Exploring opportunities for reducing obesity and promoting healthy lifestyles in adolescents in Mexico: learning from effective school-based interventions

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Table of contents

List of Tables

List of Figures

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-To Leonardo my son, my life-

List of abbreviations

BMI	Body Mass Index
ENSANUT	National Health and Nutrition Survey
FFQ	Food Frequency Questionnaire
HIC	High Income Countries
IM	Intervention Mapping
ISCOLE	International Study of Childhood Obesity, Lifestyle and the Environment
LMIC	Low and middle-income counties
MVPA	Moderate to vigorous physical activity
PA	Physical activity
PE	Physical education
SCORES	Supporting Children's Outcomes Using Rewards, Exercise and Skills
SSBs	Sugar Sweetened Beverages
WHO	World Health Organization

Abstract

Adolescence is a period of life involving many cognitive, physical and social changes (DiClemente, William, & Lynn, 1996). Acquisition of autonomy and independence from family are important milestones during this period, which represent an opportunity for setting up healthy rather than risky behaviours (DiClemente et al., 1996). Given that obesity has been commonly linked with lifestyle behaviours and that childhood obesity is likely to follow through to adulthood (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008), understanding its determinants is imperative. In Mexico, 36.3% of adolescents have been classified as obese or overweight (INSP, 2016). Behaviours including diet, physical activity (PA), sleep and sedentary time are poor among Mexican adolescents and it seems that they do not have access to health-promoting environments (Galaviz et al., 2018; INSP, 2016).

Using a mixed methods approach, the purpose of this thesis was to: (a) explore some of the determinants of obesity among Mexican adolescents and use these in a needs assessment to (b) design a theoretical and evidence-informed PA intervention prototype ready for testing with Mexican adolescents. Chapter 2 is dedicated to examining the independent relationships between modifiable lifestyle behaviours (diet, sleep duration, physical activity, and screen time) and obesity/overweight among 320 adolescents aged 13 to 15 year old in Mexico City. Participants were far from achieving the recommended guidelines for health and 41.13% were classified as obese or overweight. The lifestyle behaviours studied were not associated with BMI z scores. In line with Self-Determination Theory (SDT), Chapter 3 examined the relationship between psychological need support from physical education teachers, peers and parents and psychological need satisfaction for PA, which in turn, was expected to positively predict autonomous PA motivation, and negatively predict controlled PA motivation. Autonomous PA motivation was expected to positively predict moderate to vigorous physical activity (MVPA) and negatively predict sedentary time, whereas controlled PA motivation was expected to negatively predict MVPA and positively predict sedentary time. Data supported that need support from parents, friends and the physical education teachers positively predicted adolescents' autonomous motivation towards PA, but autonomous motivation did not predict MVPA nor

sedentary time. In Chapter 4, 79 adolescents participated in 12 focus groups with the aim to gain understanding of the concepts of PA and healthy eating, as well as perceived barriers to and facilitators of PA and healthy eating. Adolescents' views were grouped into three common themes: a) understanding the health-behaviour link, b) the impact of a restricted life, and c) social factors. Adolescents' perceived exposure to unhealthy food and personal preferences were shown to play a key role in their diet, whereas perceptions of being locked up both in the classroom and at home, lack of time and lack of social support were identified as barriers to PA.

Data from Chapters 2-4 was used to inform the development of a PA school-based intervention presented in Chapter 5. Intervention Mapping was used to systematically define the requirements for the intervention, which was then adapted to the context of Mexico. A needs assessment showed PA enjoyment, peer involvement, teachers' support for PA, PA opportunities and school policies as important and changeable PA determinants in the school context among Mexican adolescents. A list of essential (n=5) and desirable (n=6) criteria were set out. From 17 candidate interventions one was nominated for adaptation, which was modified with the addition of two behaviour change techniques and six environmental changes.

Chapter 6 summarises the main knowledge contribution of this thesis, as well as its limitations and further directions. Overall, the present work addresses gaps in the literature among a population that has received little or no attention, and which presents high levels of obesity and poor lifestyle health behaviours. In addition, a methodological contribution is provided through the systematic application of Intervention Mapping to design a PA intervention with the potential to help increase PA among Mexican adolescents.

