withdrew my ethics application and submitted an application for an alternative study. I decided to interview participants of the uncontrolled multi-component weight management feasibility trial of the Better Healthy Lifestyle (BHL) programme, conducted during an earlier phase of research (see Chapter 6).

The feasibility study took place in March-May 2019 with female students attending Saudi Electronic University (SEU) in Riyadh, KSA. The programme integrated nutrition education and physical activity education with behavioural change techniques (BCTs) to meet targeted behaviours to promote weight loss. The new qualitative component of this thesis explores the intervention’s longer-term impact on eating habits and physical activity using semi-structured phone interviews. During the interviews, participants were asked to describe their experiences maintaining post-intervention healthy lifestyle behaviours prior to COVID-19 and after lockdown.

The rest of this chapter provides more information on why I decided to change my study's research design and explains why a qualitative approach is an appropriate means to assess food-related behaviours and physical activity in the context of the COVID-19 lockdown and social distancing measures. However, before this discussion, I describe the events leading up to the COVID-19 quarantine policy in KSA. Next, I discuss findings from the public health literature on the psychology of pandemics and quarantines and their potential impacts on diet and physical activity. Studies assessing the impact of COVID-19 lockdowns on eating behaviours and physical activity were limited at the time I was preparing for the phone interviews in May 2020. However, since then, multiple papers have been published identifying the effect of COVID-19 lockdowns on food-related behaviours and physical activity worldwide, and many of these are discussed in Chapter 8 (see section 8.6). Despite the lack of empirical evidence, the following sections focus on the link between quarantine and dietary behaviours and exercise by drawing on existing empirical knowledge.

7.3 COVID-19 Lockdown

Scientists first announced a novel coronavirus (SARS-Cov-2) as the cause of an outbreak of respiratory illness, called COVID-19, in Wuhan, China, on 7Jan, 2020. Despite containment efforts, patients around the world quickly contracted the illness, and by 10 March 2020, more than 118,000 cases of COVID-19 had been reported in 114 countries. Shortly thereafter, the World Health Organization (WHO) declared COVID-19 a pandemic, giving it their most serious rating for global risk of spread and impact (World Health Organization, 11 March, 2020).

COVID-19 is a significant threat for two main reasons. First, it is transmitted easily between people, with the infected person, even when asymptomatic, spreading the disease to two or three others on average (Hoehl et al., 2020). Secondly, data suggest that COVID-19 has a mortality rate of about 1.3%, making it significantly more dangerous than seasonal influenza. However, this rate may be overestimated since asymptomatic disease and mild disease with no formal diagnosis are not counted in official statistics of the disease. Regardless of the total population death rate, COVID-19 is particularly fatal in elderly patients and people with existing health problems (Basu, 2020).

Given the potential harms of COVID-19, as well as the lack of therapeutic and vaccine options at the time, epidemiological experts advised strict social distancing measures to reduce the likelihood of contact between infected and uninfected people and to limit spread. In response, nations around the world endorsed aggressive policies, including travel bans and stay-at-home measures to protect their populations.

In KSA, authorities announced a series of measures to control spread of the virus. These included suspending international travel, sporting competitions and social events and closing schools and universities, indoor shopping malls, gyms, stadiums, and public parks. Restaurants and coffee shops (not located in indoor malls) were permitted to provide only takeaway and delivery service. Hospitals, clinics, pharmacies, and grocery stores remained open, but residents were under a strict curfew and allowed to travel only during specific hours (U.S. Embassy and Consulates in KSA, 2020; Yezli & Khan, 2020). Quarantine regulations were eased at the end of April 2020 for Ramadhan, but 24-hour lockdown was imposed for the Eid al-Fitr holiday (23rd May, 2020 until 27th May, 2020) (Suliman & Gubash, 2020).

Due to economic fallout from the lockdown, in May 2020, the Ministry of Finance raised taxes (VAT) by 10%, from 5% to 15%. The government also lifted the lockdown; however, strict precautionary measures were implemented for travel outside the home. Social gatherings remain prohibited (as of December 2020) and people mainly visit their family. Most people are worried about going outside, and therefore only leave their home for necessities.

As of 23 May, 2020, 62,545 cases of COVID-19 had been reported in KSA, out of 5.21 million cases worldwide (Suliman & Gubash, 2020). As of 12 November, 2020, 351,849 cases of COVID-19 had been reported in KSA (European Centre for Disease Prevention and Control, 2020), out of 52,733,290 cases worldwide (Johns Hopkins, 2020). As of 25 March 2021, 386,300 confirmed cases of COVID-19 have been reported in KSA, out of 124,535,520 cases worldwide (WHO 2021).

7.4 Quarantine and Psychological Effects

From a public health perspective, social distancing is critical to slowing the spread of infection and saving countless lives around the world. Nevertheless, quarantine measures are among the most aggressive a government can take to address a health epidemic. Quarantine forcibly separates people and restricts their movement, creating radical changes to people's lifestyles and putting them under huge pressure. For some, quarantine brings more time to spend with household members, with both positive and negative consequences. For instance, parents and children may enjoy seeing one another for extended time, without work or school obligations. However, domestic violence and other forms of abuse increase during quarantine, as frustration and worry heighten the potential for aggression among high risk individuals (Mazza et al., 2020).

Research on previous pandemics, including severe acute respiratory syndrome (SARS), Ebola, and H1N1 influenza, indicates that quarantines produce considerable and lasting psychological effects. Moreover, impacts are made worse by long periods of isolation, leading to post-traumatic stress symptoms (Hawryluck et al., 2004; Reynolds et al., 2008) and avoidance behaviours, such as avoiding social contact, public places and holding back at work (Marjanovic et al., 2007). Moreover, for people with existing mental health conditions, social isolation may cause greater problems (Goodman et al., 2001) and combinations of social vulnerabilities, such as loneliness, homelessness, or physical disability.

Common stressors during quarantine include separation; loss of ordinary routine; reduced social and physical contact; and a sense of isolation from the rest of the world (Blendon et al., 2004; Braunack-Mayer et al., 2009; Cava et al., 2005; Desclaux et al., 2017; Hawryluck et al., 2004; Reynolds et al., 2008; Robertson et al., 2004; Wilken et al., 2015). Quarantine produces even greater distress when people do not have basic supplies, such as food, water or medication (Blendon et al., 2004; Wilken et al., 2015), or clear guidelines from public health authorities about how to act (Braunack-Mayer et al., 2009; Caleo et al., 2018; Cava et al., 2005; Robertson et al., 2004). On top of these worries, people fear infection and the loss of loved ones (Bai et al., 2004; Cava et al., 2005; Desclaux et al., 2017; Maunder et al., 2003; Robertson et al., 2004), as well as financial loss (Blendon et al., 2005; Pellecchia et al., 2015; Taylor et al., 2008) and stigma

(Cava et al., 2005; Desclaux et al., 2017; DiGiovanni et al., 2004; Hawryluck et al., 2004; Lee et al., 2005; Maunder et al., 2003; Pan et al., 2005; Pellecchia et al., 2015; Reynolds et al., 2008; Robertson et al., 2004; Wester & Giesecke, 2019).

Boredom, frustration, depression, helplessness, anger, and chronic stress are typical reactions to quarantine. As an illustration of ongoing impact, a recent cross-sectional survey of the general public in China during COVID-19 found that 54% of respondents experienced moderate to severe levels of psychological distress (Wang et al., 2020). This finding is similar to responses during the SARS epidemic in 2003, when 29% of mainland Chinese in quarantine reported post-traumatic stress disorder symptoms, and 31% reported depressive symptoms (Hawryluck et al., 2004).

7.5 Lockdowns and Food-related Behaviours

While there is substantial research on the psychological effects of quarantine, there are few studies on dietary effects (Di Renzo et al., 2020; Scarmozzino & Visioli, 2020). Despite limited evidence, it is possible to consider how the negative emotions associated with quarantine could make it difficult to sustain healthy behaviours during lockdown. For example, there is plenty of evidence to show that acute and/or chronic stress can overwhelm individual coping strategies and produce harmful behaviours, including unhealthy eating patterns (Okyere, 2020; Oliver et al., 2000).

Some people respond to stress with cravings for foods high in sugar and fat (Michaud et al., 1990; Oliver, Wardle, & Gibson, 2000) even when they are not hungry, leading to over-eating (Dallman et al., 2005). During “stress eating” (Torres & Nowson, 2007), people substitute unhealthy energy-dense foods for main meals and vegetables (O’Connor et al., 2008), reducing the nutritional quality of their diets (Weidner et al., 1996) and increasing the likelihood of weight gain due to excess energy intake (Oliver et al., 2000; Torres & Nowson, 2007). The resulting overweight or obesity (or increases to obesity) may cause negative health consequences. However, some people respond to stress with the loss of appetite (Chao et al., 2017). There is a causal relationship between emotional well-being and dietary behaviour that can increase the negative physical and psychological effects of quarantine. Longitudinal studies indicate that higher intake of processed foods increases the risk for clinical depression (Akbaraly et al., 2009; Jacka et al., 2011a; Jacka, 2011b). Thus, the unhealthy eating habits produced by elevated stress levels during quarantine are likely to reinforce or multiply distress (Chatzi, 2011; Jacka et al., 2011a; Jack, 2011b; Li et al., 2017; Nanri et al., 2010; Oddy et al., 2009; Weng et al., 2012), impairing the ability to maintain healthy lifestyle behaviours during lockdown (Sockalingham et al., 2020).

Disaster research (in areas outside of pandemics) offers support for the relationship between collective stress and unhealthy eating behaviours. Hu et al. (2016) explored diets among three groups of women following a massive earthquake in Wenchuan China in 2008. They found that eating patterns varied by seismic zone, namely the earthquake zone, the shaking zone, and the non-seismic zone (although these differences were mediated by factors like age, residence, and nutrition knowledge). Overall, despite food shortages, food consumption increased for women in the earthquake and shaking zones, who were triggered by trauma, whereas there was no change in food consumption for women in the non-seismic zone. In addition, women in the earthquake zone were more likely than women in the other zones to engage in unhealthy eating like snacking. About 30% of these women reported that they ate to manage anxiety.

Beyond stress, other quarantine-related factors may encourage unhealthy eating habits during lockdown. For example, curfew travel restrictions may prevent people from visiting grocery stores and purchasing healthy food. In addition, limited access to supermarkets may encourage people to buy more canned and processed food, which are more easily stored, and eat these items instead of whole food products (Abbas et al., 2020). Finally, a breakdown in the food supply chain may cause food shortages, limiting access to dietary staples (New Arab, 2020).

7.6 Lockdowns and Physical Activity

In general, opportunities for physical activity have been significantly restricted due to COVID-19 lockdowns. Authorities have shut down school-based physical education, fitness programmes, sports leagues, public parks, and gyms, while shelter-in-place rules have shortened or eliminated daily walks to purchase items or travel to school and work. Restricted to their homes, people are sitting more and moving less and failing to meet WHO's recommended levels of 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic activity weekly (World Health Organization, 2020).

There is strong evidence to show that physical inactivity contributes to poor mental health, particularly depression (Jacka & Berck, 2013; Lucas et al., 2011; Pasco et al., 2011; Sacker & Cable, 2006). During quarantine, this effect may be exaggerated as the negative emotions triggered by lack of exercise - sadness, anger, irritation – compound the stress already caused by lockdown (Brooks et al., 2020). Physical activity also provides peer interaction and friendship, and the loss of these social bonds may increase feelings of loneliness during quarantine (MacDonald-Wallis et al., 2012; Montgomery et al., 2020). In a cross-sectional study of community residence among older adults, Robins et al (2018) found that higher levels of physical activity were associated with lower levels of social isolation. The authors suggested that this relationship may be mediated by depression but were unable to definitively demonstrate this, concluding that the reason for the relationship between household-based physical activity and social isolation remains unclear. In another study, Schrempft et al. (2019) discovered that time spent engaging in moderate-to-vigorous intensity physical activity was significantly lower among older adults who reported being socially isolated than those who did not report being socially isolated. As in the previous study, the authors stated that the cross-sectional relationship between social isolation and physical activity did not conclusively demonstrate a direct link and other factors (e.g. illness, limited mobility) may play a role.

Goethals et al. (2020) conducted a provisional assessment of the impact of COVID-19 on physical activity among older adults in France. The authors interviewed regular attendees of senior citizen physical activity workshops who were unable to participate due to the pandemic. Most older adults remained interested in exercise and took part in home-based physical activity. However, several reported obstacles to engaging in physical activity, including a sense of isolation and lack of group support.

In addition to mental health impairment, limited physical activity increases the risk for overweight and obesity as well as a range of comorbidities (Kivimiaki, et al., 2019; Lippi et al., 2020). The sudden cessation of physical activity, which may occur due to unexpected quarantine, may also produce negative health effects. For example, after two weeks of physical inactivity, many of the metabolic and cardiovascular benefits of exercise may be lost. Stopping physical activity in this way may increase blood pressure, atrophy muscle, and accelerate atherosclerotic disease (Lippi et al., 2020).

Physical activity levels have decreased and food consumption has increased among the population of KSA during the COVID-19 lockdown (Bakhsh et al., 2020).

7.7 Summary of Lockdown Evidence During Planning the Interview Study (May 2020)

The public health literature suggests that it may be difficult to sustain healthy lifestyle behaviours during quarantine, given essential changes to daily life and emotional well-being. It also indicates that reduced dietary quality and physical activity during lockdown puts individuals at increased risk for mental and physical challenges. These possibilities may or may not hold for BHL participants, who attended the programme’s nutrition and physical activity sessions (supported with BCTs), gaining important knowledge and skills. However, taken together, they suggest that it is critically important to consider the influence of COVID-19 on food-related behaviours and physical activity to obtain a comprehensive sense of the BHL programme’s impact.

7.8 Qualitative Interviews – Rationale

Due to the COVID-19 pandemic, I was compelled to re-orient the final stage of my thesis research and choose a different method to assess the impact of the weight loss programme. Thus, I substituted a qualitative study for the RCT originally proposed. I made this change for practical reasons since the current lockdown prevents any kind of in-person or on-campus research. Under these conditions, semi-structured phone interviews provided a straightforward means to conduct in-depth conversations with programme participants while following curfew regulations and social distancing.

The interviews offer more than just logistical advantages. They are an opportunity to collect rich data on the long-term, complex experiences of the programme participants. Despite many quantitative evaluations of weight reduction programmes, qualitative studies focusing on participant experiences are rare. Obtaining these participant views on weight management programmes is critical to designing more effective interventions in the future (Hammarstron et al., 2014), including the RCT I remain committed to implementing after the COVID-19 pandemic is over.

Interviews are also a valuable method for determining how the COVID-19 pandemic has affected food-related behaviours and physical activity, especially for those with overweight/obesity. In particular, the literature indicates that quarantine is likely to influence behaviours though complex and interactive pathways. These may best be assessed through detailed description of participants' experiences and perceptions.

7.9 Conclusion

This chapter has provided context for the decision to replace an RCT of a weight management intervention with in-depth semi-structured interviews of feasibility trial participants. The next chapter will describe the research design of the qualitative study; discuss results from the interviews; and situate the findings within the public health literature.

Chapter 8: Phone Interviews with BHL Programme Participants

8.1 Introduction

This chapter discusses findings from phone interviews with former participants of the BHL programme to explore their experiences maintaining healthy eating and physical activity behaviours post-intervention and during the COVID-19 lockdown. After that, it describes the study's theoretical frameworks, methods and approach to data analysis. Next, it presents the results, providing descriptive extracts from participants' interviews for support. Finally, it considers the findings in relation to previous research on weight management, weight loss/behaviour change maintenance, and the impact of COVID-19 lockdowns on food related and physical activity behaviours.

8.2 Rationale

Multi-component weight management interventions have shown success in improving physical activity (PA), diet and weight-related behaviours among college students (Grim et al., 2011; Plotnikoff et al., 2015). However, it is not known whether these changes are sustainable, since post-intervention follow-up is rare. For instance, Belogianni & Baldwin's (2019) "systematic review of systematic reviews" of dietary, physical activity and weight reduction interventions for university students observed that only two out of 122 studies tracked outcomes over two years. Similarly, a systematic review and meta-analysis of effective behavioural change techniques (BCTs) within weight management interventions for young adults, including college students, found just four studies out of 51 that assessed outcomes 12 months post-intervention (Ashton et al., 2020). Given this research omission, there is a need for well-designed studies that track university students' weight-related behaviours over-time to assess outcomes.

Results from studies on the efficacy of weight loss programmes for adults suggest that weight regain is common after non-surgical intervention. A systematic review of randomised controlled trials (RCTs) promoting diet, physical activity or both in adults with overweight or obesity found that 50% of initial weight loss was regained within one year after the intervention (Curioni & Lourenço, 2005). Another systematic review of the long-term effects of treatments for adults reported that people regained a third of their initial weight loss within a year and the rest within 3–5 years (Avenell et al., 2004). A more recent systematic review of weight loss maintenance interventions indicated that interventions focusing on dietary intake and physical activity slow down weight regain, but the effects are modest and varied (Dombrowski et al., 2014).

While quantitative studies of weight loss maintenance are common, qualitative studies exploring the experiences and perceptions of people maintaining weight loss or weight loss behaviours are more limited. Existing literature focuses on the perspectives of the general public (Bidgood & Buckroyd, 2005; Jackson et al., 2019; Kwasnicka et al., 2019;) or participants of formal weight loss programmes (e.g. Holdsworth et al., 2016; McGill et al., 2020; Metzgar, et al., 2015). Systematic reviews do not differentiate between weight loss methods or research based on female-only samples or mixed-sex samples (Garip & Yardley, 2011; Greaves et al., 2017; Gupta, 2014). While some work examines perspectives in female subgroups, such as African American women (Barnes et al., 2007; Barnes & Kimbro, 2012), at the time of writing, there was no qualitative research on weight loss maintenance among female university students in KSA or any other countries.

Qualitative methods are valuable because they shed light on people's lived experiences. In weight management and weight loss maintenance research, this "experiential information" (Sutcliffe et al., 2018) can help researchers to understand the mechanisms underlying behavioural change, particularly when an intervention and its evaluation are theory-driven (McMahon et al., 2016). While there are many theories of change in the literature, this study, like the focus group study in Chapter 4, is informed by the Theoretical Domains Framework (TDF) (Cane et al., 2012; Michie et al., 2005) and the Behavioural Change Wheel (BCW)/COM-B model (Michie et al., 2011) which together determine behavioural barriers and enablers and match potential BCTs with them.

Qualitative methods are also well suited for capturing social responses to the COVID-19 pandemic by providing greater insight into the reasons for people's behaviours and the process of attributing the consequences to the disease; these insights can help generate effective solutions and strategies (Teti et al., 2020). Previous qualitative research has addressed the social dynamics of other epidemics, such as SARS and H1N1; indeed, during the Ebola outbreak of 2014–2016, social scientists provided qualitative information and analysis that was valuable in addressing the socio-cultural and political dimensions of the epidemic to develop effective interventions (Institute of Development Studies and London School of Hygiene & Tropical Medicine, 2018).

Using interviews generates much needed qualitative data on weight loss maintenance behaviours. Moreover, as a mode of inquiry, interviews are an ideal way to explore the social context of the pandemic and its role in shaping people's behaviours during lockdown. Interviews also produce narratives that offer insight into how people make sense of their lives during COVID-19 (Leach et al., 2020; Teti et al., 2020). The information gleaned through interviews can provide essential knowledge about healthy food related and physical activity behaviours during pandemics and help shape responses to similar public health crises in the future.

This study's principal aim was to identify enablers and barriers to maintaining healthy food-related and physical activity behaviours among female university students in KSA. It explored these issues by drawing on interviews with former participants of the BHL programme feasibility trial (Chapter 6). BHL sought to induce fundamental changes in dietary and physical activity behaviours, using behaviour modification strategies that could be applied at the university and in other settings. These new healthy lifestyle behaviours were intended to initiate weight loss and then enable participants to sustain weight loss or manage weight after the intervention.

Interviews with the students helped to shed light on the aspects of the BHL programme that were perceived as helpful or unhelpful in initiating students' weight loss. The interviews also provided an opportunity to look at the effect of an unusual event – the COVID-19 crisis and subsequent lockdown (see Chapter 7) – on students' reported ability to maintain behavioural change. Understanding the complex cognitive, social, and environmental influences on healthy lifestyle behaviour change maintenance is important because this knowledge can help researchers to design interventions that successfully cause long-term behavioural change. Toward that end, I will use the results from the study to enhance my proposed future randomised controlled study (RCT).

8.3 Objectives

The purpose of this qualitative study was:

i) to explore the post-intervention dietary habits and PA behaviours reported by participants of an uncontrolled feasibility trial of a multi-modal weight management intervention titled the Better Healthy Lifestyle (BHL) programme.

ii) to examine participants' experiences regarding maintaining behavioural change during the KSA government's nationwide restrictions to contain the COVID-19 virus. These measures limited daily activities (e.g. going to school or university, patronising shops, or restaurants etc.) and may have created an environment that affected eating and PA behaviours fostered by the BHL programme.

iii) to generate findings to inform, with insights from Chapter 6 (feasibility study), revisions to the BHL programme. The revised programme will be implemented in a future RCT to rigorously assess empirical outcomes.

8.4 Methods

8.4.1 Recruitment of participants

This study's sample (N=14) was recruited from participants of the BHL programme held March-May 2019 at the Saudi Electronic University (see Chapter 6). The programme involved weekly, 60-minute weight management sessions for 10 weeks and enrolled 15 female university students with obesity/overweight. Approximately one year after the programme, I sent an email to all 15 participants inviting them (Appendix 5A) to participate in a phone interview to discuss their experiences maintaining healthy food-related and PA behaviours. I attached a participant information leaflet (Appendix 5B) to the email and encouraged students to email or call me for further information. The email also asked anyone not interested in participating in the study to reply to confirm receipt of the email. Students who did not respond to the email were contacted by phone and informed about the study.

Students who were interested in the study were asked to verify that they had read the leaflet and urged to contact me with any questions. If students remained interested, they were asked to sign a consent form (Appendix 5C) electronically or to print and sign a hard copy and then scan and email it prior to the interview. Fourteen of the 15 participants responded to the email invitation and were interviewed for the study in August 2020. A remaining student did not wish to participate because she was no longer located in KSA due to COVID-19 and felt that she had little to contribute since she attended only two sessions of the BHL programme.

Due to COVID-19 restriction measures in KSA, all interviews were conducted by phone, as face-to-face meetings were not possible. I chose to conduct the interviews by phone, rather than online (e.g. SKYPE call), to avoid time lags and internet connection problems (Deakin & Wakefield, 2014; Hanna, 2012). Conducting the interview by phone also provided other benefits. It ensured greater confidentiality, given potential data security concerns associated with online interviews, and eliminated any discomfort participants might feel being observed in their own homes (Deakin & Wakefield, 2014; Fielding et al., 2008).

8.4.2 Ethical Approval

UCL (University College London)'s Research Ethics Committee (Ref 15051/002) and the Institutional Review Board of King Fahad Medical City, Kingdom of Saudi Arabia (KSA) (Ref 20-257E) each approved this study (Appendix 5D).

8.4.3 Data Collection

Each phone interview lasted around 45-60 minutes and took place at a time convenient to the participant. Interviews were semi-structured and were guided by an interview schedule informed by the weight management and weight loss maintenance literature (see Appendix 5E). Questions were open-ended and focused on participants' experiences with behaviour change following the BHL programme and at the time of the COVID-19 lockdown.

Participants were asked questions in four main categories:
1) effects of the feasibility trial (dietary or physical activity behaviour change)
2) barriers and enablers to maintaining healthy lifestyle changes (food related and physical activity behaviours) post-intervention and during the COVID-19 lockdown
3) the influence of the COVID-19 lockdown (positive or negative) on lifestyle behaviours
4) the programme components perceived to be most effective and ineffective.

Participants were asked whether they would prefer to be interviewed in Arabic or English. Eight participants chose to be interviewed in Arabic, and six chose to be interviewed in English. The sessions were recorded using a digital voice recorder to ensure that all comments were captured clearly for transcription.

I took several steps to minimize participant and interviewer/researcher bias during the interviews, whilst considering how the interview's modality might affect data quality. Although phone interviews are common in quantitative research (Barriball et al., 1996; Carr & Worth, 2001), they are rarely used in qualitative studies (Sturges & Hanrahan, 2004). In fact, in-person interviews tend to be the ''gold standard'' for qualitative research (McCoyd & Kerson, 2006, p. 389), although electronic interviews are increasing in popularity (Hanna, 2012; Novick, 2008). In general, researchers tend to dismiss phone interviews as an alternative to face-to-face interviews out of a concern that the absence of visual cues will impact data quality (Sturges & Hanrahan, 2004). The main effects from the lack of visual cues (e.g. facial expressions, body language) are thought to be loss of nonverbal and verbal data and contextual information; an inability to establish rapport or to probe; and misinterpretation of responses (Creswell, 1998; Sturges & Hanrahan, 2004).

Despite concerns about phone interviews, there is little evidence that they misrepresent data or compromise its quality. Indeed, recent work suggests that there are methodological (and practical) advantages to using phone interviews. For example, phone interviews do away with the confines of shared physical space that exist in face-to-face interviews, keeping the interviewer and the participant from interrupting one another's personal space. This can create a more neutral environment for the interview process (Hanna, 2012). Indeed, participants may feel more relaxed and better able to reveal sensitive information when the interviewer is not present (Chapple, 1999; Kavanaugh & Ayres, 1998), enhancing the interview process.

Ultimately, interviewing in any setting can create interpersonal stressors that hinder conversation and impact data quality (Novick, 2008). As a result, it is always important to develop strategies that put participants at ease and develop rapport. In this study's interviews, I intentionally set about trying to create a safe and comfortable atmosphere for discussions with participants. This may have been made easier by the fact that I had a pre-existing relationship with the students as facilitator of the BHL programme, and they were already familiar with me (Gordon, 2013). Regardless, I was careful to begin each phone conversation with small talk to foster a relaxed atmosphere (Burnard, 1994). Next, to minimize social desirability bias, I assured participants that they were free to decline answering a question for any reason. I also stressed that their responses would be kept entirely confidential (Fisher, 1993; Gorber & Tremblay, 2010). Throughout the interviews, I encouraged participants to provide a full account of their experiences and responded empathically and nonjudgmentally to disclosure of sensitive information to encourage honest answers (Tausig & Freeman, 1988). As this was not a face-to-face meeting, I could not relay these sentiments nonverbally, but I carefully chose my words and intonation to convey receptivity and acceptance. While the semi-structured interviews adhered to the schedule, I asked open-ended questions, avoided leading questions, and asked follow-up questions to further diminish social desirability bias (Bergen & Labonté, 2020).

8.4.4 Data Analysis

I transcribed the audio recordings of the interviews verbatim, in the language of the interview, omitting only the introductory comments and small talk before the first question. To reorganize data analysis and conduct it in one language, I translated into English the eight interviews that were conducted in Arabic. I then asked a colleague to back translate (Brislin, 1970) these transcripts into Arabic. I subsequently compared the back translation to the text of the original translation to identify any linguistic issues or mistakes that may have occurred during the translation process. I wanted the translated transcripts to replicate the Arabic text as accurately as possible by using proper English vocabulary and syntax, and conveying all aspects of meaning comprehensibly (Esposito, 2001; Larson, 1991). The potential for translation error is discussed in the limitations section of this chapter. The interview extracts in English vary in their clarity and use of natural English, given the varying English language skills of the participants.

For data analysis, I followed the same approach used to analyse the focus group data; a full description of this method can be found in Chapter 4. In brief, I used Braun and Clarke's (2006) thematic analysis to inductively code the data and surface themes. I then mapped the themes onto the Theoretical Domains Framework (TDF) (Cane et al., 2012; Michie, et al., 2005) (see Table 4.1, Chapter 4) and identified relevant domains. Last, I mapped these domains onto the Behaviour Change Wheel (BCW)/COM-B model (Michie et al., 2011) to determine intervention functions and behaviour change techniques. Data findings are described in the section that follows.

8.5 Results

8.5.1. Sample characteristics

The study had a sample of 14 participants. Most students (n = 8) were ≤30 years. The second largest age group (n = 5) was 31–40 years old, and one participant was over 40 years old. Of the 14 participants, five were married, and nine were single. Four of the married students were over the age of 30 (meaning four out of six participants over age 30 were married). Ten were nationals of KSA and four were citizens from other Arab countries. Attendance rates for the BHL programme sessions varied for participants, as mentioned in Chapter 6.

As in Chapter 4, this sample includes a proportion of participants over the age of 30 who do not meet or fall close to the typical age range associated with university

students, 19-25 years of age. Unlike typically aged students, mature students do not undergo formative identity and psychosocial development processes during university years, although they may experience identity changes concurrent with their stage of life. However, as discussed in Chapter 4, many aspects of the university experience overlap for students of all ages and thus, the inclusion of more mature students does not impede my analysis. When there are differences in participant viewpoints based on age or marital status (which is linked with age), I have mentioned them in the results and discussion section of this chapter. Please see Chapter 4 for more discussion on this issue.

8.5.2 Summary of the TDF and COM-B model: Barriers and enablers to healthy eating and physical activity

I identified 18 themes using thematic analysis (see Table 8.1). These were then mapped directly onto 12 of the 14 TDF domains and the six COM-B components. The 12 TDF domains included “knowledge”, skills, “social/professional role and identity”, “beliefs about capability”, “beliefs about consequences”, “reinforcement”, “intentions”, “behavioural regulation”, “goals”, “memory”, “environmental context and resources” and “social influences”. The only TDF domains not relevant to the context of behaviour change maintenance among female university students in KSA were “optimism” and “emotion”. The 18 themes are categorised below according to associated TDF domains and COM-B constructs and are discussed within the context of barriers and facilitators to behaviour change maintenance. Table 8.1 lists the study’s themes and subthemes, as well as providing examples of associated transcript extracts. Table 8.2 links the TDF domains to the BCW, including intervention functions and BCTs.

Table 8.1: Interview Themes, Subthemes and Associated Transcript Extracts

S. No	Themes	Subthemes	Examples: Post-intervention	Examples: During COVID-19 Lockdown
1.	Obtained foundational and practical knowledge to maintain healthy eating and PA	Actionable base for behaviour change Practical guides to behaviour maintaining healthy eating	*I took the basic things for any diet like water, sugar content calories, in general lifestyle. If you know this information itself, that will make you change…(P7)* *There are a lot of tips and a lot of things I have learned from the programme to be healthier. (P2)*	
2.	Developed cooking skills to prepare healthy, flavoursome food	Learned to adjust recipes Learned to make new meals from scratch	*One of the programme that you made for us, that you show, was how the same food that we know in our normal life, we can make it in a healthy way, with a small amount of oil, for example, and make the vegetables and the fruit a lot in the programme. - (P6)*	*Since the lockdown, I wasn't able to eat or order any food from a restaurant, and I had to stick to home-made food. Home-made food is a healthier choice, and I know how it was prepared and what were the ingredients so that I can avoid any unhealthy choices. (P4)*
3.	The healthy lifestyle advocate reinforces her new identity by championing behaviour change		*Because of me, some of my friends and even my family members, have also changed their lifestyle. They walk with me. They started drinking more water like me, and they even try to eat healthy like me. (P8)*	
4.	The programme's focus on realistic weight loss strategies promoted personal transformation	Realistic and attainable goals boost self-efficacy and self-worth Reconceptualized lifestyle change as rewarding and integral to daily life	*It [seeing results] really changed that perspective of my life. I always feel like I can do whatever I want. I feel much better… (P12)* *The programme has changed my overall look on dieting. It's not about diet; it's about changing your own lifestyle and making it healthy. (P11)*	

S. No	Themes	Subthemes	Examples: Post-intervention	Examples: During COVID-19 Lockdown
5.	Lifestyle behaviour changes improves personal wellbeing	Mental health Physical health Other life domains	*I believe in mental health a lot, so…it's too important for me, because I see, I believe that our, affects our mental health even physically because physical exercise relieves the bad energy from the body… (P3)* *My skin is perfect, and I have no acne. I have no dehydration in my skin. (P2)* *I used to spend a lot of money on, for example, on the food from outside, the chocolates and so on, but now I have stopped buying them all…even fast food... (P10)*	*Increasing immunity for us take the healthy food… it's increasing also the immunity of our body is very concentrated about the COVID-19…Also, the doctor to ask… ask everybody: Let's take the healthy foods. (P9)*
6.	Fear of the effects of relapse sustains new lifestyle behaviours	Obesity Poor health	*… when I eat anything unhealthy, then I do more exercise. When I don't have enough time for exercising, then I try to eat less food. Because I don't want to gain weight again. I am happy to have healthy life. (P8)*	*So, I started to be more careful during COVID-19. Because I'm really looking after COVID-19, I will…and they told me…anyone tell me you become more fat or something like that. So, I really like to be in shape, and in a good health. (P5)*
7.	Rewards incentivize weight loss maintenance behaviours			*This makes me just want to not only compete with myself but with my friends… so, it's like after like a long month of like a healthy lifestyle, we'd get together and have like…just rewarding ourselves for the achievements. (P13)*

S. No	Themes	Subthemes	Examples: Post-intervention	Examples: During COVID-19 Lockdown
8.	Willpower sustains commitment and helps to integrate lifestyle behaviours into daily life	No willpower to sustain behaviour change Willpower sustains behaviour change (Pre-COVID) Willpower helped to overcome COVID-19 barriers	*Nothing is hard… whoever has a strong willing…nothing is hard...the willingness is the most important thing…(P1)*	*I used to walk more. But because I am sitting at home in this corona time, I feel lazy. I am not walking now. (P7)* *The motivation was basically since I started before the COVID-19. I really saw the changes that happened to my body, my, my emotions. Or my mental status, let's say, it really improved. I really liked it…So, I think that was the biggest motivation I had to keep going. (P12)*
9.	Setting goals and making plans structures daily routines	Healthy lifestyle behaviours goal's structure daily routines Planning helps to incorporate healthy lifestyle behaviours into daily routines	*Like you told us one time that the best exercise that we have to do to sustain a healthy way is walking, so I didn't stop. I didn't even never stop walking 10,000 steps in a day. (P6)*	*This lockdown has motivated me to set a schedule for my meals. I organised my meals depending on the food pyramid. I made sure I fulfilled every portion of the food pyramid for every day. (P5)*
10.	Mindfulness enables maintenance of food-related and physical activity behaviour		*Before when I got hungry, I used to eat anything without thinking about what I am eating… but after we took the lecture I started thinking before eating anything…I think about healthy food before I become full from food that have a high calorie contents. (P10)*	
11.	Access to gyms and exercise equipment facilitates maintenance of PA	Access to gyms and machines Lack of access to gyms during COVID-19	*I try to walk too and do exercise….After I take the programme, I go to gym. (P9)*	*I am not able to go to the gym and that has decreased my physical activity as the gym has always motivated me to become physically active with the classes and the machines around me. (P11)*

S. No	Themes	Subthemes	Examples: Post-intervention	Examples: During COVID-19 Lockdown
12.	Introducing objects into the environment and changing surroundings sustain healthy lifestyle behaviours		*The watch, I used a watch that counted…tracked my daily steps and reminded me daily to complete 10,000 steps. (P4)*	*…now when COVID-19 and try to use some application…. this application is good, but this is not too much...7 minutes… (P9)*
13.	Sufficient time is necessary to maintain healthy lifestyle behaviours	Time constraints impede maintenance of healthy lifestyle behaviours Lockdown created more time demands Lockdown provided free, unstructured time to maintain PA behaviours	*At first time, I always run out of time or I felt like I was too tired to do so because I had a long day. I think that was my conflict really. (P12)*	*Due to the lock down, I have an abundance of free time…free time has motivated me and gave me a bigger opportunity to increase my daily physical activity...I increased my step count to 15,000 steps a day, and started working out for half an hour each day. (P4)*
14.	Difficulties accessing food during the COVID-19 lockdown shaped food related behaviours	Shutting down restaurants during the COVID-19 lockdown facilitated healthier eating patterns The COVID-19 crisis made it harder to source healthy foods (online or in supermarkets)		*The only obstacle is the significant unavailability of healthy eating ingredients and natural foods cost more. (P2)* *I used to go out and eat from the restaurants, maybe like once every two weeks or sometimes order from the restaurants whenever I crave eating something. But now…we are not going out anymore, so no cravings for any unhealthy food at all. (P8)*
15.	Bounded space was a barrier to maintaining PA behaviours during lockdown	Inability to walk outside during COVID-19 Lack of space in (smaller) homes and flats.		*I couldn't go walking. This is the only problem with the programme with Coronavirus. I couldn't go walking. (P14)*

S. No	Themes	Subthemes	Examples: Post-intervention	Examples: During COVID-19 Lockdown
16.	Cultural norms around food practices are a strong influence on behaviours but can be negotiated	Types of food Social gatherings/hospitality customs Family pressure COVID-19 changed dynamics around cultural expectations of food related behaviours	*The community always provides so much sweets and so much carbohydrates food, and they're so delicious. And it used to kill me. I tried to stay away…Some people they just insist that you gotta have it. I keep insisting that I won't. And I replace it with something else… fruits. (P11)*	*I also had difficulty attending occasions before the lockdown, but the lockdown made it easier by keeping us at home and removing this difficulty choosing healthy food due to the many temptations for unhealthy food I saw at these occasions…(P2)*
17.	Social support is critical to maintaining healthy lifestyle behaviours		*Motivation from my mother, my sister...the girls in the programme...meaning there is a lot of motivation more than before...before it was only me the one who is going to do a system or something. (P14)*	*Having my sisters with me to become physically active and asking them to walk around or to do some exercises has helped me a lot, as I couldn't find them before the lockdown because they were always busy. (P11)*
18.	Self-regulation is critical to maintaining healthy lifestyle behaviours	Self-monitoring Advanced planning/compensation behaviours	*I mean, I always try to have a balance with what I eat and exercise to burn the calories. If I eat more, I diet for the rest of the day or sometimes do more and more exercise until I feel I burned the extra calories. (P8)* *After I started counting my steps, this motivated me a lot to get in more steps every single day…I'm a very competitive person, so every time I walk for a certain number of steps, the next day I compete with myself.... to have more steps the next day. (P13)*	

Table 8.2: Mapping TDF Domains to the BCW, Including Most Relevant BCTs for the RCT (Interviews)

Study's General Themes	TDF Domains	COM-B	BCW Intervention Function	(Potential) BCTs based on BCW (BCTs identified from interviews are in italics)
Obtained foundational and practical knowledge to maintain healthy eating and PA	Knowledge	Psychological capability	Education Training	*Information about social and environmental consequences* Instruction on how to perform behaviour
Developed cooking skills to prepare healthy, flavoursome food	Skills	Physical	Training	Instruction on how to perform a behaviour Demonstration on how to perform behaviour
The healthy lifestyle advocate reinforces her new identity by championing behaviour change	Social/ professional role and identity	Reflective motivation	Persuasion	Framing/reframing *Valued self-identity* *Identification of self as role model* *Identity associated with changed behaviour*
The programme's focus on realistic weight loss strategies promoted personal transformation	Beliefs about capabilities	Reflective motivation	Persuasion	Verbal persuasion about capability *Self-talk*
Lifestyle behaviour changes improves personal wellbeing Fear of the effects of relapse sustains new lifestyle behaviours	Beliefs about consequences	Reflective motivation	Education	*Information about social and environmental consequences* Information about health consequences
Rewards incentivize weight loss maintenance behaviours	Reinforcement	Automatic motivation	Incentivisation Enablement	Social Reward *Social Incentive* *Self-incentive*
Willpower sustains commitment and integrate lifestyle behaviours into daily life	Intentions	Reflective motivation	Persuasion	Framing/Reframing *Self-talk*
Setting goals and making plans structures daily routines	Goals	Reflective Motivation	Enablement	Goal setting (behaviour) Action planning
Mindfulness enables maintenance of food-related and physical activity behaviour	Memory, attention and decision processes	Psychological capability	Enablement	Framing/reframing *Self-talk* *Prompts/cues*

Study's General Themes	TDF Domains	COM-B	BCW Intervention Function	(Potential) BCTs based on BCW (BCTs identified from interviews are in italics)
Access to gyms and exercise equipment facilitates maintenance of PA Introducing objects into the environment and changing surroundings sustain healthy lifestyle behaviours Sufficient time is necessary to maintain healthy lifestyle behaviours Difficulties accessing food during the COVID-19 lockdown shaped food related behaviours Bounded space was a barrier to maintaining PA behaviours during lockdown	Environmental context and resources	Physical opportunity	Enablement Environment Restructuring	Problem solving Adding objects to the environment *Prompts/cues*
Cultural norms around food practices are a strong influence on behaviours but can be negotiated Social support is critical to maintaining healthy lifestyle behaviours	Social influences	Social opportunity	Enablement Environment Restructuring	Social support (unspecified) Restructuring the social environment
Self-regulation is critical to maintaining healthy lifestyle behaviours	Behavioural regulation	Psychological capability	Training Enablement	Goal setting (behaviour) Action Planning Self-monitoring of behaviour

8.5.3 Helpful and Unhelpful Aspects of the BHL Programme

Participants were asked directly which aspects of the intervention they found helpful and unhelpful for changing food-related and physical activity behaviours. Results were overwhelmingly positive: when students were asked about the unhelpful aspects of the programme, none of the students mentioned any. However, reading through the transcripts I identified some aspects that could be improved, although far more remarks concerned helpful than unhelpful programme components. (See section 8.6.3 for a discussion of why this may have occurred) Table 8.3 lists the helpful aspects of the programme that participants identified at least once in the interviews. It also includes four issues students thought could be improved or addressed. While students largely agreed on the helpful aspects of the programme, each of the unhelpful aspects was mentioned only once, by different students. Chapter 9 takes these statements into consideration when discussing how the BHL programme will be modified before it is tested in a randomised controlled trial (RCT). The next section refers to helpful or unhelpful aspects of the programme when discussing the study's themes.

Table 8.3: Helpful and unhelpful aspects of the BHL programme

Helpful aspects	Examples
Goals/self-monitoring/monitoring of behaviour by others	*Yes, of course, after I started counting my steps, this motivated me a lot to get in more steps every single day. (P13)*
Competition with co-participants	*It was all beneficial. All the competition we did together excited me to exercise. (P1)*
The programme's manageable pace and realistic goals	*Yes, it was very useful. I was able to lose weight in a smooth and easy way, without being deprived. I have seen beautiful and impressive results. (P2)*
Nutrition knowledge	*Actually, I am still now remembering each amount of food that I should eat from vegetables, protein. I remember the dish that you explained about what we are… how… four quarters each quarter vegetables, rice. So…I really try to be in the right and the right way with my dishes. (P5)*
Cooking skills	*We can made it in a healthy way with the small amount of oil, for example, and small and make the vegetables and the fruit a lot in the programme. (P6)*
Tips on changing diets and physical activity levels to incorporate into daily life	*Like I always use the elevator in my daily life. But with this programme, it helped me use the stairs instead which was incorporated into my lifestyle...increasing my steps. (P11)*
Social support/WhatsApp group	*The WhatsApp group also motivated me. (P8)*
Group games/activities (made exercise fun)	*Yeah, when you tell us how to play together…how we played together. Pulled the rope together…when we utilize simple games it seems like it is not exercise but would provide a good result. (P9)*
Unhelpful aspects and/or recommendations to improve the programme	**Examples**
Vigorous activity (hard to incorporate into day)	*It was sometimes difficult to incorporate vigorous physical activity in my life because I didn't have enough time. But I was able to incorporate the light and moderate physical activity behaviours. (P11)*
Cooking skills (no time to use)	*…actually, I wasn't able to cook my own healthy food because of the lack of free time. (P4)*
Start date of programme created conflicts	*Actually, the programme should be more flexible to consider our conditions, but I benefited from it a lot. It should not have started at the end of the semester, it should start at the beginning of the semester. (P7)*
Not enough recipes	*I think there was like, not a lack from the programme, it's just something that I wanted to learn…maybe we would start like with certain type of meals that the programme would provide like some recipes to certain foods. (P12)*

8.5.4 Study Themes and Associated TDF Domains

TDF Domain: Knowledge

Theme 1: Obtained foundational and practical knowledge to maintain healthy eating and PA

Most participants reported that new knowledge gained by attending the BHL programme was critical to maintaining behaviour change. The knowledge was divided into two main categories: nutrition education and practical tips for healthy eating and increased physical activity. In terms of nutrition education, participants expressed appreciation for instruction on the benefits of a healthy diet as well as on fundamental nutrition concepts such as fat and carbohydrates. This information provided a solid, actionable knowledge base that helped participants to adopt and later maintain healthier diets:

> *I learned about every, like, type of vegetable…I started to learn what every type of vegetable was and what every type of food was I could put in my body, like from vitamins and fibres and how they're actually very beneficial for your health. I started to integrate them into my diet, although I, I used to, like stay away from them before I entered the programme. – P13, age 31*

> *After the programme, my awareness is increased…I understand more because before when we went to any restaurant, I eat any thought without awareness, but after that, I did awareness. For example, Chinese foods have a lot of something like soy sauce and something like this not useful for me, also carbohydrate. I focus on carbohydrate as the most important thing about protein. – P3, age 23*

Several participants observed that increasing awareness about the link between health and diet transformed their perspectives on healthy eating. As they became more aware, these students came to see altering food related behaviours as key to safeguarding their future well-being:

> *Actually, it's the awareness. After I became aware that, like, the things that I put, that I put into my body, well with, it's like an investment for me, for*

the, in the future. In order to be healthy in the future, you have to work on your body now. – P2, age 36

Learning practical strategies or "tips" to increase PA or healthy eating was highly valued by participants, and many said these were among the most helpful aspects of the BHL programme (See Table 8.3). Typical comments included:

And I still remember a lot of advice that was in this course. And I try to execute every information that I got from this course. Because really, I became more, what they call this…more… healthier. - P5, age 43

There are a lot of tips that I learned during the programme that helped me improve my diet. -P13, age 31

These tips contained simple and workable advice on how to maximize PA (e.g. take stairs rather than lifts) and manage diets (e.g. read labels or count calories) that participants continued to use long after the programme ended:

…really you gave knowledge and information...we understand and maybe now we take it long time, but really, I am remember from your work how you tell us where, when you go to a restaurant and check the menu, check which little calorie take it, not take anything. - P9, age 38

TDF Domain: Skills

Theme 2*: Developed cooking skills to prepare healthy, flavoursome food*

Several participants reported that the BHL programme taught them how to cook healthy home-made meals, improving the quality of the food they served to themselves and others. These participants felt that the sessions taught them vital culinary skills, such as how to adjust recipes to make them healthier (e.g. cooking with less salt) and how to create new meals from scratch by incorporating healthier ingredients:

Before I used to think that all healthy food are not delicious but now, I know how to make delicious healthy food, and I enjoy eating them. I put very less oil, salt, but it is still very delicious." P8, age 25

During the COVID-19 lockdown, several participants utilized the programme's cooking tips for the first time. Prior to the lockdown, some students kept separate eating habits from their families to maintain heathy food related behaviours. For example, they consumed personal food items for dinner rather than the family meal, which did not meet their dietary standards. However, once the lockdown began, these students were unable to source alternative food and had to prepare their own meals to keep up their modified eating behaviours:

> *So now and the COVID-19, I'm like stuck with the food that is cooked by my own family, and there's not always like a part of that meal that is healthy. So, I really need to cook all over again, look for something. I get bored of eating the same food all over again throughout the week, so it's really helped me or changed the part that I keep looking for a new food to make healthy foods. – P12, age 25*

Other students, usually younger, who normally consumed restaurant food, began to prepare home cooked meals once all the restaurants were shut down during lockdown:

> *After the lockdown, I started eating homemade food. Every meal that I ate, I made myself. And I made sure that every ingredient I put in this meal was healthy and good for my body. I stopped eating at restaurants and from fast food restaurants, and I started making my own meals with my own standards… – P11, age 21*

TDF Domain: Social/Professional Role and Identity

Theme 3: The healthy lifestyle advocate reinforces her identity by championing behaviour change

Several participants described their efforts to persuade others to take up healthy lifestyles. In these accounts, students became passionate advocates of lifestyle change after seeing visible results from their new behaviours, either during the programme or soon after it ended. This positive experience prompted them to enthusiastically share programme experiences, offer nutrition advice, and promote the health benefits of PA:

> *I try to [tell] everyone I know about it. I tell them about this style, this programme…I tell to them about the eat, how what eat, the calorie what is like it...the exercise.* - P9, age 38

While one student did not comment on her ability to persuade friends or family to change their behaviours, the rest reported success in the “advocate” role, convincing others to improve their diets and/or exercise regularly:

> *I will say for my family, my mother have a diabetes. But I, after I get the programme and I encourage her to do the same as me. So, we start to walk, walk with each other, and eat the same food, the healthy food. Even my sisters and my brothers, I encourage them to get to the programme as well. - P6, age 23*

As “advocates,” participants were able to express an emerging identity centred on their status as healthy individuals. In addition, engaging in their advocacy behaviour helped students to strengthen their personal commitment to maintaining healthy food related and PA behaviours.

During the COVID-19 lockdown, some students were able to bring family into their exercise efforts. These experiences were less about direct advocacy, as described above, and more about finding joint activities to pursue during home confinement, when parents, children and siblings had excess time to spend together. These family-centred physical activities are described later in this chapter.

TDF Domain: Beliefs about Capabilities

Theme 4: The programme’s focus on realistic weight loss strategies promoted personal transformation

Many participants revealed that they initially doubted their ability to lose weight on the BHL programme. They described feeling overwhelmed using previous weight loss methods, particularly due to expectations of immediate change, and feeling discouraged when failing to achieve this outcome. In contrast, the BHL’s focus on incremental and realistic change was received positively by participants.

Those who followed the programme closely and maintained modified eating and PA behaviours experienced significant personal transformation. This included enhanced self-worth and self-efficacy and a change in attitude toward lifestyle change behaviours that facilitated their integration into daily life.

Students pointed to specific programme features that made personal transformation possible. They praised the programme's measured approach, especially the gradual introduction of attainable target behaviours:

> *…we started the programme gradually. Firstly, we began to drink a lot of water. Then we said that we have to eat healthy. Then, meaning the programme, we started it. We did not start it all at once… It is impossible to do all at once...so what happened…no … I mean gradually, so maybe that is what helped me more than anything else… - P14, age 21*

> *The programme that I attended with you helped me understand simple facts… and by following them… I was able to lose a lot of weight… Without depriving me and dropping out food… as I used to do by disturbing diets before the programme. - P2, age 36*

Participants credited the programme's pace with their initial weight loss success. Moreover, as time went on, they felt more confident in their ability to continue losing weight:

> *I started losing weight when I started drinking more water and avoiding Pepsi and other drinks. I was so happy...When I lost weight, I felt more confident and I felt…I felt I can lose even more. - P8, age 36*

This initial boost in self-confidence grew as students successfully maintained their modified behaviours and realized that they could sustain them on their own, enhancing motivation to perform behaviours and leading to greater self-efficacy and self-worth:

> *I started to love myself more every time I do something beneficial for myself. I...like I started to see it as self-love, like, every time I do something*

> *that's like an achievement in like any physical activity that I didn't used to do before. -P13, age 31*

In some cases, these cumulative achievements gave rise to a sense of empowerment that extended into other areas of daily life:

> *I did everything I can do. And the feeling that I see improvement in myself. The way I eat. The way I look and not only in my eyes, even in the people around me. The feeling that I'm powerful in their eyes, that I can do whatever I was determined to do. - P12, age 25*

The process just described also prompted students' conversion in attitude toward lifestyle change. While they once viewed it as unpleasant, even difficult, students came to see behavioural change as manageable and rewarding and something that could easily be integrated into daily life:

> *I changed my outlook on dieting and on healthy eating... It's not about restricting yourself, not about making it hard. It's about incorporating it into your lifestyle. – P11, age 21*

TDF Domain: Beliefs about Consequences

Theme 5: *Lifestyle behaviour changes improved personal wellbeing*

Participants described many positive outcomes stemming from changes in food related and PA behaviours. Students' beliefs about these consequences were a factor in motivating initial uptake of healthy lifestyle behaviours and in driving maintenance post-intervention. Overall, positive outcomes were grouped into three categories: mental health, physical health, and other life domains.

Participants described multiple mental health benefits stemming from increased PA, including improved mood, heightened mental focus and reduced stress levels:

> *…especially exercising affects me in a mental way. Because of that I get time thinking of my problem, and I decrease my stress and my negative energy from my body. - P11, age 21*

> *Now I am able to control my stress by walking…so I keep walking and walking until I am relaxed. P8, age 25*

One common motivator to maintain PA was the sense of “happiness” or “feeling good” when a fitness regime was over, a reference to satisfaction in performing the behaviour, as well as the release of endorphins during exercise which produced pleasant feelings:

> *You know, after you exercise you get this hormone going on in your body that makes you happy. I like that. I love that feeling, so I guess they were like the main thing that got me going. - P12, age 25*

Physical results covered six broad topics: “better” bodies (linked with losing weight) and complexions, heightened energy levels, improved sleep, present and future health, and strengthened immune systems. For example, participants discussed satisfaction with finally having a body shape that matched their desired body shape:

> *…taking good food with the exercise will make the good body, and the good weight. I'm concentrate on my food… healthy food and also the exercise my weight decrease. It's everyone like the body. It's very nice. – P9, age 38*

This belief yielded additional returns, such as comfort, wearing clothes that were not previously an option, due to negative feelings about body size:

> *The way I dress just changed so much. There was clothes that I just put there, because I wasn’t confident enough to wear them. But now, that’s not a problem for me. - P12, age 25*

While participants valued noticeable improvements in their physical appearance, they also were motivated to keep up behavioural changes to protect against disability or disease in the present or at a future date:

I have to do my exercise because I'm looking in the future when I become older and older. When I became older, I have to keep my body my health and safe. – P5, age 43

I also realized that my body is so important, and I should never neglect it. I should consider everything I eat and do everything that will help my body become more healthier. - P4, age 37

A few participants remarked that they were motivated to modify eating habits to build strong immune systems to ward off disease. With the emergence of COVID-19, other students viewed healthy food consumption as vital to boosting their immunity systems and protecting themselves from the virus.

We are working to save our life to, of this quarantine, of this Coronavirus and so people have to eat more food that have a lot of vitamins and...and...things that can increase their immunity system too so that they can fight this virus with a good body and immunity system. – P6, age 23

For some, concern about COVID-19 extended to preparing healthy food for their families to help them build their immune system to fight the disease:

I believe a lot of Coronavirus situation related to lifestyle and immune system… And I understand that it's related to immune system around a healthy lifestyle. So, for this reason, I focus on a lot of supplements and something natural, like for example, strawberry. Every day I make a strawberry juice for my family. - P3, age 23

A few participants pointed to positive consequences in other life domains that inspired them to maintain healthy eating and PA behaviours. These included new friendships or strengthened old ones as well as improved work performance due to greater energy levels:

Yes… it had an impact at work and in dealing with my family. I was very lazy and idle, and I did not want to go to work. But currently I feel active… and I do not wish to miss my work. – P2, age 36

Another benefit mentioned was financial savings due to less spending on unhealthy foods:

I used to spend a lot of money on, for example, on the food from outside, the chocolates and so on, but now I have stopped buying them all…even fast food….I try as much as I can to prepare food from the things inside my house as much as I can. – P10, age 21

Theme 6: Fear of relapse and obesity sustained new lifestyle behaviours

In a few cases, participants were motivated to maintain their modified behaviours out of a fear that relapse would lead to negative consequences, namely obesity and chronic disease:

For myself, I will say because I saw the experience of people who, who, who used to do the same thing as me like eating fast food and the bad foods and how that affect that life. Then I realized that I don't want to be like them, so I have to take a step to do something to prevent being fat or having a disease or something. – P6, age 23

Fear of relapse was featured prominently in narratives about the COVID-19 pandemic. Restrictions on movement outside the home caused students to worry that they would gain weight. This concern drove some students to become more active, and, as will be discussed shortly, become more creative about weight management methods:

Because we are not moving a lot like before, maybe all the time, at home. So, I'm afraid to become more fat or something like that. So, this is motivating me and push me to do a lot of exercise and do every day…I have to be in shape. – P5, age 43

TDF Domain: Reinforcement

Theme 7: *Rewards incentivize weight loss maintenance behaviours*

The BHL programme focused on reinforcing behavioural change through positive feedback and verbal praise from the facilitator and peers for reaching target behavioural goals. Many participants found this reward-based approach motivating because it fit with their competitive natures and inspired them to try and outperform co-participants, which helped fuel weight loss:

> *We started as a group in WhatsApp. So, we started to discuss and to be brave, encourage each other to walk every day. 10,000 steps. So, every day we asked each other who finished these 10,000 steps, and it was as competition between us. – P5, age 43*

Under the COVID-19 restriction measures, some participants returned to using group-based competitive strategies to motivate themselves to exercise. In one case, a student helped her family pass the time by creating PA competitions, such as a race to finish 10,000 steps first:

> *Me and my family make a competition for the step counts. That is why most of the time I walk more than 10,000 steps. But I think we need it now, because we are all at home…we are more active before. So, now during COVID 19, we have to do more exercise to be healthier. – P8, age 36*

In another case, a participant competed with her friends to keep up healthy behaviours, with the group determining winners and prizes remotely:

> *As I told you, I have a very competitive spirit. This makes me just want to not only compete with myself but with my friends....like we have some rewards for ourselves after like a long month of like a healthy lifestyle, we'd get together and have like... just rewarding ourselves for the achievements that we've done for ourselves. – P13, age 31*

TDF domain: Intentions

Theme 8: *Willpower sustains commitment leading to the integration of lifestyle behaviours into daily life*

Willpower emerged as an important theme in participants' accounts of behaviour change maintenance; students who possessed greater resolve tended to successfully sustain healthy diets and PA compared to those who lacked similar determination. Some participants acknowledged that lack of willpower had been a barrier to change in prior efforts to lose weight:

I have a problem with commitment. Even before the programme, I'd go to the gym for a week, two weeks or three, then I'd disappear. - P7, age 26

However, most described being able to push through this block during the programme or shortly after it ended to commit to behaviour change:

I used to feel hungry all the time, and I ate everything. That was what was difficult for me…the control at the beginning was so hard for me. But May God be glorified, w*hen I got this off my mind, I'd go eat salad and I felt full… at the beginning, the control was the most difficult for me then I got used to it. – P10, age 21*

Moreover, they explained that their commitment was strengthened after repeatedly seeing positive weight loss results:

> *…I used to try a diet every now and then before the programme. At that time, I didn't put the basic information in my mind. There was no commitment. But after the programme and seeing the results, this has made me more motivated. – P7, age 26*
>
> *Before the programme, I thought exercising is very difficult, and I used to be lazy, and I was not active at all. But after the programme, I started to become more conscientious. P8, age 25*

In addition, these participants reported that persistently performing healthy food related and PA behaviours made them feel familiar and, increasingly, a part of daily life:

> *As I have mentioned at the beginning and then you get used to it…so the beginning and the commitment after that it become something basic. – P9, age 38*

Nevertheless, it is important to note that lack of willpower remained a significant obstacle for a couple of participants after the intervention ended. These students, who attended fewer sessions than the others, were still struggling to maintain behavioural changes at the time of the interview. The following comment is typical:

> *I don't have a strong passion. I feel that we need some strong passion to make exercise. – P3, age 23*

The COVID-19 pandemic created conditions that challenged some participants' self-discipline. These students described experiencing long hours confined to their homes without purpose or direction, leading to mental and physical exhaustion. This diminished their drive to engage in any kind of activity, including healthy eating and PA routines:

> *Yeah, actually, it's more of the mental health that actually, it has a great like restraint on your body after the lockdown. You just don't want to do anything. You don't want to, you don't want to exercise. You don't want to eat healthy. – P13, age 31*

However, many who had trouble engaging in healthy lifestyle behaviours at the beginning of the lockdown found that they were able to overcome their resistance with time. Gradually, they adjusted to the new circumstances and resumed healthy food related and PA behaviours within a week or so:

> *Because in the beginning, I was so frustrating about the condition and the situation that we're in because of the COVID-19. I get lazy little bit of*

continuing the programme, but thank God I start to get back to the programme. Little bit one step by step. - P6, age 23

Moreover, for others, commitment to healthy eating and physical activity did not change at any point during the lockdown:

During the spread of the virus, and due to lockdown in the house, food became the only amusement. If I had not taken this programme, I would not have followed its advice and my habits would have not changed from before, and my weight would have increased significantly. It is because of the programme…I am eating healthy during this lockdown even now. – P2, age 36

For these students, these behaviours were so fully integrated into their daily routines that the change in circumstances did not diminish their steadfast commitment:

I am used to it ...in my life ….it became my lifestyle. – P1, age 24

If I follow a certain programme, I follow it until I have a new programme. But I follow a certain programme, until God willing, God helps me. – P14, age 21

TDF Domain: Goals

Theme 9: *Setting goals and making plans structures daily routines*

Goal setting played a prominent role in maintaining behavioural changes and was another aspect of the BHL programme that participants found helpful. Many participants continued to follow the dietary and PA goals established during the BHL programme, particularly the 10,000 daily step count:

It's the goals that you gave us…they made me to follow the programme…when I set any goal, it's like a game for me. I like to win. I am very competitive. I mean I work very hard to achieve that goal. - P8, age 25

But after the programme, I really started tracking down the steps. I would look at it like: Okay, I've got like 4000 steps left. I can do this. It would only take half an hour. And I'd go around, and I keep walking until I reach my goal. – P12, age 25

In addition, some participants created new target goals to diversify their PA routines or to further test themselves:

I used to just walk around like 7000 steps a day. I had to walk these steps, like when I went to the university. Whenever I saw very long walks, I'd avoid going…this was before the programme. After the programme, I started taking the stairs. I started counting my steps. This motivated me a lot to get in more steps every single day. – P13, age 31

Regardless of the goals they established, participants described these milestones as central to their day and as a key reason they persisted with modified PA behaviours

I used to have a walking machine at home, but I didn't use it. After we took the programme...I continue to use it every day…it is a must. It is one goal of the goals of the day. – P10, age 21

Related to goal setting, several participants mentioned that they began to explicitly plan what and when to eat and when to exercise each day. Following through was not easy at first, but students described setting aside the time to eat healthy meals or perform physical activity:

I have to manage my time and my, I have to choose the good time that I can walk or do my exercise. – P5, age 43

Before the programme, I used not to care about my food…but after the programme, I started caring about my food, water, and exercise. I manage my time. I establish a schedule. I follow it daily. -P1, age 24

The act of scheduling helped participants to incorporate PA and heathy food behaviours into their daily routines. Often, this was the first time that a student had used such explicit planning strategies to create fundamental change in their everyday activities:

> *Now I have plan for the food that I will eat each day one day before, usually at night, like what and when I should eat it. I never did this before the programme. I changed totally…totally after the programme. – P8, age 36*

Finally, the COVID-19 lockdown created significantly more free time for individuals who were unable to attend work or university. Without these responsibilities, several participants decided to adjust their daily goals upwards to make the most of home confinement:

> *The free time to work out and exercise and added physical activity in my daily lifestyle has changed me. During the lockdown I increased my step count to 15,000 steps a day and started working out for half an hour each day. – P4, age 37*

Others used the lockdown to better organize their days for exercise and healthy meals:

> *…the extra time I had, I had a lot of it, I think that was a motivation too. I arrange a schedule for me, throughout the day, kind of a timetable. – P12, age 25*

TDF Domain: Memory, attention, and decision processes

Theme 10: *Mindfulness enables maintenance of food-related and physical activity behaviour*

Participants often spoke about behaviour change as the outcome of intentional decision-making. They described their post-intervention eating and PA behaviours as deliberate, stemming from a set of regularised thought patterns that had been carefully promoted over time using programme strategies:

> *The programme made me use my mind more. I can make anything that is unhealthy healthy, with simple touches. For instance, if I am in a restaurant, I reduce calories. For instance, I start with a salad when I go, and I try to reduce the calories of the burgers… – P2, age 36*

> *Now I think what I eat from morning until night. I think about what kind of food I should take. – P9, age 24*

Successful behaviour change maintenance involved eliminating distractions and redirecting attention to eating healthily or exercising:

> *I started consuming fruits and vegetables with every meal and making sure to eat fruits and vegetables, a good amount each day. And I switched high calorie drinks with water to avoid sugar, and I stopped watching TV while eating to focus on what I'm eating and not get distracted. – P13, age 31*

Participants sometimes referred to these practices as "habits." However, their descriptions of these "habits" did not suggest that they stemmed from automatic performance of a behaviour. Instead, they appeared to be the result of constant mindfulness that enabled conscious eating and PA decisions. The following comments reference healthy eating "habits" but go on to describe these behaviours as the result of purposeful thought (see underlined words):

> *Yes, my eating habits have changed a lot from before the programme. I used to just eat anything without thinking. But after the programme, I started <u>thinking</u> before eating. Actually, this was the first change in my life. – P8, age 36*

> *Yes, sure, my habits really, really…when I attend this programme, my habits really change a lot. I started <u>thinking</u> about what I have to eat and amount that I should eat every day from several food. I know how I should eat, what I should eat from vegetable, fruit, protein, meat. Everything really change, I started <u>to manage</u> my food. – P5, age 43*

TDF Domain: Environmental context and resources

Theme 11: ***Access to gyms and exercise equipment facilitates maintenance of PA***

Two factors that motivated people to sustain their PA behaviours after the intervention included gym access and exercise equipment in the home. Having home-based machines made PA more convenient and saved travel time to other locations to use equipment:

> *Because I have the machine available that makes it easier that ...For instance, I do the physical activity as I have the machine available. – P10, age 21*

Gyms provided a stimulating environment, with varied exercise options (e.g. classes, aerobic machines, free weights) and the presence of people working toward similar goals:

> *The gym has always been a place that I found motivation because of the people around me, because of the classes, the machines over there and going there, I wasn't able to give up or become lazy. But with the gym, I was able to push myself harder and work harder, because I was surrounded by all these motivators. - P11, age 21*

For participants who visited fitness centres regularly, the government's decision to close these spaces during COVID-19 was challenging, as it was the nature of the gym's environment that motivated students to exercise:

> *Yeah, I usually used to go to the gym……When I was at the gym, I was provided many machines. But I don't have that now, not even weights. Not even stretch bands, nothing. So, I lack my equipment that I had before the COVID-19. – P12, age 25*

Theme 12: Introducing objects into the environment and changing surroundings sustain healthy lifestyle behaviours

Incorporating fitness devices, such as health-related phone applications and pedometers, into PA motivated students to reach their goals. At the start of the BHL programme, students were encouraged to purchase a pedometer to monitor their 10,000 daily step count. This watch continued to play an important role after the programme ended, reminding students to exercise, keeping track of their progress, and symbolizing successful weight loss and weight management:

> *It was the pedometer watch. I think it really helped, and it might have motivated me since I saw my heart rate going up. I know I was like performing cardio, so I was happy. I felt really powerful. Even if I was tired, it's really got me up and going. – P12, age 25*

Participants introduced other objects into their environment to assist them to initiate and later maintain behaviour change. This included a water bottle they carried with them to meet a two-litre daily intake target and small plates and utensils to manage portion size.

> *I bought some plates and spoons for myself. I started using smaller utensils to decrease the food portions I eat such as using a smaller plate and spoon. I also bought a water bottle after the programme. Even now, I have the water bottle with me to take everywhere I go. – P4, age 37*

Many credited the BHL programme with teaching them to control food-related behaviours by altering immediate surroundings. This involved replacing unhealthy foods (e.g. chocolate) with nutritious alternatives (e.g. fruit), particularly food kept in visible locations throughout the house. This remained a core weight management strategy for several participants after the intervention:

I tried to change my surroundings, especially the place where I watch T.V. Before I used to keep chocolates on the table near my couch and keep eating, even sometimes when I really didn't want to eat...and gain more weight. But after your programme, I keep fruits and vegetables instead of the sweets. – P8, age 36

Theme 13: Sufficient time is necessary to maintain healthy lifestyle behaviours

Some participants pointed to environmental barriers to healthy food-related and PA behaviours that persisted after the BHL programme. A common complaint was lack of time, especially during exams; students also expressed frustration at an ongoing inability to manage competing demands:

It was sometimes difficult to find time to increase my physical activity because of studying or staying with my family, and I have a lot of daily chores that I have to do.– P11, age 21

It was difficult some time to do exercise and sport, but I'm trying my best to do it. – P6, age 23

Other environmental barriers included dislike of taste, especially of vegetables, lack of access to healthy food on campus and weather, particularly summer temperatures. Even with these barriers, students had some success managing them by applying strategies/BCTs that were introduced during the intervention:

I'm most of the time at the university, and the food that is available there is not, like, it's not available. It's all the junk food and fast-food restaurants. I started bringing my own food from home and putting it in like a small lunchbox inside my backpack– P13, age 31

It was about the vegetables, not really my thing. So that part really tricked me because I tried eating them I tried stewing them. I tried doing whatever it didn't work I didn't like it. So, yeah. But there's this part where the programme tells me about a sauce that I can add vegetables, and it's really, really improved the taste – P12, age 25

During the COVID-19 lockdown, ordinary time constraints were suddenly eased. As discussed above, home confinement stripped students of university and work obligations and inspired them to find new ways to occupy their time. To keep busy, some students engaged in greater amounts of PA:

At first, I was provided with a lot of time that I was never provided with in my entire life. I had my weekdays and my weekends to do whatever I want to do throughout the physical activity. I can work out twice a day. Not even once, and maybe sometimes three times, I would walk for hours. - P12, age 25

For one student, the lockdown led to an increase in exercise and energy expended as she took care of household chores previously performed by domestic staff:

> *The motivator I found after coronavirus is that I had a lot of free time because of not going out or going to work. So, it made a lot of free time that I utilized doing more exercise and housework. Before I used to depend on the maid for this…so I feel like my exercise has increased and made my body healthy. – P2, age 36*

In contrast, another participant reported less free time during lockdown as her household responsibilities increased, making it harder to exercise:

I am spending more time with my family. And I will say this day I can't have a lot of time doing exercise because I'm, I will be busy doing food and cleaning the home, so I just maybe have hour, one hour in a day.. – P6, age 23

Theme 14: *Difficulties accessing food during the COVID-19 lockdown shaped food related behaviours*

Changes in the ability to access food during COVID-19 had both negative and positive effects on students' eating behaviours. The government's decision to close restaurants, forced people to dine at home and altered their relationship with food. Prior to the lockdown, several participants ate in restaurants regularly, relying on calorie counting to manage food intake and occasionally breaking this pattern to order hamburgers and other fatty foods. However, their feelings about restaurant eating began to change under lockdown:

… We have no restaurants in the quarantine days. I feel that I…I don't…it's not important for me after that to eat from restaurants. I focused on eating from home…From Coronavirus until this moment, I didn't eat burger or fast food until this moment. – P3, 23

Consuming their meals at home provided these participants with a better sense of what they were ingesting, as they secured their own ingredients for meals. In some cases, the experience of home cooking stopped the desire for restaurant food:

Before Corona, I used to eat fast food two times a week or once every two weeks. And once the lockdown started, I didn't eat it. I lost cravings; I don't want to eat it. I don't have the desire to eat it anymore. – P7, age 26

Yes, my eating habits has changed to better. Since the lockdown, I wasn't able to eat or order any food from restaurants, and I had to stick to home-made food. Home-made food is healthier choice, and I know how it was prepared and what were the ingredients, so that I can avoid any unhealthy choices. – P4, age 37

Several participants reported having difficulty accessing healthy foods, such as fruits and vegetables, during the COVID-19 lockdown. They encountered shortages of these products in supermarkets or online, making it harder to prepare nutritious meals at home:

> *For instance, I order using websites, for instance Hungerstation, or the website that bring from the supermarket when there was a total lockdown 24 hours. I order strawberry. I order lettuce…so not all of them are available...there is always some missing…this was the main problem during the lockdown period…not all the things available. – P9, 38*

> *During the lockdown, it was hard for me to buy the ingredients for my healthy recipes as easily as I did before the lockdown. I had to order them beforehand, and it took a while for them to get to me. This was a barrier as… as it was difficult for me to complete my healthy meals. – P4, age 37*

Theme 15: Bounded space was a barrier to maintaining PA behaviours during lockdown

Bounded space limited participants' ability to maintain exercise routines during the COVID-19 lockdown. The restriction on outdoor walking, a favourite form of exercise for many, was especially challenging. Losing this freedom of movement was distressing and diminished some participants' desire to exercise:

Not nearly because with COVID I feel…I love walking, I mean I love walking a lot now, but with COVID they locked the world down on us so we are not able to go anywhere. – P14, age 21

Especially when there was lockdown, the person cannot go out and do their daily activities. I used to walk…there was a Quraan memorising school near my home, and I used to go there by walking and coming back by walking. All of that with the Corona and the lockdown all have stopped…so I stay at home. – P10, age 21

In one case, a respondent had fitness equipment in her home, but remained frustrated by the restrictions on walking:

About lockdown, we couldn't go freely to anywhere to walk…I can do exercise in my home, but I prefer to mix with outside and at the home, but I should have tried to make at home until somebody COVID-19 vanish, if God wills. – P3, age 23

Students who resided in smaller homes or flats faced greater spatial limitations. Often, they could not make room for fitness equipment where they lived:

For me, I'm living in an apartment. It's not like a big apartment. So, all the room is small. And I don't have a big, a big space or an empty space so that I can do my exercise…so, this is one of the barriers and also this day because of the COVID-19. – P6, age 23

Despite challenges, numerous students were able to overcome lockdown barriers due to their determination to continue with behaviour change. Students' work around strategies included using personal treadmills, when walking outside was not an option, or downloading fitness phone apps, when the gym was shut down. And to contend with lack of apartment space, a few made use of alternative areas in their buildings, including the roof.

TDF Domain: Social influences

Theme 16: Cultural norms around food practices are a strong influence on behaviours

Participants' stories revealed that their food practices were influenced by cultural norms and traditions. As discussed in Chapter 4, cultural norms can exert pressure on women of KSA to conform to other people's expectations concerning appropriate food related behaviours (Al-Mohaimeed & Elmannan, 2017; Alqout & Reynolds, 201). This social pressure was apparent in several accounts shared during the interviews. However, participants often had success using strategies introduced in the programme when negotiating these difficult situations.

Social gatherings tended to present problems for students maintaining healthy food related behaviours. One student discussed how hard it was to resist rich, calorie dense foods of KSA when no alternatives were available:

> *It was hard for me to find alternatives for food during family gatherings because during family gatherings they have a lot of unhealthy food. And I sometimes find it hard to avoid eating what they eat and to find some healthy alternatives to what they eat, because they have lots of chocolates and sweets with coffee. – P11, age 21*

Another participant described similar pressure at social events. Yet, unlike the previous student, she was able to use a problem-solving skill from the BHL programme to resolve the issue:

> *We were going out a lot and going to a lot of occasions and workplaces where there are no healthy foods that are convenient or any other choices, so it means that you can't get control sometimes. So, you have to eat unhealthy sometimes, as there are a lot of temptations. But the programme made me use alternatives or substitutes…made me think and made me decide what to do. - P2, age 3*

A few participants remarked on their love of national/regional dishes like Kabsa and Mandi, which are rich in fats and carbohydrates. One student was initially hesitant to limit her intake of this cuisine but eventually learned how to make healthier food choices in restaurants:

> *Yeah, about healthy eating, the difficult thing that we have a lot of food is delicious and I like it, for example, like Kabsa, Mandi, a lot of food. I like it so much and every day I told my mother that I wish to eat like this. So, but this is difficult. For example, when I go with my friends now, I choose something cannot have a lot of carbohydrate. – P3, age 23*

Sometimes social pressure existed at home. One participant was forced to consume unhealthy family meals, until she was able to persuade her parents and siblings to modify their diets:

> *For myself, I will say here in our, in our home, all my family and all my...even my sisters and my brothers, they are that people who not care about their weight and their food or their health. The food that we are eating here in the home is not that...it's not that healthy. But this is one of the change I made it after the programme to engage my family in this programme as well. So, for me, my family and my home were one of the, one of the barriers of continue on this programme, but it's changed now. Thank God – P6, age 23*

The COVID-19 lockdown changed the dynamics of social gatherings for some participants. With the ban on non-essential travel, social outings or work events were no longer possible, and diets became much easier to manage:

> *Before the lockdown, I used to eat unhealthy when I went outside. But now I control myself and my food because of the lockdown. I am eating healthy because there are no gatherings. – P7, age 26*

Unfortunately, the lockdown also caused problems for a few younger participants trying to maintain healthier eating behaviours. While these students had previously kept their food practices separate from their families, the lockdown brought everyone together and synchronized eating schedules. As a result, these participants were expected to join family meals, where they were exposed to their favourite (less healthy) dishes. Sitting at the table with parents and siblings, participants struggled to resist these foods:

> *Because of the lockdown, I started eating my meals with my family. It was sometimes difficult to eat healthy as my family has some bad eating habits, and it gets me a little bit distracted from eating healthy because of the family. – P12, age 25*

Participants also tried to distract themselves from traditional sweets located throughout family homes:

> *They have sweets around all the time, and they have chocolate and sometimes it gets me wanting to eat what they eat, and distracting me from eating healthy. – P11, age 21*

Despite temptations, students were generally able to resist the urge to consume unhealthy food, although occasional lapses did occur.

Theme 17: Social support is critical to maintaining healthy lifestyle behaviours

Social support played a vital role in influencing weight management behaviours. As noted previously, a few participants made new friends or enriched existing friendships based on their new interest in PA. These relationships made it easier to sustain healthy behaviours:

> *Socially, like I started having...or more things to talk about with my friends. I have new friends now that actually run marathons and do like very beneficial things for their bodies…we started having things in common to talk about with each other. – P13, age 31*

The COVID-19 lockdown provided additional opportunity for social support from family. Under one roof for the entire day, family members were available to exercise together, and this provided participants with the motivation to pursue their modified eating and exercise behaviours under unusual and trying circumstances:

Before, I didn't have enough time for exercising, and I used to struggle to make the time with my…my busy schedule. Now I have a lot of time for exercising, and sometimes I play some games with my family to spend time together during COVID 19. This is a big encouragement for the family to be active…So, now with COVID 19, we do more exercise to be healthier. – P8, age 36

TDF Domain: Behavioural regulation

Theme 18: *Self-regulation is critical to maintaining healthy lifestyle behaviours*

Regulation of food intake and PA were vital to maintaining behaviour change. From the start of the BHL programme, participants were encouraged to engage in self-monitoring behaviours, such as counting their daily steps or keeping track of vegetable and fruit servings. They had also been part of group monitoring efforts, sharing their progress toward goals with co-participants at meetings and via the programme's WhatsApp group. In the interviews, multiple students revealed that they found regulatory strategies one of the more effective aspects of the intervention. These helped them to initiate behaviour change while in the programme and became an integral part of their post-intervention weight management efforts:

At the beginning, it was difficult for me to find time for the goal you gave us. Then, I wanted to put a tick mark on the paper you gave us…that tracking paper helped me to remember the goal. And the WhatsApp group also reminded me and motivated me to… I started walking to reach my goal, but now I am used to it. I walk 10,000 or even more steps sometimes every day… It is a habit now. But honestly, I love doing it now. – P14, age 21

We started as a group in WhatsApp. So, we started to discuss and to be brave, encourage each other to walk every day. 10,000 steps. So, every day we asked each other who finished these 10,000 steps, and it was as competition between us. – P5, age 43

Food regulation also included strategies to compensate for times when students engaged in excessive caloric intake. For instance, participants used advanced planning to limit food consumption before attending social gatherings without healthy food. They also made up for dietary lapses by eating less food later in the day or week and working off calories at the gym. However, students' efforts to regulate caloric intake did not always align with a healthy balanced diet.

> *Actually, I love chocolates… it is difficult for me to completely stop eating them. So, to…for my satisfaction, I try to diet for the rest of the day, thinking about the calories that my body has gained from that chocolate. I try to compensate by not eating for the rest of the day or do more and more exercise. – P8, age 36.*

21 BCTs and six out of the nine intervention functions were identified from the data which are summarised in Table 8.2.

8.6 Discussion

8.6.1 Overview

This study identified six intervention functions and 21 BCTs, of which eight BCTs were new (not identified in the focus group discussion). The new identified BCTS are Information about social and environmental consequences, Valued self-identity, Identification of self as role model, Identity associated with changed behaviour, Self-talk, Social Incentive, Self-incentive and Prompts/cues (Table 8.2).

This qualitative study highlights enablers and barriers to maintaining lifestyle change in female university students who participated in the BHL programme. The vast majority of these were (intra)personal barriers/facilitators. Participants also commented on some social and environmental factors influencing their ability to maintain healthy lifestyle behaviours inside and outside of the university environment.

The results suggest that the programme was well received by participants and viewed as helpful in initiating behaviour change. Participant narratives revealed that successful maintenance was a progressive process that developed people's internal resources, altered self-perception, and centred food related and PA behaviours in daily life. As a dynamic process, weight loss maintenance continually shaped performance of and understanding of behaviours.

The introduction of an unusual or stressful event – in this case COVID-19 – prompted mixed reactions from students. In their interviews, students discussed COVID-19 pandemic stressors, such as confinement and loss of ordinary routine (Braunack-Mayer et al., 2009; Cava et al., 2005; Desclaux et al., 2017; Reynolds et al., 2008; Robertson et al., 2004; Wilken et al., 2015). A few linked these stressors with a decline in their emotional wellbeing. While some students reported no difficulties maintaining healthy lifestyle behaviours during the COVID-19 quarantine, others struggled initially, but eventually drew on their intrinsic assets to resume these activities. A small number of participants were unable to follow through with healthy eating or exercise.

In recent months, research has emerged offering preliminary insight into how lockdowns and social distancing policies have impacted food related and PA behaviours in various global settings. While these studies universally report a decrease in PA levels for overall populations following COVID-19 restrictions (Ammar et al., 2020; Antunes et al., 2020; Gallo et al., 2020; Lesser & Nienhuis, 2020; Maugeri et al., 2020; Mutz & Gerke, 2020; Roberts et al., 2020; Sekulic et al., 2020), this trend varies by demographic characteristics, such as age and gender as well as PA levels (vigorous, moderate, walking). In addition, studies show that quarantine measures have generally led to unhealthy food intake and meal patterns (Ammar et al., 2020; Carroll et al., 2020; Robinson et al., 2020), including increased snacking and number of main meals (Al-Musharaf, 2020; Ammar et al., 2020; Carroll et al., 2020) but again, food related behaviours differ by demographic group and by region (Alhusseini & Alqahtani, 2020). This discussion section will highlight instances in which findings from this literature support or complement my study's results.

8.6.2 Study Themes in Context

Knowledge

Participants' accounts highlighted specific aspects of the programme's curriculum (including BCTs) that were helpful in supporting and/or sustaining behaviour change. Instruction in basic nutrition (e.g. benefits of a healthy diet etc.) helped to initiate change by providing critical information about the connection between dietary intake, weight, and health. Later, this information served as an actionable knowledge base for making healthy lifestyle decisions. This finding complements prior research showing that participants of weight management programmes (WMPs) often view dietary instruction favourably (Atkinson et al., 2010, Bidgood & Buckroyd, 2007; Bingham et al., 2014; Furness et al., 2011; Gray et al., 2013; Herriot et al., 2008; Jones et al., 2007; Webb et al., 2014), although this is not universal (Ahern et al., 2013; Atkinson et al., 2010; Furness et al., 2011; Gray et al., 2013; Hunt et al., 2013, 2014; Jones et al., 2007). Moreover, the finding is at odds with comments from my focus group study (see Chapter 4), in which participants expressed little interest in nutrition education, believing that they already possessed basic nutrition knowledge. In contrast to the focus group participants, the participants in the interviews were in fact positive about receiving information.

Participants described the programme's practical nutrition and physical activity advice as highly valuable and easily implementable and thus critical to maintaining behaviour change. These were strategies or "tips" to promote healthy lifestyles that required nutrition knowledge for implementation, such how to read food product labels. This finding coincides with insights from the qualitative literature on weight management programmes (WMPs) showing that participants are receptive to dissemination of practical information during WMP sessions, particularly instruction in nutrition labelling (Atkinson et al., 2010; Gray et al., 2013; Herriot et al., 2008; Jones et al., 2007) and portion sizes (Atkinson et al., 2010; Gray et al., 2013; Herriot et al., 2008; Jones et al., 2007). Based on the cumulative evidence, I will include weight management "tips" as part of sessions in the RCT's curriculum.

Skills

Several participants reported that lessons in healthy meal planning and cooking helped them to develop cooking skills to maintain healthy diets. Prior research on weight loss maintenance after WMPs has demonstrated similar findings. For example, in one study, successful weight maintainers developed new diets containing reduced fat and sugar and increased fruit and vegetables, while reducing portion sizes and employing low fat cooking methods (Kayman et al., 1990), all of which were promoted by the BHL programme. These findings also support qualitative research on participant satisfaction with WMPs showing support for cooking and menu planning in weight loss interventions (Atkinson et al., 2010).

The COVID-19 lockdown interrupted participants' normal eating patterns, encouraging some to draw on their cooking skills to prepare healthy meals, particularly since restaurants were no longer open for meals. Recent research on food intake during COVID-19 in Portugal, Italy and KSA support this finding (Alhusseini & Alqahtani, 2020; Antunes et al., 2020; Di Renzo et al., 2020). Antunes et al.'s (2020) cross-sectional study in Portugal asked participants about their food selection behaviours. Perhaps surprisingly, 42% reported making better food selections during the lockdown. While participants were not asked what caused this change, the authors speculated that home confinement created more time for people to cook. Alhusseini & Alqahtani's (2020) survey queried adults residing in Riyadh about their eating habits during lockdown. The study showed an increase in respondents rating their healthy eating habits as good/excellent from 22% before COVID-19 to 30.% during lockdown. Alhusseini & Alqahtani also found that the vast majority of respondents (86%) were eating home cooked meals during COVID-19, in contrast to 36% before the lockdown. Di Renzo et al. (2020) reported that during the lockdown in Italy, home cooking increased and adherence to the nutrient rich Mediterranean diet remained high, especially in the northern and central regions of the country and among younger adults ages 18-30.

Overall, based on participants' successful application of cooking skills, immediately following the intervention and one year later during lockdown, the future RCT will include meal and menu planning. In addition, because several participants mentioned the desire for more menu options, the RCT will introduce a greater number of healthy recipes to meet student needs.

Social/Professional Role and Identity

Several participant narratives revealed passionate advocacy of healthy lifestyle change that started during the programme and continued post-intervention. Students' enthusiasm developed after observing results, such as weight loss, for the first time. With this achievement, participants began to promote the programme's benefits and to urge others to modify their food and PA behaviours. As time progressed and the students sustained weight loss, they started to centre their identities around being a "healthy person," a self-perception that was reinforced by assuming an advocacy role and cheering on friends and family to make and maintain changes in eating and exercise.

The dynamic described above aligns with prior qualitative studies on weight loss management, which have observed similar role-taking behaviour among successful weight maintainers (Greaves et al., 2017; Hindle & Carpenter, 2011; Morrison et al., 2014; Penn et al., 2013). For example, Penn et al. (2013) investigated participants' perspectives on dietary and PA behaviour changes after a type 2 diabetes intervention. They labelled people who actively encouraged others to join the programme 'awareness champions' and reported that this social role facilitated behaviour change maintenance. Hindle and Carpenter (2011) conducted interviews with women who had successfully maintained weight loss for at least one year due to personal effort or adherence to a set programme. The authors discovered that once weight stabilised, women were keeping up behavioural changes to maintain their weight, but no longer enjoying the positive experience of seeing noticeable results (e.g. kilograms falling off). To offset this loss in positive reinforcement, women created new roles for themselves, such as acting as a role model for others or training to become exercise class instructors. These roles enhanced the women's commitment to their weight maintenance process and heightened perception of their social status. The awareness champions may cause contamination. Therefore, procedures to avoid that are proposed in my potential RCT, described in Chapter 9.

Given the current findings on social identity, my future RCT will incorporate strategies to promote the development of personal and social identity beliefs that are consistent with weight management practices. The BCTs ‘framing/reframing’ (which was included in the BHL programme), ‘identity associated with changed behaviour’ and ‘identification of self as role model’ seem appropriate for helping students to develop new identities centred around being a role model, a healthy person, or a healthy lifestyle advocate.

Beliefs about Capabilities

Self-confidence played a key role in helping participants to maintain behavioural changes. Like the advocacy role, self-confidence began to develop during the programme, when early signs of weight loss convinced many that their goals were reachable. Participants’ confidence grew over time as they met their goals and integrated eating and exercise routines into daily life. These accomplishments boosted participants’ self-worth and self-efficacy and for some, promoted a sense of self-empowerment that extended to other life domains.

Similar patterns of transformation in self-confidence and self-image have been documented in studies on weight loss maintenance (Bertz et al.,2015; Garip & Yardly, 2011; Greaves et al., 2017; Gupta, 2014; Haeffele, Trunnel, & Kinney, 2011; Hindle & Carpenter, 2011; McGill et al., 2020; Kozica et al., 2015). The specific causal mechanisms that contribute to this outcome are not always clear, but researchers have suggested various pathways linking changes in self-image with weight loss maintenance. For example, Bertz, Sparud-Lundin, and Winkvist (2015) suggest experiencing a successful result based on behaviour change may increase motivation and enhance self-image. Moreover, the repetition of this ‘virtuous circle’ (Greaves et al., 2017) brings previously contradictory mental and emotional drivers into harmony, supporting further change and weight loss maintenance. The present study indicates that a similar positive feedback loop helped participants to maintain behavioural changes.

Research also suggests that a shift in thinking about lifestyle change facilitates weight loss maintenance and the development of positive self-concept. In a systematic review of the qualitative literature on weight loss maintenance, Greaves et al. (2017) identified a theme across studies, namely that successful weight maintainers visualise weight management as an achievable project, including flexible standards, positivity, and personal learning rather than a tedious, “all or nothing” chore (Greaves et al., 2017; Hindle & Carpenter, 2011; Kozica et al., 2015; Penn et al., 2013). This attitude helps to prevent negative interpretations of lapses (Greaves et al., 2017). Similarly, participants in the current study credited the programme’s emphasis on gradual change and realistic goal setting (Hindle & Carpenter, 2011) with revising their beliefs about the possibility of maintaining healthy eating and exercise behaviours. This new outlook allowed them to make weight management a central part of their developing lifestyle (Greaves et al., 2017; Hindle & Carpenter, 2011; Stuckey et al., 2011).

Altogether, the overlap between previous research and the current study’s findings strongly suggest that the future RCT should retain the BHL programme’s content of gradual and realistic change to promote self-confidence and self-efficacy among participants. Future analysis of the RCT could concentrate on discovering the specific interplay between programme content, positive self-perception, and weight maintenance to further refine weight management interventions.

Beliefs about Consequences

Participants were motivated to maintain healthy lifestyle behaviours based on beliefs about negative or positive outcomes. Some participants feared that any relapse would lead to obesity and ill health, and their desire to avoid this result sustained weight loss efforts. During the COVID-19 lockdown, fear of weight regain motivated some participants to maintain their PA levels, even though exercise was more difficult to perform under lockdown conditions.

Beliefs about positive outcomes covered mental health, physical health, and other life domains. Key psychological benefits included reduced stress and anger and heightened mood and mental focus. Physical benefits included protection from disease, strengthened immune systems, greater energy, better sleep, and improved body shape and skin. Other life domain benefits included financial savings (since less money was spent on sweets or junk food), better relationships and enhanced work performance.

Prior research has documented similar socio-psychological (Fogel, Young & McPherson, 2009; Garip & Yardley, 2011; Jones et al., 2007; Penn et al., 2013) and physical health (Garip & Yardley, 2011; Jones et al., 2007; Penn et al., 2013) benefits from weight loss and identified them as factors in maintaining behaviour change. Given these insights, my RCT's curriculum will emphasize health benefits (as did the BHL programme) as well as stress the social benefits of behaviour change to help participants effectively initiate and maintain modified behaviours.

The advantages of healthy eating took on special significance during the COVID-19 crisis. Participants saw healthy food related behaviours as key to building up immune systems to protect themselves and their families from the virus. This finding reinforces the recommendation above to highlight health benefits in weight management interventions. In addition, it suggests that in future pandemics or quarantine scenarios, public health experts might address emotional eating, which is associated with stress events and disasters (Okyere, 2020; Oliver, Wardle, & Gibson, 2000; Ping et al., 2016; Torres & Nowson, 2007), with messaging to boost immune systems by consuming nutritious food.

Reinforcement

Some participants described using competitions and rewards for incentivisation during the COVID-19 lockdown, returning to a strategy that helped them to attain weight loss in the BHL programme. Engaging in these activities made time spent in confinement less monotonous and motivated PA behaviours under trying circumstances. Given the benefits of this kind of reinforcement, the future RCT should continue to provide opportunities for participants to compete with one another and receive rewards, including verbal praise from the facilitator (social reward). It may be worthwhile to help students find ways to receive positive reinforcement post-intervention, since reinforcement appears to be critical during the first 2–5 years following weight loss, after which weight maintenance becomes easier as new habits are fully adopted (Wing & Phelan, 2005).

Intentions

Willpower emerged as a theme throughout the participants' weight loss maintenance journeys. Some successful maintainers found it difficult to initiate behaviour change, but once they pushed through this block and saw positive results, their mental commitment deepened. They then intentionally drew on this mindset to maintain their behaviours, which, over time, were integrated into their daily lives. Alternatively, a small number of participants struggled to follow through with healthy food related and PA behaviours, finding the need to remain aware about their diets and exercise mentally and physically draining.

As in the current study, prior qualitative research has identified the presence or absence of willpower as an influence on behaviour change maintenance. People often relapse because they lack the self-discipline to resist the pull of previous obesogenic lifestyles, which, while harmful, met key psychological needs (Barnes et al., 2007; Greaves et al., 2017; Haeffele et al., 2011; Janse Van Vuuren et al., 2015). In fact, evidence suggests that willpower functions as a cognitive resource to manage this tension (Greave et al., 2017; Sarlio-Lähteenkorva, 2000), particularly in times of acute stress (Hindle & Caprenter, 2011).

This finding, and others discussed above, suggest that the future RCT should focus on building up participants' mental determination, using relevant BCTs, such as 'framing and reframing' and 'self-talk' to reorient thinking. This approach reflects research indicating that motivation for weight management shifts over time for successful maintainers, with intrinsic motivation, including willpower, playing a greater role in the maintenance phase (Greaves et al., 2017).

Willpower also played a significant role during the stressful COVID-19 lockdown. This was especially true for students who were able to transition to home confinement without interrupting their eating and exercise routines. For others, the strict quarantine created feelings of aimlessness and uncertainty, leading to mental and physical exhaustion. However, many who were discouraged by the lockdown were eventually able to overcome their issues by mentally resetting and then resuming healthy eating and physical activity. On the other hand, students without the necessary cognitive resources were unable to perform healthy lifestyle behaviours during lockdown.

In a study on leisure time sport and exercise (LTSE) activity in Germany, Mutz & Gerke (2020) similarly found that LTSE activities differed across groups under lockdown. The authors identified three categories including 1) the 'inactives'

(36%), who did not engage in LTSE before or during COVID-19; 2) the ‘reducers’ (31%), who stopped or considerably reduced LTSE during COVID-19; and 3) the ‘maintainers/intensifiers’ (33%), who were able to maintain or increase their level of LTSE. Further, Mutz & Gerke’s study reported that organized sporting and leisure were largely replaced with home-based workouts, noting that making this shift required enough intrinsic motivation to adhere to a home-based routine (Bachmann et al., 2018). Both the current study and Mutz & Gerke’s work suggest that future research on food practices and PA levels during public health quarantines should more closely examine the role of willpower and other intrinsic resources in shaping these behaviours.

Memory, attention, and decision processes

Participants reported that they were able to maintain behavioural changes through purposeful decision-making about what actions to take. Specifically, they contrasted a cavalier attitude toward eating and exercise pre-intervention with increased mindfulness of these behaviours post-intervention. These findings are consistent with results from prior qualitative research showing that concentrated attention to diet and PA, through mindfulness (Metzgar et al., 2014; Rogerson et al., 2016) and planning (Greaves et al., 2017; Haeffele et al., 2011; Hindle & Carpenter), promotes weight loss maintenance. However, research suggests mindfulness may only be a stage in the behavioural change process. In a systematic review and synthesis of qualitative research on weight loss maintenance, Greaves et al. (2017) suggest that there is an ‘advanced’ state of weight loss maintenance, in which individuals support the desired behavioural changes unconsciously, without draining cognitive resources. In these situations, habit and automaticity – rather than reflective thought and planning - are key to maintenance, as prior obesogenic behaviours are replaced with healthier habits (Bertz et al., 2015; Haeffele et al., 2011; Kwasnicka et al., 2019).

Studies have shown that weight loss maintainers use behavioural change strategies – self talk, cues, self-regulation, changing the environment etc. - to challenge existing habits, with persistent use of these strategies resulting in automatic behaviours (Greaves et al., 2017; Haeffele et al., 2011). The future RCT will incorporate the BCTs listed above, which were used in the BHL programme, to promote behavioural change. The RCT should also recognize that the experience of successful long-term change is gradual, comprised of different stages of behaviour performance and mental awareness, and strategies may vary over time.

Environmental context and resources

Participants described various environmental facilitators and barriers to weight loss maintenance. Facilitators before COVID-19 included access to gyms and home exercise equipment; use of pedometers and other devices; and restructuring the environment/replacing unhealthy food with healthy food. Barriers included lack of access to healthy food on campus; taste (disliking vegetables); summer weather; and lack of time.

In general, participants were able to maintain behaviour change when their environments were supportive of weight loss maintenance, a finding backed by previous studies (Brown et al., 2007; Hill et al., 2005; Peters et al., 2002). Toward this end, the BHL programme intentionally introduced BCTs/strategies to make environments more supportive (e.g. replacing unhealthy food with healthy food in the home). Moreover, participants were also able to draw on the BCT during the COVID-19 lockdown to contend with obstacles to PA. For instance, some addressed limited space for exercise in their homes by walking on rooftops. In addition, it also used problem solving to allow students to enhance cooking skills (e.g. learning to enhance the taste of vegetables using yogurt sauce).

The COVID-19 lockdown, which dramatically changed the physical environment, presented new obstacles for participants: lack of space to exercise (small apartments or houses); inability to walk outside; no access to gyms, weather, and lack of access to healthy ingredients. For example, several participants expressed frustration at not being able to work out at fitness centres. They missed the gym setting, which provided a stimulating (e.g. different classes, machines and people) and structured approach to exercise, and struggled to find an alternative form of PA to take its place. Magueri et al. (2020) conducted a cross-sectional study looking at PA behaviours under the strict lockdown in Italy, which banned all outside exercise, making home-based exercise the only available option. The study showed that the PA levels of participants classified before COVID-19 as highly active and moderately active declined substantially during lockdown, whereas the PA levels of participants classified before COVID-19 as low activity increased. The authors (2020) theorized that this unexpected relationship may be attributed to differences in PA behaviours between males and females. As women are far more likely to engage in home-based exercise, such as yoga, aerobics, or pilates, their fitness behaviours may have been less interrupted by the lockdown than men's behaviours, which tend toward outdoor sports. Gender aside, the difficulty participants in the current study had connecting with other forms of exercise when gym visits were prohibited is consistent with the basic trend identified in Magueri et al.'s (2020) study.

The COVID-19 lockdown also brought changes that facilitated weight loss maintenance, like the increase in free time accompanying the closing of universities and places of employment. Mutz & Gerke (2020) argue that people's opportunities to engage in PA vary depending on personal circumstances during COVID-19. Whilst some acquire more leisure time due to reduced working hours or telecommuting, others find themselves with new demands such as household and childcare responsibilities. In this study, most students, especially those who were younger and single, experienced excess 'free time,' and several reported increasing the length or intensity of their workouts as a result. These students' behaviours resembled those of a group labelled 'intensifiers' in Mutz & Gerke's (2020) study, who significantly increased their levels of physical activity under lockdown.

Social influences

Social influences acted as facilitators and barriers to behaviour change maintenance. Social pressure to conform to other people's expectations about eating behaviours was a barrier for many participants, including maintainers. This problem arose at family meals or social gatherings where hospitality customs expected people to consume calorie rich foods of KSA (e.g. coffee with sugary desserts or chocolate), a theme identified in my focus groups study (Chapter 4) and supported by the weight loss literature of KSA (Al-Mohaimeed & Elmannan, 2017; Alqout & Reynolds, 2014). Given these results, and evidence that modifying eating customs is extremely difficult (Hammarström et al., 2011), the RCT should expand the time spent on this culturally-specific issue and help students to identify various solutions during problem-solving sessions.

The availability of support, particularly social support from friends, family, or co-participants, was a key feature allowing participants to maintain healthy lifestyles/weight loss. Maintainers who assumed “advocacy” roles not only co-opted friends and family into modifying their diets and PA, which strengthened personal motivation, but formed an intimate support group. During the COVID-19 lockdown, one of the factors that enabled participants to maintain behaviour change was the opportunity to exercise with loved ones who shared home confinement but were not available under ordinary circumstances. The importance of social support as a weight loss maintenance facilitator is demonstrated in the quantitative and qualitative literature (Burke et al., 2009; Elfhag & Rossner, 2005; Hindle & Carpenter, 2011; Kayman et al., 1990; Wing & Jeffery, 1999) and given these findings, the social support BCTs used in the BHL programme will be carried over into the RCT.

Unfortunately, a few younger participants shared that they were struggling to maintain healthy food-related behaviours during COVID-19. This problem arose because they were confined to their family’s home, where meals were unhealthy and snacking on sweets was common. Not all participants reported relapsing whilst at their home but for those that did, their experiences align with findings from studies showing increases in overeating and eating unhealthy foods during the COVID-19 pandemic (Ammar et al., 2020; Antunes et al., 2020, Gallo et al., 2020; Mumena, 2020). For instance, a recent study conducted in KSA looked at eating habits and food intake during the curfew in KSA, analysing results by food security status (Mumena, 2020). While food insecure participants frequently reported food unavailability during curfew, food-secure participants (like the students in this study) reported higher intakes of fruits, savoury snacks, and sweets/candies during quarantine.

The literature indicates that gender shapes dietary behaviours during COVID-19 lockdowns. Focusing on Portugal, Antunes et al. (2020) found overall high percentages of participants eating more often (45%), in larger quantities (32%) and without selecting food carefully (58%). However, women were far more likely to have more frequent eating episodes and a higher volume of food consumed than men. Gallo et al. (2020) examined the effect of COVID-19 isolation measures in Australia on diet (24-h recall) in third-year biomedical students. They found that energy intake in women was 20% greater during the pandemic (2020) than in 2018 and 2019. Snacking frequency and energy density of consumed snacks also increased. This finding and the experiences of my participants suggest that there is a strong need for future research to determine the specific causal mechanisms prompting females to overeat during quarantine. While there is evidence to suggest that women are more prone to stress eating during periods of anxiety (Asarian & Geary, 2013; Yau & Potenza, 2013), this has not been definitively assessed in a quarantine setting.

Behavioural regulation and Goals

Participants' accounts of weight loss maintenance indicated that goal setting and self-monitoring were key to supporting and maintaining behaviour change. Students were encouraged to meet dietary and physical activity targets during the programme (e.g., eat five servings of fruit and vegetables per day) and most continued to target at least one of the programme goals post-intervention, usually the 10,000 step count per day. Often, participants established new goals to challenge themselves, such as increasing their daily count from 10,000 to 15,000 steps. Students found the process of self-monitoring, using pedometers or phone apps to count steps, engaging; and when reaching these goals, they developed a sense of satisfaction and pride as well as a desire to maintain the behaviours. Students also used self-regulatory strategies to deal with risk situations, such as social gatherings, and to compensate for any dietary lapses. Overall, these findings support the qualitative and quantitative literature linking self-regulatory strategies with successful weight loss maintenance (Dombrowski et al., 2014; Elfhag & Rossner, 2005; Greaves et al., 2017; Ohsiek & Williams, 2011; Teixeira et al., 2015) and suggest that the BCTs associated with goals and behavioural regulation in the BHL programme should be incorporated into the future RCT.

8.6.3 Limitations

This study used semi-structured phone interviews to explore food related and PA behaviour maintenance experiences of 14 female university students in KSA. These students were participants in an uncontrolled weight management feasibility trial from March-May 2019. The study's nonprobability sampling and small sample size make it difficult to generalize findings to the larger population. Despite this disadvantage, the small sample provided rich descriptions of their lived experiences (Grossoehme, 2014; Sandelowski, 1995; Tong et al., 2007), generating data that would not be possible using quantitative methods.

The interviews were a last-minute replacement for an RCT that could no longer be implemented due to the COVID-19 crisis. This created a significant time gap between the end of the trial and the date of the follow-up which may have affected participants' recall ability and subsequent interview answers. Social desirability bias - the tendency of participants to misrepresent themselves to provide what they perceive as a favourable image (Paulhus, 1991) – may also have influenced findings. First, while participants may have intended to be truthful during the interview process, their answers may have been shaped by their perceptions of me. I was well-known to the participants as a researcher, registered dietician, and creator and facilitator of the BHL programme and thus participants may have held back or exaggerated information based on what they thought I wanted to hear. In fact, participants chiefly expressed positive sentiments about the programme and credited it with helping them to maintain healthy behaviours. In addition, participants had very few (minor) criticisms of the programme. Had the participants been asked questions by a neutral interviewer (instead of me), they may have felt more comfortable discussing any perceived shortcomings of the programme. Thus, even as the programme appears to have been highly successful, the results discussed throughout this chapter should be interpreted cautiously and considered within the context of possible social desirability bias.

Secondly, health research often touches on socially sensitive topics, meaning that social desirability bias is a common concern. Not surprisingly, there is a rich literature showing evidence of social desirability bias in self-reported health behaviours (Widmar et al., 2016), including underestimates of self-reported caloric intake/eating (Hébert et al., 2001; Klesges et al., 2004) and overestimates of self-reported expenditure of energy/physical activity (Adams et al., 2005; Klesges et al. 2004) among different populations. As a result, participants may have misrepresented the true extent of changes in their food-related and physical activity behaviours to comply with normative assumptions about healthy lifestyle behaviours (World Health Organization, 2000).

In addition, the translation of interviews from Arabic to English may have affected the process of data interpretation. Due to monetary constraints, I was not able to hire an independent, certified translator and instead, personally translated the material. Despite fluency in English and having lived in an English-speaking country for several years, I lack professional credentials, and this may have influenced the quality of the translation. In qualitative analysis, understanding of meaning is fundamental, making translation that is technically and conceptually accurate critical to the interpretive process. To achieve ‘conceptual equivalence’ (Jandt, 2003), translators must produce a “culturally informed conceptualization of the contextual meaning of the participant’s words” (Squires, 2008, p. 4). While I strove to capture the linguistic and social context of participants’ words in my translation, and believe this was largely accomplished, I did not perform other procedures to ensure conceptual equivalence, such as repeatedly checking the original transcripts against the translated interpretations during data analysis and synthesis (Lyons & Coyle, 2007). And while I asked a colleague to back translate the anonymised translated English transcripts into Arabic, increasing the validity of the translated data, she too was not a professional translator and not used to making linguistic decisions to achieve equivalency in meaning between texts (Brislin 1970; Cauce et al., 1998).

A final limitation with this study is the absence of a second coder during data analysis. Double coding aids in definitional and conceptual clarity and improves the rigour of the study.

8.7 Conclusion and the impact of this study on the future RCT

This study identified cognitive, social, and environmental barriers and facilitators to maintaining food-related and PA behaviours following a weight management programme. The findings suggest that the programme was viewed favourably by the participants. In addition, many of the strategies they found useful in weight maintenance were BCTs identified in the systematic review and the focus group study conducted for this thesis. Participants were especially receptive to the programme’s content which emphasized realistic and manageable behaviour change that could easily be integrated into daily life.

Many of the students reported experiencing significant changes in self-perception and self-belief that facilitated behaviour change maintenance post-intervention and may have allowed some to maintain behaviour changes during the stressful COVID-19 lockdown. In future, the RCT should provide students with BCTs to further ensure they can facilitate changes in identity and outlook. Because weight loss maintenance is a dynamic process, the future RCT should attempt to gain greater insight into mechanisms of behavioural change using a longitudinal approach with follow-up for at least 2-3 years. Overall, only minor changes are needed to adapt the BHL programme into an implementable intervention. These are described in the next chapter.

Chapter 9: Modifications to the BHL programme and implementation method for the potential RCT

9.1 Introduction

This chapter describes proposed modifications to the Better Healthy Lifestyle (BHL) programme as well as the implementation method for the potential BHL randomised controlled trial (RCT). It begins by reviewing the behaviour change techniques (BCTs) employed during the programme and proposes BCTs for future use. Next, the chapter considers BCTs and barriers to behaviour change identified in the interview study and compares them with barriers and BCTs identified in the focus group, discussing how unresolved barriers will be addressed in the future RCT. It then lays out modifications to the BCT curriculum and programme content. Finally, methodology, measurement, assessment, and data analysis for the future RCT are outlined.

9.2 Behaviour targets for the future RCT

The targeted behaviours were once after the feasibility study and further improved after conducting the interviews. The behaviour targets are as follows:

- Diet: Consume less than one serving (<250 ml) of sugary drinks per day.
- Diet: Have two snacks or less per day
- Diet: Eat at least five portions of fruit and vegetable per day
- Diet: Prepare and cook healthy meals at home
- Physical Activity: Walking at least 10,000 steps daily

9.3 BCTs in Review and Future Use

My use of a phased research approach (i.e. systematic review, focus groups, feasibility trial, in-depth interviews) permitted ongoing identification and assessment of BCTs for the BHL programme. While many BCTs were repeatedly identified as relevant or effective in findings from the studies, several were not identified until the final semi-structured interview study. The current section considers these BCTs and, where relevant, places them in the context of (recent) literature on weight loss interventions for young adults/university students. Table 9.1 provides an overview of the BCTs identified as potentially useful in the systematic review, the focus group study, and the semi-structured interview study.