Chapter 1 General Introduction

1.1 Overview

Worldwide, approximately 1 in 10 individuals aged between 5 to17 years old are classified as obese or overweight (Lobstein, Baur, & Uauy, 2004). The proportion of children with obesity or overweight has reached an average of 30% in the Americas' region (Lobstein et al., 2004) –among the highest worldwide – and 36.3% among Mexican adolescents (INSP, 2016). Since childhood obesity is associated with detrimental physical, psychological and social consequences (Lobstein et al., 2004) and is an important predictor of obesity in adulthood (Field, Cook, & Gillman, 2005; Singh et al., 2008) and of cardiometabolic diseases and cancer later in life (Weihrauch-Blüher, Schwarz, & Klusmann, 2019), it is imperative to address the condition at an early stage of life. Schools serve as settings to deliver interventions for obesity prevention (Brown & Summerbell, 2009). This is the case as students learn and practice healthy behaviours, are exposed to the positive examples of peers and teachers, and have access to physical facilities to practice these behaviours (Brown & Summerbell, 2009). In Mexico, only a few obesity prevention interventions have been conducted with limited success (Barriguete Melendez et al., 2014; Safdie, Jennings-Aburto, et al., 2013; Shamah et al., 2012).

The aim of the present project is to explore some of the determinants of obesity among Mexican adolescents, and to design a theoretical and evidence-informed PA intervention prototype. In order to achieve these aims, four logically sequenced original studies were conducted, and each chapter introduces an overview of the topic and study rationale. The contribution of this chapter is to discuss the wider constructs, frameworks and methods underpinning the overall thesis and provide thesis logic and structure. First, a discussion of obesity is presented, including its determinants, trends and health consequences. Second, the importance of PA for positive health outcomes is discussed. Third, the current obesity and lifestyle conditions among Mexican adolescents and gaps in facility provision to improve their health are introduced. Following this, theory and frameworks that may help to understand the links between the determinants of behaviour as well as development and maintenance of obesity will be presented.

Following this introduction to this thesis, the aims and an outline of the content will be provided.

1.2 Obesity as a health problem

The prevalence of obesity has reached proportions without precedent (Chooi, Ding, & Magkos, 2019) and is considered the 5th major risk factor of morbidity worldwide (WHO, 2009). Body Mass Index (BMI) is the most widely used indirect method for estimating body composition (Lobstein et al., 2004). In adults, overweight corresponds to a BMI of 25 kg/m^2 and obesity to a BMI of 30 kg/m^2 or above, whereas in children, specific cut-off points have been established with respect to their growth, using BMI-for-age charts (overweight >+1SD and obesity >+2SD) (WHO, 2016a). Global obesity trends (based on BMI) suggest that approximately 10% of children and adolescents are obese or overweight (Lobstein et al., 2004). Among children and adolescents worldwide an increase of 0.32 kg/m^2 per decade from 1975 to 2016 has been estimated (NCD Risk Factor Collaboration, 2017).

Obesity is a health problem that can affect the whole country. Obesity can cost between 2% to7% of the total health care cost of any country (WHO, 2000) . For instance, in the United Kingdom around £5.1 billion is spent on treatment of obesity and overweight-related ill health in a period between 2006 to 2007 (Scarborough et al., 2011) and in the United States the direct cost of adult obesity can reach US$458 000 million per year (WHO, 2000) . Obesity is also a risk factor for Type II Diabetes; in Mexico diabetes is the primary cause of death in women and the second in men (Rull et al., 2005). The direct cost for Type II Diabetes in Mexico is USD$941,345,886 and the indirect cost is USD$177,220,390 (Barquera et al., 2013).

Diverse health consequences have been associated with obesity, including hypertension, coronary heart disease, and cancer (World Obesity Federation, 2015). Reviews have identified approximately 30 different types of negative physical health consequences of obesity in children and adolescents, including pulmonary (i.e. sleep apnoea), orthopedic, neurological, endocrine (i.e. menstrual problems) and cardiovascular system problems (Lobstein et al., 2004). Beyond the physical health detriments due to obesity, several psychological and social consequences have been documented, including peer rejection, discrimination, stigmatization, low self-esteem, body dissatisfaction and anxiety (Lobstein et al., 2004). Therefore, obesity and its

physical, mental and social consequences negatively affect the wellbeing and quality of life of young people.

Adolescence is a crucial period of life when autonomy is developed and many life-long habits are established (Guo et al., 2000), representing an opportunity to prevent negative behaviours and promote positive health behaviours. However, at ages 13 to18, all types of physical activity (PA, e.g. moderate, vigorous, and light) and non-organized sports participation generally decrease (Sallis, 2000). Screen-based recreational time is related to PA decrease, which for a large proportion of children and adolescents is considerable (Aubert et al., 2018; Jongenelis, Scully, Morley, Pratt, & Slevin, 2018). Since a large body of evidence suggests an association between specific modifiable lifestyle behaviours and obesity (Martinez-Gomez et al., 2010; Patrick et al., 2004) and this association is predictive of obesity in adulthood (Barnekow-Bergkvist, Hedberg, Janlert, & Jansson, 2001), strategies to address adolescence obesity and its determinants are crucial.

1.2.1 Obesity and lifestyle

A healthy lifestyle is essential for general health and wellbeing, and regular PA is an important behaviour for living healthily (Biddle & Mutrie, 2008; WHO, 1999). There are different intensities of physical activity including light intensity (e.g. walking at a slow pace or doing light household chores), moderate intensity (e.g. walking briskly or playing doubles tennis) and vigorous intensity (e.g. running or participating in a fitness class) (U.S. Department of Health and Human Services, 2008). MVPA appears to provide the most health benefits compared to all other intensities of PA (Biddle & Mutrie, 2008). The International Children's Accelerometry Database (ICAD) reported objective monitoring of PA among 20,870 children and adolescents (aged 4-18 years) living in Australia, Brazil, Europe, and the United States (Ekelund et al., 2012). The ICAD has shown that the time spent on MVPA is inversely associated with obesity and cardiometabolic risk factors and positively associated with metabolic health. In support of this evidence, WHO have listed physical benefits (e.g. metabolic health, cardiorespiratory and muscular fitness, bones health, health biomarkers) and mental health benefits (reduction of anxiety and depression) for children and adolescents when at least 60 minutes of MVPA a day are accumulated (WHO, 2010, 2018).

Screen time (TV viewing, video game playing, computer use), driving automobiles, and reading are examples of sedentary behaviours that typically involve sitting. The WHO

also recommends reducing sedentary behaviour in people of all ages and abilities (WHO, 2018). The nature of screen time has changed over recent decades. Results from the HSBC study among 30 European countries reported a significant decrease in TV viewing and an increase in computer use of around 2 hours from 2002 to 2010 (Bucksch et al., 2016). This switch in type of screen use was identified in the United States among 15,536 adolescents (Joshi, Cole, & Overton, 2016), and in a study using longitudinal models over 3 years among 600 adolescents (Witt, Massman, & Jackson, 2011). This switch in type of screen use has implications for sedentary behaviour, because they allow different functions (e.g. playing video games and watch TV shows simultaneously on a computer) (Gunnell, Brunet, & Bélanger, 2018) and time flexibility (e.g. streaming programs at desired times rather than at scheduled times on TV) which means young people may be tempted to spend more time sedentary. Conditions such as the normalization of social media usage among adolescents, easier access to internet and use of smartphones for socialising (Botterill, Bredin, & Dun, 2015) might have also contributed to this trend of increasing adolescents overall screen time. The WHO recommends that infants under 5 years have limited amount of screen time a day, that is between 0-1 year-olds should not be exposed to any screen time and children between 1-5 years should spend <1 hour a day with screens (WHO, 2019). Australia (Commonwealth Department of Health, 2019) and Canada (Tremblay et al., 2016) have developed health guidelines for children older than 5 years old and adolescents, where the recommended screen time is no more than 2 hours a day (WHO, 2010).

Sleeping is another pillar of health (Spruijt-Metz, 2011), which is particularly important for adolescents' development (Shochat, Cohen-Zion, & Tzischinsky, 2014). Sleeping is important for brain, metabolic and immunological systems functioning (Kyle & Henry, 2017). In contrast, short sleep appears to be linked to physical and mental ill-health consequences, including obesity risk (Cappuccio et al., 2008), mental and emotional dysfunction, risk behaviours, low self-esteem, and reduced academic achievement (Shochat et al., 2014). Short sleep (<8 hours/night) in adolescents has been documented using objective measures (Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998) and questionnaires (Paksarian, Rudolph, He, & Merikangas, 2015). To maintain a healthy sleep level, the National Sleep Foundation recommends that adolescents (aged 14-17 years old) sleep an average of 8-10 hours per night (The National Sleep Foundation, 2019). The Canadian 24-Hour Movement Guidelines for Children and

Youth recommends 9-11 hours of sleep per night at ages 5-13 and between 8 to10 hours at 14 to17 years (Tremblay et al., 2016).

Healthy eating is part of a healthy lifestyle (WHO, 1999). The definition of a healthy diet is complex (Branscum & Sharma, 2014), with several indexes commonly used to estimate the diet quality (i.e. Diet Quality Index, Healthy Eating Index, Healthy Diet Indicator, Dietary Guidelines Index and Mediterranean Diet Scale) (Kourlaba & Panagiotakos, 2009). According to WHO, having a diet with plenty of fruits and vegetables (>400g) and fibre and low in free sugars (<10% energy intake), saturated fats (<10% energy intake) and salt (<5g per day) (WHO, 2015) leads to better health. According to a review from the International Obesity Task Force (IOTF), some social changes in the last decades appear to be affecting children's and adolescents' diet, including: the variety of energy-dense food available, consuming energy-dense food in greater quantities, effective marketing of energy-dense food, more purchasing opportunities, higher availability of fast food stores and restaurants, larger portions for less money and pure water replacement by sugar sweetened beverages (SSBs) (Lobstein et al., 2004). In addition, this report highlighted an increase of the consumption of high energy food among children and adolescents, increase in the frequency of eating occasions (e.g. increasing likelihood of snacking on high energy food), and increase of portion sizes in some countries (e.g. the Unites States) for children and adolescents (Lobstein et al., 2004).