Goal setting and self-monitoring were originally identified as effective BCTs in the systematic review and were subsequently raised as self-regulation strategies to address barriers to lifestyle change in the focus group study and interview studies. This result is consistent with prior reviews showing that self-monitoring

Table 9.1: Identification of BCTs across research components

BCTs	Systematic Review	Focus Group Study	Feasibility Trial	In-depth Interview Study	To be included in RCT
1.1 Goal Setting (behaviour)	X	X	o	x	x
1.2 Problem solving		X	o	x	x
1.4 Action planning	X	X	o	x	x
1.9 Commitment		X	o		
2.3 Self-monitoring of behaviour	X	X	o	x	x
3.1 Social support (unspecified)		X	o	x	x
4.1 Instruction on how to perform a behaviour		X	o	x	x
5.1 Information about health consequences		X	o	x	x
5.3 Information about social/environmental consequences				x	x
6.1 Demonstration of the behaviour		X	o	x	x
7.1 Prompts/cues				x	x
8.1 Behavioural practice/rehearsal	X		o		x
8.2 Behaviour substitution		X	o		
10.4 Social Reward		X	o	x	x
10.5 Social-incentive				x	x
10.7 Self-incentive				x	x
12.1 Restructuring the physical environment		X	o		x
12.2 Restructuring the social environment		X		x	x
12.4 Distraction			o		x

BCTs	Systematic Review	Focus Group Study	Feasibility Trial	In-depth Interview Study	To be included in RCT
12.5 Adding objects to the environment		X	O	x	x
13.1 Identification of self as role model				x	x
13.2 Framing/Reframing		X	O	x	x
13.4 Valued self-identity	x			x	x
13.5 Identity associated with changed behaviour				x	x
14.5 Rewarding Completion			O		x
15.1 Verbal persuasion about capability		X	O	x	x
15.4 Self-talk			O	x	x

x=BCTs identified as relevant/useful

o=BCTs implemented as part of the intervention

encourages healthy eating, physical activity (Ashton et al., 2019; Michie et al., 2009; Samdal et al., 2017) and long term-weight loss maintenance (Varkevisser et al., 2019). Similarly, goal setting has been identified as an effective BCT for weight management (Ashton et al., 2019; Ashton et al., 2020; Dombrowski, et al. 2012; Olander et al., 2013).

Other BCTs that were recognized as potentially useful from the focus group and interview data were: problem solving, action planning, social support, instruction on how to perform a behaviour, demonstration of behaviour, prompts/cues, social reward, restructuring the physical environment, adding objects to the environment and framing/reframing. Many of these were cited as effective in a recent systematic review and meta-analysis on dietary interventions and behaviour change techniques for young adults. The review found that the following BCTs had an effectiveness ratio of more than 50%: adding objects to the environment (70%), action planning (59%), prompts/cues (58%), social support (56%), and information about health consequences (52%) (Ashton et al., 2019). Another systematic review and meta-analysis on effective BCTs to prevent weight gain and/or initiate weight loss found that social reward and social support (unspecified) had an effectiveness ratio >50% (Ashton et al., 2020).

The interview narratives also pointed to BCTs that were not used in the feasibility trial but might be effective in promoting long-term weight loss if incorporated into the BHL programme. These mainly centred around building up participant identities as 'role models' or as 'healthy individuals.' As discussed in Chapter 8, these are self-concepts initially developed through repeated performance of healthy behaviours and successful weight loss. They were further strengthened via participants' advocacy of healthy lifestyle behaviours and the BHL programme. These BCTs include 'valued self-identity', 'identification of self as role model' and/or 'identity associated with changed behaviour'. Valued self-identity may be most promising as it is focused on affirming personal values and strengths, an approach which has been shown to have small but reliable effects on health-related intentions and behaviour (Epton et al., 2015; Logel & Cohen, 2012).

9.4 Resolution of Barriers

This sequential research process helped to continually clarify barriers and enablers to healthy lifestyle behaviours as well as BCTs to facilitate behaviour change. The theoretical underpinning of the analyses, the Theoretical Domains Framework and the Behaviour Change Wheel, kept this undertaking focused and coherent. Given this approach, the following section considers in detail how the barriers and BCTs identified in the focus group data compared to the barriers and BCTs identified in the interview data. Conducting this appraisal helps to identify which barriers were resolved by the BHL programme and whether its BCTs were sufficient. This information will be useful for finalising the RCT. Based on participant comments, most obstacles to behaviour change were addressed in the feasibility trial, and thus had little or no impact on students' ability to maintain healthy food-related and physical activity behaviours post-intervention. However, three outstanding barriers hindered the performance of a few students: willpower, time, and cultural/social norms around food. Notably, the students struggling with these barriers missed several sessions of the programme; in contrast, none of the students with perfect attendance records experienced these difficulties. Also, given the BHL's programme's conflicts with significant events (e.g. exams, summer holidays and Ramadhan), which prevented students from attending sessions, it is sometimes difficult to determine whether these barriers remain because of the programme's timing issues or because students require more assistance negotiating these challenges. Regardless, the section below proceeds with a discussion about how these barriers might be addressed via programmatic changes prior to the RCT.

Lack of willpower was mentioned as a barrier to physical activity by several focus group participants. It was also a theme extracted from the interview data. Lack of willpower was typically a problem at the start of the BHL programme but, over time, participants were able to overcome this obstacle, particularly when results from healthy eating and physical activity became noticeable. Still, lack of willpower remained a hindrance for a small number of participants throughout the programme. Lack of willpower also resurfaced as an issue during the COVID-19 lockdown when the dramatic changes to daily living conditions, including barriers to exercising outside or in the gym, challenged students' desire to engage in physical activity. Nevertheless, most students managed to resume physical activity after a period of adjustment and were creative in coming up with new ways to exercise, such as walking on building rooftops or downloading exercise apps. All together, these results suggest that willpower, which corresponds with the TDF domain 'intentions' and the COM-B category 'reflective motivation,' is a characteristic that could be further targeted in the RCT, using BCTs such as 'framing/reframing' and 'self-talk' to re-orient students' thinking and help them to develop critical internal resources for maintaining behaviour change.

Time was identified as a barrier in the focus group study and entailed university, work and domestic demands that prevented physical activity or healthy meal preparation. Time was also an issue in the interview study. While most participants found time to exercise, usually as an important part of a daily routine, a few reported difficulties maintaining this behaviour during demanding periods, such as exams week. Thus, it may still be useful during sessions to emphasize time management, which corresponds with the TDF domain 'environmental context and resources' and the COM-B category 'physical opportunity,' using the BCT 'problem-solving'.

Cultural norms, especially the pressure to eat unhealthy food at social gatherings, was a theme first articulated by students in the focus groups. While most students learned to employ strategies to deal with this problem, at least one student had difficulty managing social events after the BHL programme. It may be helpful for the RCT to spend more time on the topic of cultural norms, which corresponds with the TDF domain ‘social influences’ and the COM-B category ‘social opportunity’, using the BCT ‘problem solving’.

9.4.1 Modification to the BHL programme

Based on student compliance and timeframe issues, the following organizational changes should be made to the BHL programme:

- Instead of holding 12 sessions over 12 weeks, the programme should hold six sessions over 12 weeks to accommodate student scheduling needs.
- Social media (WhatsApp group) should be introduced to promote social support, feedback, and self-monitoring.

Results from the interviews suggest several ways in which the curriculum could be altered to enhance outcomes. First, after my Viva upgrade, I decided to tighten the curriculum’s focus on food-related behaviours. I decided to drop the target behaviour ‘increase consumption of fruits and vegetables to a minimum of five portions per day’ and exchange it for ‘reduce the number of snacks to two or fewer per day’. However, in their interviews, students regularly discussed the original target behaviours and expressly related them to their success in initiating and maintaining weight loss. Given the student responses, it may make sense to reconsider adjusting the curriculum, choosing instead to keep the original target behaviours and combine them with the new target behaviour (‘reduce the number of snacks to two or less per day’).

Second, as discussed already, students’ experiences maintaining behaviour change suggest that the BCTs employed by the BHL programme were effective; students specifically mentioned ‘goal setting’, ‘self-monitoring’, and ‘social support’ as particularly helpful. Though they did not mention the BCT by name, ‘problem solving’ was also recognized as critical to weight maintenance efforts. For example, participants talked about strategies to negotiate eating at family gatherings. As mentioned earlier, data from the interviews point to several more BCTs that could be integrated into the RCT, particularly BCTs that focus on enhancing self-efficacy and self-perception and building an identity around a new healthy lifestyle by using self-affirmation and re-orienting thinking. The BCTs include ‘valued self-identity,’ and ‘identification of self as role model’ complementing ‘framing/reframing,’ ‘self-talk’ and ‘verbal persuasion of capability’ already in the BHL curriculum.

Third, the interviews highlighted the importance of engaging family and friends to promote behaviour change and behaviour change maintenance. Students reported that these interactions boosted their commitment to weight management, whether through positive feedback, social support, companionship, or friendly competition. These results suggest that revisions to the curriculum could increase the likelihood of long-term weight management. For example, the WhatsApp group, which provided social support and the means to monitor step counts, could continue after the programme’s final session and formally maintained until a pre-determined follow-up point, if resources allow. In case of no resources, students could opt to remain in (or to leave) the group and use it for peer support without the instructor’s involvement. Students could also be introduced to other rewards based BCTs (besides social reward) to engage family or friends in physical activity (e.g. social incentive or material/non-specific reward).

Finally, the results from the interview study are extremely encouraging and suggest that the BHL programme promotes long-term food related and physical activity behaviour change among female university students. With these findings in mind, the future RCT should include, at minimum, a follow up after six months from baseline to assess the statistical significance of outcomes and compare quantitative and qualitative findings. Table 9.2 presents planned revisions to the BHL programme curriculum.

9.4.2 Modification to the potential RCT

Despite the BHL programme’s potential encouraging results, significant adjustments need to be made to the intervention before an RCT is conducted. For example, the programme should be modified to address the feasibility and compliance issues identified during the feasibility trial. It also must take findings from the interviews into account when designing the new curriculum. Moreover, the RCT must devise rigorous standards for assessing outcomes.

The potential RCT of the BHL programme will include the following:

- Establish a control group
- Assess the programme's effectiveness using pre- and post-intervention anthropometric measures
- Provide standardized pedometers to all participants
- Collect demographic data (e.g. socio-economic information) to account for external influences on behaviour
- Distribute questionnaires/conduct 24-hour dietary recall to systematically assess the targeted dietary behaviours before and after the programme

Table 9.2: Revisions to the BHL Programme for the RCT

Programme sessions	RCT time-frame	BCTs to add	Target behaviours	Sample	Assessment	Other revisions to curriculum
6 sessions over 12 weeks	12-week programme Follow up at 6 months after baseline	5.3 Information about social and environmental consequences 7.1: Prompts/Cues 10.5 Social incentive 10.7 Self-incentive 13.1 Identification of self as role model 13.4 Valued self-identity 13.5 Identity associated with changed behaviour	Retain target: ‘Eat at least five portions of fruit and vegetable per day’ And change: ‘Replace high calorie beverages with water’ with ‘Consume less than one serving (<250 ml) of sugary drinks per day’ And change: ‘Making healthier food choices’ with ‘Prepare and cook healthy meals at home’ And add:‘ Have two snacks or less per day’	Large enough for statistically significant results General care group	Pre, post intervention and follow up anthropometric measurements and Step count and 24-hour dietary recall pre and post the intervention Collect demographic, including socioeconomic information	Standardized pedometers Social media (WhatsApp group – up to six months)

9.5 Research Question for the Potential RCT

Is there a difference in mean weight change for female students with overweight (BMI ≥25kg/m^2) or obesity (BMI ≥30kg/m^2) between an intervention group (students who attended a multicomponent weight management intervention) and a general care group (students who do not receive the intervention) at a university in Riyadh, KSA?

The null hypothesis is that there will be no difference in mean weight between female university students who receive an intervention (intervention group) and those who do not receive an intervention (general care group), among the population from which the samples are drawn.

Hypothesis: The intervention will result in greater reduction in mean weight in the intervention group (female university students who participate in the public health intervention) than in the general care group (female university students who do not receive the weight loss programme).

9.6 Aims and Objectives for the Potential RCT

9.6.1 Overall Aim of the Potential RCT

To assess the effectiveness of the Better Healthy Lifestyle (BHL) programme in promoting weight loss among female university students with overweight (BMI ≥25kg/m^2) or obesity (BMI ≥30kg/m^2) compared with students who do not receive the intervention, in a university setting in Riyadh, KSA.

It is my hope that this study stimulates further research and large well-designed clinical trials to tackle the obesity epidemic across KSA. Furthermore, the potential effectiveness of the weight loss programme for the Arabic speaking community may have broader application and stimulate similar trials in the Gulf and Middle East region.

9.7 Methodology

9.7.1 Study Design

MRC guidelines for developing and evaluating complex interventions state that a number of study designs are appropriate for measuring interventions. However, to reduce the risk of selection bias, randomisation is strongly recommended. Therefore, I chose an RCT as the best study design for assessing the effectiveness of the current programme (BHL programme). As part of the study, participants will be randomly assigned to an intervention or a general care group. The intervention group will receive the weight loss intervention (six sessions conducted over 12 weeks), and the general care group will receive only one education session and will receive the intervention after the study is completed if they are still interested.

9.7.2 Participants

Eligibility criteria

Participants will be female university students ages 19 years and above with BMI≥25 kg/m^2.

Exclusion criteria will be:

- male students
- students younger than 19 years old
- students with BMI<25kg/m^2
- students who are pregnant or breastfeeding
- students who have eating disorder
- students with any chronic disease, such as hypertension, diabetes, etc.

Setting

The setting will be a university located in Riyadh, KSA.

Recruitment

Participants will be recruited from the university using posters and banners placed around campus, recruitment brochures, and presentations during events and classes held at the university. Potential participants will be asked to email the study investigator (me) for further information. Once contacted, I will email interested participants a participant information leaflet and invite them to the eligibility screening (e.g., height, weight, BMI, and exclusion criteria). After the screening phase, prospective participants will be asked to confirm that they have read the information leaflet, given an opportunity to ask questions and asked to sign the consent form prior to enrolment, if still interested.

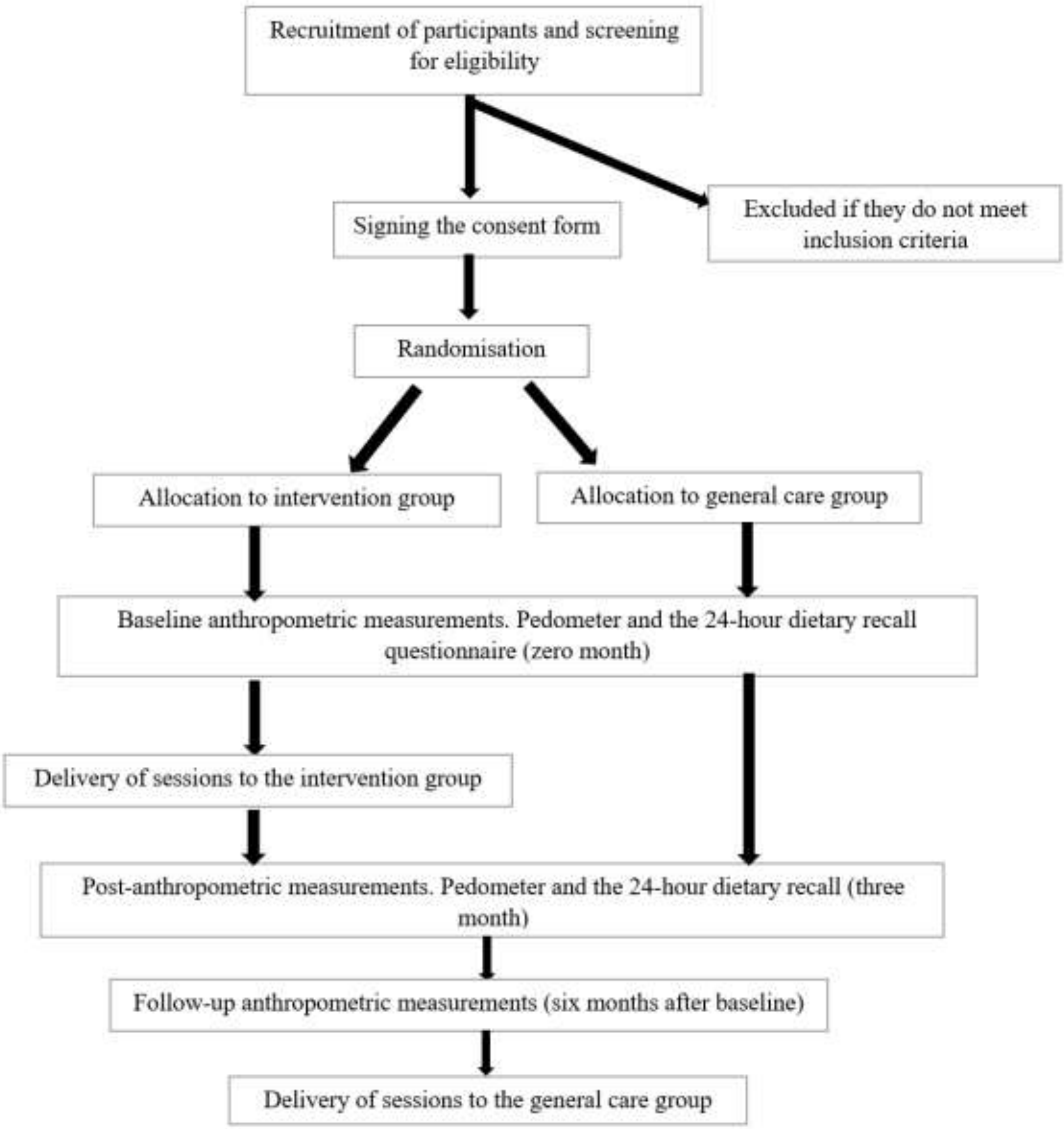
Sample size calculation

The sample size calculation for the RCT was determined after the feasibility study (Chapter 6). The RCT will require 154 participants, with 77 participants in the intervention group, and 77 in the general care group. The intervention group will be further divided into five subgroups (15-16 participants in each subgroup).

9.7.3 Randomisation

Once all eligible participants sign the consent form, they will be randomly assigned to intervention and general care groups to reduce recruitment bias. To prevent selection bias, a random sequence generation and allocation concealment will be conducted by preparing 154 opaque sealed envelopes that are then shuffled in a box. Seventy-seven envelopes will contain a piece of paper marked with an ‘I,’ which stands for intervention group, and 77 envelopes will contain a piece of paper marked with a ‘G,’ which stands for the general care group. After each participant signs the consent form, she will be asked to pick an envelope from the box and personally unseal it. The envelopes will then be reshuffled before the next participant picks an envelope. This process will be performed by a non-investigator (e.g. a volunteer faculty member) and will be repeated until the sample size reaches 154. If a student chooses an envelope marked with an “I”, she will join the intervention group, and if a student chooses an envelope marked with a “G”, she will join the waiting list general care group. This process will be conducted by the manager of the clinic. Then the list of the participants in the intervention and general care group will be given to me (the researcher) as blinding of the researcher is impossible due to the nature of the study. The intervention group will be randomly split into five groups for practical reasons, in order to ensure that the intervention is delivered to suitably sized groups. No group will exceed 16 students. This number of students in each group was chosen because it was suitable for me to deliver interactive sessions clearly during my feasibility trial for 15 students. Each intervention group will be receiving the same sessions: they are not different arms of a more complex RCT. As a final step, intervention and general care group participants will be asked to complete the 24-hour dietary recall questionnaire for three days. The flow chart of process for the RCT is illustrated in figure 9.1.

Figure 9.1: Flow chart of process for the RCT



1. Intervention group

The intervention group will attend the weight loss programme, consisting of six fortnightly nutrition and physical activity education sessions with the support of BCTs carried out over 12 weeks. Each session will be conducted for one hour at the university. This timetable provides more flexibility for students with busy schedules. The investigator will make sure that the sessions' content is standardized as much as possible across the five groups. The topics that will be covered in the sessions are summarised in Table 9.3.

2. General care group

The general care group will receive only one education session (Appendix 6D). Participants in the general care group if still interested will be able to attend the programme once the RCT study concludes.

Table 9.3: Outline of the intervention sessions

Session Number	The Topics for the Sessions	Targeted behaviour
1.	Introduction: Obesity, its causes and its impacts	Consume less than one serving (<250 ml) of sugary drinks per day.
2.	Healthy and unhealthy snacks; Label reading skills	Have two snacks or less per day
3.	Physical activity: types, benefits and making physical activity a part of a daily routine	Walking at least 10,000 steps daily
4.	Cooking and preparing healthy meals and healthy fast-food options	Prepare and cook healthy meals at home
5.	Increase the consumption of fruits and vegetables to five a day and practice problem solving (social and physical opportunities to promote a healthy lifestyle)	Eat at least five portions of fruit and vegetable per day
6.	Healthy shopping + Eating healthy meals at restaurants and social gatherings	

Materials

Materials for the intervention include leaflets (Appendix 6A), PowerPoint presentations, pedometers (fitbit flex wristband) and weekly self-monitoring sheets (Appendix 6B). All materials are ready for use.

Materials for programme activities include: a chart (Figure 9.2) with pictures of high calorie beverages (such as Pepsi®, 7up®, Miranda®, Suntop®, and Almarai® Apple Juice) and water for demonstrating the sugar and calorie content of each drink; sugar cubes, plastic packets, the high calorie beverages mentioned above and water; snacks such as 7days soft croissant with chocolate cream filling, 7days croissant with strawberry filling, Lays® potato chips (Figure 9.3), and Cheetos® crunchy chips for label reading skills and documents to identify healthy and unhealthy snacks (Appendix 6C); and circular paper and pencils (for drawing the healthy plate). BHL programme details are summarised in Appendix 6D.

Figure 9.2: 'Rethink your drink' activity

Figure 9.3: Label reading for Potato Crisps Activity (taken from a packet of Lay's® crisps)

Ingredients: Potatoes, Vegetable Oil (Sunflower, Corn and/or Canola Oil), and Salt.

Nutrition Facts
Serving Size 1 oz (28g/About 15 chips)

Amount Per Serving	
Calories 160	Calories from Fat 90
	% Daily Value*
Total Fat 10g	**16%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 170mg	**7%**
Potassium 350mg	**10%**
Total Carbohydrate 15g	**5%**
Dietary Fiber 1g	**5%**
Sugars less than 1g	
Protein 2g	

Vitamin A 0%	Vitamin C 10%
Calcium 0%	Iron 2%
Vitamin E 6%	Thiamin 4%
Niacin 6%	Vitamin B_6 10%
Magnesium 4%	Zinc 2%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500mg	3,500mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

9.8 Outcomes

Measurements and health behaviours will be assessed at baseline (zero month) and post-intervention (three months) and follow up (six months from the baseline).

9.8.1 Primary Outcome

- Weight change in kilograms

9.8.2 Secondary Outcomes

- Change in BMI
- Change in waist circumference in centimetres
- Meeting each of the targeted dietary and physical activity behaviours

9.9 Anthropometric measurements

To ensure blinding of the outcome assessment, the anthropometric measurements (weight, height and waist circumference) for each participant will be recorded by qualified volunteer nurses from the university clinic (who will remain blind to whether participants are in the intervention or general care group). These measurements will be used to calculate the body mass index (BMI) at baseline and post-intervention for each participant. All data will be recorded on an Excel sheet, with participants identifiable only by their study ID number. The standardized procedures for measuring height, weight and waist circumference are summarized in Appendix 4E.

9.9.1 Height Measurement

Clinic nurses will be trained to use a stadiometer to take height measurements based on instructions provided in *The Procedure for Measuring Adult Height* (NHS 2014) in order to standardise the measurements for all participants.

9.9.2 Weight and Waist Circumference

Clinical nurses will be trained to take weight and waist circumference measurements using the WHO STEPS Surveillance Manual in order to standardize assessments for all participants (World Health Organization, 2016). A portable electronic weighing scale will be used to weigh the participants. A standardised measuring tape will be used for measuring waist circumference.

9.9.3 Assessment of the dietary and physical activity behaviours

The four dietary behaviours will be assessed using 24-hour recalls and physical activity will be assessed using pedometers (A pedometer will be given to all participants for step count assessment). ven to all participants for step count assessment).

Assessments through 24-hour dietary recall questionnaire

A 24-hour dietary recall will be used to assess food consumption and will be conducted with each participant via phone. This captures information regarding the food and drink consumption during the previous 24 hours. Therefore, it is a standard dietary assessment tool. Three recalls will be taken for each participant before and after the intervention (Ma et al., 2010), two recalls to cover weekdays and one for the weekend.

Assessment of step counts per day

A wrist pedometer will be given to all participants (in the control and the intervention groups). The pedometers will be charged and checked to make sure they are operable before being distributed to the students. Participants will be advised to charge the pedometers overnight and then wear them during waking hours for five consecutive days (three weekdays and two weekend days). Research in habitual physical activity demonstrates that pedometer data accumulated over a five-day period (Strycker et al., 2007) is reliable, and data quality is typically enhanced by including weekdays and weekends in the time period being monitored (Strycker et al., 2007; Tudor-Locke et al., 2004), and by adapting to seasonal changes (Tudor-Locke et al., 2004). On the day the pedometers are provided, students will download an App to their phones to record step counts, eliminating the need for participants to self-record their step counts. The front of the pedometer will be covered with tape, and students will be advised not to access the phone App. Next, participants will be asked to return the pedometers to the nurse who will record the step counts on the phone before the start of the intervention. The intervention group will be provided with the pedometers again during the physical activity session (third session) to enable self-monitoring (BCT) to reach the targeted behaviour. During this session, students will view a demonstration on how to use the pedometer and will be advised to increase their physical activity to reach a minimum of 10,000 steps per day (NHS; Wattanapisit & Thanamee, 2017). Walking 10,000 steps is an alternative to the World Health Organization’s (WHO) recommendation (2011) of 150 minutes of moderate physical activity per week.

The investigator will collect the pedometers from the intervention group five days after the completion of the intervention (three months), and step counts will be recorded at that time. The general care group will be given pedometers after the intervention is completed, and a nurse will record the step counts of participants in both groups for five days post-intervention. Once the data are collected, the pedometers will be returned to the students in the intervention group. At that time, the data will be recorded on an excel sheet and the average step count will be compared between groups.

Cut-offs for the target behaviours

To assess whether behaviours were achieved by participants, cut-offs for the target behaviours will be based on Guidelines of KSA (MOH, 2013) and WHO recommendations (2015). Participants will be classified as meeting the behavioural targets if the following are met: 1) less than 250ml of sugary drinks per day 2) a maximum of 2 snacks per day; 3) at least five portions of fruits and/or vegetables daily 3) fat content ≤33% of total energy intake 4) physical activity consisting of 10,000 steps minimum daily;

9.10 Data Analysis

The treatment allocation concealment will be conducted with the help of a colleague. All data will be collected by the colleague, and I will be blinded until the end of the analysis, as the identity of the intervention and the general group will be masked. In addition, my colleague will keep the information on group identity and will reveal it only once the analysis is completed. Descriptive statistics will be used to describe the baseline characteristics of both groups.

SPSS version 20 will be used for statistical analysis. The effect of the proposed intervention programme on weight reduction will be evaluated by Analysis of Covariance (ANCOVA) if the data are distributed normally. ANCOVA can be used to compare the means of post-intervention main continuous outcome variables between two groups by adjustment of baseline values as a covariate and the post-intervention weight as the dependent variable. This statistical technique has been selected because it is best for studying the relationship between the exposure (the programme) and the outcome (weight reduction) or any other continuous secondary outcomes such as BMI and waist circumference. The level of significance to reject the null hypothesis will be set at $p < 0.05$.

Targeted behaviour data will be continuous and will be analysed using categorical factors that incorporate frequency tables and $\chi 2$ tests, as well as logistic regression. Moreover, exploratory subgroup analyses will be undertaken to determine the interactions and connections between individuals' ages, education/socioeconomic status, treatment and marital status (Beeken et al., 2016).

9.11 Dealing with loss to follow-up

I will try and get follow-up measurements for drop outs for the primary outcome. I will use an intention to treat (ITT) approach to assess the effectiveness of the intervention programme. In this approach, all participants who were randomised are included in the analysis, irrespective of completion status. As a secondary analysis, I will consider adherence in terms of completion of the programme and withdrawal from the study. Participants who failed to complete the post-test 24-hour recall, step counts and attend the measurement sessions will be deemed dropouts, as well those who attended fewer than three of the six sessions. The pre-intervention measurements will be taken for the missing values from the primary and secondary outcomes.

9.12 Ethical Considerations

9.12.1 General considerations

This study has a low risk of harm to participants; similar programmes implemented for adults in other countries have shown effectiveness, without reporting any harmful side effects (Ames et al., 2005; Hazama et al., 1994; Kondo et al., 2006; Lee et al., 2017; Schmidt et al., 2001). To protect the participants, involvement in the RCT will be purely voluntary and recruitment will involve advertisements (methods mentioned earlier). In addition, the general care group will receive the intervention after the RCT is completed, providing them with the potential benefit of participation in the programme.

9.12.2 Ethical Approval

Ethical approvals for this RCT were obtained from King Fahad Medical City [Ref 18-674E] as well as the research committee of the King Saud University [Ref KSU-HE-19-336] earlier. Since several modifications have been made to the BHL programme, an application for amendments will be submitted before conducting the RCT.

9.12.3 Informed Consent

A signed consent form will be obtained from each potential participant before they are enrolled in the study. The participant information leaflet and consent form will inform participants about the nature of the study and about their right to withdraw at any time.

9.12.4 Confidentiality

Participant information obtained during the data collection process, such as weight, height, age, etc., will be kept as a hard copy and electronically on a password-protected flash drive in a locked cabinet, in a locked room accessible only by me. Only study ID numbers, not names, will be attached to the participants' data, so that participants cannot be identified by name except on a list of names and ID codes, which will also be kept securely in a different locked cabinet in a different locked room in order to maintain participant's anonymity and confidentiality. I will destroy the list of the names and codes immediately after analysing the data and completing the study. The main study dataset will be kept for five years after completion of the study and then destroyed.

9.13 Study Limitations

Contamination bias

Students who participate in the general care group may learn about the content of the programme (e.g., target behaviours) from the treatment group, since they are studying in the same academic setting. Thus, the potential exists for general care group members to adopt programme-related behaviours. Cluster randomisation, in which groups of subjects are allocated to different treatments may help to reduce contamination bias. However, cluster randomisation requires a very large sample size. In addition, according to Bruin et al. (2014), the benefits of individual randomization in behaviour change trials may include a lower risk of recruitment bias as well as imbalances at the baseline. Therefore, other measures will be taken to minimize contamination bias by restricting access to the programme's content, so that the intervention group cannot share programme materials with the general care group. For example, I will not distribute any hard or electronic copies of the PowerPoint presentations to the intervention group, to prevent exchange of this information. Moreover, the students will be asked not to share their self-monitoring tick sheets with anyone but family members.

Compliance bias

Compliance bias arises when participants who are compliant with an intervention differ from those who are noncompliant with an intervention. However, this bias is inevitable, as often participants in interventions that include behaviour modifications at an academic setting tend to respond differently to the treatment (Sacher, 2013). Assessment of targeted behaviours may help to minimize this bias. This is why ITT analysis will be the primary endpoint.

9.14 Conclusion

This chapter discussed modifications to the BHL programme and presented the implementation method for the future RCT. The next chapter, which concludes this thesis, describes research implications, study strengths and limitations and policy recommendations.

Chapter 10: Summary, Research Implications, Strengths, Limitations and Policy Recommendations

10.1 Chapter Aims

This chapter has four principal aims: 1) to summarize the main contributions of my research to the body of public health knowledge; 2) to consider implications for future research; 3) to explore the strengths and limitations of my research; and 4) to provide programme and policy recommendations based on the thesis's findings.

10.2 Rationale

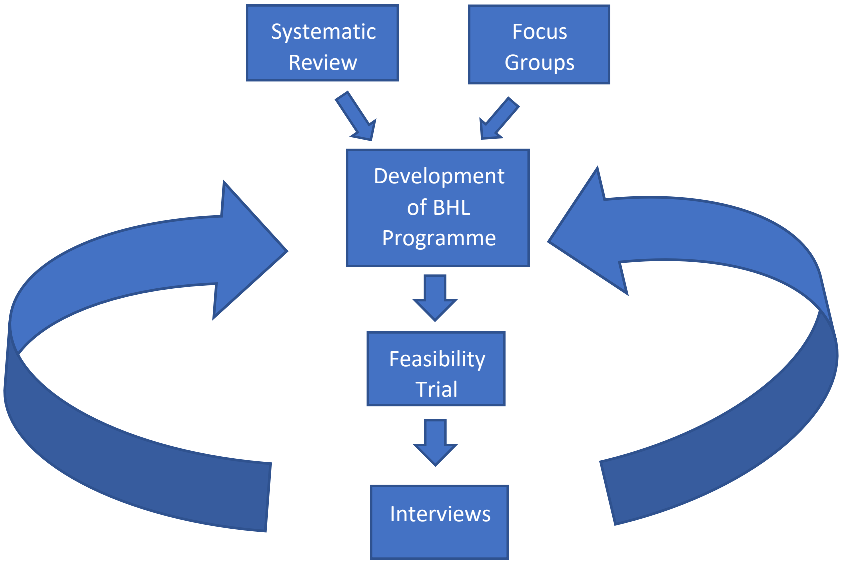
Obesity rates among female university students of KSA are high, as much as 48% according to one study (Al Qauhiz, 2010) (Chapter 1). Multiple cross-sectional studies have shown that this population has poor dietary habits (Al-Otaibi, 2013; Al Qauhiz, 2010; Alzamil et al., 2019; Hussain, 2014; Khalaf et al.,, 2014; Majeed, 2015; Saleem et al., 2016) and engages in low levels of physical activity (Al Qauhiz, 2010, Alzamil et al., 2019; Khalaf et al., 2014; Majeed, 2015). Moreover, several studies have identified these factors as obesity correlates (Al-Otaibi, 2013; Hussain, 2014; Khalaf et al., 2014). Given the link between obesity and unhealthy lifestyle behaviours among female university students of KSA, there is a crucial need for lifestyle modification programmes that promote weight loss through improved dietary and physical activity behaviours.

10.3 Review of Thesis Components

This thesis comprises multiple research phases to develop a weight management programme titled Better Healthy Lifestyle (BHL). The BHL programme is a theoretically driven and evidence-based complex intervention that combines nutrition education and physical activity with BCTs to promote weight loss. As far as I am aware, BHL is the first multicomponent weight loss intervention targeting female university students in KSA.

The stepwise, iterative process to develop the BHL programme is displayed in Figure 10.1.

Figure 10.1: Thesis Development Process



In the first phase of research, I conducted a systematic review of weight management-controlled trials targeting female university students (Chapter 3). In the second phase, I facilitated three focus group discussions with female students at Saudi Electronic University (SEU) to identify barriers and facilitators to healthy eating and exercise as well as to participation in weight loss programmes (Chapter 4). In the third phase, I developed the BHL programme, based on the Medical Research Council (MRC) framework (Craig, 2008) and the Behaviour Change Wheel (Michie et al., 2011,) using insights from the systematic review and focus group discussions (Chapter 5). In the fourth phase, I conducted the feasibility trial of the Better Healthy Lifestyle (BHL) Programme (Chapter 6). In the fifth phase, I conducted one-year follow-up interviews with participants of the BHL programme to explore the intervention's impact on weight loss management (Chapter 8). Participants were asked about barriers and facilitators to maintaining healthy food-related and physical activity behaviours post-intervention as well as during the COVID-19 lockdown. In the final phase, findings from the feasibility trial and interview study were used to revise the BHL programme for implementation in a future RCT (Chapter 9).

10.4 Major Research Contributions

This thesis's main contribution to public health knowledge is the BHL programme: the first multicomponent weight loss intervention targeting female university students in KSA. The necessary information to develop the programme was advanced gradually through sequential research steps. Each of these steps yielded important findings discussed in greater detail below.

In Chapter 3, I presented the results of the first systematic review of controlled trials for weight loss targeting female university students. The review showed that complex interventions are more effective than single modality interventions at promoting weight loss among female university students. The only studies demonstrating clinically significant weight loss were conducted for 12 weeks or more, suggesting that this would be a suitable timeframe for a future intervention. The most used BCTs in the trials were: a) self-monitoring of behaviour; b) behavioural practice/rehearsal; and c) goal setting.

In Chapter 4, I described results from the first qualitative study on female university students' perceptions of healthy food related and physical activity behaviours in KSA using Theoretical Domain Framework (TDF). During focus group discussions, students explored barriers and facilitators to healthy lifestyle behaviours as well as barriers and facilitators to attending a weight management programme (WMP). Overall, participants were interested in modifying their behaviours and attending a WMP, but only if doing so was consistent with personal preferences or needs. Participants expressed a desire for manageable exercise and dietary regimens with realistic target goals and continuous monitoring of progress. Environmental barriers to weight management existed within the university and outside of it and included lack of time; the city's size;

cost of healthy food; limited sex-segregated leisure spaces; and lack of access to healthy food on campus and at stores and restaurants.

Participants identified several social barriers to weight loss that were culturally situated. Social pressure to conform to other people's expectations about diet was a common theme, especially at social gatherings. At these events, students felt obliged to consume traditional calorie-rich foods of KSA (e.g., sugary desserts or chocolate) in accordance with hospitality norms.

Overall, the focus group data pointed to a number of BCTs to incorporate into the BHL programme. These included: a) self-monitoring; b) goal setting; c) demonstration of behaviour; d) social support; e) problem-solving, etc.

In Chapter 5, I discussed the development of the BHL programme based on the MRC and BCW framework. This chapter demonstrated step by step method for the development of the BHL programme. For instance, the findings of the systematic review, the focus group and other related systematic review were utilised to identify the BCTs that will be included in the BHL programme.

In Chapter 6, I presented results from the first feasibility trial of a lifestyle modification intervention (BHL programme) for female university students in KSA. While many university-based intervention studies focus on just one or two components, the feasibility study adopted a complex intervention to modify targeted dietary and physical activity behaviours through nutrition and physical activity education. In addition, the programme used an innovative curriculum that took sociocultural factors into account and incorporated relevant BCTs to enhance the intervention's effectiveness. The trial identified issues with feasibility, acceptability, curriculum, programme timing and flexibility to address before implementing an RCT. It also surfaced BCTs that were not identified in the focus group analysis to employ in future research, including 'rewarding behaviour' (Michie et al., 2013). Using intention to treat analysis (ITT), the trial found statistically significant differences (reduction) between pre- and post-intervention weight and BMI.

In Chapter 7, I summarised the evidence for the impacts of lockdown on food-related and physical activity behaviours.

In Chapter 8, I discussed findings from the first qualitative study to explore the effectiveness of a lifestyle intervention (BHL programme) for female university students in KSA. The study's semi-structured interviews focused on barriers and facilitators to maintaining healthy lifestyle behaviours post-intervention and during the COVID-19 lockdown. Student narratives showed that successful behaviour change was a dynamic process that began with students' realization that weight loss was achievable and rewarding. This led to the development of students' intrinsic resources, a transformation in self-concept and self-belief, and integration of healthy eating and exercise into daily life.

Students credited several aspects of the programme with helping them to maintain weight loss, including its emphasis on realistic, attainable goals and practical strategies for weight management (e.g., counting calories). Students directly referred to certain BCTs as helpful: self-monitoring of behaviour, goal setting (behaviour), problem solving, social support, restructuring the physical environment and adding objects to the environment.

Most participants claimed that they were able to sustain healthy lifestyle behaviours during the COVID-19 lockdown. A number were able to transition to quarantine without any disruption to their behaviours, relying on strong intrinsic assets (e.g. willpower) to maintain healthy food related and physical activity behaviours. Alternatively, others struggled to perform behaviours at the start of the lockdown, finding the experience mentally and physically exhausting but were eventually able to mentally reset and resume eating and exercise routines.

There were several other supports – social, environmental and skill-based - that participants drew on during lockdown to maintain behaviour change. A key means of social support included continued use of the WhatsApp support group to stay motivated. In addition, students were able to use the cooking skills they developed during the intervention, often for the first time, to eat healthily when restaurants closed due to COVID-19 restrictions. Similarly, some participants altered their exercise routines when gyms were shut down by performing physical activity at home, even when they lived in small apartment. Some participants, especially those with plenty of free time, were more likely to increase the intensity or duration of physical activity behaviours

In Chapter 9, I modified the BHL programme based on the findings from the interview. Moreover, I explained the proposed method for the implementation of the BHL programme on a larger scale.

10.5 Implications and Recommendations for Future Research

The current thesis determined the feasibility of a university-based intervention for promoting healthy eating and physical activity for female students. It also explored the participants' experiences maintaining these healthy life-style behaviours at a follow-up interview one year later. Overall, the results indicated that the intervention was effective, with most participants reporting success sustaining modified behaviours, even with the government's strict COVID-19 measures.

Besides the proposed RCT (see Chapter 9), there are other opportunities for research that build on the results of this thesis. One possibility is to explore the barriers and facilitators discussed in the focus groups or interviews for different populations, such as male university students or female students in different geographic areas or across multiple universities in KSA. Findings from the above-mentioned qualitative research could inform the design of a feasibility trial or RCT concerned with these populations. In addition, as the precise mechanisms of long-term weight maintenance remain unclear, a study with a sufficient budget to assess behaviour change over an extended time period, up to five years, would contribute critical knowledge to the field, particularly as current research suggests that weight maintenance habits are not fully internalised until two to five years after weight loss (Wing & Phelan, 2005).

Finally, the present research explored various barriers and facilitators to performing healthy lifestyle behaviours based on an understanding of the university as a socio-ecological system (Deliens et al., 2014; Sogari et al., 2018), identifying social, environmental, and organizational factors contributing to student's obesogenic behaviours. However, it did not undertake an in-depth examination of the relationship between macro level forces, such as health policies or advertising campaigns, that interact with university level influences to impede or promote healthy food related and physical activity behaviours. Future studies should look more closely at the impact of these external forces – including the food and health related policies recently introduced in KSA (discussed in Chapter 1) - on performance and maintenance of healthy lifestyle behaviours.

10.6 Limitations and Strengths of the Thesis

This section describes the various limitations and strengths of the thesis. While the original plan for my thesis was to design, implement and assess the outcomes of an RCT, this aim became impracticable after the outbreak of COVID-19 and subsequent quarantine measures. The qualitative interview study replaced the RCT, shifting the focus of this thesis and subsequently its strengths and limitations.

10.6.1 Strengths

The systematic and transparent discussion of the development and evaluation of the BHL programme is a strength of this thesis. The phased research approach created a dynamic and iterative process that allowed for continual clarification of concepts and themes. It also made visible the theories and sources of evidence that informed the intervention's content. Through careful reporting of its procedures, this thesis may serve as a template for future efforts to develop and evaluate complex interventions for weight loss or for other health behaviours (Mohler et al, 2011).

Stakeholder involvement is another strength of this thesis. Both the focus group and the interviews allowed for direct input from the target population– female university students – at various points in the research process. Taking a user-centred approach, I was able to facilitate focus groups to learn about intervention design and needs from the students' perspective (O'Cathain et al., 2019; Rousseau et al., 2019). This required recognizing the importance of context in encouraging or constraining people's behaviours (Moore & Evans, 2017) to create a culturally appropriate intervention for female university students in KSA (Levin-Zamir et al., 2015).

The semi-structured interviews allowed for a detailed investigation of the experiences of female students who received the intervention. The participants' accounts contained valuable information about the aspects of the intervention they found most effective or appealing and those they did not. As with the focus groups, this user-centred data is vital to revising the BHL programme to better meet female university students' needs.

The use of qualitative methods also strengthened the thesis by providing rich descriptions of participants' perspectives and experiences. These accounts, particularly the interviews, revealed relationships between the intervention, context and subsequent behaviours that would not have been identifiable using quantitative methods. Understanding these dynamics is key to making adaptations to the BHL programme's design.

The use of mixed methods – a systematic review, focus groups, interviews, a feasibility study - in the development and evaluation of the BHL programme is another strength. Given the multiple research questions associated with this complex intervention, combining, and integrating, quantitative and qualitative research methods provided a rich understanding of the multi-faceted and dynamic factors at play. This, in turn, may have enriched the findings of the thesis (Wisdom & Creswell, 2013).

Further strengthening the thesis, each research component followed health research reporting guidelines to ensure transparency, comprehensiveness, and rigour. The systematic review followed the Preferred Reporting Items of Systematic reviews and Meta-Analyses (PRISMA) statement which includes a 27-item checklist to encourage accurate and transparent reporting of systematic reviews (Moher et al., 2009). Similarly, the qualitative studies (focus groups and interviews) followed the Standards for Reporting Qualitative Research (SRQR) checklist, which includes 21 items to promote complete and transparent reporting (O'Brien et al., 2013). The uncontrolled feasibility trial followed a modified version of the Consolidated Standards of Reporting Trials (CONSORT) Statement for randomised controlled trials (RCT), and the RCT protocol also followed the CONSORT Statement. The CONSORT Statement includes a 25-item checklist to improve the reporting of RCTs.

Another strength of this thesis is that it is grounded in behaviour change theory. Behaviour change theory detects when change occurs, explains change dynamics, and identifies why an intervention succeeds or fails (Gainforth, West, & Michie, 2015). There is growing agreement that a theoretical understanding of behaviour change is necessary to increase the effectiveness of health interventions (Craig et al., 2008; Davis et al., 2014). Indeed, the MRC's guidance on the development and evaluation of complex interventions tasks researchers with identifying a suitable theoretical approach early in the process of intervention design and evaluation (Craig et al., 2008; Glanz & Bishop, 2010). By basing development of the BHL programme on the Theoretical Domains Framework (TDF) and Behaviour Change Wheel (BCW), I strengthened the thesis in the following ways:

1. After choosing the BCW to underpin the thesis, I explicitly conducted the systematic review (Chapter 3) to identify the BCTs that were used in existing weight loss interventions for female university students.
2. In Chapter 4 (focus group discussions), the TDF framework provided a structured, comprehensive and theory-informed approach to identify barriers and facilitators to healthy lifestyle behaviours and attendance at a weight management programme (WMP) and to identify resources to change behaviour (Phillips etal., 2015). Because the TDF is a synthesis of 33 theories, the range of factors identified during analysis was likely greater than if a single theoretical model had been used (Duncan et al., 2012; Dyson et al., 2010).
3. The BCW provided a rigorous method to identify intervention options and potential BCTs to promote healthy lifestyle behaviours. Like the TDF, the BCW synthesises existing frameworks to provide a systematic and comprehensive model.
4. Similarly, in Chapter 8 (semi-structured interviews), I used the TDF to assess barriers and facilitators to weight loss maintenance and apply the BCW to identify strategies to promote maintenance of healthy lifestyle behaviours.
5. I drew on the BCW (and BCTs) to guide the BHL programme development process and to select the intervention components detailed in chapter 5.

6. Traditionally, behaviour change interventions are often poorly reported, hindering the reader's ability to assess or replicate interventions (Wilson et al., 2017; Wood et al., 2016). By using the TDF and BCW throughout the thesis, I was able to provide a clear rationale for the design and content of the intervention as well as potentially replicable results (Francis, O'Connor, & Curran, 2012; French et al., 2012; Phillips et al., 2015). This also kept terminology consistent, creating a more coherent description of all aspects of the research.

10.6.2 Limitations

Limitations of each study have been discussed extensively in previous chapters, particularly sampling and generalisability issues. In sum, the convenience or purposeful sampling used in each study created small sample sizes, restricting my ability to draw inferences and conclusions from the data (Liamputtong & Serry, 2013). In addition, non-probability sampling in each study increased the likelihood of sampling bias, limiting the representativeness of the samples and the generalisability of the findings (Etikan et al., 2016). In the feasibility trial, the lack of a control group limited assessment of the treatment's effect. Other issues discussed in relation to the studies included researcher bias and 'group think' (Chapter 4); non-randomisation and lack of target behaviour assessment (Chapter 6); and social desirability bias, recall bias and lack of professional translation (Chapter 8).

Despite using various strategies to improve trustworthiness (Lincoln & Guba, 1985; Padgett, 1998) as discussed in Chapter 2, these efforts were not exhaustive. While participant/user input was an important part of developing the intervention, I did not employ participant feedback/respondent validation (Kuper et al., 2008) during later stages of the research process (data analysis and writing). Doing so would have provided participants with the opportunity to review and comment on study transcripts and drafts of the relevant chapter to confirm that their perspectives were faithfully interpreted and portrayed. Given the 'opt-in' nature of the qualitative research, self-selection bias may have been an issue with the samples in Chapters 4 (focus groups) and 6 (feasibility trial). For example, students with overweight/obesity who chose to participate in the studies may have felt more strongly about weight and weight management or had more negative or extreme experiences with these issues than those who did not respond. However, as participation is voluntary, there is no point in randomising / recruiting people who are not interested in participating. Even if the intervention is shown to be effective, they would not attend if they are not interested in making changes. Recognizing the role that personal experiences or histories play in driving research participation (and response) is especially relevant, given the charged dynamics surrounding obesity as a public health issue.

Another limitation of this study is that it did not directly bring students into the intervention development process in a collaborative fashion. Future efforts should use co-production methods in order to improve the quality of research and to increase stakeholders' investment in the intervention itself. Co-production could have generated student input at the outset to eliminate difficulties establishing a suitable timeframe for the programme or to avoid any hesitancy critiquing the efficacy of the programme's content.

Finally, all three studies present geographical limitations: each took place at SEU in Riyadh. Samples with a broader geographic range (and more diverse student population) may produce results that diverge from those in this thesis.

Limitations of Theoretical Domain Framework

The TDF possesses two principal limitations: first, it mainly applies to qualitative approaches, particularly interview and focus group data, and offers little guidance on how to use the TDF with other methods (e.g., surveys or observations). Secondly, the framework was developed using an informal process rather than structured consistent process, introducing the possibility of selection bias when choosing examples from the peer-reviewed literature (Atkins et al, 2017). Nonetheless, the goal was not to obtain representative examples but to provide cases in which the TDF was applied across settings and for a variety of implementation problems (Atkins et al, 2017).

Limitation of MRC Framework

Using the MRC framework presents various research challenges, especially in relation to time and resources. The framework assumes that all interventions are as adequately funded as pharmacological and other biomedical interventions;

however, most public health interventions do not receive comparable economic support. While the framework outlines a thorough development procedure and evaluation approach, it is challenging for researchers in most countries to utilise the framework due to lack of time and resources. As a result, the framework favours research in wealthier nations, where resources for development work are more accessible. Future evidence synthesis could compare the effectiveness of studies using the MRC framework with those using other guidelines to determine whether universal application of the MRC in public health intervention development is desirable (Lakshman et al., 2014).

Limitations of BCW framework

Selecting BCTs and intervention functions with the BCW is not a simple process. That is because individual BCTS are associated with multiple intervention functions and individual intervention functions are made up of multiple BCTS, making analysis complicated and time consuming. Further, the BCW encourages a deductive qualitative analysis approach that may restrict coding to the COM-B components and TDF domains, leaving out other possible interpretations/themes (Smits et al., 2018). However, I attempted to avoid this dilemma by using thematic analysis (Braun & Clarke, 2006) for coding and then mapping the resultant themes to the TDF domains.

10.7 Policy Recommendations

The strategic plan of KSA “the 2030 Vision” aims to reduce the prevalence of obesity among citizens of KSA by 2030. Toward this end, health experts and practitioners in KSA have advocated for various strategic plans to address the country’s obesity crisis and a number health promotion policies have been adopted in recent years. These include a law requiring publication of a meal’s calories on restaurant menus, and the establishment of an excise tax of 50% on sugar sweetened beverages and carbonated drinks.

Given the high prevalence of obesity among women, there are numerous proposed programmes that specifically target women, through health education (Al-Haramlah et al., 2015), workplace physical activity programmes (Albawardi et al., 2016), and interventions focused on self-efficacy and social support (Bajamal et al., 2017). Several policies specifically targeting women and girls have been enacted in the last few years. Among these initiatives is a law allowing female fitness centres to open in Saudi Arabia and a law introducing physical activity instruction in female-only public schools.

The BHL programme appears to be a promising intervention that, if shown to be effective in a formal RCT, could be widely implemented to fight obesity among young female adults. The results from the interviews indicate that the BHL programme helped students to adopt healthier lifestyles by changing dietary and physical activity behaviours targeted by the programme. Thus, the programme may have the potential to help students lose weight and then maintain a healthier weight. Consequently, if findings are similar when the programme is implemented on a larger scale, the results should be presented to the Ministry of Education of KSA and Ministry of Health for policy development on a national scale.

Most of the recommendations below lay out potential delivery modes for disseminating the intervention functions and/or the intervention itself based on several policy categories in the BCW framework. These proposals would become relevant if a formal RCT confirms that the BHL programme is effective in inducing behaviour changes and promoting weight loss.

In addition, other proposals focus more broadly on reducing obesity in KSA and/or increasing opportunities for women and girls to access opportunities to participate in physical activities/sport. These are inspired by findings in the thesis concerning the obesogenic environment in KSA, women's role in family health decision-making and ongoing cultural barriers to female engagement in physical activity.

Communication/Marketing: Media-based information and campaigns could help to motivate healthy eating and exercise among the target population by making use of education and training or persuasion strategies in this thesis. These initiatives could include TV and radio shows, press articles and online resources.

Media-based information and campaigns could also help to expand women's and girls' opportunities to participate in sport and exercise. Even as KSA has made remarkable strides in supporting women's sports and athletics in recent years (Hashem, 2021), there are still limitations on women's opportunities to participate in physical activity. These largely stem from enduring cultural attitudes that cast physical activity as unsuitable for women and girls.

In this case, the campaign should aim to further normalize physical activity for girls and women, whilst stressing that exercise is a matter of good versus bad health (and even an issue of life and death) and given such significance, should not be limited to men and boys.

One way to address this topic would be to explore it via storylines in popular soap opera or dramas. These storylines could centre around family dynamics, female roles and the role of sport and exercise in health. Broaching this topic via these widely consumed shows could be a strategic way to start a national dialogue and shift remaining restrictive attitudes towards women's and girls' involvement in physical activity.

As for disseminating the intervention, BHL programme materials include PowerPoint slides, leaflets, self-monitoring tick sheets, and activity descriptions. These materials could be distributed to government and higher education stakeholders to implement a standardised BHL programme across universities in KSA.

Guidelines: A manual describing how to implement the BHL programme could be written and published. Copies could be provided to government and higher education stakeholders interested in implementing the programme throughout universities in KSA.

Regulation: In addition to the current tax on sweetened beverages and energy drinks, the KSA government could implement other regulations aimed at reducing the intake of unhealthy food and beverages. Two such policies are a ban on advertising unhealthy food to children, and front of package (FOP) labelling for unhealthy food items.

Currently, 16 countries have statutory regulations on unhealthy food marketing to children, including Canada (Quebec), which restricts junk-food marketing to kids under age 13, and Chile, which restricts advertising to children under age 14 for foods considered high in calories, saturated fat, sugar, and sodium. Limits on television advertising, primarily during children's programming, are most common. Schools are a popular setting for restrictions (Taillie,et al., 2019).

Another policy approach, recently adopted by Mexico, is aggressive FOP labelling to warn consumers about excess calories, sugar, sodium, saturated fats, and trans-fats. Products could also include warnings about caffeine and artificial sweeteners to caution children (Appel, 2019).

Findings from this thesis demonstrate that many individuals sustain healthy lifestyle behaviours by championing the benefits of healthy eating and encouraging others in their social circle – friends and family – to adopt a similar diet. A ban on advertising to children not only has the potential to improve children's diets but supports parental efforts to improve family eating habits. Because women are in charge of food purchasing and preparation in Saudi families, bans on marketing to children and clear, FOP labels on food items give them additional control over what food their families consume.

S*ervice provision:* The Ministry of Education and the Ministry of Health should establish a voluntary course for university students introducing nutrition and physical activity education for weight management. This will not only help students to lose weight but also adopt healthier lifestyles for the long-term.

Using the programme materials and manuals, universities in KSA should implement the BHL programme. This would similarly help with improving food related and physical activity behaviours.

School environments are also ideal for sending specific messages about girls' abilities and interests by emphasizing the benefits of physical activity. As noted, public schools in KSA are now providing physical education for girls, although it is difficult to find data on rates of student involvement and/or barriers to participation. A school-based campaign that complements the nationwide push to normalize sports and exercise for women and girls could be a beneficial supplement or alternative to physical education classes. This campaign would directly target girls with positive messages about their talents and capabilities and what they stand to gain from participating in physical activity in and out of school. This same message could be added to the BHL programme when it is introduced in universities.

Environmental/social planning: This research pointed to multiple ways in which the physical and social environment could be modified to promote healthy food related and physical activity behaviours. Focusing on the university setting, the Ministry of Education could restructure university canteens to sell healthier, appetizing food options to improve students' diets. In addition, universities could build gym facilities to help students increase their physical activity levels. These modifications are worthwhile intervention even in the absence of RCT evidence. However, if applied, it would support the BHL programme to help students to adopt healthier lifestyle.

Various modifications to the broader physical and social environment in KSA could increase women's and girls' opportunities to take part in sports and exercise. Most important, significant investment is needed to build up the infrastructure for women's sports and recreation. Already Saudi women are joining the boards of international sports federations and organisations, and in 2017, the government made Princess Reema bint Bandar president of the Saudi Federation for Community Sports (Hashem, 2021). However, on the ground, the local sports and exercise infrastructure is still underdeveloped, with fewer female sports or physical education instructors, trainers and referees, sports and fitness centres, and sports clubs.

Working within the current sex-segregation model, the Ministry of Sport, Ministry of Education and/or the Ministry of Health should fund or create incentives for the development of athletic training programmes and facilities for girls and women, within institutional contexts such as schools and universities, as well as in the wider society. Moreover, as Saudi Vision 2030's Quality of Life programmes emphasize participation in diverse sports activities, the new female-only facilities should be able to accommodate a diverse range of sports and physical activities, including team and outdoor sports, and not just free weights and exercise machines.

Many of these policy recommendations are based on the available evidence from the studies conducted for this thesis. As a result, they are preliminary: more definitive policy recommendations will be established once an RCT, with appropriate sample size, control group and outcome measures, provides additional support for the intervention. The potential RCT, if proven successful and suited to the Arabic community, could be presented to stakeholders across the Gulf and the Middle East region. Moreover, participants with chronic diseases could be included if the RCT is proven successful but under the supervision of a specialised physician from the university clinic.

10.8 Summary

This thesis involves the development and evaluation of a weight management programme (BHL) to help female university students adopt healthier lifestyles. The programme targets specific dietary and physical activity behaviours with the support of BCTs. Programme development was comprehensive and systematic and was based on the Medical Research Council (MRC) framework and the Behaviour Change Wheel (BCW) framework using data from the systematic review and the focus group discussions. Semi-structured interviews with participants who attended the feasibility trial of the BHL programme produced a promising result, namely that the programme may help change dietary and physical activity behaviours for long term weight loss maintenance.

Further evaluation of the BHL programme is necessary to provide more definitive conclusions. After updating the BHL curriculum based on insights from the feasibility trial and semi-structured interviews, a large scale RCT should be further implemented to assess its effectiveness.

References

Abbas, A. M., Fathy, S. K., Fawzy, A. T., Salem, A. S., & Shawky, M. S. (2020). The mutual effects of COVID-19 and obesity. *Obesity medicine*, 19, 100250.

Abdelaal, M., le Roux, C. W., & Docherty, N. G. (2017). Morbidity and mortality associated with obesity. *Annals of Translational Medicine*, 5(7), 161.

Abdel-Megeid, F. Y., Abdelkarem, H. M., & El-Fetouh, A. M. (2011). Unhealthy nutritional habits in university students are a risk factor for cardiovascular diseases. *Saudi Medical Journal*, 32(6), 621-627.

Abolfotouh, M. A., Al-Alwan, I. A., & Al-Rowaily, M. A. (2012). Prevalence of metabolic abnormalities and association with obesity among Saudi college students. International journal of hypertension, 2012. doi: 10.1155/2012/819726.

Abu-Moghli, F. A., Khalaf, I. A., & Barghoti, F. F. (2010). The influence of a health education programme on healthy lifestyles and practices among university students. *International Journal of Nursing Practice*, 16(1), 35-42.

Abu-Saad, K., Weitzman, S., Abu-Rabiah, Y., Abu-Shareb, H., & Fraser, D. (2001). Rapid lifestyle, diet and health changes among urban Bedouin Arabs of southern Israel.

Adam, A., Osama, S., & Muhammad, K. I. (2014). Nutrition and food consumption patterns in the Kingdom of Saudi Arabia. *Pakistan Journal of Nutrition*, 13(4), 181.

Adolfsson, B., Carlson, A., Undén, A. L., & Rössner, S. (2002). Treating obesity: A qualitative evaluation of a lifestyle intervention for weight reduction. *Health Education Journal*, *61*(3), 244-258.

Afshin, A., Sur, P. J., Fay, K. A., Cornaby, L., Ferrara, G., Salama, J. S., ... & Afarideh, M. (2019). Health effects of dietary risks in 195 countries, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, 393(10184), 1958-1972.

Agar, J. (2008). What happened in the sixties?. *The British Journal for the History of Science*, 567-600.

Ahmed, H. G., Ginawi, I. A., Elasbali, A. M., Ashankyty, I. M., & Al-Hazimi, A. M. (2014). Prevalence of obesity in Hail region, KSA: in a comprehensive survey. *Journal of obesity*, 2014. doi: 10.1155/2014/961861.

Ahern A., Boyland E., Jebb S., & Cohn S. (2013). Participants' explanatory model of being overweight and their experiences of 2 weight loss interventions. *Ann Fam Med*, 11:251-257.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179-211.

Akbaraly, T. N., Brunner, E. J., Ferrie, J. E., Marmot, M. G., Kivimaki, M., & Singh-Manoux, A. (2009). Dietary pattern and depressive symptoms in middle age. *The British Journal of Psychiatry*, 195(5), 408-413.

Alanazi, R. W., Alenzi, A. A. E., Alanazi, S. M., Alqhtani, F. M. F., Almasoud, I. M. A., ... & Alanazi, B. W. (2018). 'Coexistence of Prehypertension and Hypertension and Obesity in Young Adults in Arar, Saudi Arabia', *The Egyptian Journal of Hospital Medicine*, 70(12), pp. 2029–2034. doi: 10.12816/0045025.

Al-Asfour, A., Tlaiss, H. A., Khan, S. A., & Rajasekar, J. (2017). Saudi women's work challenges and barriers to career advancement. *Career Development International.*

Al-Baghli, N. A., Al-Ghamdi, A. J., Al-Turki, K. A., Al Elq, A. H., El-Zubaier, A. G., & Bahnassy, A. (2010). Prevalence of diabetes mellitus and impaired fasting glucose levels in the Eastern Province of Saudi Arabia: results of a screening campaign. *Singapore Medical Journal*, 51(12), 923.

Al-Faris, N. A. (2017). Nutritional evaluation of selected traditional foods commonly consumed in Saudi Arabia. *J Food Nutr Res*, 5(3), 168-175.

Albarracín, D., Gillette, J. C., Earl, A. N., Glasman, L. R., Durantini, M. R., & Ho, M. H. (2005). A test of major assumptions about behavior change: a comprehensive look at the effects of passive and active HIV-prevention interventions since the beginning of the epidemic. Psychological bulletin, 131(6), 856.

Albassam, R. S., Abdel Gawwad, E. S., & Khanam, L. (2007). Weight management practices and their relationship to knowledge, perception and health status of Saudi females attending diet clinics in Riyadh city. *J Egypt Public Health Assoc*, 82(1-2), 173-201.

Albawardi, N. M., Jradi, H., & Al-Hazzaa, H. M. (2016). Levels and correlates of physical activity, inactivity and body mass index among Saudi women working in office jobs in Riyadh city. *BMC Women's Health*, 16(1), 33.

Al-Daghri, N. M., Al-Attas, O. S., Alokail, M. S., Alkharfy, K. M., Yousef, M., Sabico, S. L., & Chrousos, G. P. (2011). Diabetes mellitus type 2 and other chronic non-communicable diseases in the central region, Saudi Arabia (Riyadh cohort 2): a decade of an epidemic. *BMC Medicine*, 9(1), 76.

Al-Eisa, E. S., & Al-Sobayel, H. I. (2012). Physical activity and health beliefs among Saudi women. *Journal of Nutrition and Metabolism.* doi: 10.1155/2012/642187

Al-Eisa, E., Al-Rushud, A., Alghadir, A., Anwer, S., Al-Harbi, B., Al-Sughaier, N., ... & Al-Muhaysin, H. A. (2016). Effect of motivation by “Instagram” on adherence to physical activity among female college students. *BioMed Research International*.

Alfadda, A. A., Al-Dhwayan, M. M., Alharbi, A. A., Al Khudhair, B. K., Al Nozha, O. M., Al-Qahtani, N. M., ... & Brożek, J. L. (2016). The Saudi clinical practice guideline for the management of overweight and obesity in adults. *Saudi Medical Journal*, 37(10), 1151.

Alfhaid, F., Alzahrani, M., Almansour, M., Alghamdi, T., Ansari, T., Sami, W., ... & Alhugail, F. S. (2017). Lifestyle of health sciences students at Majmaah University, Saudi Arabia. *Australasian Medical Journal (Online)*, 10(2), 111.

Alghamdi, A. S., Yahya, M. A., Alshammari, G. M., & Osman, M. A. (2017). Prevalence of overweight and obesity among police officers in Riyadh City and risk factors for cardiovascular disease. *Lipids in Health and Disease*, 16(1), 79.

Alghamdi, R. Q. (2017). A randomized controlled trial of a 12-week intensive lifestyle intervention program at a primary care obesity clinic for adults in western Saudi Arabia. *Saudi Medical Journal*, 38(8), 837.

Al-Ghamdi, S., Alajmi, M., Al-Gonaim, A., Al-Juhayyim, S., Al-Qasem, S., & Al-Tamimi, I. (2018). Perceptions and attitudes of primary healthcare providers in Riyadh City, Saudi Arabia, toward the promotion of physical activity. *International Journal of Health Promotion and Education*, 56(2), 105-119.

Al-Ghamdi, S., Shubair, M. M., Aldiab, A., Al-Zahrani, J. M., Aldossari, K. K., Househ, M., ... & El-Metwally, A. (2018). Prevalence of overweight and obesity based on the body mass index; a cross-sectional study in Alkharj, Saudi Arabia. *Lipids in Health and Disease*, 17(1), 134.

Alhakbany, M. A., Alzamil, H. A., Alabdullatif, W. A., Aldekhyyel, S. N., Alsuhaibani, M. N., & Al-Hazzaa, H. M. (2018). Lifestyle Habits in Relation to Overweight and Obesity among Saudi Women Attending Health Science Colleges. *Journal of Epidemiology and Global Health*, 8(1), 13-19.

Al-Hanawi, M. K., Khan, S. A., & Al-Borie, H. M. (2019). Healthcare human resource development in Saudi Arabia: emerging challenges and opportunities—a critical review. *Public Health Reviews*, 40(1), 1.

Al-Haramlah, A. A., Al-Bakr, F., & Merza, H. (2015). Common Diseases and Some Demographic Characteristics among Saudi Women. *International Education Studies*, 8(12), 94-107.

Al Hazzaa, H. M. (2004). Prevalence of physical inactivity in Saudi Arabia: a brief review. *EMHJ-Eastern Mediterranean Health Journal*, 10 (4-5), 663-670.

Al-Hazzaa, H. M. (2007). Health-enhancing physical activity among Saudi adults using the International Physical Activity Questionnaire (IPAQ). *Public health nutrition*, *10*(1), 59-64.

Al-Hazzaa, H. & Al-Rasheedi, A. (2007). Adiposity and physical activity levels among preschool children in Jeddah, Saudi Arabia. *Saudi Medical Journal*, 28(5):766–73.

Al-Hazzaa, H. M. (2018). Physical inactivity in Saudi Arabia revisited: a systematic review of inactivity prevalence and perceived barriers to active living. *International Journal of Health Sciences*, 12(6), 50.

Al-Hazzaa, H. M., Abahussain, N. A., Al-Sobayel, H. I., Qahwaji, D. M., Alsulaiman, N. A., & Musaiger, A. O. (2014). Prevalence of overweight, obesity, and abdominal obesity among urban Saudi adolescents: gender and regional variations. *Journal of Health, Population, and Nutrition*, 32(4), 634.

Al-Hazzaa, H. M., & Musaiger, A. O. (2010). Physical activity patterns and eating habits of adolescents living in major Arab cities. The Arab Teens Lifestyle Study. *Saudi Medical Journal*, 31(2), 210-211.

Alhareky, M., Bedi, S., AlMulhim, A., El Tantawi, M., Farooqi, F. A., & AlHumaid, J. (2021). Impact of Sugar Tax on Sugar-sweetened Beverage Consumption among Saudi Schoolchildren. *Oral Health & Preventive Dentistry*, 19(1), 189-194.

Alhowaish, A. K. (2013). Economic costs of diabetes in Saudi Arabia. *Journal of Family & Community Medicine*, 20(1), 1.

Alhusseini, N., & Alqahtani, A. (2020). COVID-19 pandemic's impact on eating habits in Saudi Arabia. *Journal of Public Health Research*, 9(3).

Ali, H. I., Baynouna, L. M., & Bernsen, R. M. (2010). Barriers and facilitators of weight management: perspectives of Arab women at risk for type 2 diabetes. Health & Social Care in the Community, 18(2), 219-228.

Al-Kadi, A., Malik, A. M., & Mansour, A. E. (2018). Rising incidence of obesity in Saudi residents. A threatening challenge for the surgeons. *International Journal of Health Sciences*, 12(1), 45.

Allison, K. R., Dwyer, J. J. M., Goldenberg, E., Fein, A., Yoshida, K. K., & Boutilier, M. (2005). Male Adolescents' Reasons for Participating in Physical Activity, Barriers to Participation, and Suggestions for Increasing Participation. Adolescence, 40(157), 155–170.

Allom, V., & Mullan, B. (2014). Maintaining healthy eating behaviour: Experiences and perceptions of young adults.*Nutr. Food Sci*, 44, 156–167.

Al-Mahroos F, Al-Roomi K. (1999). Overweight and obesity in the Arabian Peninsula: an overview. *The Journal of the Royal Society for the Promotion of Health*, 119(4), 251-3.

Almajwal, A. (2009). Dietetic management of obesity in Saudi Arabia: towards evidence based clinical practice guidelines. *University of Wollongong. School of Health Sciences, Faculty of Health and Behavioural Sciences*

Almalki, M., FitzGerald, G., & Clark, M. (2011). Health care system in Saudi Arabia: an overview. *EMHJ-Eastern Mediterranean Health Journal, 17 (10), 784-793, 2011*.

Al-Mohaimeed, A. A., & Elmannan, A. A. A. (2017). Experiences of barriers and motivators to weight-loss among Saudi people with overweight or obesity in Qassim Region-A qualitative study. *Open Access Macedonian Journal of Medical Sciences*, 5(7), 1028.

Al-Musharaf, S. (2020). Prevalence and Predictors of Emotional Eating among Healthy Young Saudi Women during the COVID-19 Pandemic. *Nutrients*, 12(10), 2923.

Almutairi, K. M., Alonazi, W. B., Vinluan, J. M., Almigbal, T. H., Batais, M. A., Alodhayani, A. A., ... & Alhoqail, R. I. (2018). Health promoting lifestyle of university students in Saudi Arabia: a cross-sectional assessment. *BMC public health*, *18*(1), 1093.

Al Nozha, M.M., Al Mazrou, Y.Y., Al Maatouq, M.A., Arafah, M.R., Khalil, M.Z., et al (2005). Obesity in Saudi Arabia. *Saudi Medical Journal*, 26, 824-829.

Al-Nozha M.M., Al-Hazzaa H.M., Arafah M.R., Al-Khadra A., Al-Mazrou Y.Y., Al-Maatouq M.A., et al. (2007). Prevalence of physical activity and inactivity among Saudis aged 30-70 years. A population-based cross-sectional study. *Saudi Med J*;28(4), 559–568.

Al-Nuaim, A. A., Al-Nakeeb, Y., Lyons, M., Al-Hazzaa, H. M., Nevill, A., Collins, P., & Duncan, M. J. (2012). The prevalence of physical activity and sedentary behaviours relative to obesity among adolescents from Al-Ahsa, Saudi Arabia:

rural versus urban variations. *Journal of Nutrition and Metabolism.* doi: 10.1155/2012/417589

Al-Nuaim, A. A., Bamgboye, E. A., Al-Rubeaan, K. A., & Al-Mazrou, Y. (1997). Overweight and obesity in Saudi Arabian adult population, role of sociodemographic variables. *Journal of Community Health*, 22(3), 211-223.

Al-Otaibi H. H. (2014). The pattern of fruit and vegetable consumption among Saudi university students. *Global journal of health science*, 6(2), 155–162.

Al-Otaibi, H. H., Nassef, S. L., & Raouf, T. A. (2013). Body shape dissatisfaction, weight status and physical activity among a sample university students in Saudi Arabia.

Al Othaimeen, A. I., Al Nozha, M., & Osman, A. K. (2007). Obesity: an emerging problem in Saudi Arabia. Analysis of data from the National Nutrition Survey. *EMHJ-Eastern Mediterranean Health Journal*,13(2), 441-448.

Al-Otaibi, H. H., Nassef, S. L., & Raouf, T. A. (2013). Body shape dissatisfaction, weight status and physical activity among a sample university students in Saudi Arabia. Food and Nutrition Sciences. *Scientific Research An Academic Publisher, 4(*6). doi: 10.4236/fns.2013.46079

Al-Qahtani, A. M. (2019). Prevalence and Predictors of Obesity and Overweight among Adults Visiting Primary Care Settings in the Southwestern Region, Saudi Arabia. *BioMed Research International*, 19, 8073057. doi: 10.1155/2020/3796923.

Alqahtani, A., Alsubaie, A., Alateq, A., Alsagabi, B., Aloraini, M., & Benajiba, N. (2017). Comparison of lifestyle patterns and body weight management practices between normal weight and obese female university students (Riyadh-Saudi Arabia). *Ann Nutr Metab*, 71.

Alqahtani, B. A., Alenazi, A. M., Alhowimel, A. S., & Elnaggar, R. K. (2020). The descriptive pattern of physical activity in Saudi Arabia: analysis of national survey data. *International Health, 8*, ihaa027. doi: 10.1093/inthealth/ihaa027

Alqahtani, F. M. F., Alharbi, A. H. M., Alanazi, R. W., Alenzi, A. A. E., Alanazi, S. M., Alqahtani, M. F. (2019). Comparison of health-promoting lifestyle behaviours between female students majoring in healthcare and non-healthcare fields in KSA. *Journal of Taibah University Medical Sciences*, 14(6), 508-514.

Alqahtani, M. H. (2016). Dietary habits of Saudi medical students at University of Dammam. *International Journal of Health Sciences*, 10(3), 353.

Alqarni, S.S. (2016). A review of prevalence of obesity in Saudi Arabia. *J Obes Eat Disord*, *2*(2), 1-6.

Alqarni, S. S. (2018). Prevention and management of obesity in the Kingdom of Saudi Arabia. *International Journal of Medical Science and Health Research*, 2(5).

Al Qauhiz, N.M. (2010). Obesity among Saudi Female University Students: Dietary Habits and Health Behaviors. *The Journal of the Egyptian Public Health Association*, 85(1-2), 45-59.

Alqout, O., & Reynolds, F. (2014). Experiences of obesity among Saudi Arabian women contemplating bariatric surgery: an interpretative phenomenological analysis. *Journal of Health Psychology*, 19(5), 664-677.

AlQuaiz A.M. & Tayel, S.A. (2009). Barriers to a healthy lifestyle among patients attending primary care clinics at a university hospital in Riyadh. *Ann Saudi Med*, 29(1), 30–35.

Alqubali, H. F., Albalawi, K. A., Alswat, A. E., Aljebreen, A. A., Alotaib, K. E., Aljehani, H. S., ... & Albiek, H. F. (2017). Prevalence of Type 2 Diabetes Mellitus and Hypertension in Overweight and Obese People in Riyadh City, KSA 2017. *The Egyptian Journal of Hospital Medicine*, 69(6), 2614-2617.

Al-Quwaidhi, A. J., Pearce, M. S., Critchley, J. A., Sobngwi, E., & O'Flaherty, M. (2014). Trends and future projections of the prevalence of adult obesity in Saudi Arabia, 1992-2022. *Eastern Mediterranean Health Journal*, 20(10).

Al-Raddadi, R., Bahijri, S. M., Jambi, H. A., Ferns, G., & Tuomilehto, J. (2019). The prevalence of obesity and overweight, associated demographic and lifestyle factors, and health status in the adult population of Jeddah, Saudi Arabia. *Therapeutic Advances in Chronic Disease*, 10, 2040622319878997.

Al-Rethaiaa, A. S., Fahmy, A. E. A., & Al-Shwaiyat, N. M. (2010). Obesity and eating habits among college students in Saudi Arabia: a cross sectional study. *Nutrition Journal*, 9(1), 39

Alsukait, R., Wilde, P., Bleich, S., Singh, G., & Folta, S. (2019). Impact of Saudi Arabia's Sugary Drink Tax on Prices and Purchases (P10-066-19). *Current Developments in Nutrition, 3* (Supplement_1), nzz034-P10.

Al-Saeed, W. Y., Al-Dawood, K. M., Bukhari, I. A., & Bahnassy, A. (2007). Prevalence and socioeconomic risk factors of obesity among urban female students in Al-Khobar city, Eastern Saudi Arabia, 2003. *Obesity Reviews*, 8(2), 93-99.

Al Saleem, S.A., Saeed Alahmari, R. & Saeed Alahmari, M. (2016). Dietary habits among female medical student in King Khalid University, Abha City. *Int J Med Sci Public Health*, 5(6), 1268-1274.

Al-Shahrani, A. M., & Al-Khaldi, Y. M. (2013). Obesity among diabetic and hypertensive patients in Aseer region, Saudi Arabia. *Saudi Journal of Obesity*, 1(1), 14.

Al Shehri A., Al Fattani, A., & Al Alwan, I. (2013). Obesity among Saudi children. *Saudi Journal of Obesity*, 1, 3-9.

Alwin Robert, A., Abdulaziz Al Dawish, M., Braham, R., Ali Musallam, M., Abdullah Al Hayek, A., & Hazza Al Kahtany, N. (2017). Type 2 diabetes mellitus in Saudi Arabia: major challenges and possible solutions. *Current Diabetes Reviews*, 13(1), 59-64.

Alzahrani, A. A., Al-Khaldi, Y. M., & Alsamghan, A. S. (2016). Prevalence of obesity among Saudi board residents in Aseer Region, Saudi Arabia. *Saudi Journal of Obesity*, 4(1), 13.

Alzaman, N., & Ali, A. (2016). Obesity and diabetes mellitus in the Arab world. *Journal of Taibah University Medical Sciences*, 11(4), 301-309.

Alzamil, H.A., Alhakbany, M.A., Alfadda, N.A., Almusallam, S.M., Al-Hazzaa, H.M. (2019). A Profile of Physical Activity, Sedentary Behaviors, Sleep, and

Dietary Habits of Saudi College Female Students. *Journal of Family & Community Medicine*, 26(1), 1-8.

Ames, G. E., Perri, M. G., Fox, L. D., Fallon, E. A., De Braganza, N., Murawski, M. E., ... & Hausenblas, H. A. (2005). Changing weight-loss expectations: a randomized pilot study. *Eating behaviors*, *6*(3), 259-269.

Anderson, D. A., Shapiro, J. R., & Lundgren, J. D. (2003). The freshman year of college as a critical period for weight gain: an initial evaluation. *Eating Behaviors*, 4(4), 363-367.

Andreyeva, T., Sturm, R., & Ringel, J. S. (2004). Moderate and severe obesity have large differences in health care costs. *Obesity Research*, 12(12), 1936-1943.

Apovian, C. M., & Gokce, N. (2012). Obesity and cardiovascular disease. Circulation, 125(9), 1178-1182.

Appel, D. (2019, November 5). Mexico to Require Nutritional Warnings on Front-of-Package Labeling. *Hunter College Food and Policy Center*. Retrieved from https://www.nycfoodpolicy.org/mexico-to-require-nutritional-warnings-on-front-of-package-labeling.

Arabiya Network. (2017, October 3). Restaurants in Saudi Arabia Must List Calories on Menus by end of 2018. Retrieved from: https://english.alarabiya.net/life-style/healthy-living/2017/10/03/Restaurant-menus-to-list-calories-in-Saudi-Arabia

Arabnews. (2017). Saudi Arabia to Start Granting Female Gym Licenses this Month. Retrieved from: https://www.arabnews. com/node/1052881/saudi-arabia.

Arafat, Y., & Ibrahim, M. I. M. (2018). The Use of Measurements and Health Behavioral Models to Improve Medication Adherence. In *Social and Administrative Aspects of Pharmacy in Low-and Middle-Income Countries* (pp. 53-69). Academic Press. ISBN**:** 9780128112298

Ard, J. D., Rosati, R., & Oddone, E. Z. (2000). Culturally-sensitive weight loss program produces significant reduction in weight, blood pressure, and cholesterol in eight weeks. *Journal of the National Medical Association*, 92(11), 515.

Arnett, J. J. (2007). Emerging adulthood: What is it, and what is it good for?. *Child Development Perspectives*, 1(2), 68-73.

Arzu, D., Tuzun, E. H., & Eker, L. (2006). Perceived barriers to physical activity in university students. *Journal of Sports Science & Medicine*, 5(4), 615.

Ashton, L.M., Hutchesson, M.J., Rollo, M.E., Morgan, P.J., & Collins, C.E. (2017). Motivators and Barriers to Engaging in Healthy Eating and Physical Activity: A Cross-Sectional Survey in Young Adult Men. *Am. J. Men's Health,* 11, 330–343

Ashton, L. M., Sharkey, T., Whatnall, M. C., Williams, R. L., Bezzina, A., Aguiar, E. J., ... & Hutchesson, M. J. (2019). Effectiveness of interventions and behaviour change techniques for improving dietary intake in young adults: a systematic review and meta-analysis of RCTs. *Nutrients*, 11(4), 825.

Ashton, L. M., Sharkey, T., Whatnall, M. C., Haslam, R. L., Bezzina, A., Aguiar, E. J., ... & Hutchesson, M. J. (2020). Which behaviour change techniques within interventions to prevent weight gain and/or initiate weight loss improve adiposity outcomes in young adults? A systematic review and meta-analysis of randomized controlled trials. *Obesity Reviews*, *21*(6), e13009.

Atkins, L., Francis, J., Islam, R., O'Connor, D., Patey, A., Ivers, N., ... & Lawton, R. (2017). A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems. *Implementation Science*, *12*(1), 77.

Atkins, L., & Michie, S. (2015). Designing interventions to change eating behaviours. Proceedings of the Nutrition Society, 74(2), 164-170.

Atkinson L., Olander E., & French, D. (2010). Qualitative Evaluation of the Maternal and Early Years Healthy Weight Service. [Final Report for NHS West Midlands]. Coventry: Coventry University and NHS West Midlands.

Aune, D., Giovannucci, E., Boffetta, P., Fadnes, L. T., Keum, N., Norat, T., ... & Tonstad, S. (2017). Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality—a systematic review and dose-response meta-analysis of prospective studies. *International Journal of Epidemiology*, 46(3), 1029-1056.

Avenell, A., Brown, T. J., McGee, M. A., Campbell, M. K., Grant, A. M., Broom, J., ... & Smith, W. C. S. (2004). What are the long-term benefits of weight reducing diets in adults? A systematic review of randomized controlled trials. *Journal of Human Nutrition and Dietetics*, *17*(4), 317-335.

Avenell, A., Brown, T. J., McGee, M. A., Campbell, M. K., Grant, A. M., Broom, J., ... & Smith, W. C. S. (2004). What interventions should we add to weight reducing diets in adults with obesity? A systematic review of randomized controlled trials of adding drug therapy, exercise, behaviour therapy or combinations of these interventions. *Journal of Human Nutrition and Dietetics*, *17*(4), 293-316.

Avery, L., Flynn, D., Van Wersch, A., Sniehotta, F. F., & Trenell, M. I. (2012). Changing physical activity behaviour in type 2 diabetes: a systematic review and meta-analysis of behavioural interventions. Diabetes Care, 35(12), 2681-2689.

Awadalla, N. J., Aboelyazed, A. E., Hassanein, M. A., Khalil, S. N., Aftab, R., Gaballa, I. I., & Mahfouz, A. A. (2014). Assessment of physical inactivity and perceived barriers to physical activity among health college students, south-western Saudi Arabia. *East Mediterr Health J*, *20*(10), 596-604.

Azn, S. A., & Elebiary, H. A. (2010). Prevalence of overweight and obesity in relation to life-style among Saudi Arabian female nursing students. *The Medical Journal of Cairo University*, 78(2).

Ayala, G. X., & Elder, J. P. (2011). Qualitative methods to ensure acceptability of behavioral and social interventions to the target population. *Journal of public health dentistry*, *71*, S69-S79.

Azjen, I & Fishbein, M. (1980). Understanding attitudes and predicting social behavior. *Englewood Cliffs*. N.J: Prentice-Hall

Azzeh, F. S., Bukhari, H. M., Header, E. A., Ghabashi, M. A., Al-Mashi, S. S., & Noorwali, N. M. (2017). Trends in overweight or obesity and other anthropometric indices in adults aged 18–60 years in western Saudi Arabia. *Annals of Saudi Medicine,* 37(2), 106-113.

Babbie, E. R. (2010). Quantitative methods. *The Practice Of Social Research. 12th Ed. Belmont, Ca*. Oxford University Press.

Bacon, L., Keim, N.L., Loan, M.D.V., Derricote, M., Gale, B., Kazaks, A., Stern, J. (2002). Evaluating a 'non-diet' wellness intervention for improvement of metabolic fitness, psychological well-being and eating and activity behaviors. International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity. 26. 854-65.

Badran M., & Laher I. (2011). Obesity in Arabic-speaking countries. *Journal of Obesity*. doi: 10.1155/2011/686430

Bai, Y., Lin, C.-C., Lin, C.-Y., Chen, J.-Y., Chue, C.-M., & Chou, P. (2004). Survey of stress reactions among health care workers involved with the SARS outbreak. Psychiatric Services, 55(9), 1055-1057.

Bajamal, E., Robbins, L. B., Ling, J., Smith, B., Pfeiffer, K. A., & Sharma, D. (2017). Physical activity among female adolescents in Jeddah, Saudi Arabia: A health promotion model-based path analysis. *Nursing Research,* 66(6), 473-482.

Bakhotmah, B. A. (2012). Nutritional knowledge and desire to change of food preferences among Saudi women in Jeddah, Saudi Arabia. *Ecology of Food and Nutrition*, 51(4), 313-328.

Bakhsh, M., & Khawandanah, J., Naaman, R., & Alashmali, S. (2020). The Impact of COVID-19 quarantine on dietary habits and physical activity in Saudi Arabia: a cross-sectional study. 10.21203/rs.3.rs-104354/v1.

Balhareth, A., Meertens, R., Kremers, S., & Sleddens, E. (2019). Overweight and obesity among adults in the G ulf S tates: A systematic literature review of correlates of weight, weight-related behaviours, and interventions. *Obesity Reviews*, 20(5), 763-793.

Bandura, A. (1999). A social cognitive theory of personality. In L. Pervin & O. John Hnadbook of personality. New York, Guildford Publications: 154-196. *Psychological review,* 106(4), 676.

Barnes, A. S., Goodrick, G. K., Pavlik, V., Markesino, J., Laws, D. Y., & Taylor, W. C. (2007). Weight loss maintenance in African–American women: Focus group results and questionnaire development. *Journal of General Internal Medicine*, *22*(7), 915-922.

Barnes, A. S., & Kimbro, R. T. (2012). Descriptive study of educated African American women successful at weight-loss maintenance through lifestyle changes. *Journal of General Internal Medicine*, *27*(10), 1272-1279.

Barroso, C. S., Peters, R. J., Johnson, R. J., Kelder, S. H., & Jefferson, T. (2010). Beliefs and perceived norms concerning body image among African-American and Latino teenagers. *Journal of Health Psychology*, 15(6), 858-870.

Bartholomew Eldredge, L. K., Markham, C. M., Ruiter, R. A., Fernández, M. E., Kok, G., & Parcel, G. S. (2016). Planning health promotion programs: an intervention mapping approach.

Basu, A. (2020). Estimating The Infection Fatality Rate Among Symptomatic COVID-19 Cases In The United States: Study estimates the COVID-19 infection fatality rate at the US county level. *Health Affairs*, 10.

Baxter, A., & Britton, C. (2001). Risk, identity and change: Becoming a mature student. *International Studies in Sociology of Education*, 11(1), 87-104.

Beeken, R. J., Croker, H., Heinrich, M., Smith, L., Williams, K., Hackshaw, A., ... & Roylance, R. (2016). Study protocol for a randomised controlled trial of brief, habit-based, lifestyle advice for cancer survivors: exploring behavioural outcomes for the Advancing Survivorship Cancer Outcomes Trial (ASCOT). *BMJ open*, *6*(11).

Belogianni, K., & Baldwin, C. (2019). Types of Interventions Targeting Dietary, Physical Activity, and Weight-Related Outcomes among University Students: A Systematic Review of Systematic Reviews. *Advances in Nutrition*, 10(5), 848-863.

Benajiba, N., & Mahboub, S.M. 2019. Consumption of Sugar-Sweetened Soft Drinks Among Saudi Adults: Assessing Patterns and Identifying Influencing Factors Using Principal Component Analysis. *Pakistan Journal of Nutrition*, 18: 401-407.

Benjamin, K., & Donnelly, T. T. (2013). Barriers and facilitators influencing the physical activity of Arabic adults: A literature review. *Avicenna*, *2013*(1), 8.

Bertz, F., Sparud-Lundin, C., & Winkvist, A. (2015). Transformative Lifestyle Change: key to sustainable weight loss among women in a post-partum diet and exercise intervention. *Maternal & Child Nutrition*, *11*(4), 631-645.

Bessesen, D. H., & Van Gaal, L. F. (2018). Progress and challenges in anti-obesity pharmacotherapy. *The Lancet Diabetes & Endocrinology*, *6*(3), 237-248.Bidgood, J., & Buckroyd, J. (2005). An exploration of obese adults' experience of attempting to lose weight and to maintain a reduced weight. *Counselling and Psychotherapy Research*, *5*(3), 221-229.

Bingham D., Parnell D., Curran K., Jones R., & Richardson D. (2014). Fit Fans: perspectives of a practitioner and understanding participant health needs within a health promotion programme for older men delivered within an English Premier League Football Club. *Soccer Soc*, 15, 883-901.

Bird, E. L., Baker, G., Mutrie, N., Ogilvie, D., Sahlqvist, S., & Powell, J. (2013). Behaviour change techniques used to promote walking and cycling: A systematic review. *Health Psychology*, 32(8), 829.

Blendon, R. J., Benson, J. M., DesRoches, C. M., Raleigh, E., & Taylor-Clark, K. (2004). The public's response to severe acute respiratory syndrome in Toronto and the United States. Clinical infectious diseases, 38(7), 925-931.

Boeka, A. G., Prentice-Dunn, S., & Lokken, K. L. (2010). Psychosocial predictors of intentions to comply with bariatric surgery guidelines. *Psychology, Health & Medicine*, 15(2), 188-197.

Bornstein, M. H., Jager, J., & Putnick, D. L. (2013). Sampling in developmental science: Situations, shortcomings, solutions, and standards. *Developmental Review*, *33*(4), 357-370.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77-101.

Braunack-Mayer, A., Tooher, R., Collins, J. E., Street, J. M., & Marshall, H. (2013). Understanding the school community's response to school closures during the H1N1 2009 influenza pandemic. *BMC public health*, 13(1), 344.

Brislin, R. W. (1970). Back-translation for cross-cultural research. *Journal of Cross-cultural Psychology*, 1(3), 185-216.

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The lancet*, *395*(10227), 912-920.

Brown, T., Kelly, S., & Summerbell, C. (2007). Prevention of obesity: a review of interventions. *Obesity Reviews*, 8, 127-130.

Bruin, Marijn & McCambridge, Jim & Prins, Maria. (2014). Reducing the risk of bias in health behaviour change trials: Improving trial design, reporting or bias assessment criteria? A review and case study. *Psychology & health*. 30. 1-43.

Buchwald, H., Avidor, Y., Braunwald, E., Jensen, M. D., Pories, W., Fahrbach, K., & Schoelles, K. (2004). Bariatric surgery: a systematic review and meta-analysis. *Jama*, 292(14), 1724-1737.

Bull, E. R., McCleary, N., Li, X., Dombrowski, S. U., Dusseldorp, E., & Johnston, M. (2018). Interventions to promote healthy eating, physical activity and smoking in low-income groups: a systematic review with meta-analysis of behavior change techniques and delivery/context. *International journal of behavioral medicine*, *25*(6), 605-616.

Burgess, E., Hassmén, P., Welvaert, M., & Pumpa, K. L. (2017). Behavioural treatment strategies improve adherence to lifestyle intervention programmes in adults with obesity: a systematic review and meta-analysis. *Clinical Obesity*, 7(2), 105-114.

Burke, J. D., Reilly, R. A., Morrell, J. S., & Lofgren, I. E. (2009). The University of New Hampshire's young adult health risk screening initiative. *Journal of the American Dietetic Association*, 109(10), 1751-1758.

Burke, L. E., Swigart, V., Warziski Turk, M., Derro, N., & Ewing, L. J. (2009). Experiences of self-monitoring: successes and struggles during treatment for weight loss. *Qualitative Health Research*, 19(6), 815-828.

Butland, B., Jebb, S., Kopelman, P., et al. (2007) Foresight. Tackling obesities: Future choices—Project report. Government Office for Science, London, 1-161.

Butler, S. M., Black, D. R., Blue, C. L., & Gretebeck, R. J. (2004). Change in diet, physical activity, and body weight in female college freshman. *American journal of health behavior*, *28*(1), 24-32.

Caleo, G., Duncombe, J., Jephcott, F., Lokuge, K., Mills, C., Looijen, E.,.. Squire, J. (2018). The factors affecting household transmission dynamics and community compliance with Ebola control measures: a mixed-methods study in a rural village in Sierra Leone. *BMC public health*, 18(1), 248.

Campbell, M., Fitzpatrick, R., Haines, A., Kinmonth, A.L., Sandercock, P., Spiegelhalter, D., & Tyrer, P. (2000). Framework for design and evaluation of complex interventions to improve health. *Bmj*, 321(7262), 694-696.

Campbell, N.C., Murray, E., Darbyshire, J., Emery, J., Farmer, A., Griffiths, F., Guthrie, B., Lester, H., Wilson, P., & Kinmonth, A.L. (2007). Designing and evaluating complex interventions to improve health care. *Bmj*, 334(7591), 455-459.

Cane, J., O'Connor, D., & Michie, S. (2012). Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implementation Science*, 7(1), 37.

Carroll, N., Sadowski, A., Laila, A., Hruska, V., Nixon, M., Ma, D. W., & Haines, J. (2020). The impact of COVID-19 on health behavior, stress, financial and food security among middle to high income Canadian families with young children. *Nutrients*, 12(8), 2352.

Case, M. A., Burwick, H. A., Volpp, K. G., & Patel, M. S. (2015). Accuracy of smartphone applications and wearable devices for tracking physical activity data. *Jama*, *313*(6), 625-626.

Cauce, A. M., Coronado, N., & Watson, J. (1998). Conceptual and methdological issues in conducting culturally competent research. M., Hernandez, R. Isaacs, (Ed.), *Promoting cultural competence in children's mental health services*. N. J: Brookes.

Cava, M. A., Fay, K. E., Beanlands, H. J., McCay, E. A., & Wignall, R. (2005). The experience of quarantine for individuals affected by SARS in Toronto. *Public Health Nursing*, 22(5), 398-406.

Celis-Morales, C., Lara, J., & Mathers, J. C. (2015). Personalising nutritional guidance for more effective behaviour change. *Proceedings of the Nutrition Society*, 74(2), 130-138.

Central Intelligence Agency (CIA). (2017). The World Fact Book. Explore All Countries - Saudi Arabia, Middle East. Retrieved from https://www.cia.gov/the-world-factbook/countries/saudi-arabia/

Champion, V. L., & Skinner, C. S. (2008). The health belief model. *Health behavior and health education: Theory, research, and practice*, *4*, 45-65.

Chan, C. B., Ryan, D. A., & Tudor-Locke, C. (2004). Health benefits of a pedometer-based physical activity intervention in sedentary workers. *Preventive medicine*, *39*(6), 1215-1222.

Chang, M-W, Brown, R, & Nitzke, S. (2017). Results and lessons learned from a prevention of weight gain program for low-income overweight and obese young mothers: Mothers In Motion. *BMC Public Health*, 17(1), 182.

Chao, A. M., Jastreboff, A. M., White, M. A., Grilo, C. M., & Sinha, R. (2017). Stress, cortisol, and other appetite-related hormones: Prospective prediction of 6-month changes in food cravings and weight. Obesity (Silver Spring, Md.), 25(4), 713–720. https://doi.org/10.1002/oby.21790

Chatzi, L., Melaki, V., Sarri, K., Apostolaki, I., Roumeliotaki, T., Georgiou, V., ... Kogevinas, M. (2011). Dietary patterns during pregnancy and the risk of postpartum depression: the mother–child ‘Rhea’cohort in Crete, Greece. *Public health nutrition*, 14(9), 1663-1670.

Chenoweth, D., & Leutzinger, J. (2006). The economic cost of physical inactivity and excess weight in American adults. *Journal of Physical Activity and Health*, 3(2), 148-163.

Choguill, C. L. (2008). Developing sustainable neighbourhoods. *Habitat international*, 32(1), 41-48.

Clarke, V., & Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. *The psychologist*, *26*(2).

Cluskey, M., & Grobe, D. (2009). College weight gain and behaviour transitions: male and female differences. *Journal of the American Dietetic Association*, 109(2), 325-9.

Cohen, A. K., Rai, M., Rehkopf, D. H., & Abrams, B. (2013). Educational attainment and obesity: a systematic review. *Obesity Reviews*, 14(12), 989-1005.

Connelly, L. M. (2008). Pilot studies. *Medsurg Nursing*, 17(6), 411-2.

Coupe, N., Peters, S., Rhodes, S., & Cotterill, S. (2019). The effect of commitment-making on weight loss and behaviour change in adults with obesity/overweight; a systematic review. *BMC public health*, *19*(1), 816.

Cowdell, F., & Dyson, J. (2019). How is the theoretical domains framework applied to developing health behaviour interventions? A systematic search and narrative synthesis. BMC public health, 19(1), 1180.

Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M, Mitchie S, Nazareth I, Petticrew M (2008). Developing and evaluating complex interventions: the new medical research council guidance. *British Medical Journal*, 337, a1655.

Crombie, A. P., Ilich, J. Z., Dutton, G. R., Panton, L. B., & Abood, D. A. (2009). The freshman weight gain phenomenon revisited. *Nutrition Reviews*, *67*(2), 83-94.

Crombie, A.P., Liu, P.Y., M.J. Ormsbee, & Ilich, J.Z. (2012). Weight and body-composition change during the college freshman year in male general-population students and army Reserve Officer Training Corps (ROTC) cadets. *Int. J. Sport Nutr. Exercise Metab*, 22, 412-421.

Croot, L., O'Cathain, A., Sworn, K., Yardley, L., Turner, K., Duncan, E., & Hoddinott, P. (2019). Developing interventions to improve health: a systematic mapping review of international practice between 2015 and 2016. *Pilot and Feasibility Studies*, 5(1), 1-13.

Crowther, D., & Lancaster, G. (2008). Research Methods. *A concise Introduction to research in management and business consultancy*, 87-92.

Curioni, C. C., & Lourenco, P. M. (2005). Long-term weight loss after diet and exercise: a systematic review. *International Journal of Obesity*, *29*(10), 1168-1174.

Dallman, M. F., Pecoraro, N. C., & la Fleur, S. E. (2005). Chronic stress and comfort foods: self-medication and abdominal obesity. Brain, behavior, and immunity, 19(4), 275-280.

Danaei, G., Ding, E. L., Mozaffarian, D., Taylor, B., Rehm, J., Murray, C. J., & Ezzati, M. (2009). The preventable causes of death in the United States: comparative risk assessment of dietary, lifestyle, and metabolic risk factors. PLoS medicine, 6(4), e1000058.

Daniel, W. W., & Cross, C. L. (2010). *Biostatistics: basic concepts and methodology for the health sciences* (pp. 410-412). New York: John Wiley & Sons. ISBN: 978-1-118-65291-6

Daniels, M. C., & Popkin, B. M. (2010). Impact of water intake on energy intake and weight status: a systematic review. Nutrition reviews, 68(9), 505–521.

Dansinger, M. L., Gleason, J. A., Griffith, J. L., Selker, H. P., & Schaefer, E. J. (2005). Comparison of the Atkins, Ornish, Weight Watchers, and Zone diets for weight loss and heart disease risk reduction: a randomized trial. *Jama*, 293(1), 43-53.

Daskapan, A., & Tüzün, E., & Eker, L. (2006). Perceived Barriers to Physical Activity in University Students. Journal of sports science & medicine. 5. 615-20.

Davis, R., Campbell, R., Hildon, Z., Hobbs, L., & Michie, S. (2015). Theories of behaviour and behaviour change across the social and behavioural sciences: a scoping review. *Health psychology review,* 9(3), 323-344.

Deakin, H., & Wakefield, K. (2014). Skype interviewing: Reflections of two PhD researchers. *Qualitative Research*, 14(5), 603-616.

Dee, A., Kearns, K., O'Neill, C., Sharp, L., Staines, A., O'Dwyer, V., ... & Perry, I. J. (2014). The direct and indirect costs of both overweight and obesity: a systematic review. *BMC Research Notes*, 7(1), 242.

Deforche, B., Van Dyck, D., Deliens, T., & De Bourdeaudhuij, I. (2015). Changes in weight, physical activity, sedentary behaviour and dietary intake during the transition to higher education: a prospective study. *International Journal of Behavioral Nutrition and Physical Activity,* 12(1), 16.

DeJonckheere, M., & Vaughn, L. M. (2019). Semistructured interviewing in primary care research: a balance of relationship and rigour. *Family Medicine and Community Health*, *7*(2).

De Nicola, E., Aburizaiza, O. S., Siddique, A., Khwaja, H., & Carpenter, D. O. (2015). Obesity and public health in the Kingdom of Saudi Arabia. *Reviews on Environmental Health*, 30(3), 191-205.

Denscombe, M. (2014). *The good research guide: for small-scale social research projects*. McGraw-Hill Education (UK)*, 6.* ISBN: 0335226868

Denzin, N. K., Lincoln, Y. S., & Giardina, M. D. (2006). Disciplining qualitative research. *International journal of qualitative studies in education*, *19*(6), 769-782.

Desclaux, A., Badji, D., Ndione, A. G., & Sow, K. (2017). Accepted monitoring or endured quarantine? Ebola contacts' perceptions in Senegal. *Social Science & Medicine*, 178, 38-45.

De Ridder, D., Kroese, F., Evers, C., Adriaanse, M., & Gillebaart, M. (2017). Healthy diet: Health impact, prevalence, correlates, and interventions. *Psychology & Health*, 32(8), 907-941.

Devaux, M., Sassi, F., Church, J., Cecchini, M., & Borgonovi, F. (2011). Exploring the relationship between education and obesity. *OECD Journal*: *Economic Studies*, 1, 1-40.

De Vet, E., De Nooijer, J., De Vries, N. K., & Brug, J. (2005). Stages of change in fruit intake: A longitudinal examination of stability, stage transitions and transition profiles. *Psychology & Health*, *20*(4), 415-428.

DiGiovanni, C., Conley, J., Chiu, D., & Zaborski, J. (2004). Factors influencing compliance with quarantine in Toronto during the 2003 SARS outbreak. Biosecurity and bioterrorism: biodefense strategy, practice, and science, 2(4), 265-272.

Dixon, J. B. (2010). The effect of obesity on health outcomes. *Molecular and Cellular Endocrinology*, 316(2), 104-108.

Di Renzo, L., Gualtieri, P., Pivari, F., Soldati, L., Attinà, A., Cinelli, G., ... & Esposito, E. (2020). Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. *Journal of Translational Medicine*, 18(1), 1-15.

Dobbs, R., Sawers, C., Thompson, F., Manyika, J., Woetzel, J., Child, P., ... & Spatharou, A. (2014). Overcoming obesity: an initial economic analysis. McKinsey Global Institute. *AIMS Agriculture and Food*, *4*(3), 731-755.

Dombrowski, S. U., Sniehotta, F. F., Avenell, A., Johnston, M., MacLennan, G., & Araújo-Soares, V. (2012). Identifying active ingredients in complex behavioural interventions for obese adults with obesity-related co-morbidities or additional risk factors for co-morbidities: a systematic review. *Health Psychology Review*, 6(1), 7-32.

Dombrowski, S. U., Knittle, K., Avenell, A., Araujo-Soares, V., & Sniehotta, F. F. (2014). Long term maintenance of weight loss with non-surgical interventions in obese adults: systematic review and meta-analyses of randomised controlled trials. *BMJ*, *348*, g2646.

Donnelly, T.T., Al Suwaidi, J,. Al Bulushi, A., Al Enazi, N., Yassin, K., Rehman, A.M., Hassan, A.A., Idris, Z. (2011). The influence of cultural and social factors on healthy lifestyle of Arabic women. Avicenna. 2011 Dec 243.

Douketis, J. D., Macie, C., Thabane, L., & Williamson, D. F. (2005). Systematic review of long-term weight loss studies in obese adults: clinical significance and applicability to clinical practice. *International journal of obesity*, *29*(10), 1153-1167.

Drew, C. J., Hardman, M. L., & Hosp, J. L. (2008). *Designing and conducting research in education*. Sage Publications. Retrieved from https://dx.doi.org/10.4135/9781483385648

Duncan, E. M., Francis, J. J., Johnston, M., Davey, P., Maxwell, S., McKay, G. A., ... & Bond, C. (2012). Learning curves, taking instructions, and patient safety: using a theoretical domains framework in an interview study to investigate prescribing errors among trainee doctors. *Implementation Science*, 7(1), 86.

Dyer, R. G. (1994). 8 Traditional treatment of obesity: does it work?. *Bailliere's Clinical Endocrinology and Metabolism*, 8(3), 661-688.

Dyson, J., Lawton, R., Jackson, C., & Cheater, F. (2013). Development of a theory-based instrument to identify barriers and levers to best hand hygiene practice among healthcare practitioners. *Implementation Science*, 8(1), 1-9.

Ebong, I. A., Goff Jr, D. C., Rodriguez, C. J., Chen, H., & Bertoni, A. G. (2014). Mechanisms of heart failure in obesity. Obesity research & clinical practice, 8(6), e540-e548.

Economos, C. D., Hildebrandt, M. L., & Hyatt, R. R. (2008). College freshman stress and weight change: differences by gender. *American Journal of Health Behavior*, 32(1), 16-25.

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. Increase in studies of publication bias coincided with increasing use of meta-analysis. *British Medical Journal*, *316*, 629-634.

Elbadawi, A. S., Altemani, A. H., Alhawiti, I. S., & Altuwaylie, M. M. (2015). Prevalence and risk factors of obesity among male primary school students in Tabuk, Saudi Arabia. *Basic Research Journal of Medicine and Clinical Sciences*, 4(12), 262-266.

Eldridge, S. M., Lancaster, G. A., Campbell, M. J., Thabane, L., Hopewell, S., Coleman, C. L., & Bond, C. M. (2016). Defining feasibility and pilot studies in preparation for randomised controlled trials: development of a conceptual framework. *PloS one*, *11*(3), e0150205.

Elfhag, K., & Rössner, S. (2005). Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. *Obesity reviews*, *6*(1), 67-85.

Elfil, M., & Negida, A. (2017). Sampling methods in Clinical Research; an Educational Review. Emergency (Tehran, Iran), 5(1), e52.

Elkum, N., Al-Tweigeri, T., Ajarim, D., Al-Zahrani, A., Amer, S. M. B., & Aboussekhra, A. (2014). Obesity is a significant risk factor for breast cancer in Arab women. *BMC Cancer*, 14(1), 788.

Elliott, J. O., Seals, B. F., & Jacobson, M. P. (2007). Use of the Precaution Adoption Process Model to examine predictors of osteoprotective behavior in epilepsy. *Seizure*, *16*(5), 424-437.

Elsoadaa, S. S., Abdelhafez, A. M., Rabeh, N. M., Zahran, S. E., & Osfor, M. M. (2013). Consumption of fruits and vegetables among UmmAl-Qura University students in Makkah, Saudi Arabia: a cross-section study. *Life Science Journal*, *4*, 10.

Elsoadaa, S.S. (2013). Overweight and obesity among Saudi female population. *Journal of American Science*, 9(12).

Emerging Risk Factors Collaboration. (2011). Separate and combined associations of body-mass index and abdominal adiposity with cardiovascular disease: collaborative analysis of 58 prospective studies. *The Lancet*, 377(9771), 1085-95.

European Association for the Study of Obesity (EASO). (2020). Obesity Statistics. Retrieved from https://easo.org/media-portal/statistics. World Health Organisation (Fact sheet N°311)

European Centre for Disease Prevention and Control (ECDC). (2020). Coronvirus Disease. An Agency of the European Union. Retrieved 25 March, 2021, from https://www.ecdc.europa.eu/en.