The primary causes of obesity and overweight are complex and diverse; to date there is no consensus about its aetiology (Ross, Flynn, & Pate, 2016). Data from multinational studies among adolescents living in countries of similar income, support the association between lifestyle behaviours and obesity (Garaulet et al., 2011; Janssen et al., 2005) (Ekelund et al., 2004; Katzmarzyk et al., 2013; Riddoch et al., 2005). Based on self-reported data from adolescents living in high-income countries (HIC), two multinational studies have shown similar associations, namely the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) (Garaulet et al., 2011) and the Health Behaviour in School-Aged Children Study (HBSC) (Janssen et al., 2005). In the HELENA study, self-reports from 3,311 adolescents living in 10 European cities showed a positive association between short sleep and obesity (Garaulet et al., 2011). In the HBSC self-reports from 162,305 adolescents (aged 10-16) from 34 countries highlighted that lower physical activity and higher TV viewing are associated with obesity (Janssen et al., 2005). Using accelerometer-based data, the European Youth Heart Study (EUYHS)

(Riddoch et al., 2005) among 1,292 children (aged 9-10 years) from 4 European countries reported an association between low MVPA and increased BMI (Ekelund et al., 2004). The same study also found a positive association between TV viewing and obesity (Ekelund et al., 2006). Likewise, the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) produced similar findings. The difference was that data were obtained from children rather than adolescents, who were living in 12 countries at different levels of development in the ISCOLE rather than HIC only in the EUYHS (Katzmarzyk et al., 2013). Based on data from 6,025 children (ages 9-11 years), the ISCOLE reported an association between obesity and low levels of objectively measured MVPA, short sleep duration, and high TV viewing but not diet (Katzmarzyk et al., 2015).

Large sample national studies and meta-analyses also support the association between PA, sleep, screen time and obesity. In terms of the association with sleep, a study conducted among 8640 Taiwanese adolescents showed that those getting lower levels of MVPA were typically 1.15 times more likely to be obese than those getting more than 2 hours of MVPA (95% CI =1.3-7.4) (Liou, Liou, & Chang, 2010). The same study also revealed that those who sleep 7.7 or less hours per night during weekends were more likely to be obese (girls: OR =4.2, 95% CI =2.0–5.5; boys: OR =1.6, 95% CI =1.2–2.1). Studies exploring the association between screen time use and obesity have shown that boys who watch TV for 2 or more hours were 1.4 (OR =1.4, 95% CI =1.1–,9) times more likely to be obese than their peers, and girls are 1.8 times more likely (95% CI =1.1–2.8) (Liou et al., 2010). Objectively measured sedentary time among 1862 UK children (aged 9-10 years) was also found to be positively associated with obesity indicators (Steele, van Sluijs, Cassidy, Griffin, & Ekelund, 2009). Data from 656 Taiwanese adolescents showed that those who sleep between 6 to 8 hours on more than four weekdays were 1.7 times more likely to be a healthy weight (i.e., non-obese; 95% CI = 1.3-2.4) (Chen, Jeng, & Wang, 2006). A meta-analysis provided strong evidence that supports the association between short sleep and overweight/obesity in populations aged 0-18 years indicating that those children and adolescents with short sleep are 1.6 times likely to be overweight or obese (95% CI: 1.22-2.10)(Chen, Beydoun, & Wang, 2008).

The association between MVPA, sleep time, screen time, and fruit and vegetable consumption and obesity and overweight has also been examined simultaneously using self-reports from 9866 Canadian adolescents (ages 11-17 years) (Menon, Philipneri,

Ratnasingham, & Manson, 2019). This study showed that PA but not the other studied behaviours was associated with body composition, suggesting this may be the most important of the predictors of excess weight; adolescents who did not accumulate 60 minutes of MVPA were 1.24 times more likely to be obese or overweight (95% CI: 1.06–1.45) (Menon, Philipneri, Ratnasingham, & Manson, 2019). Data from 18748 Mexican adolescents (ages 10-19 years) showed that adolescents who reported being physically active were less likely to be overweight or obese (OR= 0.59, 95% CI; 0.48-0.73) whereas those who spend 14 hours or more per week on screen time were 1.29 times more likely to be obese (95% CI: 1.13–1.48) (Del Carmen Morales-Ruán, Hernández-Prado, Gómez-Acosta, Shamah-Levy, & Cuevas-Nasu, 2009). Collectively, these studies set an important premise on the association between lifestyle behaviours and obesity and overweight.

There is currently mixed evidence, however, with respect to the importance of diet in predicting obesity in children and adolescents. A systematic review of the association between obesity and fruit and vegetable intake has concluded that this association is unclear (except for one longitudinal study, no association was found in other longitudinal and experimental studies) (Ledoux, Hingle, & Baranowski, 2011). Another systematic review about the association between the energy density of the diet and overweight or obesity in adolescents reported consistent evidence of no association (Arango-Angarita, Rodriguez-Ramirez, Serra-Majem, & Shamah-Levy, 2018). The HSBC study revealed a lack of an association between the consumption of fruit and vegetables ,SSBs and overweight among school children (Janssen et al., 2005). The findings of Janssen et al., (2005) are consistent with large sample studies among 3,311 US children and adolescents (aged 6-19 years) (Forshee & Storey, 2003) and 374 British children (aged 9-11 years) (Wilkie, Standage, Gillison, Cumming, & Katzmarzyk, 2016). Conversely, a systematic review of a cross-sectional, prospective cohort, and experimental studies on the association between SSBs and obesity support a positive association between the high intake of SSBs and obesity in children and adults (Malik, Schulze, & Hu, 2006). However, the results of the above-mentioned review highlighted some limitations of the studies that were reviewed, including design (cross-sectional), sample size (small), and duration of follow-up (short or not included) (Malik et al., 2006). According to the results of a meta-analysis, lifestyle interventions could lead to significant weight loss when a dietary component is included (Ho et al., 2012).

Therefore, more research is needed on the relationship between diet and obesity among adolescents.

To date, most of the available evidence on the association between these lifestyle behaviours and obesity is limited to particular contexts. Current multinational studies have reported data mostly from adolescents living in HIC (e.g. HSBC, HELENA) (Garaulet et al., 2011; Janssen et al., 2005) or children (e.g. ISCOLE) (Katzmarzyk et al., 2015). In addition, given the cross-sectional design and sample characteristics, these studies, findings cannot be generalised to adolescents living in different contexts.

Particular conditions of the social and physical context of low and middle-income countries (LMIC), and particularly countries in Latin America represents a challenge for gaining an understanding of factors influencing lifestyle behaviours and their link with obesity. For example, a study based on data from the Colombian National Nutrition Survey, Gonzalez-Casanova et al. (2014) explored the association between individual, family, and community predictors of overweight and obesity among 21,520 children and adolescents (aged 8-18 years) based in 12,452 households, and 104 municipalities in Colombia . The variability of BMI z-scores was accounted primarily at the household level (31%), whereas the community level explained only 2-3% of the variability. Some similarities between HIC were shown in this study, such as the fact that wealth and sex (female) were positively associated with being overweight. However, being part of an extended family was a more specific factor within the Colombian context, increasing the likelihood to develop obesity. In many Latin American countries extended families are common and existing evidence suggests that other members of the family are potential barriers to healthy eating (Berger-Jenkins et al., 2017). There is an acceptance of childhood overweight (Foster & Hale, 2015), concerns about having a skinny child and even preferences for heavier children (Sosa, 2012).

Traditional gender norms also influence adolescents' behaviours. The HBSC study showed that boys living in more gender unequal countries reported higher levels of physical activity than boys in more gender equal countries; showing overall lower levels of PA among girls than boys (de Looze, Elgar, Currie, Kolip, & Stevens, 2019). Some of traditional gender norms remain in many Latin American countries. For example, a comparative study among women living in Colombia, Mexico, Peru, and Uruguay revealed high rates of unpaid housework and unpaid direct childcare specially in women from low SES (Amarante & Rossel, 2018). According to this study, unpaid work could be as much as 33 hours per week in Uruguay, 38 in Colombia, and 38 and 39 in Peru

and Mexico. Household activities are light or moderate intensity PA (U.S. Department of Health and Human Services) and therefore women might engage more in these types of activities. Adolescent girls living in deprived areas of Canada have reported lack of time for PA because they have to clean their house or take care of their younger siblings comparated to adolescents' in high income areas of Canada which reported lack of time for PA due to schoolwork (Humbert et al., 2006). Research on the leisure time PA among Latino women (95% from Mexico) living in the United States found barriers such as childcare, household duties and the perceived pressure on the role of mother and wife from the Latino community as important barriers for leisure time PA. In addition, most participants of the study perceived house duties as their daily PA (Skowron, Stodolska, & Shinew, 2008). In support of the influence of these traditional gender norms, a qualitative exploration of Equatorial adolescents' barriers for PA highlighted that girls felt obligated to do cleaning or cooking while at home, which leaves less time for other leisure time PA (Van Royen et al., 2015). The factors associated with obesity, then, appear to differ between countries and cultures, and therefore, a comprehensive approach is necessary to address obesity among children and adolescents.