Evenson, K. R., & Furberg, R. D. (2017). Moves app: a digital diary to track physical activity and location. *British journal of sports medicine*, *51*(15), 1169-1170.

El Bcheraoui, C., Basulaiman, M., Wilson, S., Daoud, F., Tuffaha, M., AlMazroa, M. A., ... & Mokdad, A. H. (2015). Breast cancer screening in Saudi Arabia: free but almost no takers. *Plos One*, 10(3).

El Bcheraoui, C., Tuffaha, M., Daoud, F., Kravitz, H., Al Mazroa, M. A., Al Saeedi, M., ... & Mokdad, A. H. (2016). On your mark, get set, go: levels of physical activity in the Kingdom of Saudi Arabia, 2013. *Journal of Physical Activity and Health*, 13(2), 231-238.

El Nashar, D. E., Alananbeh, K. M., & Al Hassan, N. (2017). Genetic, dietary, and non-dietary risk factors of obesity among preparatory-year female students at Taibah University, Saudi Arabia. *Journal of Taibah University for Science*, 11(3), 408-421.

El-Qudah, J.M., Al-Omran, H., Abu-Alsoud, B., & Yousef, T.O.A.S. (2012). Nutritional status among a sample of Saudi college students. *Current Research Journal of Biological Sciences*, 4(5), 557-62.

Epton, T., Harris, P. R., Kane, R., Van Koningsbruggen, G. M., & Sheeran, P. (2015). The impact of self-affirmation on health-behavior change: A meta-analysis. *Health Psychology*, 34(3), 187–196.

Esposito, N. (2001). From meaning to meaning: The influence of translation techniques on non-English focus group research. *Qualitative Health Research*, 11(4), 568-579.

Esterberg, K.G. (2002). Qualitative methods in social research (No. 300.18 E8).

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4.

Fielding, N. G., Lee, R. M., & Blank, G. (Eds.). (2008). *The SAGE handbook of online research methods*. Sage. ISBN 1412922933

Fanzo, J., & Davis, C. (2019). Can Diets Be Healthy, Sustainable, and Equitable?. *Current Obesity Reports*, 8(4), 495-503.

Fatani, H. H., Mira, S. A., & El-Zubier, A. G. (1987). Prevalence of diabetes mellitus in rural Saudi Arabia. *Diabetes Care*, 10(2), 180-183.

Fedewa M.V., Das, B.M., Evans, E.M., & Dishman, R.K. (2014). Change in weight and adiposity in college students: a systematic review and meta-analysis. *American Journal of Preventive Medicine*, 47(5), 641-52.

Field, A. E., Coakley, E. H., Must, A., Spadano, J. L., Laird, N., Dietz, W. H., ... & Colditz, G. A. (2001). Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of Internal Medicine*, 161(13), 1581-1586.

Finkelstein, E. A., Trogdon, J. G., Cohen, J. W., & Dietz, W. (2009). Annual Medical Spending Attributable To Obesity: Payer-And Service-Specific Estimates: Amid calls for health reform, real cost savings are more likely to be achieved through reducing obesity and related risk factors. *Health Affairs*, 28(Suppl1), w822-w831.

Fishbein, M., & Ajzen, I. (1977). Belief, attitude, intention, and behavior: An introduction to theory and research. Reading, MA: Addison-Wesley Retrieved from https://people.umass.edu/aizen/f&a1975.html

Fogel, S., Young, L., & McPherson, J. B. (2009). The experience of group weight loss efforts among lesbians. *Women & Health*, *49*(6-7), 540-554.

Francis, J. J., O'Connor, D., & Curran, J. (2012). Theories of behaviour change synthesised into a set of theoretical groupings: introducing a thematic series on the theoretical domains framework. *Implementation Science*, 7(1), 35.

Frank, S. M., Webster, J., McKenzie, B., Geldsetzer, P., Manne-Goehler, J., Andall-Brereton, G., ... & McClure, R. W. (2019). Consumption of fruits and vegetables among individuals 15 years and older in 28 low-and middle-income countries. *The Journal of Nutrition*, 149(7), 1252-1259.

Frederick, C.B., Snellman, K., & Putnam, R.D. (2014). Increasing socioeconomic disparities in adolescent obesity. *Proceedings of the National Academy of Sciences*, 111(4), 1338-42.

Freedson, P., Bowles, H. R., Troiano, R., & Haskell, W. (2012). Assessment of physical activity using wearable monitors: recommendations for monitor calibration and use in the field. Medicine and Science in Sports and Exercise, 44(1 Suppl 1), S1.

French, S. D., Green, S. E., O'Connor, D. A., McKenzie, J. E., Francis, J. J., Michie, S., ... & Grimshaw, J. M. (2012). Developing theory-informed behaviour change interventions to implement evidence into practice: a systematic approach using the Theoretical Domains Framework. *Implementation Science*, 7(1), 1-8.

Furness P., McSeveny K., Arden M., Garland C., Dearden A., & Soltani H. (2011). Maternal obesity support services: a qualitative study of the perspectives of women and midwives. *BMC Pregnancy Childbirth*, 11, 69.

Gainforth, H. L., West, R., & Michie, S. (2015). Assessing connections between behavior change theories using network analysis. *Annals of Behavioral Medicine*, 49(5), 754-761.

Garawi, F., Ploubidis, G. B., Devries, K., Al-Hamdan, N., & Uauy, R. (2015). Do routinely measured risk factors for obesity explain the sex gap in its prevalence? Observations from Saudi Arabia. *BMC Public Health*, 15, 254.

Garip, G., & Yardley, L. (2011). A synthesis of qualitative research on overweight and obese people's views and experiences of weight management. *Clinical Obesity*, *1*(2-3), 110-126.

Gates, D. M., Succop, P., Brehm, B. J., Gillespie, G. L., & Sommers, B. D. (2008). Obesity and presenteeism: the impact of body mass index on workplace productivity. *Journal of Occupational and Environmental Medicine*, 50(1), 39-45.

GBD 2015 Obesity Collaborators. (2017). Health effects of and obesity in 195 countries over 25 years. *New England Journal of Medicine*, 377(1), 13-27

Glanz, K. (1997). *Theory at a glance: A guide for health promotion practice* (No. 97). US Department of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute. Retrieved from https://sbccimplementationkits.org/demandrmnch/ikitresources/theory-at-a-glance-a-guide-for-health-promotion-practice-second-edition/

Glanz, K. (2008). Health behavior and health education: Theory, research, and practice. (4th ed.). San Francisco: Jossey-Bass. (second ed.): Prentice-Hall, Inc.

Glanz, K., & Bishop, D.B. (2010). The role of behavioral science theory in development and implementation of public health interventions. *Annual review of public health*, 31, 399-418.

Glanz, K. (2010). Social and behavioral theories. Behavioural & Social Science Research, e-Source. Retrieved from https://obssr.od.nih.gov/wp-content/uploads/2016/05/Social-and-Behavioral-Theories.pdf

Gill, B., Hayes, S., & Senior, C. (2015). The effects of family support and gender on mature student engagement in higher education. *Frontiers in Psychology*, 6, 156.

Gillen, M. M., & Lefkowitz, E. S. (2011). The 'freshman 15': trends and predictors in a sample of multiethnic men and women. *Eating Behaviors*, 12(4), 261-266.

Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *American Journal of Public Health*, 89(9), 1322-1327.

Gómez-López, M., Gallegos, A. G., & Extremera, A. B. (2010). Perceived barriers by university students in the practice of physical activities. *Journal of Sports Science & Medicine*, 9(3), 374.

Gordon-Larsen, P., Adair, L.S., Nelson, M.C., Popkin, B.M. (2004). Five-year obesity incidence in the transition period between adolescence and adulthood: the National Longitudinal Study of Adolescent Health. *The American Journal of Clinical Nutrition*, 80(3), 569-75.

Gordon, N. (1998). Critical reflection on the dynamics and processes of qualitative research interviews. Nurse Researcher (through 2013), 5(2), 72.

Gray C., Hunt K., Mutrie N., Anderson A., Leishman J., & Dalgarno L. (2013). Football Fans in Training: the development and optimization of an intervention delivered through professional sports clubs to help men lose weight; become more active and adopt healthier eating habits. *BMC Public Health*, 13, 232.

Green, L. W., & Kreuter, M. W. (2005). Health Program Planning: An Educational and Ecological Approach. (4th ed.) New York: McGraw-Hill

Green, M., & Piel, J. A. (2009). Theories of human development: A comparative approach. *Psychology Press* Routledge Taylor & Francis Group. ISBN 9780205665686

Green S, Higgins J.P, Alderson P, Clarke M, Mulrow C.D, Oxman A.D. (2008). *Cochrane handbook for systematic reviews of interventions*. John Wiley & Sons Chichester, UK.

Gropper, S.S., Simmons, K.P., Connell, L.J., & Ulrich, P.V. (2012). Changes in body weight, composition, and shape: a 4-year study of college students. *Applied Physiology, Nutrition, and Metabolism*, 37(6), 1118-23.

Gropper, S. S., Simmons, K. P., Gaines, A., Drawdy, K., Saunders, D., Ulrich, P., & Connell, L. J. (2009). The freshman 15—a closer look. *Journal of American College Health*, 58(3), 223-231.

Gunes, F. E., Bekiroglu, N., Imeryuz, N., & Agirbasli, M. (2012). Relation between eating habits and a high body mass index among freshman students: a cross-sectional study. *Journal of the American College of Nutrition*, 31(3), 167-174.

Gall, T. L., Evans, D. R., & Bellerose, S. (2000). Transition to first-year university: Patterns of change in adjustment across life domains and time. *Journal of Social and Clinical Psychology,* 19(4), 544-567.

Gardner, C. D., Trepanowski, J. F., Del Gobbo, L. C., Hauser, M. E., Rigdon, J., Ioannidis, J. P., ... & King, A. C. (2018). Effect of low-fat vs low-carbohydrate diet on 12-month weight loss in overweight adults and the association with genotype pattern or insulin secretion: the DIETFITS randomized clinical trial. *Jama*, *319*(7), 667-679.

Gary T.L., Gross, S.M., Browne, D.C., & LaVeist, T.A. (2006). The College Health and Wellness Study: baseline correlates of overweight among African Americans. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*. 83(2), 253-65.

Gibson, A. A., & Sainsbury, A. (2017). Strategies to improve adherence to dietary weight loss interventions in research and real-world settings. *Behavioral Sciences*, *7*(3), 44.

Goethals, L., Barth, N., Guyot, J., Hupin, D., Celarier, T., & Bongue, B. (2020). Impact of Home Quarantine on Physical Activity Among Older Adults Living at Home During the COVID-19 Pandemic: Qualitative Interview Study. *JMIR aging*, 3(1), e19007.

Goettler, A., Grosse, A., & Sonntag, D. (2017). Productivity loss due to overweight and obesity: a systematic review of indirect costs. *BMJ Open*, 7(10).

Gorin, A. A., Phelan, S., Hill, J. O., & Wing, R. R. (2004). Medical triggers are associated with better short-and long-term weight loss outcomes. *Preventive medicine*, *39*(3), 612-616.

Greaves, C. J., Sheppard, K. E., Abraham, C., Hardeman, W., Roden, M., Evans, P. H., & Schwarz, P. (2011). Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC Public Health*, 11(1), 119.

Greaves, C., Poltawski, L., Garside, R., & Briscoe, S. (2017). Understanding the challenge of weight loss maintenance: a systematic review and synthesis of qualitative research on weight loss maintenance. *Health Psychology Review*, *11*(2), 145-163.

Grim, M., Hortz, B., & Petosa, R. (2011). Impact evaluation of a pilot web-based intervention to increase physical activity. *American journal of health promotion: AJHP*, 25(4), 227-30.

Gupta, H. (2014). Barriers to and facilitators of long-term weight loss maintenance in adult UK people: a thematic analysis. *International Journal of Preventive Medicine*, *5*(12), 1512.

Haeffele, J., Trunnell, E. P., & Kinney, A. (2011). A Grounded Theory Approach to the Process of Successful and Advanced Weight Maintenance. *International Journal of Health, Wellness & Society*, *1*(3).

Hahm, H. C., Speliotis, A. E., & Bachman, S. S. (2008). Failure to receive health care among people with mental illness: theory and implications. *Journal of social work in disability & rehabilitation*, *7*(2), 94-114.

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., Ekelund, U., & Lancet Physical Activity Series Working Group. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. *The Lancet*, 380(9838), 247-257.

Hamam F.A., Eldalo A.S., Alnofeie A.A., Alghamdi W.Y., Almutairi S.S., & Badyan, F.S. (2017). The association of eating habits and lifestyle with overweight and obesity among health sciences students in Taif University, KSA. *Journal of Taibah University Medical Sciences*, 12(3):249-60.

Hamdy O. (2017). Obesity Clinical Presentation. *Semin Gastrointes Dis.,* 9,156–62.

Hammarström, A., Wiklund, A. F., Lindahl, B., Larsson, C., & Ahlgren, C. (2014). Experiences of barriers and facilitators to weight-loss in a diet intervention-a qualitative study of women in Northern Sweden. *BMC Women's Health*, 14(1), 59.

Hankonen, N., Sutton, S., Prevost, A. T., Simmons, R. K., Griffin, S. J., Kinmonth, A. L., & Hanna P. (2002). Using internet technologies (such as Skype) as a research medium: a research note. *Qual Res*, 12(2), 239–42.

Hardeman, W. (2014). Which behaviour change techniques are associated with changes in physical activity, diet and body mass index in people with recently diagnosed diabetes?. *Annals of Behavioural Medicine*, 49(1), 7-17.

Hansen, T., & Jensen, J., & Solgaard, H. (2004). Predicting online grocery buying intention: A comparison of the theory of reasoned action and the theory of planned behavior. *International Journal of Information Management*. 24. 539-550.

Hartmann-Boyce, J., Johns, D. J., Jebb, S. A., Aveyard, P., & Behavioural Weight Management Review Group. (2014). Effect of behavioural techniques and delivery mode on effectiveness of weight management: systematic review, meta-analysis and meta-regression. *obesity reviews*, *15*(7), 598-609.

Harvard, C.H. (2011). Healthy Eating Plate. Harvard T.H. Chan. School of Public Health. *Harvard University Home*. Retrieved from https://www.hsph.harvard.edu/nutritionsource/healthy-eating-plate/

Harvey-Berino, J., Pope, L., Gold, B. C., Leonard, H., & Belliveau, C. (2012). Undergrad and overweight: an online behavioral weight management program for college students. *Journal of nutrition education and behavior*, *44*(6), 604-608.

Hashem, H. (2021, February 11). Saudi Arabian Women in Sports. Retrieved from: https://salaamgateway.com/story/saudi-arabia-women-in-sports-miles-ahead-five-years-on-but-still-a-lot-more-ground-to-cover.

Hawryluck, L., Gold, W. L., Robinson, S., Pogorski, S., Galea, S., & Styra, R. (2004). SARS control and psychological effects of quarantine, Toronto, Canada. *Emerging Infectious Diseases*, 10(7), 1206.

Hazama, T., Tanaka, K., Nakadomo, F., & Maeda, K. (1994). Effects of aerobic conditioning at intensities corresponding to lactate threshold plus reduced energy intake in college-age females. *The Annals of Physiological Anthropology*, 13(5), 245-52.

Head, K. J., & Noar, S. M. (2014). Facilitating progress in health behaviour theory development and modification: The reasoned action approach as a case study. *Health Psychology Review*, *8*(1), 34-52.

Herriot A., Thomas D., Hart K., Warren J., & Truby H. (2008). A qualitative investigation of individuals' experiences and expectations before and after completing a trial of commercial weight loss programmes. *J Hum Nutr Diet*, 21, 72-80.

Heyer, K. (2012). The Food Court in the Magic Kingdom: Globalization, Cuisine and Attitudes in Saudi Arabia.

Higgins, J. P. T., Altman, D. G., & Sterne, J. A. (2008). Assessing risk of bias in included studies (Chapter 8). *Cochrane handbook for systematic reviews of interventions version*, Chichester: Wiley-Blackwell, *5*(1).

Higgins, J. P. T., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., & Sterne, J. A. C. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ (Online)*, 343 (7829), 1–9.

Higgins, J.P.T., & Green, S. (editors). (2011). Cochrane Handbook for Systematic Reviews of Interventions. *The American Journal of the Medical Sciences*, 331(4), 219-225. The Cochrane Collaboration, Version 5.1.0 [updated March 2011]. Available from: http://handbook.cochrane.org.

Hill, J. O., Thompson, H., & Wyatt, H. (2005). Weight maintenance: what's missing?. *Journal of the American Dietetic Association*, *105*(5), 63-66.

Hindle, L., & Carpenter, C. (2011). An exploration of the experiences and perceptions of people who have maintained weight loss. *Journal of Human Nutrition and Dietetics*, *24*(4), 342-350.

Hoehl, S., Rabenau, H., Berger, A., Kortenbusch, M., Cinatl, J., Bojkova, D., ... Naujoks, F. (2020). Evidence of SARS-CoV-2 infection in returning travelers from Wuhan, China. *New England Journal of Medicine*, 382(13), 1278-1280.

Holdsworth, E., Thorogood, N., Sorhaindo, A., & Nanchahal, K. (2017). A qualitative study of participant engagement with a weight loss intervention. *Health Promotion Practice*, *18*(2), 245-252.

Holloway, I., & Todres, L. (2003). The status of method: Flexibility, consistency and coherence. *Qualitative Research*, 3, 345–357.

Horaib, G. B., Al-Khashan, H. I., Mishriky, A. M., Selim, M. A., AlNowaiser, N., BinSaeed, A. A., ... & AlQumaizi, K. (2013). Prevalence of obesity among military personnel in Saudi Arabia and associated risk factors. *Saudi Medical Journal*, 34(4), 401-407.

Howlett, N., Trivedi, D., Troop, N. A., & Chater, A. M. (2019). Are physical activity interventions for healthy inactive adults effective in promoting behavior change and maintenance, and which behavior change techniques are effective? A systematic review and meta-analysis. *Translational behavioral medicine*, *9*(1), 147-157.

Hu, P., Han, L.-l., Hou, F.-g., Xu, X.-l., Sharma, M., & Zhao, Y. (2016). Dietary attitudes and behaviours of women in China after the 2008 Wenchuan earthquake in three seismically different zones. *Asia Pacific journal of clinical nutrition*, 25(4), 849.

Huang, J., Yu, H., Marin, E., Brock, S., Carden, D., & Davis, T. (2004). Physicians' weight loss counseling in two public hospital primary care clinics. *Academic Medicine*, 79(2),156-61.

Hunt K., Gray C., Maclean A., Smillie S., Bunn C., & Wyke., S. (2014). Do weight management programmes delivered at professional football clubs attract and engage high risk men? BMC *Public Health*, 14, 50.

Hunt, K., McCann, C., Gray, C. M., Mutrie, N., & Wyke, S. (2013). "You've got to walk before you run": Positive evaluations of a walking program as part of a gender-sensitized, weight-management program delivered to men through professional football clubs. *Health Psychology*, *32*(1), 57.

Hussein, R. A. E. H. (2014). Socioeconomic status and dietary habits as predictors of home breakfast skipping in young women. *The Journal of The Egyptian Public Health Association*, 89(2), 100-104.

Hutchesson, M. J., Hulst, J., & Collins, C. E. (2013). Weight management interventions targeting young women: a systematic review. *Journal of the Academy of Nutrition and Dietetics*, *113*(6), 795-802.

Iii, C. M. Y., Brethauer, S., Burton, W. N., Fabius, R. J., Hymel, P., Kothari, S., ... & Roslin, M. S. (2018). Obesity in the workplace: Impact, outcomes, and recommendations. Northwell Health. Donald and Barbara Zucker School of Medicine Academic Works. School of Medicine at Hofsra University. *J Occup Environ Med*

Islam, M. A., Al-Karasneh, A. F., Hussain, A. B., Muhanna, A., Albu-Hulayqah, T., Naqvi, A. A., ... & Haseeb, A. (2020). Assessment of beverage consumption by young adults in Saudi Arabia. Saudi Pharmaceutical Journal. *28(12)*:1635-1647. doi: 10.1016/j.jsps.2020.10.010

Jaccard, J., Dodge, T., & Dittus, P. (2002). Parent-adolescent communication about sex and birth control: A conceptual framework. *New directions for child and adolescent development*, *2002*(97), 9-42.

Jacka, F. N., & Berk, M. (2013). Depression, diet and exercise. *The Medical Journal of Australia*, 199(6), S21-S23.

Jacka, F. N., Kremer, P. J., Berk, M., de Silva-Sanigorski, A. M., Moodie, M., Leslie, E. R., ... Swinburn, B. A. (2011a). A prospective study of diet quality and mental health in adolescents. PLoS One, 6(9), e24805.

Jacka, F. N., Mykletun, A., Berk, M., Bjelland, I., & Tell, G. S. (2011b). The association between habitual diet quality and the common mental disorders in community-dwelling adults: the Hordaland Health study. *Psychosomatic medicine*, 73(6), 483-490.

Jackson, S. E., Holter, L., & Beeken, R. J. (2019). 'Just because I'm old it doesn't mean I have to be fat': a qualitative study exploring older adults' views and experiences of weight management. *BMJ Open*, *9*(2), e025680.

Jandt F. (2003). *An introduction to intercultural communication: identities in a global community*. Sage: Thousand Oaks, CA.

Janis, I. L. (1972). Victims of Groupthink: A psychological study of foreign-policy decisions and fiascoes. Boston: Houghton Mifflin.

Janis, I. L. (1982). Groupthink: Psychological studies of policy decisions and fiascoes. Boston: Houghton Mifflin.

Jankovic, N., Geelen, A., Streppel, M. T., De Groot, L. C., Orfanos, P., Van Den Hooven, E. H., ... & Bueno-de-Mesquita, H. B. (2014). Adherence to a healthy diet according to the World Health Organization guidelines and all-cause mortality in elderly adults from Europe and the United States. *American Journal of Epidemiology*, 180(10), 978-988.

Janse Van Vuuren, M., Strodl, E., White, K. M., & Lockie, P. (2015). Psychosocial presentation of revisional LAGB patients: A qualitative study. *Clinical obesity*, *5*(5), 273-280.

Jeeran. (2013). Insights on Saudi Consumers. Retrieved from http://www.wamda.com/2013/10/Saudi-consumers-hungry-search-trends-kindom-infographic.

Jensen, M. D., Ryan, D. H., Apovian, C. M., Ard, J. D., Comuzzie, A. G., Donato, K. A., … Obesity Society (2014). 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Circulation*, 129(25 Suppl 2), S102–S138.

Johns, D. J., Hartmann-Boyce, J., Jebb, S. A., & Aveyard, P. (2014). Diet or exercise interventions vs combined behavioral weight management programs: a systematic review and meta-analysis of direct comparisons. *Journal of the Academy of Nutrition and Dietetics*, 114 (10), October 2014, 1557-1568.

Johns Hopkins School of Medicine. (2020). Coronavirus Resource Center. Retrieved from https://coronavirus.jhu.edu/

Jones N., Furlanetto D., Jackson J., &Kinn S. (2007). An investigation of obese adults' views of the outcomes of dietary treatment. *J Hum Nutr Diet*, 20, 486-494.

Jumbe, S., Bartlett, C., Jumbe, S. L., & Meyrick, J. (2016). The effectiveness of bariatric surgery on long term psychosocial quality of life–A systematic review. *Obesity Research & Clinical Practice*, 10(3), 225-242.

Jung, M. E., Bray, S. R., & Ginis, K. A. M. (2008). Behavior change and the freshman 15: tracking physical activity and dietary patterns in 1st-year university women. *Journal of American College Health*, 56(5), 523-530.

Kadam, P., & Bhalerao, S. (2010). Sample size calculation. *International journal of Ayurveda research*, 1(1), 55–57.

Kalaf, H., AlMesned, A., Soomro, T., Lasheen, W., Ewid, M., & Al-Mohaimeed, A. A. (2016). Cardiovascular disease risk profile among young Saudi women of Al-

Qassim, Saudi Arabia: A cross-sectional study. *International Journal of Health Sciences*, 10(1), 29.

Kan, M. P. H., & Fabrigar, L. R. (2017). Theory of planned behavior. *Encyclopedia of Personality and Individual Differences. Cham, Switzerland: Springer International Publishing*. 1-8. doi: 10.1007/978-3-319-28099-8_1191-1

Katayose, Y., Tasaki, M., Ogata, H., Nakata, Y., Tokuyama, K., & Satoh, M. (2009). Metabolic rate and fuel utilization during sleep assessed by whole-body indirect calorimetry. Metabolism, 58(7), 920-926.

Kayman, S., Bruvold, W., & Stern, J. S. (1990). Maintenance and relapse after weight loss in women: behavioural aspects. *The American Journal of Clinical Nutrition*, *52*(5), 800-807.

Kelly, T., Yang, W., Chen, C.S., Reynolds, K., & He, J. (2008). Global burden of obesity in 2005 and projections to 2030. *International Journal of Obesity*, 32(9),1431.

Khalaf, A., Ekblom, Ö., Kowalski, J., Berggren, V., Westergren, A., & Al-Hazzaa, H. (2013). Female university students' physical activity levels and associated factors—a cross-sectional study in southwestern Saudi Arabia. *International Journal of Environmental Research and Public Health*, 10(8), 3502-3517.

Khalaf, A., Westergren, A., Berggren, V., Ekblom, Ö., & Al-Hazzaa, H. M. (2015). Prevalence and association of female weight status and dietary habits with sociodemographic factors: a cross-sectional study in Saudi Arabia. *Public Health Nutrition*, 18(5), 784-796.

Khambalia, A. Z., Dickinson, S., Hardy, L. L., Gill, T. A., & Baur, L. A. (2012). A synthesis of existing systematic reviews and meta-analyses of school-based behavioural interventions for controlling and preventing obesity. *Obesity Reviews*, *13*(3), 214-233.

Kearney, J. (2010). Food consumption trends and drivers. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1554), 2793-2807.

Kickbusch, I., Gleicher, D. (2012). Governance for Health in the 21st Century. Copenhagen: World Health Organization (WHO). *Regional Office for Europe.* https://apps.who.int/iris/handle/10665/326429

King, N. (2004). Using templates in the thematic analysis of text. In Cassell, C., Symon, G. (Eds.), Essential guide to qualitative methods in organizational research (pp. 257–270). London, UK: Sage, *Retrieved from https://www.scirp.org/(S(351jmbntvnsjt1aadkozje))/reference/ReferencesPapers.aspx?ReferenceID=716242*

King's College. (2018). Adding a search filter to your search: Example. Retrieved from: https://libguides.kcl.ac.uk/systematicreview/SRFilters (last accessed 7-7-2018).

Kinsey, A., & Ormsbee, M. (2015). The health impact of nighttime eating: old and new perspectives. Nutrients, 7(4), 2648-2662.

Kitzinger, J. (1995). Introducing focus groups. *British Medical Journal*, *311*(7000), 299–302.

Kondo T, Kobayashi I, Murakami M. Effect of exercise on circulating adipokine levels in obese young women. *Endocrine journal*. 2006;53(2):189-95.

Koura, M. R., Al Dabal, B. K., Rasheed, P. A. R. V. E. E. N., Al Sowielem, L. S., & Makki, S. M. (2012). Prehypertension among young adult females in Dammam, Saudi Arabia. *EMHJ-Eastern Mediterranean Health Journal*, 18(7), 728-734.

Kozica, S., Lombard, C., Teede, H., Ilic, D., Murphy, K., & Harrison, C. (2015). Initiating and continuing behaviour change within a weight gain prevention trial: a qualitative investigation. *PLoS One*, *10*(4), e0119773.

KPMG. (2019, December). Excise Tax on Sweetened Beverages in Saudi Arabia. Retrieved from https://assets.kpmg/content/dam/kpmg/sa/pdf/2019/excise-tax-on-sweetened-drinks-in-ksa.pdf.

Krebs-Smith, S. M., Guenther, P. M., Subar, A. F., Kirkpatrick, S. I., & Dodd, K. W. (2010). Americans do not meet federal dietary recommendations. *The Journal of Nutrition*, 140(10), 1832-1838.

Kreidieh, D., Itani, L., El Kassas, G., El Masri, D., Calugi, S., Grave, R. D., & El Ghoch, M. (2018). Long-term Lifestyle-modification programs for overweight and obesity management in the Arab states: Systematic review and meta-analysis. Current Diabetes Reviews, 14(6), 550-558.

Krueger, R. A. (1994). Focus groups: A practical guide for applied research. Thousand Oaks, CA: Sage Publications Inc. *Lancet*. (2013). Global Burden of Disease Study. Retrieved from https://www.thelancet.com/gbd/2013

Kuper, A., Reeves, S., & Levinson, W. (2008). An introduction to reading and appraising qualitative research. *Bmj*, *337*, a288.

Kwasnicka, D., Dombrowski, S. U., White, M., & Sniehotta, F. F. (2019). 'It's not a diet, it's a lifestyle': a longitudinal, data-prompted interview study of weight loss maintenance. *Psychology & Health*, *34*(8), 963-982.

LaCaille, L.J., Nichols Dauner, K.N., Krambeer, R.J., & Pedersen, J. (2011). Psychosocial and Environmental Determinants of Eating Behaviors, Physical Activity, and Weight Change Among College Students: AQualitative Analysis. *J. Am. Coll. Health*, 59, 531–538.

Lakerveld, J., & Mackenbach, J. (2017). The Upstream Determinants of Adult Obesity. *Obesity facts*, 10(3), 216–222.

Lakshman, R., Griffin, S., Hardeman, W., Schiff, A., Kinmonth, A. L., & Ong, K. K. (2014). Using the Medical Research Council framework for the development and evaluation of complex interventions in a theory-based infant feeding intervention to prevent childhood obesity: the baby milk intervention and trial. *Journal of obesity*, 2014, 646504.

Lal, A., Moodie, M., Ashton, T., Siahpush, M., & Swinburn, B. (2012). Health care and lost productivity costs of overweight and obesity in New Zealand. *Australian and New Zealand Journal of Public Health*, 36(6), 550-556.

Lappalainen, R., Kearney, J., & Gibney, M. (1998). A pan EU survey of consumer attitudes to food, nutrition and health: an overview. *Food Quality and Preference*, 9(6), 467-478.

Larson, M. L. (Ed.). (1991). *Translation: theory and practice, tension and interdependence*. John Benjamins Publishing. ISBN 9789027231802

Leach, M., Parker, M., MacGregor, H., & Wilkinson, A. (2020). COVID-19—A social phenomenon requiring diverse expertise. *Institute of Development Studies.* Retrieved from https://www.ids.ac.uk/opinions/covid-19-a-social-phenomenon-requiring-diverse-expertise/.

Le Blanc, E. S., O'Connor, E., Whitlock, E. P., Patnode, C. D., & Kapka, T. (2011). Effectiveness of primary care–relevant treatments for obesity in adults: a systematic evidence review for the US Preventive Services Task Force. *Annals of Internal Medicine*, 155(7), 434-447.

Lee, K. S., Lee, J. K., & Yeun, Y. R. (2017). Effects of a 10-day intensive health promotion program combining diet and physical activity on body composition, physical fitness, and blood factors of young adults: a randomized pilot study. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, *23*, 1759.

Lee, S., Chan, L. Y., Chau, A. M., Kwok, K. P., & Kleinman, A. (2005). The experience of SARS-related stigma at Amoy Gardens. *Social Science & Medicine*, 61(9), 2038-2046.

Levitsky, D. A., Halbmaier, C. A., & Mrdjenovic, G. (2004). The freshman weight gain: a model for the study of the epidemic of obesity. *International Journal of Obesity*, 28(11), 1435-1442.

Lewis, C. E., Jacobs Jr, D. R., McCreath, H., Kiefe, C. I., Schreiner, P. J., Smith, D. E., & Williams, O. D. (2000). Weight gain continues in the 1990s: 10-year trends in weight and overweight from the CARDIA study. *American Journal of Epidemiology*, 151(12), 1172-1181.

Li, Y., Lv, M.-R., Wei, Y.-J., Sun, L., Zhang, J.-X., Zhang, H.-G., & Li, B. (2017). Dietary patterns and depression risk: a meta-analysis. *Psychiatry research*, 253, 373-382.

Liamputtong, P., & Serry, T. (2013). Making sense of qualitative data. Research methods in health: Foundations for evidence-based practice, 365-379.

Lincoln, Y. G., & Guba, E. (1985). Naturalistic Inquiry. London, Sage Publications. Contextualization: Evidence from Distributed Teams. *Information Systems Research*, 16(1), 9-27.

Lindberg, N. M., Stevens, V. J., & Halperin, R. O. (2013). Weight-loss interventions for Hispanic populations: the role of culture. *Journal of Obesity*, 2013.

Lippi, G., Henry, B. M., & Sanchis-Gomar, F. (2020). Physical inactivity and cardiovascular disease at the time of coronavirus disease 2019 (COVID-19). *European Journal of Preventive Cardiology*, 2047487320916823.

Livhits, M., Mercado, C., Yermilov, I., Parikh, J. A., Dutson, E., Mehran, A., ... & Gibbons, M. M. (2010). Behavioral factors associated with successful weight loss after gastric bypass. *The American Surgeon*, 76(10), 1139-1142.

Lloyd-Richardson, E. E., Bailey, S., Fava, J. L., Wing, R., & Tobacco Etiology Research Network. (2009). A prospective study of weight gain during the college freshman and sophomore years. *Preventive Medicine*, 48(3), 256-261.

Logel, C., & Cohen, G. L. (2011). The role of the self in physical health: testing the effect of a values-affirmation intervention on weight loss. *Psychological Science*, 23(1) 53–55.

Lucas, M., Mekary, R., Pan, A., Mirzaei, F., O'Reilly, É. J., Willett, W. C., ... Ascherio, A. (2011). Relation between clinical depression risk and physical activity and time spent watching television in older women: a 10-year prospective follow-up study. *American journal of epidemiology*, 174(9), 1017-1027.

Lynch, A. (2016). "When the honeymoon is over, the real work begins:" Gastric bypass patients' weight loss trajectories and dietary change experiences. *Social Science & Medicine*, 151, 241-249.

Lyons, E. E., & Coyle, A. E. (2007). *Analysing qualitative data in psychology*. Sage Publications Ltd. ISBN 9781412907835

Ma, Y., Olendzki, B. C., Pagoto, S. L., Hurley, T. G., Magner, R. P., Ockene, I. S., Schneider, K. L., Merriam, P. A., & Hébert, J. R. (2009). Number of 24-hour diet recalls needed to estimate energy intake. Annals of epidemiology, 19(8), 553–559. https://doi.org/10.1016/j.annepidem.2009.04.010

Mabry, R., Koohsari, M. J., Bull, F., & Owen, N. (2016). A systematic review of physical activity and sedentary behaviour research in the oil-producing countries of the Arabian Peninsula. *BMC Public Health*, 16(1), 1003.Macdonald-Wallis, K., Jago, R., & Sterne, J. A. (2012). Social network analysis of childhood and youth physical activity: a systematic review. *American journal of preventive medicine*, 43(6), 636-642.

MacLean, P. S., Wing, R. R., Davidson, T., Epstein, L., Goodpaster, B., Hall, K. D., ... & Rothman, A. J. (2015). NIH working group report: innovative research to improve maintenance of weight loss. *Obesity*, *23*(1), 7-15.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, 15(4), 351-377.

Magosso, R. F. (2017). The Role of Exercise in Weight Loss and Maintenance: A New Paradigm Based on Motor Skills Repertoire. *EC Nutrition*, *9*, 230-236.

Majeed, F. (2015). Association of BMI with diet and physical activity of female medical students at the University of Dammam, Kingdom of Saudi Arabia. *Journal of Taibah University Medical Sciences*, 10(2), 188-196.

Malinowski, S. S. (2006). Nutritional and metabolic complications of bariatric surgery. *The American Journal of the Medical Sciences*, 331(4), 219-225.

Marjanovic, Z., Greenglass, E. R., & Coffey, S. (2007). The relevance of psychosocial variables and working conditions in predicting nurses' coping strategies during the SARS crisis: an online questionnaire survey. *International journal of nursing studies*, 44(6), 991-998.

Martin, J. S., Chater, A., & Lorencatto, F. (2013). Effective behaviour change techniques in the prevention and management of childhood obesity. International Journal of Obesity, 37(10), 1287-1294.

Maryon-Davis, A. (2005). Weight management in primary care: how can it be made more effective? *Proceedings of the Nutrition Society*, 64(1), 97-103.

Maunder, R., Hunter, J., Vincent, L., Bennett, J., Peladeau, N., Leszcz, M., ... Mazzulli, T. (2003). The immediate psychological and occupational impact of the 2003 SARS outbreak in a teaching hospital. *Cmaj*, 168(10), 1245-1251.

McEvoy, C. T., Moore, S. E., Appleton, K. M., Cupples, M. E., Erwin, C., Kee, F., ... & Woodside, J. V. (2018). Development of a peer support intervention to encourage dietary behaviour change towards a Mediterranean diet in adults at high cardiovascular risk. BMC Public Health, 18(1), 1194.

McEwen, M. (2014). Theoretical frameworks for research. *Nursing Research-E-Book: Methods and Critical Appraisal for Evidence-Based Practice*, 75.

McGill, B., O'Hara, B. J., Phongsavan, P., Bauman, A., Lawler, L., & Grunseit, A. C. (2020, March). "I'm Still on Track": A Qualitative Exploration of Participant Experiences of a Weight Loss Maintenance Program. In *Healthcare* (Vol. 8, No. 1, p. 21). Multidisciplinary Digital Publishing Institute.

McLafferty, I. (2004). Focus group interviews as a data collecting strategy. *Journal of advanced nursing*, *48*(2), 187-194.

McMahon, N. E., Visram, S., & Connell, L. A. (2016). Mechanisms of change of a novel weight loss programme provided by a third sector organisation: a qualitative interview study. *BMC Public Health*, *16*(1), 378.

Mechanick, J. I., Kushner, R. F., Sugerman, H. J., Gonzalez-Campoy, J. M., Collazo-Clavell, M. L., Spitz, A. F., ... & Anderson, W. A. (2009). American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. *Obesity*, 17(S1), S3-S72.

Megally, R., & Al-Jawaldeh, A. (2020). Impact of sin taxes on consumption volumes of sweetened beverages and soft drinks in Saudi Arabia. *F1000Research*, 9.

Mehmood, Y., Al-Swailmi, F. K., & Al-Enazi, S. A. (2016). Frequency of obesity and comorbidities in medical students. *Pakistan Journal of Medical Sciences*, 32(6), 1528.

Memish, Z. A., El Bcheraoui, C., Tuffaha, M., Robinson, M., Daoud, F., Jaber, S., ... & Al Rabeeah, A. A. (2014). Peer reviewed: obesity and associated factors—Kingdom of Saudi Arabia, 2013. *Preventing Chronic Disease*, 11.

Memon, A.R., Masood, T., Awan, W.A., Waqas, A. (2018). The effectiveness of an incentivized physical activity programme (Active Student) among female medical students in Pakistan: A Randomized Controlled Trial. *JPMA The Journal of the Pakistan Medical Association*, 68(10),1438-45.

Menon, S. (2008). Determinants of Physical Activity among young sedentary adults (Doctoral dissertation). Kinesiology. Digital Commons & Cortland, *125.* Retrieved from https://digitalcommons.cortland.edu/theses/125/

Metzgar, C. J., Preston, A. G., Miller, D. L., & Nickols-Richardson, S. M. (2015). Facilitators and barriers to weight loss and weight loss maintenance: a qualitative exploration. *Journal of Human Nutrition and Dietetics*, *28*(6), 593-603.

Michaud, C., Kahn, J., Musse, N., Burlet, C., Nicolas, J., & Mejean, L. (1990). Relationships between a critical life event and eating behaviour in high-school students. *Stress Medicine*, 6(1), 57-64.

Michie, S. (2008). Designing and implementing behaviour change interventions to improve population health. *Journal of Health Services Research & Policy*, 13(3_suppl), 64-69.

Michie, S., Atkins, L., & West, R. (2014). The behaviour change wheel. A guide to designing interventions. 1st ed. Great Britain: Silverback Publishing, 1003-1010.

Michie, S., Abraham, C., Whittington, C., McAteer, J., & Gupta, S. (2009). Effective techniques in healthy eating and physical activity interventions: a meta-regression. *Health Psychology*, 28(6), 690.

Michie, S., & Johnston, M. (2012). Theories and techniques of behaviour change: Developing a cumulative science of behaviour change. *Health Psychology Review. 6(1),* 1-6

Michie, S., Johnston, M., Abraham, C., Lawton, R., Parker, D., & Walker, A. (2005). Making psychological theory useful for implementing evidence based practice: a consensus approach. *BMJ Quality & Safety*, *14*(1), 26-33.Michie, S., Johnston, M., Francis, J., Hardeman, W., & Eccles, M. (2008). From theory to intervention: mapping theoretically derived behavioural determinants to behaviour change techniques. Appl Psychol, 57, 660-680

Michie, S., Marques, M.M., Norris, E. & Johnston, M. (2018). Theories and interventions in health behaviour change. In Revenson, T.A & Gurung, R.A.R. (Eds.). Handbook of Health Psychology. New York: Routledge. Pp 69-88.

Michie, S., & Prestwich, A. (2010). Are interventions theory-based? Development of a theory coding scheme. Health psychology, 29(1), p.1.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., ... & Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Annals of behavioral medicine*, *46*(1), 81-95.

Michie, S., Van Stralen, M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(1), 42.

Michie, S. F., West, R., Campbell, R., Brown, J., & Gainforth, H. (2014). ABC of behaviour change theories. Silverback Publishing London.

Midhet, F. M., & Sharaf, F. K. (2011). Impact of health education on lifestyles in central Saudi Arabia. *Saudi Med J*, 32(1), 71-76.

Mihalopoulos, N. L., Auinger, P., & Klein, J. D. (2008). The Freshman 15: is it real?. *Journal of American College Health*, 56(5), 531-534.

Miller, R., & Brown, W. (2004). Meeting physical activity guidelines and average daily steps in a working population. Journal of Physical Activity and Health, 1(3), 218-226.

Mimiaga, M. J., Noonan, E., Donnell, D., Safren, S. A., Koenen, K. C., Gortmaker, S., ... & Mayer, K. H. (2009). Childhood sexual abuse is highly associated with

HIV risk–taking behavior and infection among MSM in the EXPLORE study. *Journal of acquired immune deficiency syndromes (1999)*, *51*(3), 340.

Ministry of Health SA. (2017). The Saudi Guidelines on the Prevention and Management of Obesity, Riyadh. Ministry of Health. SASMBS. Retrieved from www.moh.gov.sa

Mohamed, A. G., & Mohammed, S. S. (2019). Eating pattern among adolescent female student, Applied Medical Sciences College, University of Hafr-Al Batin. *Journal of Nursing Education and Practice*, 9(4).

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Prisma Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS med*, *6*(7), e1000097.

Montaño, D. E., & Kasprzyk, D. (2015). Theory of reasoned action, theory of planned behavior, and the integrated behavioral model. *Health behavior: Theory, research and practice*, *70*(4), 231.

Montaño, D. E., & Kasprzyk, D. (2008). *Theory of reasoned action, theory of planned behavior, and the integrated behavioral model.* In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory, research, and practice* (p. 67–96). Jossey-Bass.

Monteiro, C. A., Moubarac, J. C., Cannon, G., Ng, S. W., & Popkin, B. (2013). Ultra-processed products are becoming dominant in the global food system. *Obesity Reviews*, 14, 21-28.

Montesi, L., El Ghoch, M., Brodosi, L., Calugi, S., Marchesini, G., & Dalle Grave, R. (2016). Long-term weight loss maintenance for obesity: a multidisciplinary approach. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 9, 37-46.

Montgomery, S. C., Donnelly, M., Bhatnagar, P., Carlin, A., Kee, F., & Hunter, R. F. (2020). Peer social network processes and adolescent health behaviors: a systematic review. Preventive medicine, 130, 105900.

Moore, G. F., & Evans, R. E. (2017). What theory, for whom and in which context? Reflections on the application of theory in the development and evaluation of complex population health interventions. *SSM-population health*, 3, 132-135.

Moradi-Lakeh, M., El Bcheraoui, C., Tuffaha, M., Daoud, F., Al Saeedi, M., Basulaiman, M., Memish, Z. A., Al Mazroa, M. A., Al Rabeeah, A. A., & Mokdad, A. H. (2016). The health of Saudi youths: current challenges and future opportunities. BMC family practice, 17, 26. https://doi.org/10.1186/s12875-016-0425-z Morgan, D. L. (1996). Focus groups. *Annual review of sociology*, *22*(1), 129-152.

Mordor Intelligence. (2021). Saudi Arabia foodservice market - growth, trends, covid-19 impact and forecasts (2021 - 2026) Retrieved from https://www.mordorintelligence.com/industry-reports/saudi-arabia-foodservice-market.

Morrison, Z., Douglas, A., Bhopal, R., & Sheikh, A. (2014). Understanding experiences of participating in a weight loss lifestyle intervention trial: a qualitative evaluation of South Asians at high risk of diabetes. *BMJ Open*, *4*(6).

Morrow, M. L., Heesch, K. C., Dinger, M. K., Hull, H. R., Kneehans, A. W., & Fields, D. A. (2006). Freshman 15: fact or fiction?. *Obesity*, *14*(8), 1438-1443.

Muijs, D. (2010). *Doing quantitative research in education with SPSS*. Sage. doi: 10.4135/9781849203241

Musaiger, A. O. (2011). Overweight and obesity in eastern Mediterranean region: Prevalence and possible causes. *Journal of Obesity*, 2011.

Musaiger, A. O., Awadhalla, M. S., Al-Mannai, M., AlSawad, M., & Asokan, G. V. (2017). Dietary habits and sedentary behaviors among health science university students in Bahrain. *International Journal of Adolescent Medicine and Health*, 29(2).

Musaiger, A.O., Al-Mannai, M., Tayyem, R., Al-Lalla, O., Ali, E.Y., Kalam, F., et al. (2013). Perceived barriers to healthy eating and physical activity among adolescents in seven Arab countries: a cross-cultural study. *Scientific World Journal*.

Mytton, O. T., Nnoaham, K., Eyles, H., Scarborough, P., & Mhurchu, C. N. (2014). Systematic review and meta-analysis of the effect of increased vegetable and fruit consumption on body weight and energy intake. *BMC public health*, *14*(1), 886.

Nabavi, R. T. (2012). Bandura's social learning theory & social cognitive learning theory. *Theory of Developmental Psychology*, 1-24.

Naeem, Z. (2012). Increasing trend of Junk food use in Saudi Arabia and health implications. *International Journal of Health Sciences*, 6(1), V.

Nanri, A., Kimura, Y., Matsushita, Y., Ohta, M., Sato, M., Mishima, N., ... Mizoue, T. (2010). Dietary patterns and depressive symptoms among Japanese men and women. *European journal of clinical nutrition*, 64(8), 832-839.

Narciso, J., Silva, A. J., Rodrigues, V., Monteiro, M. J., Almeida, A., Saavedra, R., & Costa, A. M. (2019). Behavioral, contextual and biological factors associated with obesity during adolescence: A systematic review. *PloS one*, 14(4), e0214941. https://doi.org/10.1371/journal.pone.0214941

National Institute for Health and Clinical Excellence (NICE) Guidance. (2015). Obesity: the Prevention, Identification, Assessment and Management of Overweight and Obesity in Adults and Children. Retrieved 25 March, 2021, from https://www.nice.org.uk/guidance/ng7/chapter/glossary#physical-activity

National Institute for Health and Clinical Excellence (NICE). (2018). Treatment Summary. Retrieved 25 March, 2021, from https://bnf.nice.org.uk/treatment-summary/obesity.html.

National Institute for Health Research (NHS), 2014, Procedure for Measuring Adult Height. NIHR Southampton Biomedical Research Centre. Retrieved 25 March, 2021, from http://www.uhs.nhs.uk/Media/Southampton-Clinical-Research/Procedures/BRCProcedures/Procedure-for-adult-height.pdf

Needham, C. (2008). Realising the Potential of Co-production: Negotiating Improvements in Public Services. *Social Policy and Society*, 7(2), 221-231. doi:10.1017/S1474746407004174

Nelson, M. C., Story, M., Larson, N. I., Neumark-Sztainer, D., & Lytle, L. A. (2008). Emerging adulthood and college-aged youth: an overlooked age for weight-related behavior change. *Obesity*, *16*(10), 2205.

New Arab, The. (April 14, 2020). Coronavirus: Saudi orders restrictions on basic foodstuffs sold at supermarket, sparking fears of food shortages. Retrieved from https://english.alaraby.co.uk/english/news/2020/4/14/is-saudi-arabia-facing-food-shortages-

Ng, S. W., Zaghloul, S., Ali, H. I., Harrison, G., & Popkin, B. M. (2011). The prevalence and trends of overweight, obesity and nutrition-related non-communicable diseases in the Arabian Gulf States. *Obesity Reviews*, *12*(1), 1-13.

NHS (National Health Service). (2007). *Lifestyle and Exercise*. Retrieved 25 March, 2021, from https://www.nhs.uk/news/lifestyle-and-exercise/pedometers-make-those-steps-count/

NICE. (2018). Treatment Summary. Retrieved from: https://bnf.nice.org.uk/treatment-summary/obesity.html.

Niemeier, H. M., Raynor, H. A., Lloyd-Richardson, E. E., Rogers, M. L., & Wing, R. R. (2006). Fast food consumption and breakfast skipping: predictors of weight gain from adolescence to adulthood in a nationally representative sample. *Journal of Adolescent Health*, 39(6), 842-849.

Nilsen, P. (2015). Making sense of implementation theories, models and frameworks. *Implementation science*, *10*(1), 53.

Noar, S.M. and Zimmerman, R.S., 2005. Health behavior theory and cumulative knowledge regarding health behaviors: are we moving in the right direction?. Health education research, 20(3), pp.275-290.

Nuttall, F. Q. (2015). Body mass index: obesity, BMI, and health: a critical review. *Nutrition Today*, 50(3), 117.

O’Brien, B. C., Harris, I. B., Beckman, T. J., Reed, D. A., & Cook, D. A. (2014). Standards for reporting qualitative research: a synthesis of recommendations. *Academic Medicine*, 89(9), 1245-1251.

O'Cathain, A., Croot, L., Duncan, E., Rousseau, N., Sworn, K., Turner, K. M., Yardley, L., & Hoddinott, P. (2019). Guidance on how to develop complex interventions to improve health and healthcare. *BMJ open*, 9(8), e029954.

O'Connor, D. B., Jones, F., Conner, M., McMillan, B., & Ferguson, E. (2008). Effects of daily hassles and eating style on eating behavior. *Health Psychology*, 27(1S), S20.

Oddy, W. H., Robinson, M., Ambrosini, G. L., Therese, A., de Klerk, N. H., Beilin, L. J., ... Stanley, F. J. (2009). The association between dietary patterns and mental health in early adolescence. *Preventive medicine*, 49(1), 39-44.

Office of Behavioural and Social Sciences Research, (2006). Healthier lives through behavioral and social science research. *National Institute of Health* Bethesda, MD.

Ogden, J., Clementi, C., Aylwin, S., & Patel, A. (2005). Exploring the impact of obesity surgery on patients' health status: a quantitative and qualitative study. *Obesity Surgery*, 15(2), 266-272.

Ohsiek, S., & Williams, M. (2011). Psychological factors influencing weight loss maintenance: an integrative literature review. *Journal of the American Academy of Nurse Practitioners*, *23*(11), 592-601.

Okyere, J. (2020). Stress-Induced Eating Amidst a Pandemic. University of Cape Coast. doi: 10.31124/advance.12144882.v1

Olander, E. K., Fletcher, H., Williams, S., Atkinson, L., Turner, A., & French, D. P. (2013). What are the most effective techniques in changing obese individuals’ physical activity self-efficacy and behaviour: a systematic review and meta-analysis. *International Journal of Behavioural Nutrition and Physical Activity*, 10(1), 29.

Oliver, G., Wardle, J., & Gibson, E. L. (2000). Stress and food choice: a laboratory study. *Psychosomatic medicine*, 62(6), 853-865.

Onwuegbuzie, A. J., & Leech, N. L. (2005). Taking the “Q” out of research: Teaching research methodology courses without the divide between quantitative and qualitative paradigms. *Quality and Quantity*, *39*(3), 267-295.

Padgett, D. K. (1998). Does the glove really fit? Qualitative research and clinical social work practice. *Social Work*, 43(4), 373-381.

Paffenbarger Jr, R. S., Hyde, R., Wing, A. L., & Hsieh, C. C. (1986). Physical activity, all-cause mortality, and longevity of college alumni. *New England journal of medicine*, *314*(10), 605-613.

Painter, J. E., Borba, C. P., Hynes, M., Mays, D., & Glanz, K. (2008). The use of theory in health behavior research from 2000 to 2005: a systematic review. *Annals of Behavioral Medicine*, *35*(3), 358-362.

Pampel, F., & Denney, J., & Krueger, P. (2012). Obesity, SES, and Economic Development: A Test of the Reversal Hypothesis. *Social science & medicine* (1982). 74. 1073-81.

Pan, P. J., Chang, S.-H., & Yu, Y.-Y. (2005). A support group for home-quarantined college students exposed to SARS: Learning from practice. *The Journal for Specialists in Group Work*, 30(4), 363-374.

Pandolfino, J. E., Krishnamoorthy, B., & Lee, T. J. (2004). Gastrointestinal complications of obesity surgery. MedGenMed: Medscape general medicine, 6(2), 15.

Papandreou, C., Mourad, T.A., Jildeh, C., Abdeen, Z., Philalithis, A., & Tzanakis, N. (2008). Obesity in Mediterranean region (1997–2007): A systematic review. *Obesity Reviews*, 9(5), 389-99.

Paquette, M. C. (2005). Perceptions of healthy eating: state of knowledge and research gaps. *Canadian Journal of Public Health/Revue Canadienne de Sante'e Publique*, S15-S19.

Parkin, D. M., Boyd, L., & Walker, L. C. (2011). 16. The fraction of cancer attributable to lifestyle and environmental factors in the UK in 2010. *British journal of cancer*, 105 Suppl 2(Suppl 2), S77–S81. https://doi.org/10.1038/bjc.2011.489

Pasco, J. A., Williams, L. J., Jacka, F. N., Henry, M. J., Coulson, C. E., Brennan, S. L., ... Berk, M. (2011). Habitual physical activity and the risk for depressive and anxiety disorders among older men and women. *International psychogeriatrics*, 23(2), 292-298.

Pellecchia, U., Crestani, R., Decroo, T., Van den Bergh, R., & Al-Kourdi, Y. (2015). Social consequences of Ebola containment measures in Liberia. *PLoS One*, 10(12).

Peltzer, K., Pengpid, S., Samuels, T.A., Ozcan, N.K., Mantilla, C., Rahamefy, O.H., et al. (2014). Prevalence of overweight/obesity and its associated factors among university students from 22 countries. *Int J Environ Res Public Health*, 11(7), 7425-41.