1.1.2 Physical activity beyond obesity therapy

Lifestyle modifications are the first option for paediatric obesity prevention and treatment (Weihrauch-Blüher et al., 2019). PA has been identified as an important contributor to weight loss (Petridou, Siopi, & Mougios, 2019) but beyond weight management, regular PA also contributes to several positive physical, mental and social health outcomes and even to premature mortality prevention (Ekelund et al., 2019). A systematic review of the health outcomes of physical activity in children and adolescents highlighted positive effects on bone health and improved control of blood pressure (Janssen & Leblanc, 2010). PA can lead to improved wellbeing such as better mood, higher energy levels, lower fatigue, longer and deep sleep (Biddle, 2015). Moreover, PA has been documented to contribute to the reduction of anxiety and depression (Tyson, Wilson, Crone, Brailsford, & Laws, 2010) and the increase of self-acceptance (Crone, Smith, & Gough, 2005). School children also benefit from PA in terms of increased cognitive functioning (Biddle, 2015) school engagement (Owen et al., 2016) and health-related quality of life (Wu et al., 2017). This evidence highlights the importance of PA during childhood and adolescence and therefore, the need to understand PA behaviour, its determinants and the mechanisms that help to engage with PA and maintain PA throughout the whole life.

1.1.3 Challenges on obesity and lifestyle among Mexican adolescents

Historically, the areas of concern have varied between children and adolescents living in different income countries. For children and adolescents from HIC, obesity has been studied to a larger extent, whether as undernutrition is typically examined in children and adolescents from LMIC (Ezzati et al., 2017). Nevertheless, in recent decades, LMIC have faced a relatively rapid transition from undernutrition to obesity and overweight among children and adolescents (Ezzati et al., 2017; Kroker-Lobos, Pedroza-Tobías, Pedraza, & Rivera, 2014). In fact, WHO reported that there are fewer children and adolescents with obesity and overweight in HIC than in LMIC (WHO, 2016b).

In Mexico, the rate of obesity or overweight has increased by 48% since 1988 (Bonvecchio et al., 2015; Kroker-Lobos et al., 2014) (Figure 1-1). Mexico is one of the 11 countries where obesity had reached >20% of the population including Germany, Brazil, Argentina, Russia, United Kingdom, Turkey, South Africa, Iraq, US, and Egypt (Chooi et al., 2019). Around 36.3% of Mexican adolescents (aged 12-19 years) are classified as obese or overweight (INSP, 2016), rates that are much higher than those in other countries such as Lithuania (0.4%) or Latvia (0.5%) (Janssen et al., 2005). In Mexico, obesity prevalence is higher among girls (39.2%) than boys (33.5%), reaching proportions as high as 41.6% as for girls in Mexico City (Shamah-Levy et al., 2018).

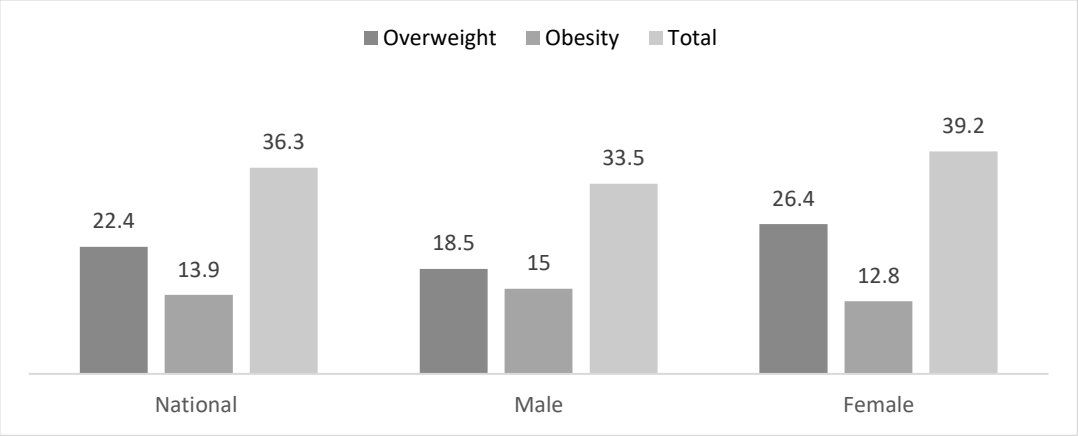

Figure 1-1 Prevalence of obesity and overweigh by sex in 2016 among Mexican adolescents aged between 12-19 years