Pengpid, S, & Peltzer, K. (2014). Prevalence of overweight/obesity and central obesity and its associated factors among a sample of university students in India. *Obesity Research & Clinical Practice*, 8(6), 558-70.

Penn, L., Dombrowski, S. U., Sniehotta, F. F., & White, M. (2013). Participants' perspectives on making and maintaining behavioural changes in a lifestyle intervention for type 2 diabetes prevention: a qualitative study using the theory domain framework. *BMJ Open*, *3*(6).

Penn, L., Moffatt, S. M., & White, M. (2008). Participants' perspective on maintaining behaviour change: a qualitative study within the European Diabetes Prevention Study. *BMC Public Health*, 8 (235).

Perneger, T. V., Courvoisier, D. S., Hudelson, P. M., & Gayet-Ageron, A. (2015). Sample size for pre-tests of questionnaires. *Quality of Life Research*, *24*(1), 147-151.

Peters, J. C., Wyatt, H. R., Donahoo, W. T., & Hill, J. O. (2002). From instinct to intellect: the challenge of maintaining healthy weight in the modern world. *Obesity Reviews*, *3*(2), 69-74.

Phillips, C. J., Marshall, A. P., Chaves, N. J., Jankelowitz, S. K., Lin, I. B., Loy, C. T., ... & Wilkinson, S. A. (2015). Experiences of using the Theoretical Domains

Framework across diverse clinical environments: a qualitative study. *Journal of multidisciplinary healthcare*, 8, 139.

Phillips, M., Flemming, N., & Tsintzas, K. (2009). An exploratory study of physical activity and perceived barriers to exercise in ambulant people with neuromuscular disease compared with unaffected controls. *Clinical Rehabilitation*, *23*(8), 746-755.

Pliner, P., & Saunders, T. (2008). Vulnerability to freshman weight gain as a function of dietary restraint and residence. *Physiology & Behavior*, 93(1-2), 76-82.

Plotnikoff, R. C., Costigan, S. A., Williams, R. L., Hutchesson, M. J., Kennedy, S. G., Robards, S. L., ... & Germov, J. (2015). Effectiveness of interventions targeting physical activity, nutrition and healthy weight for university and college students: a systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 45.

Polak, R., Phillips, E. M., & Campbell, A. (2015). Legumes: Health benefits and culinary approaches to increase intake. *Clinical Diabetes*, 33(4), 198-205.

Poobalan, A. S., Aucott, L. S., Precious, E., Crombie, I. K., & Smith, W. C. S. (2010). Weight loss interventions in young people (18 to 25 year olds): a systematic review. *Obesity reviews*, *11*(8), 580-592.

Popkin, B. M., Adair, L. S., & Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews*, 70(1), 3-21.

Povey, R., Conner, M., Sparks, P., James, R., & Shepherd, R. (1998). Interpretations of healthy and unhealthy eating, and implications for dietary change. *Health Education Research*, 13(2), 171-183.

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: toward an integrative model of change. *Journal of consulting and clinical psychology*, *51*(3), 390.

Prospective Studies Collaboration. (2009). Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *The Lancet*, *373*(9669), 1083-1096.

Provencher, V., Polivy, J., & Herman, C. P. (2009). Perceived healthiness of food. If it's healthy, you can eat more!. *Appetite*, *52*(2), 340-344.

Racette, S.B., Deusinger, S.S., Strube, M.J., Highstein, G.R., & Deusinger, R.H. (2005). Weight changes, exercise, and dietary patterns during freshman and sophomore years of college. *J Am Coll Health*, 53, 245–251.

Radzi, W.M., Jasimah, C.W., Salarzadeh Jenatabadi, H., Alanzi, A. R., Mokhtar, M. I., Mamat, M. Z., & Abdullah, N. A. (2019). Analysis of obesity among Malaysian University Students: a combination study with the application of Bayesian structural equation modelling and Pearson correlation. *International Journal of Environmental Research and Public Health*, 16(3), 492.

Rasheed, P. (1998). Perception of body weight and self-reported eating and exercise behaviour among obese and non-obese women in Saudi Arabia. *Public Health*, 112(6), 409-414.

Reed, J. A., & Phillips, D. A. (2005). Relationships between physical activity and the proximity of exercise facilities and home exercise equipment used by undergraduate university students. *Journal of American College Health*, 53(6), 285-290.

Redfern, J., McKevitt, C., & Wolfe, C. D. (2006). Development of complex interventions in stroke care: a systematic review. *Stroke*, *37*(9), 2410-2419.

Reuters. (2017). Saudi Arabia to Introduce Physical Education for Schoolgirls. Retrieved from: https://www.reuters.com/article/ us-saudi-education-women-idUSKBN19W1DM

Reynolds, D. L., Garay, J., Deamond, S., Moran, M. K., Gold, W., & Styra, R. (2008). Understanding, compliance and psychological impact of the SARS quarantine experience. *Epidemiology & Infection*, 136(7), 997-1007.

Rhodes, R. E., Janssen, I., Bredin, S. S., Warburton, D. E., & Bauman, A. (2017). Physical activity: Health impact, prevalence, correlates and interventions. *Psychology & Health*, *32*(8), 942-975.

Richardson, M., Khouja, C. L., Sutcliffe, K., & Thomas, J. (2019). Using the theoretical domains framework and the behavioural change wheel in an overarching synthesis of systematic reviews. *BMJ open*, *9*(6), e024950.

Rissanen, A. M. (1996, January). The economic and psychosocial consequences of obesity. In Ciba Foundation Symposium (pp. 194-200).

Ritzer, George. (1991) *The Mcdonaldization Thesis*. London: Sage.

Roach, J. B., Yadrick, M. K., Johnson, J. T., Boudreaux, L. J., Forsythe III, W. A., & Billon, W. (2003). Using self-efficacy to predict weight loss among young adults. *Journal of the American Dietetic Association*, *103*(10), 1357-1359.

Robertson, E., Hershenfield, K., Grace, S. L., & Stewart, D. E. (2004). The psychosocial effects of being quarantined following exposure to SARS: a qualitative study of Toronto health care workers. *The Canadian Journal of Psychiatry*, 49(6), 403-407.

Robins, L. M., Hill, K. D., Finch, C. F., Clemson, L., & Haines, T. (2018). The association between physical activity and social isolation in community-dwelling older adults. *Aging & mental health*, 22(2), 175-182.

Robinson, E., Boyland, E., Chisholm, A., Harrold, J., Maloney, N. G., Marty, L., ... & Hardman, C. A. (2020). Obesity, eating behavior and physical activity during COVID-19 lockdown: A study of UK adults. *Appetite*, 104853.

Rogerson, D., Soltani, H., & Copeland, R. (2016). The weight-loss experience: a qualitative exploration. *BMC Public Health*, 16(1), 1-12.

Rousseau, N., Turner, K. M., Duncan, E., O'Cathain, A., Croot, L., Yardley, L., & Hoddinott, P. (2019). Attending to design when developing complex health interventions: A qualitative interview study with intervention developers and associated stakeholders. *PLoS One*, 14(10), e0223615.

Ryan, D., & Heaner, M. (2014). Guidelines for managing overweight and obesity in adults. Preface to the full report. *Obesity* (Silver Spring) 2014; 22 (suppl 2): S1–3.

Ryan, D. H., & Kahan, S. (2018). Guideline Recommendations for Obesity Management. *The Medical clinics of North America*, 102(1), 49-63.

Sabra, A. A. (2014). Obesity among female intermediate nursing students of health science collage in Dammam city, Saudi Arabia: prevalence and associated factors. *Canadian Journal of Clinical Nutrition*, 2(1).

Sacher, Paul & Kolotourou, Maria & Chadwick, Paul & Cole, Tim & Lawson, Margaret & Lucas, Alan & Singhal, Atul. (2010). Randomized Controlled Trial of the MEND Program: A Family-based Community Intervention for Childhood Obesity. *Obesity* (Silver Spring, Md.). 18 Suppl 1. S62-8.

Sacker, A., & Cable, N. (2006). Do adolescent leisure-time physical activities foster health and well-being in adulthood? Evidence from two British birth cohorts. *The European Journal of Public Health*, 16(3), 331-335.

Sallis, J. F. (2010). Measuring physical activity: practical approaches for program evaluation in Native American communities. Journal of public health management and practice: JPHMP, 16(5), 404.

Sallis, J.F., & Owen N, F.E. (2008). Social and Behavioral Theories', Health Behavior and Health Education: Theory, Research, and Practice, 4th, pp. 465-486. Doi: 10.1146/annurev.publhealth.012809.103604

Samara, A., Andersen, P. T., & Aro, A. R. (2019). Health promotion and obesity in the arab gulf states: Challenges and good practices. *Journal of Obesity*. doi: 10.1155/2019/4756260

Samdal, G. B., Eide, G. E., Barth, T., Williams, G., & Meland, E. (2017). Effective behaviour change techniques for physical activity and healthy eating in overweight and obese adults; systematic review and meta-regression analyses. *The International Journal of Behavioral Nutrition and Physical Activity*, 14(1), 42.

Sandelowski, M. (1995). Sample size in qualitative research. *Research in nursing & health,* 18(2), 179-183.

Sarlio-Lähteenkorva, S. (2000). 'The battle is not over after weight loss': Stories of successful weight loss maintenance. *Health*, 4(1), 73-88.

Saudi Arabia. (2020). Weather Online. Retrieved from https://www.weatheronline.co.uk/reports/climate/Saudi-Arabia.htm

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., & Burroughs, H. C. Jinks (2017). Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & Quantity*.

Scarmozzino, F., & Visioli, F. (2020). Covid-19 and the Subsequent Lockdown Modified Dietary Habits of Almost Half the Population in an Italian Sample. *Foods*, *9*(5), 675.

Schroeder, S. A. (2007). We can do better—improving the health of the American people. *New England Journal of Medicine*, *357*(12), 1221-1228.

Schmidt, W. D., Biwer, C. J., & Kalscheuer, L. K. (2001). Effects of long versus short bout exercise on fitness and weight loss in overweight females. *Journal of the American College of Nutrition*, 20(5), 494-501.

Schmier, J. K., Jones, M. L., & Halpern, M. T. (2006). Cost of obesity in the workplace. *Scandinavian Journal of Work, Environment & Health*, 5-11.

Schrempft, S., Jackowska, M., Hamer, M., & Steptoe, A. (2019). Associations between social isolation, loneliness, and objective physical activity in older men and women. *BMC public health*, 19(1), 74.

Seagle, H.M., Bessesen, D.H., & Hill, J.O. (1998).Effects of sibutramine on resting metabolic rate and weight loss in overweight women. *Obesity Research*, 6(2),115-21.

Serdula, M. K., Gillespie, C., Kettel-Khan, L., Farris, R., Seymour, J., & Denny, C. (2004). Trends in fruit and vegetable consumption among adults in the United States: behavioral risk factor surveillance system, 1994–2000. *American Journal of Public Health*, 94(6), 1014-1018.

Seidell, J. C. (1998). Societal and personal costs of obesity. *Experimental and Clinical Endocrinology & Diabetes*, 106(S 02), 7-10.

SGAS. (2017) SGAfS. Gross Domestic Product Per Capita, 2017

Sharara, E., Akik, C., Ghattas, H., & Obermeyer, C. M. (2018). Physical inactivity, gender and culture in Arab countries: a systematic assessment of the literature. *BMC Public Health*, 18(1), 639.

Sharma, A., Madaan, V., & Petty, F. D. (2006). Exercise for mental health. Primary care companion to the Journal of clinical psychiatry, 8(2), 106. Retrieved from https://doi.org/10.4088/pcc.v08n0208a

Sheppard, B. H., Hartwick, J., & Warshaw, P. R. (1988). The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. *Journal of consumer research*, *15*(3), 325-343.

Sherrington, A., Newham, J. J., Bell, R., Adamson, A., McColl, E., & Araujo-Soares, V. (2016). Systematic review and meta-analysis of internet-delivered interventions providing personalized feedback for weight loss in overweight and obese adults. *Obesity Reviews*, 17(6), 541-551.

Sidawi, B., & Al-Hariri, M. T. A. (2012). The impact of built environment on diabetic patients: the case of Eastern Province, Kingdom of Saudi Arabia. *Global Journal of Health Science*, 4(4), 126.

Silfee, V. J., Haughton, C. F., Jake-Schoffman, D. E., Lopez-Cepero, A., May, C. N., Sreedhara, M., ... & Lemon, S. C. (2018). Objective measurement of physical activity outcomes in lifestyle interventions among adults: A systematic review. *Preventive Medicine Reports*, 11, 74-80.

Silliman, K., Rodas-Fortier, K., & Neyman, M. (2004). Survey of dietary and exercise habits and perceived barriers to following a healthy lifestyle in a college population. *Californian Journal of Health Promotion*, 2(2), 10-19.

Sim, L. J., Parker, L., & Kumanyika, S. K. (Eds.). (2010). Bridging the evidence gap in obesity prevention: a framework to inform decision making. National Academies Press. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK220174/

Siqiang, G. (2017). Experimental study of aerobic exercise on the weight loss effect of obese female college students. Biomedical Research 2018; Special Issue: S193-S196

Slavin, J. L., & Lloyd, B. (2012). Health benefits of fruits and vegetables. *Advances in Nutrition*, 3(4), 506-516.

Smith-Jackson, T., & Reel, J. J. (2012). Freshmen women and the “Freshman 15”: perspectives on prevalence and causes of college weight gain. *Journal of American College Health*, 60(1), 14-20.

Smits, S., McCutchan, G., Wood, F., Edwards, A., Lewis, I., Robling, M., ... & Brain, K. (2018). Development of a behavior change intervention to encourage timely cancer symptom presentation among people living in deprived communities using the behavior change wheel. *Annals of Behavioral Medicine*, *52*(6), 474-488.

Sockalingam, S., Leung, S. E., & Cassin, S. E. (2020). The Impact of Coronavirus Disease 2019 on Bariatric Surgery: Redefining Psychosocial Care. *Obesity*, *28*(6), 1010-1012.

Sogari, G., Velez-Argumedo, C., Gómez, M. I., & Mora, C. (2018). College students and eating habits: A study using an ecological model for healthy behavior. *Nutrients*, *10*(12), 1823.

Sparling, P. B. (2007). Obesity on campus. *Preventing Chronic Disease*, 4(3).

Specchia, M. L., Veneziano, M. A., Cadeddu, C., Ferriero, A. M., Mancuso, A., Ianuale, C., ... & Ricciardi, W. (2015). Economic impact of adult obesity on health systems: a systematic review. *The European Journal of Public Health*, 25(2), 255-262.

Squires, A. (2008). Language barriers and qualitative nursing research: methodological considerations. *International Nursing Review*, 55(3), 265-273.

Srinivasan, S. R., Bao, W., Wattigney, W. A., & Berenson, G. S. (1996). Adolescent overweight is associated with adult overweight and related multiple cardiovascular risk factors: the Bogalusa Heart Study. *Metabolism*, 45(2), 235-240.

Stack, J., Mahoney, S., & Christopher, H. (2014). Factors associated with diabetes risk in south Texas college students. *International Journal of Exercise Science*, 7, Article 2.

Stanger-Hall, K. F., & Hall, D. W. (2011). Abstinence-only education and teen pregnancy rates: Why we need comprehensive sex education in the US. *PloS one*, *6*(10), e24658.

Sterne, J. A., Hernán, M. A., Reeves, B. C., Savović, J., Berkman, N. D., Viswanathan, M., ... & Higgins, J. P. (2016). ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. bmj, 355.

Sterne, J. A., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., ... & Higgins, J. P. (2019). RoB 2: a revised tool for assessing risk of bias in randomised trials. bmj, 366.

Stok, F. M., Renner, B., Clarys, P., Lien, N., Lakerveld, J., & Deliens, T. (2018). Understanding eating behavior during the transition from adolescence to young adulthood: A literature review and perspective on future research directions. *Nutrients*, 10(6), 667.

Stokols, D. (1996). Translating social ecological theory into guidelines for community health promotion. *American Journal of Health Promotion*, 10(4), 282-298.

Stokols D., Grzywacz J.G., McMahan S., & Phillips K. (2003). Increasing the health promotive capacity of human environments. *American Journal of Health Promotion*, 18(1), 4–13.

Stroebele-Benschop, N., Damms-Machado, A., Milan, F. M. P., Hilzendegen, C., & Bischoff, S. C. (2013). Gender differences in the outcome of obesity treatments and weight loss maintenance-a systematic review. *J Obes Weight Loss Ther*, *3*(4), 1-11.

Strong, K. A., Parks, S. L., Anderson, E., Winett, R., & Davy, B. M. (2008). Weight gain prevention: identifying theory-based targets for health behavior change in young adults. *Journal of the American Dietetic Association*, 108(10), 1708-1715.

Strycker, L. A., Duncan, S. C., Chaumeton, N. R., Duncan, T. E., & Toobert, D. J. (2007). Reliability of pedometer data in samples of youth and older women. *International Journal of Behavioral Nutrition and Physical Activity*, *4*(1), 4.

Stuckey, H. L., Boan, J., Kraschnewski, J. L., Miller-Day, M., Lehman, E. B., & Sciamanna, C. N. (2011). Using positive deviance for determining successful weight-control practices. *Qual Health Res*, 21, 563-579.

Suliman, A. & Gubash, C. (May 21, 2020). As the middle east prepares for Eid holiday, coronavirus cases spike. NBCNews.com. Retrieved from https://www.nbcnews.com/news/world/middle-east-prepares-eid-holiday-coronavirus-cases-spike-n1211851.

Sutcliffe, K., Melendez-Torres, G. J., Burchett, H. E., Richardson, M., Rees, R., & Thomas, J. (2018). The importance of service-users' perspectives: A systematic review of qualitative evidence reveals overlooked critical features of weight management programmes. *Health Expectations*, *21*(3), 563-573.

Swinburn B & Eggar G. (2002). Preventive strategies against weight gain and obesity. *Obesity Reviews*, 3(4), 289–301

Swinburn, B. A., Sacks, G., Hall, K. D., McPherson, K., Finegood, D. T., Moodie, M. L., & Gortmaker, S. L. (2011). The global obesity pandemic: shaped by global drivers and local environments. *The Lancet*, *378*(9793), 804-814.

Sylvia, L. G., Bernstein, E. E., Hubbard, J. L., Keating, L., & Anderson, E. J. (2014). Practical guide to measuring physical activity. *Journal of the Academy of Nutrition and Dietetics*, 114(2), 199–208. Retrieved from https://doi.org/10.1016/j.jand.2013.09.018

Taillie, L. S., Reyes, M., Colchero, M. A., Popkin, B., & Corvalán, C. (2020). An evaluation of Chile's Law of Food Labeling and Advertising on sugar-sweetened beverage purchases from 2015 to 2017: A before-and-after study. *PLoS Medicine*, 17(2), e1003015.

Tate, D. F., Turner-McGrievy, G., Lyons, E., Stevens, J., Erickson, K., Polzien, K., ... & Popkin, B. (2012). Replacing caloric beverages with water or diet beverages for weight loss in adults: main results of the C hoose H ealthy O pt i ons C onsciously E veryday (CHOICE) randomized clinical trial. *The American journal of clinical nutrition*, *95*(3), 555-563.

Taylor, J., & Muller, D. (2005). Nursing adolescents research and psychological perspectives. London: Wiley BlackWell Science. ISBN: 0632036257

Taylor, M. R., Agho, K. E., Stevens, G. J., & Raphael, B. (2008). Factors influencing psychological distress during a disease epidemic: data from Australia's first outbreak of equine influenza. *BMC public health*, 8(1), 347.

Teixeira, P. J., Carraça, E. V., Marques, M. M., Rutter, H., Oppert, J. M., De Bourdeaudhuij, I., ... & Brug, J. (2015). Successful behavior change in obesity interventions in adults: a systematic review of self-regulation mediators. *BMC medicine*, *13*(1), 84.

Teti, M., Schatz, E., & Liebenberg, L. (2020). Methods in the time of COVID-19: The vital role of qualitative inquiries. *International Journal of Qualitative Methods*. doi: 10.1177/1609406920920962

Thome, J.L., & Espelage, D.L. (2007). Obligatory exercise and eating pathology in college females: Replication and development of a structural model. Eat Behav, 8(3), 334–49.

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*, 19(6), 349-357.

Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and Applications*, 5, 147-158.

Torres, S. J., & Nowson, C. A. (2007). Relationship between stress, eating behavior, and obesity. *Nutrition*, 23(11-12), 887-894.

Tremmel, M., Gerdtham, U. G., Nilsson, P. M., & Saha, S. (2017). Economic burden of obesity: a systematic literature review. *International Journal of Environmental Research and Public Health*, 14(4), 435.

Trigueros, R., Juan, M., & Sandoval, F. H. (2017). Qualitative and quantitative research instruments: Research tools. *Handbook of research methods and applications in political science*, 341-342.

Tudor-Locke, C., & Bassett, D. R. (2004). How many steps/day are enough?. *Sports medicine*, *34*(1), 1-8.

Turner, L. J., Houchen, L., Williams, J., & Singh, S. J. (2012). Reliability of pedometers to measure step counts in patients with chronic respiratory disease. Journal of cardiopulmonary rehabilitation and prevention, 32(5), 284-291.

U.S. Embassy and Consulates in Saudi Arabia. (2020). Ask a Covid 19 Question. Retrieved 25 March, 2021, from https://sa.usembassy.gov/u-s-citizen-services/covid-19-information.

Vadeboncoeur, C., Townsend, N., & Foster, C. (2015). A meta-analysis of weight gain in first year university students: is freshman 15 a myth?. *BMC Obesity*, 2(1), 22.

Van der Horst, K., Brunner, T. A., & Siegrist, M. (2011). Ready-meal consumption: associations with weight status and cooking skills. *Public health nutrition*, *14*(2), 239-245.

Van Genugten, L., Dusseldorp, E., Webb, T. L., & Van Empelen, P. (2016). Which combinations of techniques and modes of delivery in internet-based interventions effectively change health behavior? A meta-analysis. *Journal of Medical Internet Research*, 18(6), e155.

Varkevisser, R.D.M., van Stralen, M. M., Kroeze, W., Ket, J.C.F., & Steenhuis, I.H.M. (2018). Determinants of weight loss maintenance: a systematic review. Obes Rev., 20(2), 171-211.

Vella-Zarb,R.A., & Elgar, F.J. (2009). The ‘freshman 5’: a meta-analysis of weight gain in the freshman year of college. *Journal of American College Health*, 58(2), 161-166.

Von Ah, D., Ebert, S., Ngamvitroj, A., Park, N., & Kang, D. H. (2004). Predictors of health behaviours in college students. *Journal of Advanced Nursing*, 48(5), 463-474.

Wadden, T. A., Neiberg, R. H., Wing, R. R., Clark, J. M., Delahanty, L. M., Hill, J. O., ... & Look AHEAD Research Group. (2011). Four-year weight losses in the

Look AHEAD study: factors associated with long-term success. *Obesity*, 19(10), 1987-1998.

Wallston, K. A., Strudler Wallston, B., & DeVellis, R. (1978). Development of the multidimensional health locus of control (MHLC) scales. *Health education monographs*, *6*(1), 160-170.

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., & Ho, R. C. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *International journal of environmental research and public health*, 17(5), 1729.

Wang, Y.C., McPherson, K., Marsh, T., Gortmaker, S.L, & Brown, M. (2011). Health and economic burden of the projected obesity trends in the USA and the UK. *The Lancet*, 378(9793), 815-25.

Wattanapisit, A. & Thanamee, S., (2017). Evidence behind 10,000 steps walking. *J Health Res*. vol.31 no.3 June 2017

Webb, J., Foster, J., & Poulter, E. (2016). Increasing the frequency of physical activity very brief advice for cancer patients. Development of an intervention using the behaviour change wheel. Public health, 133, 45-56.

Webb, R., Davies I., Johnson B., Abayomi J. (2014). A qualitative evaluation of an NHS Weight Management Programme for obese patients in Liverpool. Nutr Food Sci, 44, 144-155.Weidner, G., Kohlmann, C.-W., Dotzauer, E., & Burns, L. R. (1996). The effects of academic stress on health behaviors in young adults. Anxiety, stress, and coping, 9(2), 123-133.

Weinstein, N. D. (1988). The precaution adoption process. *Health psychology*, *7*(4), 355.

Weinstein, N. D., Lyon, J. E., Sandman, P. M., & Cuite, C. L. (1998). Experimental evidence for stages of health behavior change: the precaution adoption process model applied to home radon testing. *Health psychology*, *17*(5), 445.

Weinstein, N. D., & Sandman, P. M. (2002). Chapter two: the precaution adoption process model and its application. *Emerging theories in health promotion practice and research: strategies for improving public health. San Francisco, CA, USA: Jossey-Bass*, 16-39.

Wells, J.C.K., & Fewtrell, M.S. (2006). Measuring body composition. *Archives of Disease in Childhood*, 91(7), 612-7.

Weng, T.-T., Hao, J.-H., Qian, Q.-W., Cao, H., Fu, J.-L., Sun, Y., ... Tao, F.-B. (2012). Is there any relationship between dietary patterns and depression and anxiety in Chinese adolescents? *Public health nutrition*, 15(4), 673-682.

West., R. (2005). Time for a change: putting the Transtheoretical (Stages of Change) Model to rest. Addiction. 100(8),1036-1039.

Wester, M., & Giesecke, J. (2019). Ebola and healthcare worker stigma. Scandinavian journal of public health, 47(2), 99-104.

WHO/FAO Expert Consultation (2003). Diet, Nutrition and the Prevention of Chronic Diseases. Retrieved from http://www.fao.org/3/AC911E/ac911e00.htm#Contents.

Widmar, N. J. O., Byrd, E. S., Dominick, S. R., Wolf, C. A., & Acharya, L. (2016). Social desirability bias in reporting of holiday season healthfulness. *Preventive medicine reports*, 4, 270-276.

Wight, D., Wimbush, E., Jepson, R., & Doi, L. (2016). Six steps in quality intervention development (6SQuID). *J Epidemiol Community Health*, 70(5), 520-525.

Wilken, J. A., Pordell, P., Goode, B., Jarteh, R., Miller, Z., Saygar, B. G., ... Walker, G. W. (2017). Knowledge, attitudes, and practices among members of households actively monitored or quarantined to prevent transmission of Ebola Virus Disease—Margibi County, Liberia: February-March 2015. *Prehospital and disaster medicine*, 32(6), 673-678.

Wilkinson, S. (1998). Focus groups in health research: Exploring the meanings of health and illness. *Journal of Health Psychology*, *3*(3), 329-348.

Willeboordse, M., Kant, K. D. V. D., Tan, F. E., Mulkens, S., Schellings, J., Crijns, Y., ... & Dompeling, E. (2016). A multifactorial weight reduction programme for children with overweight and asthma: a randomized controlled trial. *PloS one*, *11*(6), e0157158.

Williamson, D. A., Bray, G. A., & Ryan, D. H. (2015). Is 5% weight loss a satisfactory criterion to define clinically significant weight loss?. *Obesity,* 23(12), 2319-2320.

Wing, R.R., & Jeffery, R.W. (1999). Benefits of recruiting participants with friends and increasing social support for weight loss and maintenance. *J. Consult. Clin. Psychol*, 67, 132–138.

Wing, R. R., & Phelan, S. (2005). Long-term weight loss maintenance–. *The American Journal of Clinical Nutrition*, 82(1), 222S-225S.

Wisdom, J., & Creswell, J. W. (2013). Mixed methods: integrating quantitative and qualitative data collection and analysis while studying patient-centered medical home models. *Rockville: Agency for Healthcare Research and Quality*. AHRQ Publication No: 13-0028-EF

Withrow, D., & Alter, D.A. (2011).The economic burden of obesity worldwide: a systematic review of the direct costs of obesity. *Obesity Reviews*, 12(2), 131-41.

Winter, J.E. (2014). BMI and all-cause mortality in older adults: a meta-analysis. *Am J Clin Nutr*, 99(1),

Wolf, A. M., & Colditz, G. A. (1994). The cost of obesity. *Pharmacoeconomics*, 5(1), 34-37.

World Bank. (2017). GDP per Capita in Saudi Arabia. World Bank Group Retrieved 25 March, 2021, from https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=SA

World Bank. (2021). Urban population (% of total population) - Saudi Arabia. Retrieved from: (https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=SA.

Wood, C. E., Hardeman, W., Johnston, M., Francis, J., Abraham, C., & Michie, S. (2015). Reporting behaviour change interventions: do the behaviour change technique taxonomy v1, and training in its use, improve the quality of intervention descriptions?. *Implementation Science*, 11(1), 84.

World Health Organization. (2011). Global Strategy on Diet, Physical Activity and Health. Retrieved 25 March, 2021, from https://www.who.int/dietphysicalactivity/factsheet_adults/en/

World Health Organization. (2002). Global database on BMI. Retrieved 25 March, 2021, from http://apps.who.int/bmi/index.jsp?introPage=intro_3.html2002.

World Health Organization. (2015). Healthy Diet. Retrieved 25 March, 2021, from https://www.who.int/nutrition/publications/nutrientrequirements/healthydiet_factsheet394.pdf

World Health Organization. (2018). Healthy Diet. Retrieved 25 March, 2021, from https://www.who.int/news-room/fact-sheets/detail/healthy-diet

World Health Organization. (2019) Mean Body Mass Index (BMI). Global Health Observatory (GHO) data. Retrieved 25 March, 2021, from https://www.who.int/gho/ncd/risk_factors/overweight_obesity/obesity_adults/en/.2019

World Health Organization. (2020b). Mean Body Mass Index. Retrieved 25 March, 2021, from https://www.who.int/gho/ncd/risk_factors/bmi_text/en/.

World Health Organization. (2017b). Mean body mass index trends among adults, age-standardized (kg/m²). Estimates by WHO region. Retrieved from http://apps.who.int/gho/data/view.main.BMIMEANAREGv?lang=en.

World Health Organization. (2018). Obesity and Overweight. Retrieved 25 March, 2021, from https://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight.

World Health Organization. (2020c). Overweight and obesity. Retrieved 25 March, 2021, from https://www.who.int/gho/ncd/risk_factors/bmi_text/en/.

World Health Organization. (2020d). Physical Activity and Adults. Retrieved 25 March, 2021, from https://www.who.int/dietphysicalactivity/factsheet_adults/en/.

World Health Organization. Physical Status. (1995). The use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser., 854, 1–452.

World Health Organization. (2017a). Prevalence of obesity among adults, BMI ≥ 30, age-standardized Estimates by country. Retrieved 25 March, 2021, from http://apps.who.int/gho/data/view.main.CTRY2450A?lang=en.

World Health Organization. (2016). STEPS Surveillance Manual. e WHO STEP wise Approach to Chronic Disease Risk Factor Surveillance. (PAHO): World Health Organization; 2016. Retrieved 25 March, 2021, from http://www1.paho.org/hq/dmdocuments/2009/STEPSmanual.pdf

World Health Organization. (1995). The use and interpretation of anthropometry: report of a WHO expert committee. *World Health Organ Tech Rep Ser*. 854, 312-409.

World Health Organization. (2020a). Unhealthy diet. Retrieved 25 March, 2021, from https://www.who.int/gho/ncd/risk_factors/unhealthy_diet_text/en/.

World Health Organization. (March 11, 2020). WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. Retrieved 25 March, 2021, from https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

World Population Review (2020). 2020 World Population by Country, Retrieved from https://worldpopulationreview.com/Wyatt, H. R. (2013). Update on treatment strategies for obesity. *The Journal of Clinical Endocrinology & Metabolism*, 98(4), 1299-1306.

WHO. (2021). Confirmed Cases of COVID-19 Saudi Arabia. World Health Organization. Retrieved 25 March, 2021, from https://covid19.who.int/region/emro/country/sa

Yanovski, S. Z., & Yanovski, J. A. (2014). Long-term drug treatment for obesity: a systematic and clinical review. *Jama*, 311(1), 74-86.

Yakusheva, O., Kapinos, K., & Weiss, M. (2011). Peer effects and the freshman 15: evidence from a natural experiment. *Economics & Human Biology*, 9(2), 119-132.

Yar, T. (2008). Using “spinal shrinkage” as a trigger for motivating students to learn about obesity and adopt a healthy lifestyle. *Adv Physiol Educ,* 32(3), 237-241.

Yezli, S., & Khan, A. (2020). COVID-19 social distancing in the Kingdom of Saudi Arabia: Bold measures in the face of political, economic, social and religious challenges. *Travel Medicine and Infectious Disease,* 101692.

Zhang, Y., Liu, J., Yao, J., Ji, G., Qian, L., Wang, J., ... & Liu, Y. (2014). Obesity: pathophysiology and intervention. Nutrients, 6(11), 5153-5183.

Appendices

Appendix 1. Literature Search and Quality Assessment

Appendix 1A: PICOS for Identified Keywords and Index Terms for Literature Search

Search Terms	MeSH	Free-text.mp
Population	university student/ or university/ college student/ college	university education.mp. universities.mp.
Intervention	health promotion health education/ exercise/ or physical activity/ diet/ nutrition sport/ lifestyle/	health behaviour.mp. obesity management.mp. sports.mp. weight management.mp. weight reduction programs.mp. health behaviour.mp.
Comparator	-	control.mp.
Outcome	Weight/BMI/body fat	(weight adj5 los*).mp. BMI.mp.
Study Design (Filter)	randomised controlled trial/ controlled clinical trial/ placebo/	randomised.mp. randomly.mp. trial.mp. groups.mp.

Appendix 1B: General Search Strategy

Boolean operators 'AND' and 'OR' were used. Moreover, to ensure that words spelt differently in British English and American English, both spelling were used (for example, 'behaviour' and 'behavior'). In addition to this, the positional operator 'adjn' and Truncation '*' were used to enhance the efficacy of the search. 'Adjn' is a positional operator that helps to retrieve records that contain search terms in any order within a certain number of words of each other, e.g., ' adj5' operator was used for this review to find terms in any order in which there were four or fewer words between them. The endings of words were symbolised by an asterisk (*) so that all variations from the root of a word could be located, e.g., a search for 'los*' resulted in the appearances of 'losing' 'loss' lost' or 'lose.' These techniques were used to capture all relevant studies

Databases Search Strategies and Search Terms

Database: Embase

Date searched: 1980 to March 2019 (week 17)

Search Strategy:

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1 university student/ or university/ (115190)

2 college student/ (14395)

3 college/ (110118)

4 tertiary education.mp. (1239)

5 universities.mp. (25464)

6 health promotion/ (91330)

7 health behaviour.mp. or health behavior/ (63391)

8 health education/ (84284)

9 exercise/ or physical activity/ (360307)

10 diet/ (190514)

11 nutrition/ (95395)

12 obesity management.mp. (1488)

13 sports.mp. or sport/ (94729)

14 weight management.mp. (8611)

15 weight reduction programs.mp. (186)

16 lifestyle/ (103719)

17 weight reduction/ (146810)

18 (weight adj5 los*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word] (149535)

19 randomized controlled trial/ (541295)

20 controlled clinical trial/ (461705)

21 randomized.mp. (1004603)

22 randomly.mp. (402915)

23 trial.mp. (1951489)

24 placebo/ (318829)

25 groups.mp. (2626893)

26 1 or 2 or 3 or 4 or 5 (249632)

27 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 (920038)

28 17 or 18 (210371)

29 19 or 20 or 21 or 22 or 23 or 24 or 25 (4477231)

30 26 and 27 and 28 and 29 (308)

Database: Ovid MEDLINE(R)

Date searched: 1946 to April week 4, 2019

Search Strategy:

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1 Universities/ or university student.mp. (37923)

2 university.mp. (283064)

3 tertiary education.mp. (728)

4 college student.mp. (1766)

5 college.mp. (82632)

6 Health Promotion/ (69230)

7 Health Behavior/ (46610)

8 health behaviour.mp. (3168)

9 Health Education/ (58785)

10 physical activity.mp. or Exercise/ (149069)

11 DIET/ (150062)

12 nutrition.mp. (192387)

13 Obesity Management/ (62)

14 SPORTS/ (28947)

15 weight management.mp. (4449)

16 Weight Reduction Programs/ (1725)

17 Life Style/ (53702)

18 weight reduction.mp. (9236)

19 (weight adj5 los*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (89587)

20 Randomized Controlled Trial/ (480664)

21 Controlled Clinical Trial/ (93027)

22 randomized.mp. (718414)

23 randomly.mp. (265847)

24 placebo.mp. (184890)

25 trial.mp. (1041938)

26 groups.mp. (1775174)

27 1 or 2 or 3 or 4 or 5 (367501)

28 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 (632464)

29 18 or 19 (93559)

30 20 or 21 or 22 or 23 or 24 or 25 or 26 (2795060)

31 27 and 28 and 29 and 30 (317)

Database: PsycINFO

Date searched: 1806 to April week 4, 2019

Search Strategy:

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1 universities.mp. (22737)

2 university student.mp. (1567)

3 university.mp. (139708)

4 exp COLLEGES/ or college.mp. (245658)

5 college student.mp. or exp College Students/ (87647)

6 tertiary education.mp. (710)

7 exp Health Promotion/ (23193)

8 exp Health Behavior/ or health behaviour.mp. (28386)

9 exp Health Education/ (17723)

10 exp Physical Activity/ (38338)

11 exp EXERCISE/ (24598)

12 diet.mp. or exp DIETS/ (27807)

13 exp NUTRITION/ (9981)

14 obesity management.mp. (188)

15 exp SPORTS/ (24789)

16 weight management.mp. (2162)

17 weight reduction programs.mp. (65)

18 exp Lifestyle/ (11085)

19 weight reduction.mp. (1322)

20 (weight adj5 los*).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] (13412)

21 randomized controlled trial.mp. (16145)

22 controlled clinical trial.mp. (1423)

23 randomized.mp. (68233)

24 randomly.mp. (68716)

25 exp PLACEBO/ (5233)

26 trial.mp. (101037)

27 groups.mp. (513754)

28 1 or 2 or 3 or 4 or 5 or 6 (347173)

29 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 (153541)

30 19 or 20 (14038)

31 21 or 22 or 23 or 24 or 25 or 26 or 27 (659084)

32 28 and 29 and 30 and 31 (106)

Database: EBM Reviews - Cochrane Central Register of Controlled Trials

Date searched: March 2019

Search Strategy:

----

1 university student.mp. or Universities/ (1283)

2 university.mp. (40951)

3 tertiary education.mp. (43)

4 college student.mp. (756)

5 college.mp. (17298)

6 Health Education/ (3592)

7 Health Behavior/ (3669)

8 health behaviour.mp. (462)

9 Health Promotion/ (5094)

10 physical activity.mp. (24422)

11 Exercise/ (13999)

12 Diet/ (6301)

13 nutrition.mp. (21588)

14 obesity management.mp. (186)

15 Sports/ (835)

16 Weight Reduction Programs/ or weight management.mp. (2286)

17 Life Style/ (2997)

18 weight reduction.mp. (6958)

19 (weight adj5 los*).mp. [mp=title, original title, abstract, mesh headings, heading words, keyword] (18962)

20 Randomized Controlled Trial/ (129)

21 Controlled Clinical Trial/ (34)

22 randomized.mp. (749599)

23 randomly.mp. (213304)

24 placebo.mp. (276089)

25 trial.mp. (764892)

26 groups.mp. (415211)

27 1 or 2 or 3 or 4 or 5 (56683)

28 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 (67442)

29 18 or 19 (20875)

30 20 or 21 or 22 or 23 or 24 or 25 or 26 (1117199)

31 27 and 28 and 29 and 30 (353)

Appendix 1C: Cochrane risk-of-bias tool for randomised trials (RoB 2)

Unique ID	A1	**Study ID**	Study_01	**Assessor**	DR
Ref or Label	Memon_2018	**Aim**	adhering to intervention (the 'per-protocol' effect)	**The effect of adhering to interventi on…**	occurrence of non-protocol interventions; failures in implementing the intervention that could have affected the outcome; non-adherence to their assigned intervention by trial participants
Experimental	Incentivised Physical Activity	**Comparator**	Non-incentivised	**Source**	Journal article(s) with results of the trial
Outcome	BMI	**Results**		**Weight**	1

Domain	Signalling question	Respons e	Comments
Bias arising from the randomization process	1.1 Was the allocation sequence random?	Y	Quote: "The selected subjects were randomly allocated to either the incentivized group or the non-incentivized group through a computer-generated randomised table with an allocation ratio of 1:1" Comment: No Information regarding concealment of allocation

	1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	NI	
	1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?	Y	Large baseline differences - intervention group had many more steps at baseline indicating randomization problem?
	Risk of bias judgement	High	Considerable baseline differences apparent and no concealment information provided.
Bias due to deviations from intended interventions	2.1 Were participants aware of their assigned intervention during the trial?	Y	Comment: Not possible to blind participants or researchers to intervention due to study context - incentivised vs non incentivised.
	2.2 Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?	Y	
	2.3. [If applicable:] If Y/PY/NI to 2.1 or 2.2: Were important non-protocol interventions balanced across intervention groups?	Y	Comment: No information given regarding deviations, but given the context this is unlikely.
	2.4. [If applicable:] Were there failures in implementing the intervention that could have affected the outcome?	N	No

	2.5. [If applicable:] Was there non-adherence to the assigned intervention regimen that could have affected participants' outcomes?	N	No
	2.6. If N/PN/NI to 2.3, or Y/PY/NI to 2.4 or 2.5: Was an appropriate analysis used to estimate the effect of adhering to the intervention?	NA	
	Risk of bias judgement	Some concerns	Since it is not feasibly possible to blind this type of study, risk of placebo affect is high.
Bias due to missing outcome data	3.1 Were data for this outcome available for all, or nearly all, participants randomized?	Y	Comment: Outcome data for all randomised participants.
	3.2 If N/PN/NI to 3.1: Is there evidence that result was not biased by missing outcome data?	NA	
	3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?	NA	
	3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?	NA	
	Risk of bias judgement	Low	Outcome data for all randomised participants.
Bias in measurement of the outcome	4.1 Was the method of measuring the outcome inappropriate?	N	Comment: Number of steps and BMI are appropriate measures.

	4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?	N	Comment: No discernible differences between groups
	4.3 Were outcome assessors aware of the intervention received by study participants?	Y	Comment: Study not blinded.
	4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?	N	Comment: Reporting of the outcome of steps taken and BMI cannot be influenced by knowledge since it was recorded automatically.
	4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?	NA	
	Risk of bias judgement	Low	Appropriate outcome measurement.
Bias in selection of the reported result	5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis?	PY	Comment: Researchers do not explicitly confirm this, but analytic method explained in detail and no reason to assume this was changed after outcome data received.
	5.2 ... multiple eligible outcome measurements (e.g. scales, definitions, time points) within the outcome domain?	PN	Comment: There is only one way to measure BMI and steps taken. However, secondary outcomes were measured but not reported on fully, and these measures do have multiple outcome measures (body image scale, body dissatisfaction scale, physical appearance scale). However, these results were not discussed and so no apparent bias.

	5.3 ... multiple eligible analyses of the data?	N	Comment: Analysis of data not using multiple analytical methods.
	Risk of bias judgement	Low	Low risk of bias. Reporting of results is simple and in line with prespecified criteria and no evidence to suggest analysis was selected for reasons that could bias results.
Overall bias	Risk of bias judgement	High	Key limitations in study design bias this study in favour of intervention, since blinding not possible and large baseline differences noted.

Unique ID	A2	**Study ID**	Study_02	**Assessor**	DR
Ref or Label	Roach_2003	**Aim**	adhering to intervention (the 'per-protocol' effect)	**The effect of adhering to interventi on…**	occurrence of non-protocol interventions; failures in implementing the intervention that could have affected the outcome; non-adherence to their assigned intervention by trial participants
Experimental	Self-efficacy intervention	**Comparator**	No self-efficacy intervention	**Source**	Journal article(s) with results of the trial

Outcome	WCQ, DRA, Weight	Results		Weight	1

Domain	Signalling question	Response	Comments
Bias arising from the randomization process	1.1 Was the allocation sequence random?	NI	Comment: Study reports that "all students who volunteered were randomly placed in either the intervention or control group using a ratio of approximately two to one. Whilst this suggests randomisation was used, there is no information about how this was achieved or whether this process was appropriate. No information given about concealment.
	1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	NI	
	1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?	N	No apparent differences at baseline for all outcome measures.
	Risk of bias judgement	Some concerns	There is a risk that appropriate randomisation and concealment have not been used as details are not offered. However, baseline characteristics are similar.

Bias due to deviations from intended interventions	2.1 Were participants aware of their assigned intervention during the trial?	Y	Comment: Due to nature of intervention (self-efficacy education course), both researchers and participants would be aware of allocation to intervention or otherwise.
	2.2 Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?	Y	
	2.3. [If applicable:] If Y/PY/NI to 2.1 or 2.2: Were important non-protocol interventions balanced across intervention groups?	Y	Comment: Researchers report no deviations from intended interventions.
	2.4. [If applicable:] Were there failures in implementing the intervention that could have affected the outcome?	N	
	2.5. [If applicable:] Was there non-adherence to the assigned intervention regimen that could have affected participants' outcomes?	N	
	2.6. If N/PN/NI to 2.3, or Y/PY/NI to 2.4 or 2.5: Was an appropriate analysis used to estimate the effect of adhering to the intervention?	NA	
	Risk of bias judgement	Some Concerns	Non blind study
Bias due to missing outcome data	3.1 Were data for this outcome available for all, or nearly all, participants randomized?	N	Comment: Outcome data not provided for approx. 10% of participants.
	3.2 If N/PN/NI to 3.1: Is there evidence that result was not biased by missing outcome data?	N	Comment: No discussion of sensitivity analysis or adjustments for bias in missing data.

	3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?	Y	Comment: Withdrawal from study could potentially be related to participants health status. However, drop out rates were similar across both groups and it is not very likely that withdrawal from intervention was due to the intervention itself or health characteristics of the participant, but this is possible.
	3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?	PN	
	Risk of bias judgement	Some concerns	Some possible concerns relating to missing data for withdrawn participants.
Bias in measurement of the outcome	4.1 Was the method of measuring the outcome inappropriate?	N	Comment: Weight and DRA/WCQ scales are appropriate measures.
	4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?	N	Comment: No discernible difference in outcome measurement between groups.
	4.3 Were outcome assessors aware of the intervention received by study participants?	PN	Comment: No information regarding this, but since the study was not blinded, it is to be assumed that outcome assessment was not blinded.
	4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?	NA	
	4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?	NA	
	Risk of bias judgement	Low	Appropriate outcome measurement.

Bias in selection of the reported result	5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis?	PY	Comment: Not discussed by researchers but no evidence to suggest analysis was amended after outcomes.
	5.2 ... multiple eligible outcome measurements (e.g. scales, definitions, time points) within the outcome domain?	N	Comment: Multiple measurement scales were utilised but all were reported on.
	5.3 ... multiple eligible analyses of the data?	N	Comment: Multiple analyses were not conducted.
	Risk of bias judgement	Low	Appropriate reporting and analysis of results.
Overall bias	Risk of bias judgement	Some Concerns	Despite appropriate analysis and outcome measurement, non-blinding renders study at risk of bias.

Unique ID	A3	**Study ID**	Study_03	**Assessor**	DR

Ref or Label	Ames_2005	Aim	adhering to intervention (the 'per-protocol' effect)	The effect of adhering to interventi on…	occurrence of non-protocol interventions; failures in implementing the intervention that could have affected the outcome; non-adherence to their assigned intervention by trial participants
Experimental	RCBT	Comparator	SBT	Source	Journal article(s) with results of the trial
Outcome	weight, weight expectation	Results		Weight	1

Domain	Signalling question	Respons e	Comments
Bias arising from the randomization process	1.1 Was the allocation sequence random?	NI	Quote: "Women... were subsequently randomised to one of two treatment groups." Comment: No further information provided. No information relating to allocation sequence.
	1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	NI	
	1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?	N	Quote: "No significant differences were observed between conditions at baseline for age, weight, BMI, race/ethnicity or for any of the self-report measures"
	Risk of bias judgement	Some concerns	Some concerns when judged by strict measures as randomization not fully explained.

Bias due to deviations from intended interventions	2.1 Were participants aware of their assigned intervention during the trial?	Y	Comment: Nature of study most likely means that blinding not possible, although this is not discussed.
	2.2 Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?	Y	
	2.3. [If applicable:] If Y/PY/NI to 2.1 or 2.2: Were important non-protocol interventions balanced across intervention groups?	Y	Comment: No reported deviations from intended intervention.
	2.4. [If applicable:] Were there failures in implementing the intervention that could have affected the outcome?	N	
	2.5. [If applicable:] Was there non-adherence to the assigned intervention regimen that could have affected participants' outcomes?	N	
	2.6. If N/PN/NI to 2.3, or Y/PY/NI to 2.4 or 2.5: Was an appropriate analysis used to estimate the effect of adhering to the intervention?	NA	
	Risk of bias judgement	Some concerns	Blinding not possible
Bias due to missing outcome data	3.1 Were data for this outcome available for all, or nearly all, participants randomized?	N	Quote: "28 participants completed the phase 1 run-in period" Less than half of randomised participants completed trial.
	3.2 If N/PN/NI to 3.1: Is there evidence that result was not biased by missing outcome data?	N	Quote: "Completers had significantly lower BMI and were more likely to be white"

	3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?	Y	Comment: Non completers had higher BMI and therefore this is highly likely biased especially in terms of weight loss expectations. However, differences did not exist between groups.
	3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?	Y	
	Risk of bias judgement	High	High dropout rate amongst higher BMI and ethnic minority women has probably biased results.
Bias in measurement of the outcome	4.1 Was the method of measuring the outcome inappropriate?	N	Comment: Entirely appropriate measurements taken.
	4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?	PN	Comment: No reason to suspect that measurement differed between groups, although not explicitly confirmed by authors.
	4.3 Were outcome assessors aware of the intervention received by study participants?	PY	Comment: Not explicitly confirmed but since this was not a blinded study, we can assume probably that authors were aware of groups. Since some measures are self-reported, assessor is participant in some cases. In this case definitely were aware of intervention.
	4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?	Y	Comment: For self-reported measures, yes - reporting potentially biased by knowledge of intervention. Reasonably likely.

	4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?	PY	
	Risk of bias judgement	High	Self-reporting in a non-blind study is at substantial risk for bias in favour of intervention, since participants in intervention group may feel pressured in some way into responding more positively towards experimenter.
Bias in selection of the reported result	5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis?	Y	Comment: Analysis plan outlined in detail.
	5.2 ... multiple eligible outcome measurements (e.g. scales, definitions, time points) within the outcome domain?	PN	Comment: No reason to believe that researchers have selected analysis based upon measure. All measures reported.
	5.3 ... multiple eligible analyses of the data?	PN	Comment: As above.
	Risk of bias judgement	Low	Low risk of bias in analysis.
Overall bias	Risk of bias judgement	High	Non blinded study with self-reported measurements at high risk of bias towards intervention.

Unique ID	A4	Study ID	Study_04	Assessor	DR
Ref or Label	Lee, 2017	Aim	adhering to intervention (the 'per-protocol' effect)	The effect of adhering to intervention…	occurrence of non-protocol interventions; failures in implementing the intervention that could have affected the outcome; non-adherence to their assigned intervention by trial participants
Experimental	Health Program	Comparator	No program	Source	Journal article(s) with results of the trial
Outcome	body composition, fitness	Results		Weight	1

Domain	Signalling question	Respons e	Comments
Bias arising from the randomization process	1.1 Was the allocation sequence random?	Y	Quote: "Research randomization 4.0, a randomized computer program, was used to perform the randomization" Comment: No information on concealment.
	1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	NI	
	1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?	N	Quote: "Before the intervention, there were no statistically significant differences in any variables between the intervention and control group"

	Risk of bias judgement	Some concerns	Appropriate randomization confirmed with baseline homogeneity.
Bias due to deviations from intended interventions	2.1 Were participants aware of their assigned intervention during the trial?	Y	Comment: Not possible to blind participants to intervention, due to the nature of the study.
	2.2 Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?	Y	
	2.3. [If applicable:] If Y/PY/NI to 2.1 or 2.2: Were important non-protocol interventions balanced across intervention groups?	Y	Comment: No information about deviations from intended intervention.
	2.4. [If applicable:] Were there failures in implementing the intervention that could have affected the outcome?	N	No
	2.5. [If applicable:] Was there non-adherence to the assigned intervention regimen that could have affected participants' outcomes?	N	No
	2.6. If N/PN/NI to 2.3, or Y/PY/NI to 2.4 or 2.5: Was an appropriate analysis used to estimate the effect of adhering to the intervention?	NA	
	Risk of bias judgement	Some concerns	
Bias due to missing outcome data	3.1 Were data for this outcome available for all, or nearly all, participants randomized?	Y	Comment: Data available for 30 out of 34 randomised participants, relatively equally distributed between intervention and control.
	3.2 If N/PN/NI to 3.1: Is there evidence that result was not biased by missing outcome data?	NA	

	3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?	NA	
	3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?	NA	
	Risk of bias judgement	Low	Low risk of bias due to missing outcome data as nearly all participants completed study.
Bias in measurement of the outcome	4.1 Was the method of measuring the outcome inappropriate?	N	Comment: BMI, bloods, muscle mass, grip strength, flexibility, cardio capacity are all appropriate measures.
	4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?	N	Comment: Outcome measurement was the same between groups.
	4.3 Were outcome assessors aware of the intervention received by study participants?	PY	Comment: No information provided regarding this but it is reasonable to assume that assessors were aware of group since this is not blinded study.
	4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?	PN	Comment: Outcomes are quantitative and objective, hence unlikely to be influenced except for in the case of deliberate falsification, which is very unlikely.
	4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?	NA	
	Risk of bias judgement	Low	Appropriate outcome measures.

Bias in selection of the reported result	5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis?	PY	Comment: Not discussed, but safe to assume that data analysed in accordance with specified analysis.
	5.2 ... multiple eligible outcome measurements (e.g. scales, definitions, time points) within the outcome domain?	N	Comment: Result unlikely to have been selected on the basis of outcome measurement - all measures reported on.
	5.3 ... multiple eligible analyses of the data?	N	Comment: Result unlikely to have been selected on the basis of other analyses.
	Risk of bias judgement	Low	Appropriate selection of results.
Overall bias	Risk of bias judgement	Some concerns	Some concerns with bias, especially since study is not blind, but outcome measures, randomization and analyses are all rigorous.