A large proportion of children and adolescents in Mexico do not meet health recommendations. Results from the National Health Survey 2016 (ENSANUT) indicate that in Mexico, 82.8% of children and 35% of adolescents do not meet the

recommended 60 minutes of MVPA (Medina, Jauregui, Campos-Nonato, & Barquera, 2018). ENSANUT also identified that 78.6% of adolescents (INSP, 2016) exceed the screen time recommendations of >2 hours per day (Tremblay et al., 2016). There is also data suggesting that only 65% of adolescents meet the minimum recommended 8 hours of sleep per night (Argumedo et al., 2020). Furthermore, Mexico ranked 2nd place worldwide in the consumption of carbonated soft drinks (31.7 gallons per person per year) (Basu, McKee, Galea, & Stuckler, 2013). ENSANUT has shown a regular consumption of SSBs in 83.9% of adolescents.

Evidence also supports that adolescents' environment in Mexico is not conducive to good health levels and more specifically does not promote PA participation. A useful synthesis of the available data on environmental support for physical activity for children and adolescents is provided by the Mexican Report Card (Argumedo et al., 2020; Galaviz et al., 2018). This is generated as part of an international collaboration using similar approaches to grade countries according to a set of common criteria (Aubert et al., 2018). Each country is graded from A+ to F (or Incomplete, where insufficient data is available) across 10 indicators organised into four categories. The grade is assigned according to the percentage of children and adolescents who meet stablished benchmarks (e.g. walking to school, meeting PA recommendations) and the percentage of effort made by institutions that facilitate and lead PA opportunities (e.g. PA policies at school, PA programmes by NGOs). The Cards evaluate four broad indicators namely daily behaviours (e.g. pa, sedentary behaviour), physical fitness (e.g. body strength), settings and sources of influence (e.g. schools, family, community, environment), strategies and investments (e.g. NGOs, government).

In the Report Card, Mexico was awarded a D+ grade for the schools indicator - in 2012 (Rodriguez et al., 2012), in 2016 (Galaviz et al., 2016) and in 2018 (Argumedo et al., 2020). This grade indicates that schools in Mexico have been failing to provide adequate PA opportunities (e.g. mandatory physical education, enough physical education specialist teachers), reaching only approximately one-third of school children. Regional studies conducted in Mexico have confirmed the limited availability of physical education (PE) teachers, so that non-specialist teachers frequently deliver PE or lessons are cancelled (Gharib et al., 2015). There is also evidence that only 10% of recess time is spent in moderate and intense PA, and students mostly walk or stand during breaks (Medina, Barquera, Katzmarzyk, & Janssen, 2015). While government mandated regulation states that schools should provide 50 minutes of PE, two times per

week (INSP, 2018), this is not the case in Mexico. According to a study among 20 schools in Mexico City, PE takes place only once a week, running for an average of 33.6 minutes (Gharib et al., 2015). The Mexico Report Card also reveals a lack of data about family support, although this is generally provided in every edition of this evaluation for other countries (Argumedo et al., 2020; Galaviz et al., 2016; Rodriguez et al., 2012; Rodriguez et al., 2014). The indicator for the community and environment has been awarded with failing grades (D+) in every version of the Report Card for Mexico. These grades suggest insufficient numbers of well-maintained and safe infrastructures, facilities, parks and policies that promote physical activity. For example, nearly 80% of parents in Mexico do not allow their children to play outside due to safety concerns (Instituto Nacional de Estadística y Geografía, 2018). Overall, Mexico was ranked in 34th place of the 49 countries for which data are available (Aubert et al., 2018).

The school and home environment in Mexico appear to be conducive for an unhealthy diet. A study conducted among 645 children (aged 9 years) from 99 different schools across the country has shown that 82% consume unhealthy snacks at school and only 27% of the food and beverages sold at school meet the statutory nutrition standards (Perez-Ferrer et al., 2018). However, results of this study should be taken with caution as it refers to data with low representativeness per school (1-6 participants).

At home, data from ENSANUT shows that in those households with food insecurity (a proxy measure of SES) there is a reduction in the intake of fruits and vegetables but not in of fat, cereals and sugars (Vega-Macedo, 2014). The overall diet quality among Mexican children and adolescents is affected by food insecurity in their households (Rodríguez, Mundo-Rosas, Méndez-Gómez-Humarán, Pérez-Escamilla, & Shamah-Levy, 2017) This evidence is important as approximately 46.2% of Mexican population live in poverty (CONEVAL, 2014) and 70% in food insecurity (INSP, 2012).