Unique ID	A5	**Study ID**	Study_05	**Assessor**	DR
Ref or Label	Logel, 2012	**Aim**	adhering to intervention (the 'per-protocol' effect)	**The effect of adhering to interventi on…**	occurrence of non-protocol interventions; failures in implementing the intervention that could have affected the outcome; non-adherence to their assigned intervention by trial participants
Experimental	values affirmation	**Comparator**	non-priority value affirmation	**Source**	Journal article(s) with results of the trial
Outcome	BMI, memory	**Results**		**Weight**	1

Domain	Signalling question	Respons e	Comments
Bias arising from the randomization process	1.1 Was the allocation sequence random?	NI	Quote: "randomly assigned to either an affirmation or no-affirmation condition" Comment: Not enough information to confirm randomization Quote: "The experimenters were blind to condition". Comment: Unclear as to extent of concealment.
	1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	NI	
	1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?	N	Quote: "randomization was successful, baseline BMI did not differ between the two conditions Fs < 1, n.s."
	Risk of bias judgement	Some concerns	Some concerns with randomization and concealment processes but unlikely to have biased study, as implied by baseline characteristics.
Bias due to deviations from intended interventions	2.1 Were participants aware of their assigned intervention during the trial?	Y	Comment: Due to nature of study, participants were aware of intervention. Quote: "The experimenters were blind to condition" Comment: Somewhat vague assertion as to experimenters blinding status.
	2.2 Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?	PN	

	2.3. [If applicable:] If Y/PY/NI to 2.1 or 2.2: Were important non-protocol interventions balanced across intervention groups?	Y	Comment: Researchers report no deviations. However, researchers not that a number of participants refused consent to be weighed and a number dropped out of study. This could be feasibly related to the study context, meaning that the assignment to intervention or more likely non-intervention, lead to some participants not feeling comfortable with being weighed.
	2.4. [If applicable:] Were there failures in implementing the intervention that could have affected the outcome?	N	No
	2.5. [If applicable:] Was there non-adherence to the assigned intervention regimen that could have affected participants' outcomes?	PY	Comment: Researchers report no deviations. However, researchers note that a number of participants refused consent to be weighed and a number dropped out of the study. This could be feasibly related to the study context, meaning that the assignment to intervention or more likely non-intervention lead to some participants not feeling comfortable being weighed.
	2.6. If N/PN/NI to 2.3, or Y/PY/NI to 2.4 or 2.5: Was an appropriate analysis used to estimate the effect of adhering to the intervention?	N	No appropriate analysis used to reflect changes.
	Risk of bias judgement	Some concerns	Unblinded study, with deviations potentially related to study context.
Bias due to missing outcome data	3.1 Were data for this outcome available for all, or nearly all, participants randomised?	N	Quote: "82% attended session 2"
	3.2 If N/PN/NI to 3.1: Is there evidence that result was not biased by missing outcome data?	Y	Quote: "Session 2 attendees did not differ in baseline weight F < 1, n.s."
	3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?	NA	

	3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?	NA	
	Risk of bias judgement	Low	Low risk of bias as attrition equal across both groups and at follow up.
Bias in measurement of the outcome	4.1 Was the method of measuring the outcome inappropriate?	PY	Quote: "Self-reported weight was obtained from 5 participants who did not consent"
	4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?	PN	Comment: A similar number refused consent between groups and refusal to consent is probably not dependent on the trial context.
	4.3 Were outcome assessors aware of the intervention received by study participants?	NA	
	4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?	NA	
	4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?	NA	

	Risk of bias judgement	High	Potentially biased by self-reporting of weight allowed by some participants. Those participants who weighed more may have been more likely to refuse consent. However, this did not differ between groups.
Bias in selection of the reported result	5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis?	PY	Comment: Analysed according to prespecified criteria.
	5.2 ... multiple eligible outcome measurements (e.g. scales, definitions, time points) within the outcome domain?	PY	Quote: "Other takes, not reported here, were also completed in session 1".
	5.3 ... multiple eligible analyses of the data?	PN	Comment: No reason to assume that other analyses were conducted.
	Risk of bias judgement	High	Appropriate analysis, however other measures/outcomes are mentioned without further discussion. Possible source of analytic bias.
Overall bias	Risk of bias judgement	High	High risk of bias. Weight is self-reported in a non-blinded study, significantly biasing results.

Appendix 1D: The Risk Of Bias In Non-randomised Studies – of Interventions (ROBINS-I) assessment tool

ROBINS-I tool: Hamaza (1994)

Risk of bias assessment

Responses underlined in green are potential markers for low risk of bias, and responses in red are potential markers for a risk of bias. Where questions relate only to sign posts to other questions, no formatting is used.

	Signalling questions	Description	Response options
Bias due to confounding			
	1.1 Is there potential for confounding of the effect of intervention in this study? **If N/PN to 1.1:** the study can be considered to be at low risk of bias due to confounding and no further signalling questions need be considered	Confounders outlined above could affect outcome.	Y
	If Y/PY to 1.1: determine whether there is a need to assess time-varying confounding:		
	1.2. Was the analysis based on splitting participants' follow up time according to intervention received? **If N/PN**, answer questions relating to baseline confounding (1.4 to 1.6) **If Y/PY**, go to question 1.3.	Participant's follow up time did not differ between groups	N

	1.3. Were intervention discontinuations or switches likely to be related to factors that are prognostic for the outcome? **If N/PN**, answer questions relating to baseline confounding (1.4 to 1.6) **If Y/PY**, answer questions relating to both baseline and time-varying confounding (1.7 and 1.8)		NA
	Questions relating to baseline confounding only		
	1.4. Did the authors use an appropriate analysis method that controlled for all the important confounding domains?	No appropriate analytical techniques used to control confounding.	N
	1.5. **If Y/PY to 1.4**: Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?		NA
	1.6. Did the authors control for any post-intervention variables that could have been affected by the intervention?		N
	Questions relating to baseline and time-varying confounding		
	1.7. Did the authors use an appropriate analysis method that controlled for all the important confounding domains and for time-varying confounding?		NA
	1.8. **If Y/PY to 1.7**: Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?		NA

	Risk of bias judgement	Only age and medication were controlled. All other confounders were not controlled in the study design.	Serious
	Optional: What is the predicted direction of bias due to confounding?		Unpredictable

Bias in selection of participants into the study			
	2.1. Was selection of participants into the study (or into the analysis) based on participant characteristics observed after the start of intervention? If N/PN to 2.1: go to 2.4	Participants were recruited to the study based on characteristics observed before the start of the intervention.	PN
	2.2. **If Y/PY to 2.1**: Were the post-intervention variables that influenced selection likely to be associated with intervention? 2.3 **If Y/PY to 2.2**: Were the post-intervention variables that influenced selection likely to be influenced by the outcome or a cause of the outcome?		NA NA

	2.4. Do start of follow-up and start of intervention coincide for most participants?	Participants followed from start of intervention.	PY
	2.5. **If Y/PY to 2.2 and 2.3, or N/PN to 2.4**: Were adjustment techniques used that are likely to correct for the presence of selection biases?		NA
	Risk of bias judgement	All participants who would have been eligible for the target trial were included in the study *and* for each participant, start of follow up and start of intervention coincided.	Low
	Optional: What is the predicted direction of bias due to selection of participants into the study?		

Bias in classification of interventions			
	3.1 Were intervention groups clearly defined?	Although not randomized, this is still an experimental trial, with clearly defined groups.	Y
	3.2 Was the information used to define intervention groups recorded at the start of the intervention?	Although it was not stated clearly, it is reasonable to assume this is the case due to experimental design.	PY
	3.3 Could classification of intervention status have been affected by knowledge of the outcome or risk of the outcome?	Classification were done at the start of the intervention and hence not affected by the knowledge of the outcome	N
	Risk of bias judgement	Intervention status is well defined *and* Intervention definition is based solely on information collected at the time of intervention.	Low

	Optional: What is the predicted direction of bias due to classification of interventions?		

Bias due to deviations from intended interventions			
	If your aim for this study is to assess the effect of assignment to intervention, answer questions 4.1 and 4.2		
	4.1. Were there deviations from the intended intervention beyond what would be expected in usual practice?		NA
	4.2. **If Y/PY to 4.1**: Were these deviations from intended intervention unbalanced between groups *and* likely to have affected the outcome?		NA
	If your aim for this study is to assess the effect of starting and adhering to intervention, answer questions 4.3 to 4.6		
	4.3. Were important co-interventions balanced across intervention groups?	No co interventions detailed	Y
	4.4. Was the intervention implemented successfully for most participants?	No information to suggest that any participants did not receive successful intervention.	PY
	4.5. Did study participants adhere to the assigned intervention regimen?	No information, including on dropout rates.	NI

	4.6. **If N/PN to 4.3, 4.4 or 4.5**: Was an appropriate analysis used to estimate the effect of starting and adhering to the intervention?		NA
	Risk of bias judgement	The important **co-interventions** were balanced across intervention groups, and there were no reported deviations from the intended interventions (in terms of **implementation or adherence**) that were likely to impact on the outcome. Probably low, but due to poor reporting, moderate risk.	Moderate
	Optional: What is the predicted direction of bias due to deviations from the intended interventions?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias due to missing data			
	5.1 Were outcome data available for all, or nearly all, participants?	Study does not report on outcome numbers, missing data, dropout rates etc.	NI
	5.2 Were participants excluded due to missing data on intervention status?		NI

	5.3 Were participants excluded due to missing data on other variables needed for the analysis?		NI
	5.4 **If PN/N to 5.1, or Y/PY to 5.2 or 5.3**: Are the proportion of participants and reasons for missing data similar across interventions?		NI
	5.5 **If PN/N to 5.1, or Y/PY to 5.2 or 5.3**: Is there evidence that results were robust to the presence of missing data?		NI
	Risk of bias judgement	Poor reporting on missing data on dropout rates increases risk of bias.	Moderate
	Optional: What is the predicted direction of bias due to missing data?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias in measurement of outcomes			
	6.1 Could the outcome measure have been influenced by knowledge of the intervention received?	Aerobic capacity, blood lipids and body composition recorded for all groups, and not reasonably affected by knowledge of intervention as they are objective outcomes not subjective.	N

	6.2 Were outcome assessors aware of the intervention received by study participants?		PY
	6.3 Were the methods of outcome assessment comparable across intervention groups?		Y
	6.4 Were any systematic errors in measurement of the outcome related to intervention received?	No systematic errors reported.	PN
	Risk of bias judgement	Appropriate measurement outcomes.	Low
	Optional: What is the predicted direction of bias due to measurement of outcomes?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias in selection of the reported result			
	Is the reported effect estimate likely to be selected, on the basis of the results, from...	All domains reported on.	
	7.1. ... multiple outcome *measurements* within the outcome domain?		N

	7.2 ... multiple *analyses* of the intervention-outcome relationship?	Multiple analyses of body composition and bloods are not likely.	PN
	7.3 ... different *subgroups*?	No sub groups.	N
	Risk of bias judgement	Low risk of bias in result selection.	Low
	Optional: What is the predicted direction of bias due to selection of the reported result?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Overall bias			
	Risk of bias judgement	Although much of the study could be reasonably comparable to an RCT, the lack of treatment of confounding variables places study at serious risk of bias.	Serious
	Optional: What is the overall predicted direction of bias for this outcome?		Unpredictable

ROBINS-I tool: Kondo et al. (2006)

Risk of bias assessment

Responses underlined in green are potential markers for low risk of bias, and responses in red are potential markers for a risk of bias. Where questions relate only to sign posts to other questions, no formatting is used.

	Signalling questions	Description	Response options
Bias due to confounding			
	1.1 Is there potential for confounding of the effect of intervention in this study? **If N/PN to 1.1:** the study can be considered to be at low risk of bias due to confounding and no further signalling questions need be considered	Age, smoking status and previous medications, as well as history of cardiovascular disease controlled. Ethnicity potentially controlled as study was only using Japanese students, but Japanese is not technically only an ethnicity (although likely to be). Other confounders outlined above could potentially affect outcome.	Y
	If Y/PY to 1.1: determine whether there is a need to assess time-varying confounding:		
	1.2. Was the analysis based on splitting participants' follow up time according to intervention received? **If N/PN**, answer questions relating to baseline confounding (1.4 to 1.6) **If Y/PY**, go to question 1.3.	Participant's follow up time did not differ between groups	N
	1.3. Were intervention discontinuations or switches likely to be related to factors that are prognostic for the outcome? **If N/PN**, answer questions relating to baseline confounding (1.4 to 1.6) **If Y/PY**, answer questions relating to both baseline and time-varying confounding (1.7 and 1.8)		NA
	Questions relating to baseline confounding only		

	1.4. Did the authors use an appropriate analysis method that controlled for all the important confounding domains?	No appropriate analytical techniques used to control confounding.	N
	1.5. **If Y/PY to 1.4**: Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?		NA
	1.6. Did the authors control for any post-intervention variables that could have been affected by the intervention?	Authors did not mention any post intervention variables.	N
	Questions relating to baseline and time-varying confounding		
	1.7. Did the authors use an appropriate analysis method that controlled for all the important confounding domains and for time-varying confounding?		NA
	1.8. **If Y/PY to 1.7**: Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?		NA
	Risk of bias judgement	Some potential confounders unaccounted for. No statistical analysis techniques utilised that could lessen risk of confounding bias.	Moderate
	Optional: What is the predicted direction of bias due to confounding?		Unpredictable

Bias in selection of participants into the study			
	2.1. Was selection of participants into the study (or into the analysis) based on participant characteristics observed after the start of intervention? If N/PN to 2.1: go to 2.4	Participants were recruited to the study based on characteristics observed before the start of the intervention.	PN

	2.2. **If Y/PY to 2.1**: Were the post-intervention variables that influenced selection likely to be associated with intervention? 2.3 **If Y/PY to 2.2**: Were the post-intervention variables that influenced selection likely to be influenced by the outcome or a cause of the outcome?		NA NA
	2.4. Do start of follow-up and start of intervention coincide for most participants?	Participants followed from start of intervention.	PY
	2.5. **If Y/PY to 2.2 and 2.3, or N/PN to 2.4**: Were adjustment techniques used that are likely to correct for the presence of selection biases?		NA
	Risk of bias judgement	All participants who would have been eligible for the target trial were included in the study *and f*or each participant, start of follow up and start of intervention were at the same time.	Low
	Optional: What is the predicted direction of bias due to selection of participants into the study?		

Bias in classification of interventions			
	3.1 Were intervention groups clearly defined?	Clearly defined groups based on BMI.	Y
	3.2 Was the information used to define intervention groups recorded at the start of the intervention?	Information recorded at start of trial	PY
	3.3 Could classification of intervention status have been affected by knowledge of the outcome or risk of the outcome?	Classification based on BMI at start of trial and therefore could not have been affected by knowledge outcome.	N
	Risk of bias judgement	Intervention status is well defined *and* Intervention definition is based solely on information collected at the time of intervention.	Low

	Optional: What is the predicted direction of bias due to classification of interventions?		

Bias due to deviations from intended interventions			
	If your aim for this study is to assess the effect of assignment to intervention, answer questions 4.1 and 4.2		
	4.1. Were there deviations from the intended intervention beyond what would be expected in usual practice?		NA
	4.2. **If Y/PY to 4.1**: Were these deviations from intended intervention unbalanced between groups *and* likely to have affected the outcome?		NA
	If your aim for this study is to assess the effect of starting and adhering to intervention, answer questions 4.3 to 4.6		
	4.3. Were important co-interventions balanced across intervention groups?	No co interventions detailed	Y
	4.4. Was the intervention implemented successfully for most participants?	No information to suggest that any participants did not receive successful intervention.	PY
	4.5. Did study participants adhere to the assigned intervention regimen?	No information, but no drop outs.	NI
	4.6. **If N/PN to 4.3, 4.4 or 4.5**: Was an appropriate analysis used to estimate the effect of starting and adhering to the intervention?		NA
	Risk of bias judgement	The important **co-interventions** were balanced across intervention groups, and there were no reported deviations from the intended interventions (in terms of **implementation or adherence were not different from what they planned**) that were likely to impact on the outcome.	Low

	Optional: What is the predicted direction of bias due to deviations from the intended interventions?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias due to missing data			
	5.1 Were outcome data available for all, or nearly all, participants?	Outcome data available for all participants	Y
	5.2 Were participants excluded due to missing data on intervention status?	No missing data	N
	5.3 Were participants excluded due to missing data on other variables needed for the analysis?	No missing data	N
	5.4 **If PN/N to 5.1, or Y/PY to 5.2 or 5.3**: Are the proportion of participants and reasons for missing data similar across interventions?		NA
	5.5 **If PN/N to 5.1, or Y/PY to 5.2 or 5.3**: Is there evidence that results were robust to the presence of missing data?		NA
	Risk of bias judgement	100% completion rate with no missing data	Low
	Optional: What is the predicted direction of bias due to missing data?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias in measurement of outcomes			
	6.1 Could the outcome measure have been influenced by knowledge of the intervention received?	Metabolic parameters, adiponectin, blood lipids and body composition recorded for all groups, and not reasonably affected by knowledge of intervention.	N

	6.2 Were outcome assessors aware of the intervention received by study participants?	Yes, not a blinded study (authors gave feedback on their PA).	PY
	6.3 Were the methods of outcome assessment comparable across intervention groups?	Identical outcome assessments across groups.	Y
	6.4 Were any systematic errors in measurement of the outcome related to intervention received?	No systematic errors reported.	PN
	Risk of bias judgement	Appropriate measurement outcomes.	Low
	Optional: What is the predicted direction of bias due to measurement of outcomes?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias in selection of the reported result			
	Is the reported effect estimate likely to be selected, on the basis of the results, from...	All domains reported on.	
	7.1. ... multiple outcome *measurements* within the outcome domain?		N
	7.2 ... multiple *analyses* of the intervention-outcome relationship?	Metabolic, body composition and blood analysis are not likely.	PN
	7.3 ... different *subgroups*?	No sub groups.	N
	Risk of bias judgement	Low risk of bias in result selection.	Low
	Optional: What is the predicted direction of bias due to selection of the reported result?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Overall bias			
	Risk of bias judgement	Although much of the study could be reasonably almost similar to an RCT, the minor lack of treatment of confounding variables places study at moderate risk of bias due to confounding. All other areas of bias low.	Moderate
	Optional: What is the overall predicted direction of bias for this outcome?		Unpredictable

ROBINS-I tool (Stage II): Schmidt (2001)

Risk of bias assessment

Responses underlined in green are potential markers for low risk of bias, and responses in red are potential markers for a risk of bias. Where questions relate only to sign posts to other questions, no formatting is used.

	Signalling questions	Description	Response options
Bias due to confounding			
	1.1 Is there potential for confounding of the effect of intervention in this study? **If N/PN to 1.1:** the study can be considered to be at low risk of bias due to confounding and no further signalling questions need be considered	Most prognostic factors unaccounted for and therefore possibility that this could potentially confound results.	Y
	If Y/PY to 1.1: determine whether there is a need to assess time-varying confounding:		
	1.2. Was the analysis based on splitting participants' follow up time according to intervention received? **If N/PN**, answer questions relating to baseline confounding (1.4 to 1.6) **If Y/PY**, go to question 1.3.	Participant's follow up time did not differ between groups	N
	1.3. Were intervention discontinuations or switches likely to be related to factors that are prognostic for the outcome? **If N/PN**, answer questions relating to baseline confounding (1.4 to 1.6) **If Y/PY**, answer questions relating to both baseline and time-varying confounding (1.7 and 1.8)		NA

	Questions relating to baseline confounding only		
	1.4. Did the authors use an appropriate analysis method that controlled for all the important confounding domains?	No appropriate analytical techniques used to control confounding.	N
	1.5. **If** Y/PY **to 1.4**: Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?		NA
	1.6. Did the authors control for any post-intervention variables that could have been affected by the intervention?	Post intervention variables not controlled.	N
	Questions relating to baseline and time-varying confounding		
	1.7. Did the authors use an appropriate analysis method that controlled for all the important confounding domains and for time-varying confounding?		NA
	1.8. **If** Y/PY **to 1.7**: Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?		NA
	Risk of bias judgement	Potential confounders unaccounted for. No statistical analysis techniques utilised that could reduce the risk of confounding bias.	Serious
	Optional: What is the predicted direction of bias due to confounding?		Unpredictable

Bias in selection of participants into the study			
	2.1. Was selection of participants into the study (or into the analysis) based on participant characteristics observed after the start of intervention? If N/PN to 2.1: go to 2.4	Participants were recruited to the study based on characteristics observed before the start of the intervention - BMI	PN

	2.2. **If Y/PY to 2.1**: Were the post-intervention variables that influenced selection likely to be associated with intervention? 2.3 **If Y/PY to 2.2**: Were the post-intervention variables that influenced selection likely to be influenced by the outcome or a cause of the outcome?		NA NA
	2.4. Do start of follow-up and start of intervention coincide for most participants?	Participants followed from start of intervention.	PY
	2.5. **If Y/PY to 2.2 and 2.3, or N/PN to 2.4**: Were adjustment techniques used that are likely to correct for the presence of selection biases?		NA
	Risk of bias judgement	All participants who would have been eligible for the target trial were included in the study *and* for each participant, start of follow up and start of intervention coincided.	Low
	Optional: What is the predicted direction of bias due to selection of participants into the study?		

Bias in classification of interventions			
	3.1 Were intervention groups clearly defined?	Clearly defined groups based on BMI	Y
	3.2 Was the information used to define intervention groups recorded at the start of the intervention?	Information recorded at start of trial	PY
	3.3 Could classification of intervention status have been affected by knowledge of the outcome or risk of the outcome?	Classification based on BMI at start of trial and therefore could not have been affected by knowledge outcome.	N
	Risk of bias judgement	Intervention status is well defined *and* Intervention definition is based solely on information collected at the time of intervention.	Low
	Optional: What is the predicted direction of bias due to classification of interventions?		

Bias due to deviations from intended interventions		
If your aim for this study is to assess the effect of assignment to intervention, answer questions 4.1 and 4.2		
4.1. Were there deviations from the intended intervention beyond what would be expected in usual practice?		NA
4.2. **If Y/PY to 4.1**: Were these deviations from intended intervention unbalanced between groups *and* likely to have affected the outcome?		NA
If your aim for this study is to assess the effect of starting and adhering to intervention, answer questions 4.3 to 4.6		
4.3. Were important co-interventions balanced across intervention groups?	Diet restriction in place across both groups.	Y
4.4. Was the intervention implemented successfully for most participants?	No information to suggest that any participants did not receive successful intervention.	PY
4.5. Did study participants adhere to the assigned intervention regimen?	No information. However, diet was self-reported and so there is a risk that those in exercise group adhered to diet more or less than control group.	NI
4.6. **If N/PN to 4.3, 4.4 or 4.5**: Was an appropriate analysis used to estimate the effect of starting and adhering to the intervention?		NA
Risk of bias judgement	There were no reported deviations from the intended interventions (in terms of **implementation or adherence**) that were likely to impact on the outcome, however there is some risk that co-intervention of calories restriction was not adhered to between groups and so minor risk of deviation bias.	Low
Optional: What is the predicted direction of bias due to deviations from the intended interventions?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias due to missing data			
	5.1 Were outcome data available for all, or nearly all, participants?	Outcome data available for most participants Quote: “four subjects dropped out of both the control and the 3 X 10 groups while two dropped out of the 2 x 15” It is possible that dropout rates were related to the of the trial. There were greater dropouts in the 3X10 groups, which require more instances of exercise and so could be due to logistical issues. Potential to bias results due to this missing data. Participating in exercising for 3 times a day is time consuming and difficult to find time for, this could be the reason for the drop out. It is not that3x10 is not affective, it could be the time.	Y
	5.2 Were participants excluded due to missing data on intervention status?	No exclusions due to missing data.	N
	5.3 Were participants excluded due to missing data on other variables needed for the analysis?	No	N
	5.4 **If PN/N to 5.1, or Y/PY to 5.2 or 5.3**: Are the proportion of participants and reasons for missing data similar across interventions?		NA
	5.5 **If PN/N to 5.1, or Y/PY to 5.2 or 5.3**: Is there evidence that results were robust to the presence of missing data?		NA
	Risk of bias judgement	Low dropout rate and low risk of bias for missing data	Low

	Optional: What is the predicted direction of bias due to missing data?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias in measurement of outcomes			
	6.1 Could the outcome measure have been influenced by knowledge of the intervention received?	Body composition recorded for all groups, and not reasonably affected by knowledge of intervention.	N
	6.2 Were outcome assessors aware of the intervention received by study participants?	Not a blinded study.	PY
	6.3 Were the methods of outcome assessment comparable across intervention groups?	Identical outcome assessments across groups.	Y
	6.4 Were any systematic errors in measurement of the outcome related to intervention received?	No systematic errors reported.	PN
	Risk of bias judgement	Appropriate measurement outcomes although unblinded.	Low
	Optional: What is the predicted direction of bias due to measurement of outcomes?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias in selection of the reported result			
	Is the reported effect estimate likely to be selected, on the basis of the results, from...	All domains reported on.	
	7.1. ... multiple outcome *measurements* within the outcome domain?		N
	7.2 ... multiple *analyses* of the intervention-outcome relationship?	Body composition are not likely.	PN

	7.3 ... different *subgroups*?	No sub groups.	N
	Risk of bias judgement	Low risk of bias in result selection.	Low
	Optional: What is the predicted direction of bias due to selection of the reported result?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Overall bias			
	Risk of bias judgement	Although much of the study could be reasonably comparable to an RCT, the lack of treatment of confounding variables places study at moderate risk of bias due to confounding. Potential bias due to missing data.	Serious
	Optional: What is the overall predicted direction of bias for this outcome?		Unpredictable

ROBINS-I tool: Siqiang (2018)

Risk of bias assessment

Responses underlined in green are potential markers for low risk of bias, and responses in red are potential markers for a risk of bias. Where questions relate only to sign posts to other questions, no formatting is used.

	Signalling questions	Description	Response options
Bias due to confounding			
	1.1 Is there potential for confounding of the effect of intervention in this study? **If N/PN to 1.1:** the study can be considered to be at low risk of bias due to confounding and no further signalling questions need be considered	Only age is controlled for. Therefore, all other prognostic factors could potentially confound results.	Y
	If Y/PY to 1.1: determine whether there is a need to assess time-varying confounding:		
	1.2. Was the analysis based on splitting participants' follow up time according to intervention received? **If N/PN**, answer questions relating to baseline confounding (1.4 to 1.6) **If Y/PY**, go to question 1.3.	Participant's follow up time did not differ between groups	N
	1.3. Were intervention discontinuations or switches likely to be related to factors that are prognostic for the outcome? **If N/PN**, answer questions relating to baseline confounding (1.4 to 1.6) **If Y/PY**, answer questions relating to both baseline and time-varying confounding (1.7 and 1.8)		NA

	Questions relating to baseline confounding only		
	1.4. Did the authors use an appropriate analysis method that controlled for all the important confounding domains?	No appropriate analytical techniques used to control confounding.	N
	1.5. **If Y/PY to 1.4**: Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?		NA
	1.6. Did the authors control for any post-intervention variables that could have been affected by the intervention?	Post intervention variables not controlled.	N
	Questions relating to baseline and time-varying confounding		
	1.7. Did the authors use an appropriate analysis method that controlled for all the important confounding domains and for time-varying confounding?		NA
	1.8. **If Y/PY to 1.7**: Were confounding domains that were controlled for measured validly and reliably by the variables available in this study?		NA
	Risk of bias judgement	Other than age, all potential confounders unaccounted for. No statistical analysis techniques utilised that could lessen risk of confounding bias.	Serious
	Optional: What is the predicted direction of bias due to confounding?		Unpredictable

Bias in selection of participants into the study			
	2.1. Was selection of participants into the study (or into the analysis) based on participant characteristics observed after the start of intervention? If N/PN to 2.1: go to 2.4	Participants were recruited to the study based on characteristics observed before the start of the intervention. Weight over 58kg	PN

	2.2. **If Y/PY to 2.1**: Were the post-intervention variables that influenced selection likely to be associated with intervention? 2.3 **If Y/PY to 2.2**: Were the post-intervention variables that influenced selection likely to be influenced by the outcome or a cause of the outcome?		NA NA
	2.4. Do start of follow-up and start of intervention coincide for most participants?	Participants followed from start of intervention.	PY
	2.5. **If Y/PY to 2.2 and 2.3, or N/PN to 2.4**: Were adjustment techniques used that are likely to correct for the presence of selection biases?		NA
	Risk of bias judgement	All participants who would have been eligible for the target trial were included in the study *and f*or each participant, start of follow up and start of intervention coincided.	Low
	Optional: What is the predicted direction of bias due to selection of participants into the study?		

Bias in classification of interventions			
	3.1 Were intervention groups clearly defined?	Clearly defined groups based on weight above or below 58kg	Y
	3.2 Was the information used to define intervention groups recorded at the start of the intervention?	Information recorded at start of trial	PY
	3.3 Could classification of intervention status have been affected by knowledge of the outcome or risk of the outcome?	Classification based on weight at start of trial and therefore could not have been affected by knowledge outcome.	N
	Risk of bias judgement	Intervention status is well defined *and* Intervention definition is based solely on information collected at the time of intervention.	Low
	Optional: What is the predicted direction of bias due to classification of interventions?		

Bias due to deviations from intended interventions		
If your aim for this study is to assess the effect of assignment to intervention, answer questions 4.1 and 4.2		
4.1. Were there deviations from the intended intervention beyond what would be expected in usual practice?		NA
4.2. **If Y/PY to 4.1**: Were these deviations from intended intervention unbalanced between groups *and* likely to have affected the outcome?		NA
If your aim for this study is to assess the effect of starting and adhering to intervention, answer questions 4.3 to 4.6		
4.3. Were important co-interventions balanced across intervention groups?	No co interventions detailed	Y
4.4. Was the intervention implemented successfully for most participants?	No information to suggest that any participants did not receive successful intervention.	PY
4.5. Did study participants adhere to the assigned intervention regimen?	No information, but no drop outs.	NI
4.6. **If N/PN to 4.3, 4.4 or 4.5**: Was an appropriate analysis used to estimate the effect of starting and adhering to the intervention?		NA
Risk of bias judgement	No co-interventions, and there were no reported deviations from the intended interventions (in terms of **implementation or adherence**) that were likely to impact on the outcome.	Low
Optional: What is the predicted direction of bias due to deviations from the intended interventions?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias due to missing data		
5.1 Were outcome data available for all, or nearly all, participants?	Outcome data available for all participants	Y
5.2 Were participants excluded due to missing data on intervention status?	No missing data	N
5.3 Were participants excluded due to missing data on other variables needed for the analysis?	No missing data	N
5.4 **If PN/N to 5.1, or Y/PY to 5.2 or 5.3**: Are the proportion of participants and reasons for missing data similar across interventions?		NA
5.5 **If PN/N to 5.1, or Y/PY to 5.2 or 5.3**: Is there evidence that results were robust to the presence of missing data?		NA
Risk of bias judgement	100% completion rate with no missing data	Low
Optional: What is the predicted direction of bias due to missing data?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias in measurement of outcomes		
6.1 Could the outcome measure have been influenced by knowledge of the intervention received?	blood lipids and body composition recorded for all groups, and not reasonably affected by knowledge of intervention.	N
6.2 Were outcome assessors aware of the intervention received by study participants?	Not a blinded study.	PY
6.3 Were the methods of outcome assessment comparable across intervention groups?	Identical outcome assessments across groups.	Y
6.4 Were any systematic errors in measurement of the outcome related to intervention received?	No systematic errors reported.	PN

	Risk of bias judgement	Appropriate measurement outcomes.	Low
	Optional: What is the predicted direction of bias due to measurement of outcomes?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Bias in selection of the reported result			
	Is the reported effect estimate likely to be selected, on the basis of the results, from...	All domains reported on.	
	7.1. ... multiple outcome *measurements* within the outcome domain?		N
	7.2 ... multiple *analyses* of the intervention-outcome relationship?	Body composition and blood analysis are not likely.	PN
	7.3 ... different *subgroups*?	No sub groups.	N
	Risk of bias judgement	Low risk of bias in result selection.	Low
	Optional: What is the predicted direction of bias due to selection of the reported result?		Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Overall bias			
	Risk of bias judgement	Although much of the study could be reasonably comparable to an RCT, the lack of treatment of confounding variables places study at moderate risk of bias due to confounding. All other areas of bias low.	Serious
	Optional: What is the overall predicted direction of bias for this outcome?		Unpredictable

Appendix 2. Focus Groups

Appendix 2A: Focus group poster

YOUR VOICE MATTERS!
FOCUS GROUP

- Join us

Join us in a group to help us learn about motivators and barriers for a healthy lifestyle.

- Process/ Contribution

Share your views in a focus group discussion.

- Eligibility Criteria

University students
Attempted to lose weight at least once

To participate you must

- Attend a meeting that will last for about one hour

For further information please contact:

[redacted]

Appendix 2B: Focus group Consent form

Consent Form

Focus Group Purpose: To explore the barriers to and motivators of a healthy lifestyle

I agree to take part in the focus group discussion specified above. I have listened and understood the study purpose as described by the researcher. I understand that agreeing to take part means that I am willing to:

1. I agree to be involved in a focus group discussion
2. I agree to allowing the focus group to be audio-recorded

I understand that my participation is voluntary and that I can withdraw at any stage of the project without being disadvantaged in any way. I understand that any identifiable data will be removed from the audio recordings and the transcripts.

I understand that any data that the researcher extracts from the focus group for use in reports or published findings will not, under any circumstances, contain names or identifying characteristics.

Participant's Code:

Signature:

Date:

Appendix 2C: IRB Approval

Kingdom of Saudi Arabia
Ministry of Health
King Fahad Medical City
(162)

مدينة الملك فهد الطبية
King Fahad Medical City

المملكة العربية السعودية
وزارة الصحة
مدينة الملك فهد الطبية
(١٦٢)

IRB Registration Number with KACST, KSA: H-01-R-012
IRB Registration Number with OHRP/NIH, USA: IRB00010471
Approval Number Federal Wide Assurance NIH, USA: FWA00018774

December 23, 2018
IRB Log Number: 18-674E
Department: External - University College London
Category of Approval: EXPEDITED

Dear Aljohrah Aldubikhi,

I am pleased to inform you that submission dated December 20, 2018 for the study titled '**A public health intervention to manage obesity and to promote healthy lifestyles among female university students in the Kingdom of Saudi Arabia**' was reviewed and was approved according to Good Clinical Practice guidelines.

Please be informed that in conducting this study, you as the Principal Investigator are required to abide by the rules and regulations of the Government of Saudi Arabia, the KFMC/IRB policies and procedures, and the ICH Good Clinical Practice guidelines. Further, you are required to submit a Progress report every 6 months starting from the date of approval. Approvals are for 1 year and are renewable on submission of satisfactory 6-monthly reports. The approval of this proposal will automatically be **suspended on December 23, 2019** pending the acceptance of the end-of-year Progress Report. You also need to notify the IRB as soon as possible in the case of:

1. Any amendments to the project;
2. Termination of the study;
3. Any serious unexpected adverse events (within two working days);
4. Any event or new information that may affect the benefit/risk ratio of the proposal.

Please observe the following:

1. Personal identifying data should only be collected when necessary for research;
2. The data collected should only be used for this proposal;
3. Data should be stored securely so that a few authorized users are permitted access to the database;
4. Secondary disclosure of personal identifiable data is not allowed;
5. Copy of the Consent Form should be kept in the Research Subject's Medical Record and the consent process should be documented in the medical record;
6. Copy of the pharmacy clearance (IDS) must be in the medical record.

Kingdom of Saudi Arabia
Ministry of Health
King Fahad Medical City
(162)

مدينة الملك فهد الطبية
King Fahad Medical City

المملكة العربية السعودية
وزارة الصحة
مدينة الملك فهد الطبية
(١٦٢)

Please be advised that regulations require that you submit a progress report on your research every 6 months. You are also required to submit any manuscript resulting from this research for approval by IRB before submission to journals for publication.

As a researcher you are required to have current and valid certification on protection human research subjects that can be obtained by taking a short online course at the US NIH site or the Saudi NCBE site followed by a multiple choice test. Please submit your current and valid certificate for our records. Failure to submit this certificate shall a reason for suspension of your research project.

We wish you every success in your research endeavor.

If you have any further questions feel free to contact me.

Sincerely yours,n

[redacted]

Prof. Omar H. Kasule
Chairman, Institutional Review Board (IRB)
King Fahad Medical City, Riyadh, KSA
Tel: + 966 1 288 9999 Ext. 26913
E-mail: okasule@kfmc.med.sa

F M C
Approved
23 DEC 2018
I R B

Appendix 2D: SEU Approval

المملكة العربية السعودية
وزارة التعليم العالي
الجامعة السعودية الالكترونية
Saudi Electronic University
(٠٥٥)
وكالة الجامعة للدراسات العليا والبحث العلمي
عمادة البحث العلمي

الجامعة السعودية الالكترونية
Saudi Electronic University

رقم الصادر:
التاريخ:
المرفقات:
الموضوع / بشأن قبول طلب جمع بيانات

سعادة الأستاذة/ الجوهره بنت إبراهيم الدبيخي **حفظها الله**

السلام عليكم ورحمة الله وبركاته ... وبعد:

إشارة إلى موافقة سعادة مدير الجامعة على ضوابط تعبئة أدوات جمع البيانات للباحثين المرفوعين بالخطاب رقم 4239 وتاريخ 1436/3/15هـ، وبناء على توصية لجنة فحص ادوات جمع البيانات للطلبات المقدمة إليها ومنها طلبكم المقدم بعنوان

A public health intervention to manage obesity and to promote healthy lifestyles among female university students in the Kingdom of Saudi Arabia

أفيدكم بصدور الموافقة على توصية اللجنة، وبإمكانكم البدء بالعمل.

نأمل منكم تزويد الجامعة لاحقاً بنسخة من البحث وأي بحوث منشورة بناء على هذه الدراسة.

وتقبلوا خالص التحية و التقدير ،،،

[redacted]

www.seu.edu.sa T: +966 11 2613500 F: +966 11 2613578 P. O. Box: 93499 - Riyadh: 11673

Appendix 2E: The focus group guide

Focus Group

January and February, 2019

Title: Motivations and the barriers to a healthy lifestyle

I. Background

"Welcome, and thank you for coming to my focus group discussion about a desirable weight loss programme. I am Aljohrah Aldubikhi, my PhD research is aiming at getting your feedback about barriers and motivators of having a healthy lifestyle today to find out all the motivations and the barriers that people often face when attending a weight loss program. In addition, what features should be included in the weight loss program to make it more attractive and desirable by the participants."

"So, your answers will help to design a new program for students interested in losing weight.

I will be moderating our discussion today. To do this, I will be asking you several questions that each of you can respond to. If you wish, you can also respond to each other's comments, like you would in an ordinary conversation."

II. Rules of Focus Group

"Please feel free to talk and share all your opinions today as there is no right or wrong answer. I am interested in everyone's opinions, so may you please do not interrupt each other while talking. Therefore, please wait until the other person stops and then you may share your opinions and please be respectful of each other's comments during the discussion. You have the right to withdraw at any time during the discussion. Also, please know that you do not have to answer any question you are not comfortable with. Thank you for agreeing to participate in this focus group discussion and signing the consent forms. For research purposes only, the discussion of this focus group will be audio recorded. The recordings will be deleted after revising the transcripts and completing the

analysis. The transcripts will not contain any identifiable data. I highly appreciate your cooperation in advance."

"The identities of all participants will be kept anonymous and confidential. Therefore, your name will not be mentioned in the study. The likeness of you will not be mentioned separately as it will be combined. The discussion will last for almost 60 minutes. Please switch off your cell phones and remain seated in the room to avoid distractions until the discussion is over."

"Before we get started, does anyone have any questions?"

"Thank you. We'll now start our conversation."

III. Introductions

"As I have mentioned earlier, I am Aljohrah Aldubikhi, I am a PHD student, a researcher and a lecturer at SEU who recruited you last week."

"Before we start, please provide me with your first name, tell me what you are studying at the Saudi electronic University and what are your hobbies."

"I will start, Hello my name is Aljohrah. I did my bachelor's in Clinical Nutrition at King Saud University and Master's degree in Public Health Nutrition at the University of Westminster. I am a lecturer at the Saudi Electronic University and currently doing my PhD at UCL. My hobbies are swimming and reading books.''

"We'll now start our discussion about weight loss."

Focus Group Schedule		
	Questions	**Prompts/Probes**
Introduction	Tell me a little about yourself, such as hobbies, areas of study etc.?	
Weight loss	Why do you want to lose weight?	
Nutrition/identifying healthy food	What is a healthy food (or a healthy diet)?	Can you explain why is this healthy or unhealthy?
Benefits of PA	Are there benefits to being physical active?	If yes, what are they? If no, explain why not.
Barriers to PA	Are there any barriers preventing you from being physically active?	If yes, what are they? If no, explain why not.
Enablers to PA	Is there anything that would motivate you to become more physically active?	If yes, what is/are it/they? If no, explain why not.
Barriers to healthy eating	Are there any barriers preventing you from healthy eating?	If yes, what are they? If no, explain why not.
Enablers to healthy eating	Is there anything that would motivate you to eat more healthily?	If yes, what is/are it/they? If no, explain why not.
Weight management programme enablers	What aspects of a weight management programme (WMP) would motivate you to attend it?	Why is this encouraging/motivating?
WMP barriers	What aspects of a WMP would deter you from attending it?	Why is this discouraging?

Appendix 3. Developing the BHL Weight Loss Programme

Appendix 3A: The Outline of the sessions

Session 1: Introduction: Obesity, its causes and its impacts			
Aim: To increase awareness of causes and negative impacts of obesity			
Session Properties			
Duration: 90 minutes		**Objective:** **By the end of this session students will be able to:** Define overweight and obesity Understand the key causes of obesity Understand the negative impacts of obesity and the benefits of reducing overweight	
Activity: ☒ **Yes** ☐ **No**		**Activity Details:** Simon Says (The researcher takes the role of "Simon" and provides instructions (usually physical actions such as "stand" or "sit") to the participants, which should be followed by the participants only when prefaced with the phrase "Simon says")	
Intervention Details			
Time	**Contents**	**Mode of teaching**	**BCTs used**
5 minutes	Introduce myself	Discussion	
10 minutes	Students introduce themselves	Discussion	
5 minutes	Explain the programme	Information	
10 minutes	Purpose and benefits of the programme	Information	
15 minutes	Simon Says	Warm up activity (Individual activity)	
10 minutes	Explain how to calculate BMI and classify overweight and obesity	Brainstorm and power point presentation	
5 minutes	Causes of obesity	Brainstorm and power point presentation	5.1: Information about Health Consequences
15 minutes	Simon Says	Warm up activity (Individual activity)	
10 minutes	Complications of obesity and diseases associated with obesity	Brainstorm and power point presentation	5.1: Information about Health Consequences
5 minutes	Summary of the session	Discussion	
Targeted Behaviour			

Session 2: Types of foods: healthy and unhealthy			
Aim: To help students differentiate between healthy and unhealthy foods			
Session Properties			
Duration: 90 minutes		**Objective:** **By the end of this session students will be able to:** Differentiate between healthy and unhealthy types of food Spices and healthy ingredients	
Activity: ☒ **Yes** ☐ **No**		**Activity Details:** The researcher provided six pictures of healthy and unhealthy food on an A4 paper. Each group was provided with different pictures and asked to identify the healthy food from it.	
Intervention Details			
Time	**Contents**	**Mode of teaching**	**BCTs used**
15 minutes	In groups, identify high fat, high sugar and high fibre foods looking at pictures on A4 paper	Group activity (5 min) Demonstrate (the healthy food and reasons how each group chose it) Discussion (5 min)	
25 minutes	Differentiate between healthy and unhealthy types of food	Brainstorm and power point presentation	
15 minutes	Spices and healthy ingredients that can be added to the meals to make the healthy meals tastier	Brainstorm and power point presentation	4.1: Instruction on how to perform behaviour
30 minutes			
5 minutes	Summary of the session Healthy recipes will be provided through WhatsApp	Discussion	6.1: Demonstration of the behaviour
Targeted Behaviour			

Session 3: Physical activity and its benefits; Incorporating physical activity in one's daily routine and Inexpensive activities that can be fun and be undertaken with the family.

Aim: To help the students to be physically active and incorporate physical activity in one’s daily routine.

Session Properties

Duration: 90 minutes	**Objective:** **By the end of this session students will be able to:** Understand the importance of physical activity, its benefits and WHO recommendation Understand how to make physical activity a part of a daily routine Have ideas for organizing ‘fun’ activities Benefits of walking 10,000 steps daily
Activity: ■ **Yes** ☐ **No**	**Activity Details:** Walk while talking for 5 minutes inside the campus to identify the step counts

Intervention Details

Time	Contents	Mode of teaching	BCTs used
15 minutes	Understand the importance of physical activity	Brainstorm, discussion and Power point presentation	
10 minutes	Benefits of physical activity	Discussion	
10 minutes	WHO recommendations for physical activity	Information	
10 minutes	Make physical activity a part of your daily routine As a group list a minimum of four physical activities that you could incorporate into your lifestyle.	Group activity and discussion and	
5 minutes	Examples of fun activities (indoor or outdoor) that they may practice with family or friends	Discussion	4.1: Instruction on how to perform behaviour
5 minutes	Benefits of increasing step count to 10,000 per day.	Discussion	
30 minutes	Walking in a group with the researcher inside the campus using pedometer/step-count related phone App	Individual activity	6.1: Demonstration of the behaviour 8.1: Behavioural Practice/Rehearsal
5 minutes	Summary of the session	Discussion	

Targeted Behaviour

Increase walking to reach a minimum of 10,000 steps daily

<table>
<tr><th colspan="4">Session 4: Healthy and Unhealthy dietary habits; Food portions and servings; Healthy plate</th></tr>
<tr><td colspan="4">Aim: To help students understand healthy and unhealthy dietary habits and how to make better healthy choices.</td></tr>
<tr><th colspan="4">Session Properties</th></tr>
<tr><td colspan="2">Duration: 90 minutes</td><td colspan="2">Objective:

By the end of this session students will be able to:

Food groups, portion sizes, servings and examples (Saudi Healthy food palm)
Create healthy plate
Benefits on increasing fruits and vegetable consumption</td></tr>
<tr><td colspan="2">Activity:

■ Yes □ No</td><td colspan="2">Activity Details:

Each student will draw what do they think about a healthy plate from their point of view on a paper plate.</td></tr>
<tr><th colspan="4">Intervention Details</th></tr>
<tr><th>Time</th><th>Contents</th><th>Mode of teaching</th><th>BCTs used</th></tr>
<tr><td>15 minutes</td><td>Explain the Healthy Food Palm: Food groups, Portion sizes of servings and examples</td><td>Power point presentation</td><td></td></tr>
<tr><td>15 minutes</td><td>Create a healthy plate on a paper plate

Explain how to create a healthy plate</td><td>Individual activity

Power point presentation</td><td></td></tr>
<tr><td>15 minutes</td><td>Benefits on increasing the consumption of fruits and vegetables</td><td>Brainstorm, discussion and Power point presentation</td><td></td></tr>
<tr><td>30 minutes</td><td>NHS healthy breakfast recipes</td><td>Power point presentation</td><td></td></tr>
<tr><td>10 minutes</td><td>How to increase fruits and vegetables in your diet</td><td>Brainstorm, discussion and Power point presentation</td><td>13.2: Framing/reframing</td></tr>
<tr><td>5 minutes</td><td>Summary of the session</td><td>Discussion</td><td></td></tr>
</table>

Targeted Behaviour
Making healthier food choices Increase the consumption of fruits and vegetables: Eat at least 400g or five portions of fruit and vegetables per day

<table>
<tr><th colspan="4">Session 5: Autonomous motivation and stimulus control (Internal and External Cues)</th></tr>
<tr><td colspan="4">Aim: To help students understand healthy and unhealthy dietary habits and how to make better healthy choices.</td></tr>
<tr><th colspan="4">Session Properties</th></tr>
<tr><td colspan="2">Duration: 90 minutes</td><td colspan="2">Objective:

By the end of this session students will be able to:

Understand internal and external cues
Benefits of replacing high calorie beverages with water</td></tr>
<tr><td colspan="2">Activity:

☒ Yes ☐ No</td><td colspan="2">Activity Details: The researcher will give the students five different calorie drinks and ask them to identify the sugar and calorie contents in them. This is to illustrate how much is the calorie content in each drink that they consume and how it might lead to weight gain. To reduce the calorie intake in order to reduce weight, this activity and would help them rethink when they drink any beverages especially, the high calorie beverages and replace them with water.</td></tr>
<tr><th colspan="4">Intervention Details</th></tr>
<tr><th>Time</th><th>Contents</th><th>Mode of teaching</th><th>BCTs used</th></tr>
<tr><td>15 minutes</td><td>Understand internal cues/triggers</td><td>Discussion, Power point presentation</td><td>15.1: Verbal persuasion about capability</td></tr>
<tr><td>15 minutes</td><td>Understand external cues/triggers</td><td>Discussion, Power point presentation</td><td>12.1: Restructuring the physical environment</td></tr>
<tr><td>5 minutes</td><td>Benefits of drinking water</td><td>Brainstorm, discussion and Power point presentation</td><td></td></tr>
<tr><td>10 minutes</td><td>Rethink drink activity (beverages, calories and sugar content)</td><td>Group activity</td><td>13.2: Framing/reframing</td></tr>
<tr><td>10 minutes</td><td>Benefits of replace high calorie drinks with water</td><td>Demonstration of beverages’ contents (A board), and power point presentation,</td><td>8.2: Behaviour substitution</td></tr>
</table>

30 minutes	NHS healthy lunch recipes	Power point presentation	
5 minutes	Summary of the session	Discussion	
Targeted Behaviour			
Replace high calorie beverages with water			

Session 6: Goal setting			
Aim: To help students set goals			
Session Properties			
Duration: 90 minutes		**Objective:** **By the end of this session students will be able to:** SMART Goals Goal setting Target behaviours	
Activity: ☒ **Yes** ☐ **No**		**Activity Details:** Two tables will be placed on the opposite sides of a room. One table will have tooth picks scattered on it and the other table will have a cup to put the toothpicks. Each student will collect one toothpick at a time and put it in the cup on the other table 30 seconds (students can walk swiftly but not run).	
Intervention Details			
Time	**Contents**	**Mode of teaching**	**BCTs used**
25 minutes	The importance of goals and how to establish SMART (specific, measurable, attainable, timely and realistic goals)	Power point presentation	1.9: Commitment
15 minutes	Put the toothpicks into the cup	Individual activity (warming up the students)	
10 minutes	Goals to be achieved: The first target behaviour: Replace high calorie drinks with water	Brainstorm, discussion and Power point presentation	
10 minutes	Goals to be achieved: The second target behaviour: Increase consumption of fruits and vegetables	Brainstorm, discussion and Power point presentation	8.2: Behaviour substitution
15 minutes	Put the toothpicks into the cup	Individual activity (warming up the students)	

10 minutes	Goals to be achieved: The third target behaviour: Increase walking to reach up to 10,000 steps daily	Brainstorm, discussion and Power point presentation	13.2: Framing/reframing 12.5: Adding Objects to the Environment
5 minutes	Summary of the session	Discussion	
Targeted Behaviour			
Replace high calorie beverages with water; Increase fruits and vegetables consumption; Increase walking to reach a minimum of 10,000 steps daily; Making healthier food choices			

Session 7: Self-monitoring of behaviour	
Aim: To help students to self-monitor their behaviours	
Session Properties	
Duration: 90 minutes	**Objective:** **By the end of this session students will be able to:** Review evidence-based studies on self-monitoring of behaviour. Self-monitor of behaviour
Activity: ☑ **Yes** ☐ **No**	**Activity Details:** Musical chair: A game of elimination of participants that involves participants, chairs, and music, with one fewer chair than the number of participants. When the investigator turn on the music participants run around the chairs and when the music stops whichever participant fails to sit on the chair will be eliminated and a chair will be removed at the same time. And the process will be repeated until only one participant remains.

Intervention Details			
Time	**Contents**	**Mode of teaching**	**BCTs used**
5 minutes	How they got on with their goal from the previous session	Discussion	1.5: Review behaviour goals
25 minutes	Review evidence-based studies on self-monitoring of behaviour.	Discussion, Power point presentation	
15 minutes	Musical chairs	(Individual Activity) Warming up the students	
20 minutes	Explain Action planning. Ask the students to set their goal. Explain the tick sheet. Nutritional goals: Replace high calorie beverages with water, make healthier food choices and increase fruits and vegetables consumption	Distributing the tick sheet	1.1: Goal setting (behaviour) 1.4: Action Planning 2.3: Self-monitoring of behaviour
5 minutes	Physical activity goal: Increase walking to reach up to 10,000 steps daily	Brainstorm, discussion and Power point presentation	12.5: Adding Objects to the Environment 13.2: Framing/reframing

<table>
<tr><td>15 minutes</td><td>Musical chairs</td><td>(Individual Activity)
Warming up the students</td><td></td></tr>
<tr><td>5 minutes</td><td>Summary of the session</td><td>Discussion</td><td></td></tr>
<tr><td colspan="4">Targeted Behaviour</td></tr>
<tr><td colspan="4">Replace high calorie beverages with water; Increase fruits and vegetables consumption; Increase walking to reach a minimum of 10,000 steps daily; Making healthier food choices</td></tr>
</table>

Session 8: Problem Solving			
Aim: To discuss and find solutions for the problems faced while meeting the introduced targeted behaviours			
Session Properties			
Duration: 90 minutes		**Objective:** **By the end of this session students will be able to:** Discuss the problems that may be faced while meeting the targeted behaviour and the solutions for it	
Activity: ☐ **Yes** ■ **No**		**Activity Details:**	
Intervention Details			
Time	**Contents**	**Mode of teaching**	**BCTs used**
5 minutes	How they got on with their goal from the previous session	Discussion	
80 minutes	Discuss the problems that may be faced while meeting the four targeted behaviours and work with the group to come up with solutions for these problems	Discussion	1.2: Problem solving 12.4: Distraction 15.1: Verbal persuasion about capability 15.4: Self-talk
5 minutes	Summary of the session	Discussion	
Targeted Behaviour			
Replace high calorie beverages with water Increase fruits and vegetables consumption Increase walking to reach a minimum of 10,000 steps daily Making healthier food choices			

<table>
<tr><th colspan="4">Session 9: Label reading skills</th></tr>
<tr><td colspan="4">Aim: Label reading skills</td></tr>
<tr><th colspan="4">Session Properties</th></tr>
<tr><td colspan="2">Duration: 60 minutes</td><td colspan="2">Objective:
By the end of this session students will be able to:
Read food label
Healthy and unhealthy dietary habits</td></tr>
<tr><td colspan="2">Activity:
☑ Yes ☐ No</td><td colspan="2">Activity Details:
Each group will be given an item of snack and identify the fat, sugar and calorie content in it.</td></tr>
<tr><th colspan="4">Intervention Details</th></tr>
<tr><th>Time</th><th>Contents</th><th>Mode of teaching</th><th>BCTs used</th></tr>
<tr><td>5 minutes</td><td>How they got on with their goal from the previous session</td><td>Discussion</td><td></td></tr>
<tr><td>10 minutes</td><td>Each group will be given an item of snack and identify the fat, sugar and calorie content in it.</td><td>Group activity</td><td></td></tr>
<tr><td>30 minutes</td><td>Understand the nutritional Labels and the proper techniques on how to read labels of food products</td><td>Power point presentation</td><td>4.1: Instruction on how to perform behaviour</td></tr>
<tr><td>30 minutes</td><td>NHS Dinner Recipes</td><td>Power point presentation</td><td></td></tr>
<tr><td>10 minutes</td><td>Discussion on unhealthy and healthy dietary habits</td><td>Discussion</td><td>4.1: Instruction on how to perform a behaviour</td></tr>
<tr><td>5 minutes</td><td>Summary of the session</td><td>Discussion</td><td></td></tr>
<tr><th colspan="4">Targeted Behaviour</th></tr>
<tr><td colspan="4">Replace high calorie beverages with water
Increase fruits and vegetables consumption
Increase walking to reach a minimum of 10,000 steps daily
Making healthier food choices</td></tr>
</table>

Session 10: Healthy Shopping			
Aim: To organise healthy shopping			
Session Properties			
Duration: 60 minutes		**Objective:** **By the end of this session students will be able to:** Make healthier food choices when shopping Tips for healthy shopping	
Activity: **Yes** **No**		**Activity Details:** Paper and pencil will be given to each group. Each group will be asked to write down healthy shopping tips which will be discussed. Walking around the campus.	
Intervention Details			
Time	**Contents**	**Mode of teaching**	**BCTs used**
5 minutes	How they got on with their goal from the previous session	Discussion	1.5: Review behaviour goals
5 minutes	Making healthier choices when shopping	Discussion	
10 minutes	Write few shopping tips and discuss it.	Group activity	
35 minutes	Tips for healthy shopping: Avoid snack and chocolate section while shopping Spend more time in the fruits and vegetable section Avoid shopping when hungry Buy different coloured fruits and vegetables to maximize nutrition Vary types of fruits and vegetables to prevent feeling bored Attend farmers markets to buy cheaper fruits and vegetables Shop once a week for fresh fruit and vegetables Look for baked food Keep vegetables clean and stored Make lists before going to the supermarket Try to walk more	Discussion	
30 minutes	Walking around the campus	Individual activity	
5 minutes	Summary of the session	Discussion	

Targeted Behaviour
Replace high calorie beverages with water; Increase fruits and vegetables consumption; Increase walking to reach a minimum of 10,000 steps daily; Making healthier food choices

Session 11: Cooking and preparing healthy meals and healthy fast food options

Aim: To cook healthy and make healthy fast food options

Session Properties

Duration: 90 minutes	**Objective:** **By the end of this session students will be able to:** Work safely in the kitchen Identify fussy eating hints and tips Provide healthy fast food options
Activity: ☒ **Yes** ☐ **No**	**Activity Details:** Walking around the campus.

Intervention Details

Time	Contents	Mode of teaching	BCTs used
5 minutes	How they got on with their goal from the previous session	Discussion	1.5: Review behaviour goals
30 minutes	Walking around the campus	Individual activity	
10 minutes	Tips to work safely in the kitchen	Brainstorm, discussion and Power point presentation	
10 minutes	Identify fussy eating habits and tips to overcome this.	Brainstorm, discussion and Power point presentation	
10 minutes	How to make unhealthy meals (e.g. fried chicken nuggets, burgers, fries) healthy at home	Pictures	6.1: Demonstration of the behaviour
20 minutes	Provide healthy fast food options	Brainstorm, discussion and Power point presentation	
5 minutes	Summary of the session	Discussion	

Targeted Behaviour

Replace high calorie beverages with water

Increase fruits and vegetables consumption

Increase walking to reach a minimum of 10,000 steps daily

Making healthier food choices

Session 12: Eating healthy meals at restaurants and social gatherings

Aim: To eat healthy at restaurants and social gatherings

Session Properties

Duration: 90 minutes	**Objective:** **By the end of this session students will be able to:** Make healthier choices in restaurants and at social gatherings
Activity: ☐ Yes ■ No	**Activity Details:** Post anthropometric measurements

Intervention Details

Time	Contents	Mode of teaching	BCTs used
5 minutes	How they got on with their goal from the previous session	Discussion	
15 minutes	Eat healthy at university, restaurants and cinema	Brainstorm, discussion and Power point presentation	
15 minutes	Eating healthy in gatherings	Brainstorm, discussion and Power point presentation	
15 minutes	How to maintain throughout: Students will be provided with self-monitoring sheets for the targeted behaviour and to do problem solving if they faced any problems	Discussion, information, tick sheet	2.3: Self-monitoring of behaviour
5 minutes	Summary of the session	Discussion	
30 minutes	Post anthropometric measurements: Students will go to the university clinic for the measurements		

Targeted Behaviour

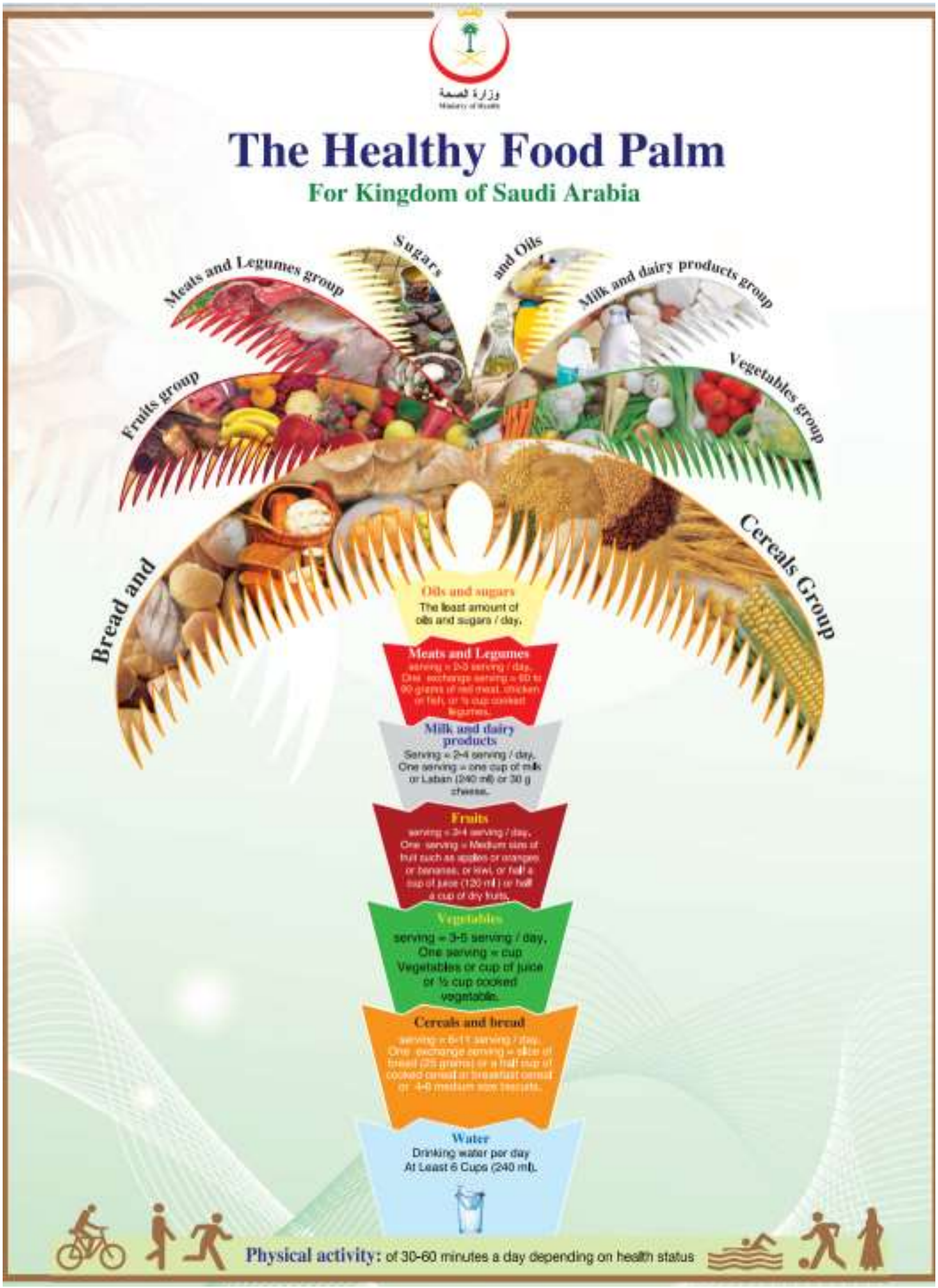
Replace high calorie beverages with water

Increase fruits and vegetables consumption

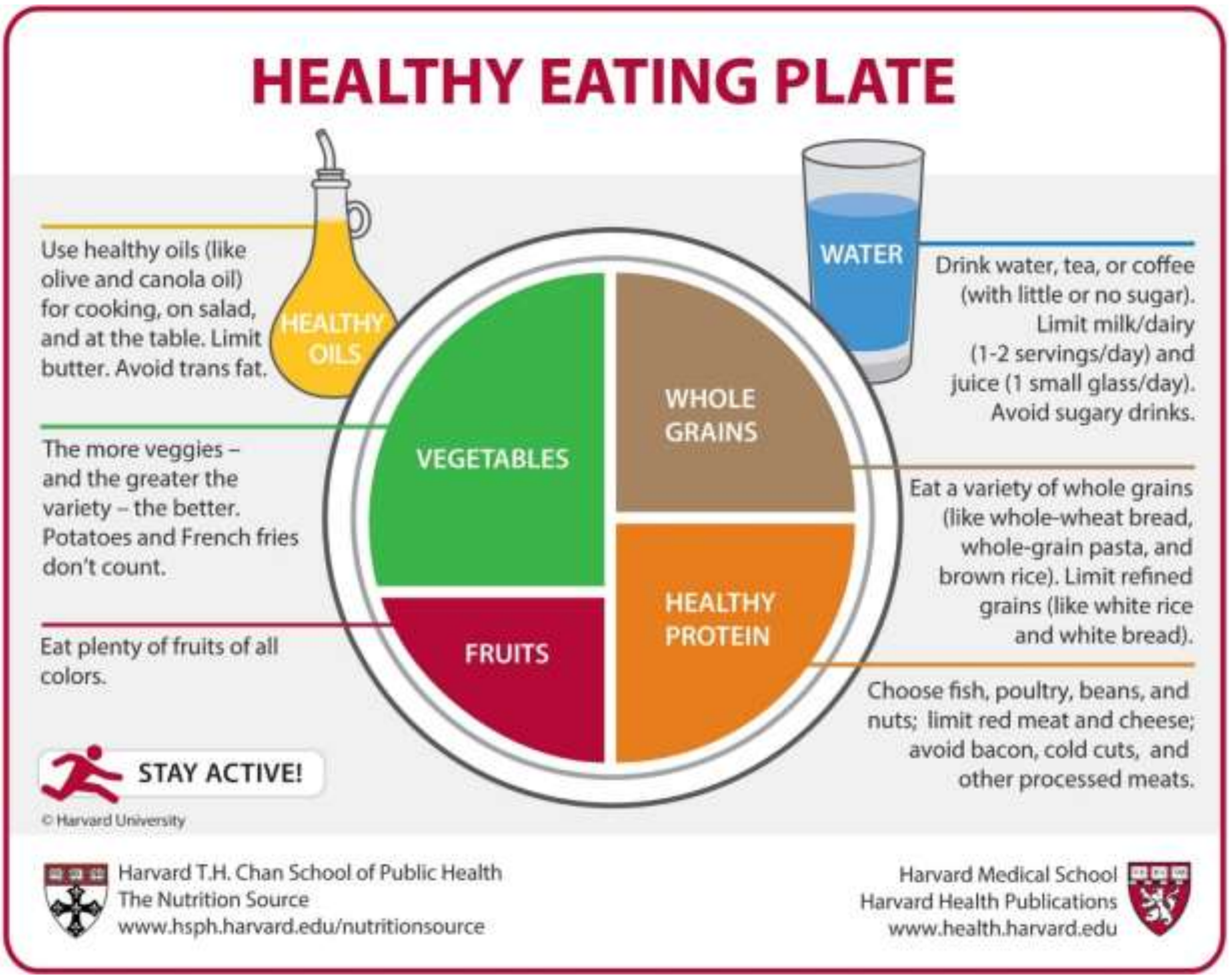
Increase walking to reach a minimum of 10,000 steps daily

Making healthier food choices

Appendix 3B: Saudi Healthy Food Palm



Appendix 3C: Healthy Eating Plate



Appendix 4. The Feasibility Study

Appendix 4A: Recruitment Email for the Feasibility Study

Mail - Aljohrah I. Aldubikhi - Outlook - Google Chrome

outlook.office.com/mail/deeplink?version=20201012008.12&popoutv2=1

Reply all | Delete | Junk | Block

Re: Approval and Poster

From: Aljohrah I. Aldubikhi <a.aldubikhi@seu.edu.sa>
Sent: Thursday, January 3, 2019 1:21 PM
To: [redacted]
Subject: Approval and Poster

Dear [redacted],

I hope you are in good health.

Thank you so much for all your support. I am writing this in regard to starting my research study as I am glad to inform you that I have received the IRB approval which is attached within this email. I have also attached the poster for recruiting the participants. Moreover, I highly appreciate if you may please make an announcement in the university website regarding my study in order to recruit the participants soon. Once again thank you for all your help and guidance.

Your cooperation is highly appreciated.

Looking forward to hearing from you soon.

Best regards,
Aljohrah

أ. الجوهرة الدبيخي
عضو هيئة تدريس
كلية العلوم الصحية
a.aldubikhi@seu.edu.sa

Appendix 4B: Feasibility Study Poster

PARTICIPANTS WANTED

For a Nutritional, Physical and Behavioural Research

WEIGHT LOSS STUDY

Do you want to lose weight?

Are you a female university student?

Additional Eligibility Requirements:

Not pregnant

Physically Healthy (No chronic diseases)

You will be awarded with a certificate and rewards for participation and completion of the study. All queries are confidential.

For further information please contact:

[redacted]

Appendix 4C: Feasibility Study Information Leaflet

Participant Information leaflet

Title of Project: Managing obesity in young female university students in KSA

Please take the time to read this questionnaire carefully and to understand any accompanying information.

Ethical Approval

The Saudi Electronic University Board and the Ministry of Health of Saudi Arabia have approved this research study.

Purpose of the Study:

The proposed research is aimed to empower the overweight female students aged over 19 years old to reduce their weight through providing them with the knowledge and skills needed to adopt a healthy lifestyle.
The study will consist of nutritional and physical activity educational and behavioural change encouragement session every week for 16 weeks.

What Will I Be Asked To Do?

You will be asked to read and answer questions pertaining to obesity management and to provide some demographic information, please. In addition to that, your weight and height measurements will be taken prior to and at the end of the study.

What Type of Personal Information Will Be Collected?

No personal identifying information will be collected in this study, and all participants will remain anonymous. If you agree to participate, you may voluntarily choose to reveal your some demographic characteristics such as age and nationality. You may choose to give all, some or none of this demographic information and still complete the study.

Are There Risks or Benefits If I Participate?

There is no risk in participating in this study. The benefits are that you help us to increase knowledge about obesity management, and to develop recommendations for improving obesity management in universities in KSA. The recommendations from the findings will be submitted to the Ministry of Health and Ministry of Education of Saudi Arabia for their review. By participating in the study, you will know about the findings of this study, even before they are published. You may also benefit personally from increased understanding about how to achieve and maintain a healthy weight.

What Happens to the Information Provided?

The data will be encrypted and stored in a secure computer file which will be protected by a password, with a single disk back-up locked away in the principal investigator's university office. At no point will anyone be able to connect your responses to you.

With whom shall I lodge a complaint, if any?

To lodge any complaint, you may contact [redacted], by email at [redacted].

Inclusion Criteria

Overweight or obese female university students aged 19 years or over.

Exclusion Criteria

- Any student who is pregnant.
- Any student who suffers from any chronic diseases.

Questions/Concerns

If you have any questions about this research and/or your participation, please contact:

Aljohrah Ibraheem Aldubikhi
Institute of Epidemiology and Health Care
UCL (University College London) , London, United Kingdom

Saudi Mobile: [redacted]

Appendix 4D: Feasibility Study Consent Form

Managing obesity in female university students in KSA

Consent Form

I confirm that I understand that by ticking each box below I am consenting to this element of the study. I understand that it will be assumed that unticked boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element I may be deemed ineligible for the study.

		Tick Box
1.	I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction, and I would like to take part in group discussions.	
2.	I understand that I will be able to withdraw my data at any time during the study (but not after the study).	
3.	I consent to the processing of my personal information (such as height, weight and waist circumference measurements) for the purposes explained to me. I understand that such information will be handled in accordance with all applicable data protection legislation.	
4.	**Use of the information for this project only** I understand that all personal information will remain confidential and that all efforts will be made to ensure I cannot be identified. I understand that my data gathered in this study will be stored anonymously and securely. It will not be possible to identify me in any publications.	
5.	I understand that my information may be subject to review by responsible individuals from the University.	
6.	I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.	
7.	I understand the potential risks of participating and the support that will be available to me should I become distressed during the course of the research.	
8.	I understand the direct/indirect benefits of participating.	
9.	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	
10	I understand that I will not benefit financially from this study or from any possible outcome it may result in in the future.	
11	I agree that my pseudonymised research data may be used by others for future research. [No one will be able to identify you when this data is shared.]	

12	I understand that the information I have submitted will be published as a report and I wish to receive a copy of it. Yes/No	
13	I hereby confirm that I understand the inclusion criteria as detailed in the Information Sheet and explained to me by the researcher.	
14	I hereby confirm that: (a) I understand the exclusion criteria as detailed in the Information Sheet and explained to me by the researcher; and (b) I do not fall under the exclusion criteria.	
15	I have informed the researcher of any other research in which I am currently involved or have been involved in during the past 12 months.	
16	I am aware of who I should contact if I wish to lodge a complaint.	

Please specify your mode of completing the questionnaire (tick one response):

1. Printed questionnaire ( )
2. Web questionnaire ( )

Declaration
I give my informed consent to participate in this study.

Name of participant	Date	Signature

Email Address (to receive a summary of the results):

....

Researcher	Date	Signature

Questions/Concerns
If you have any questions about this research and/or your participation, please contact:

Aljohrah Ibraheem Aldubikhi
Institute of Epidemiology and Health Care
UCL (University College London), London, United Kingdom

Saudi Mobile: [redacted]

Appendix 4E: Height, Weight and Waist Circumference Measurements

Weight Measurements (The standardized procedure for measuring weight)

The Equipment that will be used: A portable electronic weighing scale

The methods of measurement:

The following instructions is based on the *WHO STEPS Surveillance Manual* (2016) and will be used to direct all volunteers during this measurement:

1. The scale is placed on a flat and firm surface.
2. The scale will be set on zero when turned on.
3. The subject should be wearing light clothing and remove all their footwear before stepping onto the scales.
4. The subject will need to face forward with arms held close the sides. Once weight is measured the subject will be asked to step off the scales.
5. The weight will be recorded in kilograms up to 1 decimal place.

Waist Circumference Measurements (The Standardized procedure for measuring waist circumference)

The Equipment that will be used: A standardized measuring tape **(**constant tension tape)

The methods of measurement:

The following instructions is based on the *WHO STEPS Surveillance Manual* (2016) and will be used to direct all volunteers during this measurement:

1. With a fine pen, mark where the lowest margin of the last rib is and the top of the hip bone while the subject stands by the side of the operator.
2. Find the midpoint with a tape measure and mark the point.

3. Utilise a standardized measuring tape and place over the marked midpoint, and then ask the subject to wrap it around themselves in a horizontal manner across the back and front
4. The subject will stand with feet together and with his/her arms by their side with hand palms facing inwards, while breathing out in a gentle manner
5. The waist circumference will be measured and recorded to the closest 0.1 cm.

Height Measurements (The standardized procedure for measuring height)

The Equipment that will be used: A stadiometer

The methods of measurement:

The following instructions is based on *The Procedure for Measuring Adult Height* (NHS 2014) and will be used to direct all volunteers during this measurement:

1. The subject should remove their footwear and any form of head gear
   Note: The height measurement may be recorded over light fabric if it is deemed insensitive to ask a person to remove a scarf or veil (i.e. for religious purposes).
2. The subject should stand on the base plate with their back to the wall.
3. The subject should stand with their feet together and straight knees.
4. The subject should look directly ahead not up or downwards directions.
5. The subject’s head must be in a “Frankfort Plane” (eyes need to be at the same level as her ears).
6. The measuring point will be gently secured onto the head of the subject while the subject is asked to breathe in and stand as tall as possible with feet flat on the ground.
7. The height will be read in centimetres at the exact measurement.

Appendix 4F: Initial Sample Size Calculation for the Proposed RCT

An initial sample size was calculated for a future randomised controlled trial (RCT) based on the successful results of Alghamdi (2017), in which weight loss was 5% or more. Alghamdi's study involveds the behaviour change approach to address food-related and physical activity behaviours to affect weight change but in a different setting (primary health care clinic) than mine (primary health care clinic, not a university) in Kingdom of Saudi Arabia (KSA). Like Alghamdi, I calculated the sample size to achieve an effect of 5% weight loss from the total body weight of intervention participants in comparison to the control group, with a power of 80% and a significance level of 5%. Based on the calculations, 128 subjects are required. In anticipation of a drop-out rate of 20%, 26 students should be added to the sample size. Therefore, 154 subjects are required for the RCT. I conducted the calculations manually, and the steps involved are summarized below:

Calculation of sample size will be as follows:

$K = n_2/n_1 = 1$

$n1 = (\sigma1^2 + \sigma2^2 /K) (z_{1-\alpha/2} + z_{1-\beta})^2 / \Delta^2$

Calculating the same
$\sigma1 = 5.6$
$z1- \alpha/2 = 1.96$
$z1 - \beta = 0.84$
$\Delta = 2.78$

where

$\Delta = |\mu2-\mu1|$ = absolute difference between two means
σ1, σ2 = variance of mean #1 and #2
n1 = sample size for group #1
n2 = sample size for group #2
α = probability of type I error (usually 0.05)
β = probability of type II error (usually 0.2)
z = critical Z value for a given α or β
k = ratio of sample size for group #2 to group #1
Henceforth assuming that
Experimental group mean change in weight was 5.58 ± 5.6
Control group change in weight was 2.8 ± 4.96
Putting values in the formula

$= (5.6^2+4.96^2/1)\ (1.96+0.84)^2 / (2.78)^2$
$n_1=57$
$n_2 = k*n1 = 57$
Total sample size = 114

Considering a drop-out rate of 20%
20% of 114 = 0.2(114) = 23

Therefore, the required sample size = 114 + 23 = 137

Appendix 5. Interview Study

Appendix 5A: Recruitment email for the interview

Dear Potential Participant,

I am Aljohrah Aldubikhi, a PhD student from UCL (University College London). I am conducting one-to-one phone interviews about the weight management programme that you attended in March-May, 2019 at SEU (Saudi Electronic University). I would like to invite you to attend an interview. If you are interested please contact me either via my email or phone and I will send you more information about this. For further details, the participant information leaflet is attached. Your cooperation is highly appreciated.

I should be grateful if you would contact me even if you feel you do not wish to have an interview, just to let me know, so I know that you received this email. Thank you.

Looking forward to hearing from you.

Sincerely,

AljohrahAldubikhi

Email: aljohrah.aldubikhi.16@ucl.ac.uk

Phone No. : [redacted]

Appendix 5B: Interview Participant Information leaflet

Title of Project: Experiences of the Better Healthy Lifestyle (BHL) Programme

Please take the time to read this information leaflet carefully and to understand it.

Ethical Approval

UCL's Research Ethics Committee has approved this study (Ref 15051/002).

The Institutional Review Board of King Fahad Medical City also approved the research study (Ref 20-257E).

Purpose of the Study:

This study aims to explore your experiences and behaviours in the period after the intervention and during the (current) COVID-19 lockdown.

What Will I Be Asked to Do?

You will be invited to attend a one-to-one phone interview for approximately 45-60 minutes. The interview will be audio recorded as this is required if you agree to participate. These will include discussions about your experiences and behaviours in the period after the Better Healthy Lifestyle intervention in 2019 and during the (current) COVID-19 lockdown in 2020.

You will be asked to answer questions about the weight management intervention that you attended. The interview will be conducted via phone; therefore, you will be requested to remain in a quiet room to avoid distractions and where you feel comfortable and not overheard until the interview is over.

What Type of Personal Information Will Be Collected?

If you agree to participate, you may choose to provide some personal information such as age, marital status, and nationality. You may choose to give all, some or none of this personal information and still complete the interview. The interview will be audio recorded.

Who will my personal information be shared with?

Your personal information will not be shared with anyone and will be used only for the research purpose. It will not be used to contact you after the completion of the study for any reasons. Your name will be confidential and all your responses will remain anonymous.

Your rights

You do not need to answer questions that you prefer not to and you have the right to withdraw at any time during the interview.

Are There Risks or Benefits If I Participate?

There is no risk in participating in this study. Your participation will help us to increase knowledge about healthy weight management, and to develop recommendations for healthy lifestyle in universities in KSA.

Who will transcribe the audio recordings? And how long the information will be kept and where?

The researcher who is conducting the interview will transcribe the audio recording herself. Your name will not be used in the transcripts.

The transcripts, audio recordings and the signed consent forms will be stored in a locked, safe location in the researcher's locked room in Saudi Arabia (not at UCL). The audio recordings will be destroyed after revising the transcripts and completing the analysis (in case of need for further checking against the raw data). Any data from the transcript that might identify you, will be removed from the transcript.

Will I be able to withdraw my data and if so, how can this be done, and up to what point will this no longer be possible?

Yes, you will be able to withdraw your data by contacting the researcher but only before the analysis is conducted. It will not be possible to withdraw any data after the analysis is completed.

Will I receive a copy of the results, and if so how?

Yes, you will receive a lay summary of the results if you are interested even before publication, via email.

What Happens to the Information Provided?

The audio recordings (keeping you anonymous) and the transcripts will be kept in a password protected flash-drive in a locked office. At no point will anyone be able to connect your responses to you.

For how long is my information kept?

The audio recordings will be destroyed after completing the analysis. The transcripts will be destroyed five years after the completion of the study.

With whom shall I lodge a complaint, if any?

To lodge any complaint, you may contact Prof. Jennifer Mindell (Professor of Public Health, UCL) by email at j.mindell@ucl.ac.uk. Alternatively, if you wish to contact the Research Ethics Committee at UCL, you may send an email to ethics@ucl.ac.uk

UCL

Why am I being asked to take part in this study?

You are one of the university students who attended the weight management programme I conducted in 2019 at SEU.

Local Data Protection Privacy Notice

Notice:

The controller for this project will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk

This 'local' privacy notice sets out the information that applies to this particular study. Further information on how UCL uses participant information can be found in our 'general' privacy notice:

For participants in health and care research studies, click here

The information that is required to be provided to participants under data protection legislation (GDPR and DPA 2018) is provided across both the 'local' and 'general' privacy notices.

The lawful basis that will be used to process your personal data are: 'Public task' for personal data and' Research purposes' for special category data.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, or if you would like to contact us about your rights, please contact UCL in the first instance at data-protection@ucl.ac.uk.

Questions/Concerns

If you have any questions about this research and/or your participation, please contact:

Aljohrah Ibraheem Aldubikhi

Institute of Epidemiology and Health Care

UCL (University College London), London, United Kingdom

Email: aljohrah.aldubikhi.16@ucl.ac.uk

Appendix 5C: Interview Consent Form

E4_Consent Form

UCL

Topic: Experiences of Better Healthy Lifestyle (BHL) Programme

Consent Form

I confirm that I understand that by ticking each box below I am consenting to this element of the study. I understand that it will be assumed that unticked boxes mean that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element I may be deemed ineligible for the study.

		Tick Box
1.	I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction, and I would like to take part in the interview.	
2.	I understand that the interview will be audio recorded.	
3.	I understand that I will be able to withdraw my data at any time during the study (but not after the study).	
4.	I consent to the processing of my personal information (such as age, marital status and nationality) for the purposes explained to me. I understand that such information will be kept anonymous.	
5.	**Use of the information for this project only** I understand that all personal information will remain confidential and that all efforts will be made to ensure I cannot be identified. I understand that my data gathered in this study will be stored anonymously and securely. It will not be possible to identify me in any publications.	
6.	I understand that my information may be subject to review by responsible individuals from the University.	
7.	I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.	
8.	I understand the direct/indirect benefits of participating.	
9.	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	

Consent form_v1 17-07-2020

10.	I understand that I will not benefit financially from this study or from any possible outcome it may result in the future.	
11.	I understand that the audio recording will be transcribed by the researcher herself. .	
12.	I understand that any identifiable data will be removed from the audio recordings and the transcripts.	
13.	I understand that the audio recording will be destroyed after analysis and the transcripts will be destroyed five years after the completion of the study.	
14.	I understand that the information I have submitted will be published as a report and I wish to receive a copy of it. Yes/No	
15.	I am aware of who I should contact if I wish to lodge a complaint.	
16.	I understand that this signed form will be stored in a locked, safe location in the researcher's locked room and will be destroyed five years after the completion of the study.	

Declaration

I give my informed consent to participate in this study.

_________________________ ________________ ___________________

Name of participant Date Signature

Email Address (to receive a summary of the results):

……………………………………………………………………………………………………

_________________________ ________________ ___________________

Researcher Date Signature

Questions/Concerns

If you have any questions about this research and/or your participation, please contact:

Aljohrah Ibraheem Aldubikhi

Institute of Epidemiology and Health Care

UCL (University College London), London, United Kingdom

Email: aljohrah.aldubikhi.16@ucl.ac.uk

UCL's Research Ethics Committee has approved this study (Ref 15051/002).

The Institutional Review Board of King Fahad Medical City also approved the research study (Ref 20-257E).

Appendix 5D: Interview IRB Approval

Kingdom of Saudi Arabia Ministry of Health King Fahad Medical City (162)	وزارة الصحة مدينة الملك فهد الطبية King Fahad Medical City	المملكة العربية السعودية وزارة الصحة مدينة الملك فهد الطبية (١٦٢)

IRB Registration Number with KACST, KSA:	H-01-R-012
IRB Registration Number with OHRP/NIH, USA:	IRB00010471
Approval Number Federal Wide Assurance NIH, USA:	FWA00018774

July 12, 2020
IRB Log Number: 20-257E
Category of Approval: EXEMPT

Dear Dr. Mohammed Al-Mohaithef,

This is to certify that Aljohrah Aldubikhi can immediately start her research activity for study '**Experiences of the weight management intervention among female university students who attended the Better Healthy Lifestyle (BHL) Programme**'.

If you have any further questions feel free to contact me.

Sincerely yours,

Institutional Review Board
Approved
Date: 12 JUL 2020

[redacted]

Prof. Omar H. Kasule
Chairman, Institutional Review Board (IRB)
King Fahad Medical City, Riyadh, KSA
Tel: + 966 1 288 9999 Ext. 26913
E-mail: okasule@kfmc.med.sa

Appendix 5E: Interview Guide

Interview Guide

I. Background

"Welcome, and thank you for attending the phone interview about the weight management programme that you have attended in March-May, 2019. As you are already aware, I am AljohrahAldubikhi, my PhD research is aiming at getting your experiences related to having a healthy lifestyle after attending the weight management program and currently under COVID-19 lockdown."

"So, your answers will help to modify the program for students interested in losing weight.

I will be the interviewer today. To do this, I will be asking you several questions that you can respond to. You can respond like you would in an ordinary conversation."

II. Rules of one-to-one interview

"Please feel free to talk and share all your opinions today as there is no right or wrong answer. I am interested in your opinions. Also, please know that you do not have to answer any question you are not comfortable with. Thank you for agreeing to participate in this interview and signing the consent form. For research purposes only, this interview will be audio recorded. I highly appreciate your cooperation in advance."

"Your identity will be kept anonymous and confidential. Therefore, your name will not be mentioned in the report. The discussion will last for about 45-60 minutes. Please could you remain in a quiet room to avoid distractions and where you feel comfortable and not overheard until the interview is over."

"Before we get started, do you have any questions?"

"Thank you. Before we start, please provide me with your age, marital status and your nationality. We'll now start our conversation."

III. Introductions

"As I mentioned earlier, I am Aljohrah Aldubikhi, I am a PHD student, a researcher and a lecturer at SEU who conducted the weight management intervention in March-May, 2019 that you kindly participated in. Let us move to the first question."

IV. Questions and Probes

Q1: Did your eating/food-related habits change after taking part in the weight management programme (before COVID-19 lockdown)?

a) If yes, how did they change? Please describe any changes you made to your eating habits after the intervention.
b) If no, why do you think they remained the same?

Q2: What helped you to engage in healthy eating after the weight management programme (but before the COVID-19 lockdown)?

Q3: What did you find difficult about healthy eating after the weight management programme (but before the COVID-19 lockdown)?

Q4: Wereany aspects of the programme helpful in changing your eating habits?

a) Why were these helpful or effective?

Q5: Were any aspects of the programme not helpful to changing your eating habits?

a) Why were these unhelpful or ineffective?

Q6: Have your eating habits changed since the COVID-19 lockdown?

a) If yes, please describe the changes.

Q7: Are there any motivators to healthy eating that you experience in your daily life due to the COVID-19 lockdown?

a) Can you tell me more about these?

b) What is about xx that makes it motivating?

Q8: Are there any barriers to healthy eating that you experience in your daily life due to the COVID-19 lockdown?

a) Can you tell me more about these?

b) What is it about xx that makes it difficult?

Q9: Did your physical activity behaviours change after taking part in the weight management programme (before COVID-19)?

a) If yes, how did they change? Please describe any changes you made to your physical activity behaviours after the intervention.
b) If no, why do you think they remained the same?

Q10: What helped you to perform physical activity after the weight management programme (but before the COVID-19 lockdown)?

Q11: What did you find difficult about performing physical activity after the weight management programme (but before the COVID-19 lockdown)?

Q12: Were any aspects of the programme helpful in changing your physical activity behaviours?

a) Why were these helpful or effective?

Q13: Were any aspects of the programme not helpful to changing your physical activity behaviour?

a) Why were these unhelpful or ineffective?

Q14: Are there any motivators to physical activity that you experience in your daily life due to the COVID-19 lockdown?

a) Can you tell me more about these?

b) What is it about xx that makes it motivating?

Q15: Are there any barriers to physical activity that you experience in your daily life due to the COVID-19 lockdown?

a) Can you tell me more about these?

b) What is it about xx that makes it difficult?

Q16: Did the weight management program affect your mental well-being or outlook in any way?

a) Please describe how and why or why not.

Q17: Did the weight management programme affect any other area(s) or aspect(s) of your life (besides mental well-being, eating and physical activity)?

a) If yes, please describe the changes.

Q18: Will the current situation (COVID-19 lockdown) influence your eating habits and physical activity behaviours longer term?

a) If yes, please describe why and how you think that xx will influence your behaviour in the future?
b) If no, please describe why and how you think your behaviours will remain the same.

Q19: What other issues or topics that we have not talked about would like to comment on before we complete the interview?

Appendix 6. The Better Healthy Lifestyle (BHL) Programme

Appendix 6A: Leaflets


BETTER HEALTHY LIFESTYLE (BHL) PROGRAMME
WEEK 7 & 8


TIPS FOR PREPARE AND COOK HEALTHY MEALS AT HOME
BREAKFAST
LUNCH
DINNER
Plan Ahead
First fill your plate with lots of vegetables before you fill in your meal
Think carefully about the portion and size
Cook meals that has less fat
Make your healthy plate


BETTER HEALTHY LIFESTYLE (BHL) PROGRAMME
WEEK 9 & 10


TIPS FOR INCREASING FRUIT AND VEGETABLE CONSUMPTION
Fill half of your plate with fruits and vegetables while eating main meal
Make sure to eat five a day
Add fruits and vegetables in your recipes
Pack fruits and vegetables as snacks
Keep fruits and vegetables to your reach and sight

Appendix 6B: Self-monitoring Documents

B H L

BETTER HEALTHY LIFESTYLE

Tick Sheet

Targeted Behaviours	Week 1							Week 2							Week 3							Week 4						
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Consume less than one serving (<250ml) of sugary drinks per day																												
Have two snacks or less per day																												
Increase walking to reach up to 10,000 steps daily																												
Prepare and cook healthy meals at home																												
Eat atleast five portions of fruit and vegetable per day																												

1

B H L

BETTER HEALTHY LIFESTYLE

Tick Sheet

Targeted Behaviours	Week 5							Week 6							Week 7							Week 8						
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Consume less than one serving (<250ml) of sugary drinks per day																												
Have two snacks or less per day																												
Increase walking to reach up to 10,000 steps daily																												
Prepare and cook healthy meals at home																												
Eat atleast five portions of fruit and vegetable per day																												

2

B H L

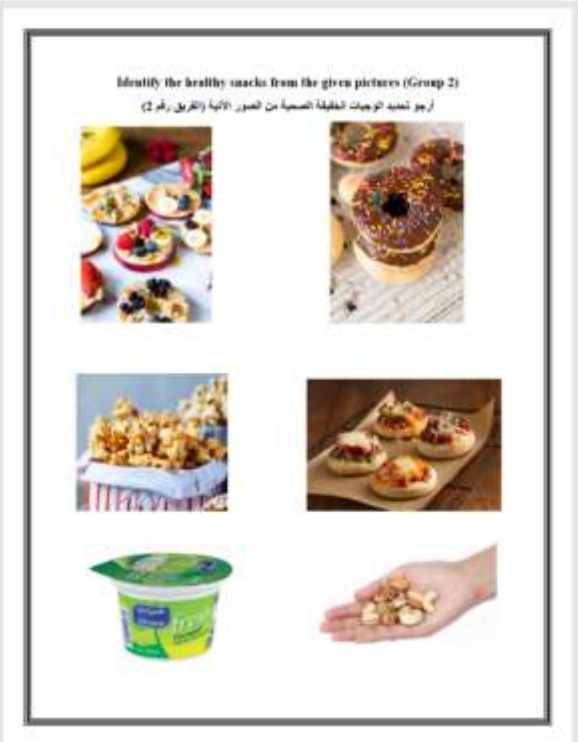
BETTER HEALTHY LIFESTYLE

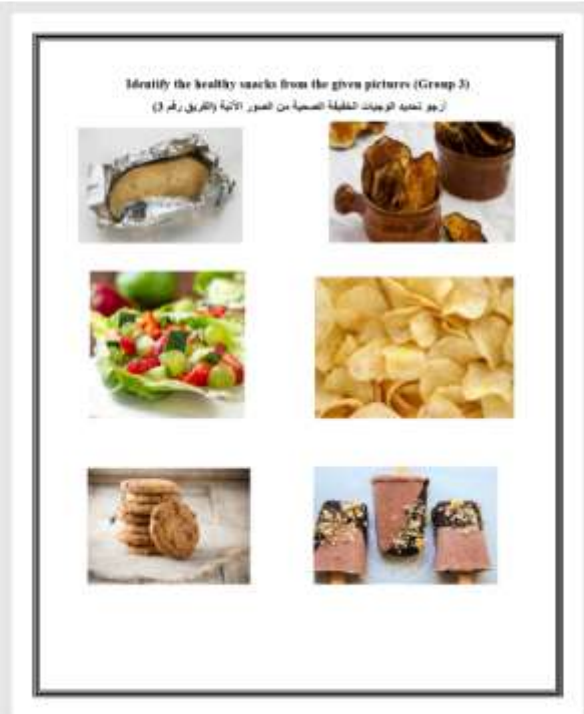
Tick Sheet

Targeted Behaviours	Week 9							Week 10							Week 11							Week 12						
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Consume less than one serving (<250ml) of sugary drinks per day																												
Have two snacks or less per day																												
Increase walking to reach up to 10,000 steps daily																												
Prepare and cook healthy meals at home																												
Eat atleast five portions of fruit and vegetable per day																												

3

Appendix 6C: Activity Materials





Appendix 6D: Outline of the sessions

Better Healthy Lifestyle (BHL) Programme

Targeted behaviour, Behaviour Change Techniques (BCTs) and Assessment

Targeted behaviour	BCTs	Assessment
Consume less than one serving (<250 ml) of sugary drinks per day	Goal setting, self-monitoring, behaviour substitution, adding objects to the environment, prompts/cues, information about health consequences, framing/reframing	24 hour dietary recall
Have two snacks or less per day	Review behaviour goals, action planning, goal setting, self-monitoring of behaviour, prompts/cues, instruction on how to perform a behaviour	24 hour dietary recall
Increase walking to reach up to 10,000 steps daily	Review behaviour goals, goal setting, self-monitoring, adding objects to the environment, prompts/cues, framing/reframing, instruction on how to perform behaviour, demonstration of the behaviour	Pedometer
Prepare and cook healthy meals at home	Review behaviour goals, instruction on how to perform a behaviour, goal setting, self-monitoring of behaviour, prompts/cues, demonstration of the behaviour	24 hour dietary recall
Eat at least five portions of fruit and vegetable per day	Review behaviour goals, instruction on how to perform a behaviour, goal setting, self-monitoring of behaviour, prompts/cues, demonstration of the behaviour	24 hour dietary recall

Materials that will be provided to the participants

1. Pedometers (fitbit flex wristband)

2. Leaflets and self-monitoring tick sheets of the targeted behaviour

Better Healthy Lifestyle (BHL) Session Plans for the Intervention Group

Session 1: Introduction: Obesity, its causes, impacts and introducing the first behaviour (Reduce the consumption of high calorie drinks.)	
Aim: To help students to consume less than one serving (<250 ml) of sugary drinks per day.	
Session Properties	
Duration: 60 minutes	**Objective:** **By the end of this session students will be able to:** • Define overweight and obesity • Understand the key causes of obesity • Understand the negative impacts of obesity and the benefits of reducing overweight • Understand the role of decreasing the consumption of high calorie/sugary drinks for weight management • Consume less than one serving (<250 ml) of sugary drinks per day • Set a goal and apply BCTs: adding objects to the environment and behaviour substitution
Activity: ■ **Yes** □ **No**	**Activity Details:** The researcher will give the students five different calorie drinks and ask them to identify the sugar and calorie contents in them. This is to illustrate how much is the calorie content in each drink that they consume and how it might lead to weight gain. To reduce the calorie intake in order to reduce weight, this activity and would help them rethink when they drink any beverages especially, the high calorie beverages and replace them with water.

Intervention Details

Time	Contents	Mode of teaching	BCTs used
10 minutes	Introduce myself and get to know the students	Discussion	
5 minutes	Describe and explain the programme	Information	
5 minutes	Explain how to calculate BMI and classify overweight and obesity	Brainstorm and power point presentation	
5 minutes	Causes of obesity	Brainstorm and power point presentation	5.1: Information about Health Consequences
5 minutes	Complications of obesity and diseases associated with obesity	Brainstorm and power point presentation	5.1: Information about Health Consequences
5 minutes	Rethink drink activity (beverages, calories and sugar content)	Group activity	13.2: Framing/reframing
10 minutes	Introduce the first targeted behaviour and its benefits (goal setting, behaviour substitution and adding objects to the environment): Understand the role of reducing high calorie drinks for weight management (Consume less than	Demonstration of beverages' contents (A board), and power point presentation,	8.2: Behaviour substitution

	one serving (<250 ml) of sugary drinks per day)		
5 minutes	Set a goal around this behaviour (SMART)	Discussion	1.1: Goal setting (behaviour)
5 minutes	Apply the BCT ‘adding objects to the environment’, ‘behaviour substitution’, ‘self-monitoring of behaviour’ and ‘prompts/cues’ to this behaviour	Leaflet, tick sheet	2.3: Self-monitoring of behaviour 7.1: Prompts/cues
5 minutes	Summary of the session	Discussion	
Targeted Behaviour			
Consume less than one serving (<250 ml) of sugary drinks per day			

<table>
<tr><th colspan="4">Session 2: The frequency of snacking</th></tr>
<tr><td colspan="4">Aim: To help the students to have two snacks or less per day.</td></tr>
<tr><th colspan="4">Session Properties</th></tr>
<tr><td colspan="2">Duration: 60 minutes</td><td colspan="2">Objective:
By the end of this session students will be able to:
• Understand what is healthy and unhealthy snacking
• Choose the correct portion size of snacks
• Read food label
• Have two snacks or less per day
• Perform action planning for the targeted behaviour
• Set a goal and apply BCTs: action planning and goal setting
• Know how to make healthy snacks</td></tr>
<tr><td colspan="2">Activity:
■ Yes □ No</td><td colspan="2">Activity Details
Activity one: The researcher will provide six pictures of healthy and unhealthy snacks on an A4 paper. Each group will be provided with different pictures and asked to identify the healthy snacks from it.
Activity two:
Each group will be given an item of snack and identify the fat, sugar and calorie content in it.</td></tr>
<tr><th colspan="4">Intervention Details</th></tr>
<tr><th>Time</th><th>Contents</th><th>Mode of teaching</th><th>BCTs used</th></tr>
<tr><td>5 minutes</td><td>How they got on with their goals from the previous session</td><td>Brainstorm</td><td>1.5: Review behaviour goals</td></tr>
<tr><td>10 minutes</td><td>Identifying healthy snacks
By differentiating between healthy and unhealthy snacks that have same calories</td><td>Group activity (5 min)
Demonstrate (same calorie of healthy and unhealthy snack)
Discussion (5 min)</td><td></td></tr>
<tr><td>5 minutes</td><td>Portion size of snacks</td><td>Pair discussion (show the students examples of same food but different portion size: guess the calories through Ppt)</td><td></td></tr>
<tr><td>10 minutes</td><td>Label reading skills
Exercises about fat, sugar and calorie content of snacks</td><td>Power point presentation</td><td>4.1: Instruction on how to perform behaviour</td></tr>
<tr><td>5 minutes</td><td>Each group will be given an item of snack and identify the fat, sugar and calorie content in it.</td><td>Group activity</td><td></td></tr>
<tr><td>5 minutes</td><td>Introducing the targeted behaviour: Have two snacks or less per day (refer to BCTs previously introduced (goal setting, self-monitoring) as</td><td>Discussion, leaflet</td><td>1.1: Goal setting (behaviour)
1.4: Action Planning
2.3: Self-monitoring of behavior</td></tr>
</table>

	ways to help change this behaviour).		7.1: Prompts/cues
5 minutes	Explain Action planning Ask the students to set their goal	Leaflet, Tick sheet	1.1: Goal setting (behaviour) 1.4: Action Planning 2.3: Self-monitoring of behaviour 7.1: Prompts/cues
10 minutes	Examples of healthy snacks pictures and resources	Information	
5 minutes	Summary of the session	Discussion	
Targeted Behaviour			
Have two snacks or less per day			

Session 3: Physical activity: types, benefits and making physical activity a part of a daily routine

Aim: To help the students to be physically active by increasing step count to 10,000 per day

Session Properties

Duration: 60 minutes	**Objective:** **By the end of this session students will be able to:** • Understand the importance of physical activity, its types, benefits and WHO recommendation • Understand how to make physical activity a part of a daily routine • Have ideas for organizing 'fun' activities • Use pedometer to know their step count • Set a goal around this behaviour and apply BCTs: goal setting, self-monitoring, framing/reframing and adding objects to the environment
Activity: **Yes** **No**	**Activity Details:** Walk while talking for 5 minutes inside the campus to identify the step counts

Intervention Details

Time	Contents	Mode of teaching	BCTs used
5 minutes	How they got on with their goals from the previous session	Brainstorm	
5 minutes	Understand the importance of physical activity	Brainstorm, discussion and Power point presentation	
10 minutes	Types of physical activity	Power point presentation	
5 minutes	Benefits of physical activity	Discussion	5.6: Information about health consequences
5 minutes	WHO recommendations for physical activity	Information	
5 minutes	Make physical activity a part of your daily routine As a group list a minimum of four physical activities that you could incorporate into your lifestyle.	Group activity and discussion and	
5 minutes	Examples of fun activities (indoor or outdoor) that they may practice with family or friends	Discussion	4.1: Instruction on how to perform behaviour
5 minutes	Increase walking to reach up to 10,000 steps daily (refer to BCTs previously introduced (goal setting, self-monitoring) as ways to help change this behaviour).	Discussion, leaflet, Power point presentation, Tick sheet	13.2: Framing/reframing 2.3: Self-monitoring of behaviour 7.1: Prompts/cues
5 minutes	Provide pedometers to the students to follow the targeted	Information	1.1: Goal setting

	behaviour. Ask students to set their goals. Explain how to use pedometers		2.3: Self-monitoring of behaviour 12.5: Adding Objects to the Environment
5 minutes	Walking in a group with the researcher inside the campus using pedometer	Individual activity	6.1: Demonstration of the behaviour
5 minutes	Summary of the session	Discussion	
Targeted Behaviour			
Increase walking to reach up to 10,000 steps daily			

Session 4: Cooking and preparing healthy meals

Aim: To enhance knowledge about how to prepare and cook healthy meals at home

Session Properties

Duration: 60 minutes

Objective:
By the end of this session students will be able to:

- Identify the food groups
- Portion sizes, servings and examples
- Create healthy plate
- Examples of healthier main meals
- Have increased knowledge about how to cook healthy delicious meals
- Prepare and cook healthy meals at home

Activity:

■ **Yes** □ **No**

Activity Details:
Each student will draw what do they think about a healthy plate from their point of view on a paper plate.

Intervention Details

Time	Contents	Mode of teaching	BCTs used
5 minutes	How they got on with their goal from the previous session	Brainstorm and discussion	1.5: Review behaviour goals
10 minutes	Portion sizes of servings and examples	Power point presentation	
5 minutes	Create a healthy plate on a paper plate Explain how to create a healthy plate	Individual activity Power point presentation	
15 minutes	Examples of healthier main meals and provide them with resources (NHS LINK)	Power point presentation	4.1: Instruction on how to perform behaviour
10 minutes	Spices and healthy ingredients that can be added to the meals to make the healthy meals tastier	Discussion and Power point presentation	
5 minutes	How to make unhealthy meals (e.g. fried chicken nuggets, burgers, fries) healthy at home	Pictures	6.1: Demonstration of the behaviour
5 minutes	Prepare and cook healthy meals at home (Goal setting, Instruction on how to perform a behaviour)	Discussion, leaflet, Power point presentation, Tick sheet	4.1: Instruction on how to perform a behaviour 2.3: Self-monitoring of behaviour 7.1: Prompts/cues
5 minutes	Summary of the session Healthy recipes will be provided through WhatsApp	Discussion	6.1: Demonstration of the behaviour

Targeted Behaviour

Prepare and cook healthy meals at home

Session 5: Problem Solving (Social and physical opportunities to promote healthy lifestyle)	
Aim: Eat at least five portions of fruit and vegetable per day. Discuss and find solutions for the problems faced while meeting the introduced targeted behaviours	
Session Properties	
Duration: 60 minutes	**Objective:** **By the end of this session students will be able to:** • Eat at least five portions of fruit and vegetable per day • Discuss the problems that may be faced while meeting the targeted behaviour and the solutions for it (internal and external cues)
Activity: ☒ **Yes** ☐ **No**	**Activity Details:** Picking balls from one end and putting into the baskets on the other end in an empty room (without chairs) through brisk walking

Intervention Details

Time	Contents	Mode of teaching	BCTs used
10 minutes	Increase the consumption of fruits and vegetables		
15 minutes	Discuss the problems that may be faced while meeting the four targeted behaviours and work with the group to come up with solutions for these problems (internal cues)	Discussion	1.2: Problem solving 1.9: Commitment 12.4: Distraction 13.1 Identification of self as role model 13.4 Valued self-identity 13.5 Identity associated with changed behaviour 15.1: Verbal persuasion about capability 15.4: Self-talk
15 minutes	Discuss the problems that may be faced while meeting the four targeted behaviours and work with the group to come up with solutions for these problems (external cues).	Discussion	1.2: Problem solving 12.1: Restructuring the physical environment 13.2: Framing/reframing
5 minutes	How did you benefit from this programme so far	Discussion	
10 minutes	Brisk walking game	Individual activity	
5 minutes	Summary of the session	Discussion	

Targeted Behaviour
Eat at least five portions of fruit and vegetable per day

<table>
<tr><th colspan="4">Session 6: Healthy shopping; Eating healthy meals at restaurants and social gatherings</th></tr>
<tr><td colspan="4">Aim: To make heathier food choices when shopping, at social gathering and in restaurants</td></tr>
<tr><th colspan="4">Session Properties</th></tr>
<tr><td colspan="2">Duration: 60 minutes</td><td colspan="2">Objective:
By the end of this session students will be able to:
• Make healthier food choices when shopping
• Understand healthy fast food options
• Make healthier choices in restaurants and at social gatherings
• Apply BCTs: Self-monitoring of behaviour</td></tr>
<tr><td colspan="2">Activity:
☒ Yes ☐ No</td><td colspan="2">Activity Details:
Each student will write down on how she is planning to move forward incorporating their behaviour and group leader will talk about it.</td></tr>
<tr><th colspan="4">Intervention Details</th></tr>
<tr><th>Time</th><th>Contents</th><th>Mode of teaching</th><th>BCTs used</th></tr>
<tr><td>15 minutes</td><td>Healthy shopping</td><td>Discussion and power point presentation</td><td></td></tr>
<tr><td>10 minutes</td><td>Ideas on healthy fast food options</td><td>Discussion and power point presentation</td><td></td></tr>
<tr><td>5 minutes</td><td>How to eat healthy meals at restaurants and social gatherings</td><td>Discussion</td><td>5.3 Information about social/environmental consequences</td></tr>
<tr><td>10 minutes</td><td>Each student will talk about how she is planning to move forward and keep following the targeted behaviour</td><td>Group activity</td><td></td></tr>
<tr><td>10 minutes</td><td>How to maintain throughout: Students will be provided with self-monitoring sheets for the targeted behaviour and to do problem solving if they faced any problems</td><td>Discussion, information, tick sheet</td><td>2.3 Self-monitoring of behaviour
7.1 Prompts and cues</td></tr>
<tr><td>5 minutes</td><td>Summary of the session</td><td>Discussion</td><td></td></tr>
<tr><th colspan="4">Targeted Behaviour</th></tr>
<tr><td colspan="4"></td></tr>
</table>

Better Healthy Lifestyle (BHL) Session Plans for the General Care Group

Session 1: Introduction: Obesity, its causes and impacts	
Aim: To give information about obesity, its causes and impacts	
Session Properties	
Duration: 60 minutes	**Objective:** **By the end of this session students will be able to:** • Define overweight and obesity • Understand the key causes of obesity • Understand the negative impacts of obesity and the benefits of reducing overweight
Activity: ☑ **Yes** ☐ **No**	**Activity Details:** Musical chair: A game of elimination of participants that involves participants, chairs, and music, with one fewer chair than the number of participants. When the investigator turn on the music participants run around the chairs and when the music stops whichever participant fails to sit on the chair will be eliminated and a chair will be removed at the same time. And the process will be repeated until only one participant remains.

Intervention Details

Time	Contents	Mode of teaching	BCTs used
10 minutes	Introduce myself and get to know the students	Discussion	
15 minutes	Warm up Activity	Individual Activity	
10 minutes	Explain how to calculate BMI and classify overweight and obesity	Brainstorm and power point presentation	
10 minutes	Causes of obesity	Brainstorm and power point presentation	5.1: Information about Health Consequences
10 minutes	Complications of obesity and diseases associated with obesity	Brainstorm and power point presentation	5.1: Information about Health Consequences
5 minutes	Summary of the session	Discussion	