Only a few studies have been conducted in Mexico exploring the association between PA and obesity. A study based on data from 18,784 Mexican adolescents included in the 2016 National Health and Nutrition Survey (ENSANUT), identified a positive association between screen time and obesity and overweight, but no association between self-reported MVPA and obesity and overweight (Del Carmen Morales-Ruán et al., 2009). Analysis of the ENSANUT data in 2016 (N=1072 Mexican adolescents) showed that these relationships were stable over time; screen time (>2 hours) was associated with greater risk of obesity and overweight, but there was no association with MVPA (Medina-Zacarias, Shamah-Levy, Cuevas-Nasu, Gomez-Humaran, &

Hernandez-Cordero, 2020). A self-reported diet high in SSBs and high energy and high fat foods was also associated with greater obesity and overweight. While overall MVPA is not always associated with the classification of overweight status, there is some evidence that some sub-types of PA may be associated with BMI, as was found in a multicity study (Mexico City, Puerto Vallarta, and Guadalajara City) in 1996, where self-reported PA via active commuting to school was negatively associated with BMI (Parker et al., 2016). More up to date data would be useful to explore to see if this relationship still stands. Overall, these nationally representative results suggest that in contrast to adolescents from other contexts, PA may be a weaker predictor of obesity and overweight in Mexico. Nevertheless, the results of these studies are based on self-reported PA, so more information is also needed regarding this association using more accurate instruments (e.g. accelerometers).

So far in Mexico, evidence of the association between objectively measured PA and obesity has only been reported among pre-school and primary school children. A study among 400 pre-school Mexican children using accelerometer-based data reported a lack of association between MVPA and obesity (Jáuregui et al., 2020). The same study also reported that less than 1% of participants met PA guidelines recommendations, so in part this finding may be limited by a restricted level of variation. Another study using pedometers among 193 children (M_{age}= 11 years) reported a negative association between PA and BMI (Galaviz et al., 2012). These conflicting results highlight the need to conduct more research in this arena, including schoolchildren and adolescents and using objective measures of PA.

1.2 Self-Determination Theory

This thesis draws on Self-Determination Theory (SDT) (Ryan & Deci, 2017), a framework of human motivation that stipulates that regardless of cultural differences and contexts, people have three universal psychological needs that underpin their motivation and drive behaviour. These needs are autonomy, competence, and relatedness (Ryan & Deci, 2017). The needs are essential for psychological health and functioning (Ryan & Deci, 2017). Autonomy refers the ownership of one's own actions (e.g. volitional desire to ride a bike); competence consist of the need to interact with the social environment effectively (e.g. feeling able to ride a bike everyday); and relatedness is the need to feel connected with others (e.g. enjoy riding a bike with friends) (Deci & Ryan, 2008). According to this framework, the satisfaction of these

three psychological needs is derived from the perceived need support from the social environment (Ryan & Deci, 2017). In contrast to need satisfaction, when needs are frustrated by the social context, non-optimal outcomes are generated (Deci & Ryan, 2002). A need-supportive environment is one in which the individual perceives adequate support for making choices (autonomy support), for challenge and growth (competence support) and for being cared for and accepted (relatedness support) (Emm-Collison, Standage, & Gillison, 2016).

SDT differentiates amotivation (lack of motivation) from different types of motivation distributed on a continuum from autonomous to controlled. Autonomous motivation covers intrinsic regulation (i.e. riding a bike because it is fun) and identified regulation (i.e. riding a bike because is considered good for health). Controlled motivation includes introjected regulation (i.e. riding a bike so as not to feel guilty) and external regulation (e.g. avoiding direct punishment). Individuals functioning in a more autonomously motivated manner (self-determined) report more healthy functioning, persistence, creativity, better performance and wellbeing, than those acting through controlled motivation (Ryan & Deci, 2017).

SDT principles have been tested in several life domains including learning, workplace motivation, exercise and sports, physiotherapy, health care, cultural and religious socialisation, parenting, sustainability, aging and virtual worlds (Ryan & Deci, 2017). Alongside these domains, this framework has served as means of understanding individuals' motives and supporting their healthy functioning. More specifically, SDT has been widely used to understand PA and exercise engagement and people's persistence as documented by Teixeira et al (2012), whose systematic review on the association between PA, exercise and SDT principles showed the relevance of autonomous motivation in nurturing PA (Teixeira, Carraca, Markland, Silva, & Ryan, 2012).

1.3 Behaviour change interventions

Behaviour change interventions are widely used to promote healthy lifestyles and are defined as "*coordinated sets of activities designed to change specified behaviour patterns*" (Michie, van Stralen, & West, 2011, p. 11).

The ecological perspective explains this interaction between individuals and their environment (McLeroy, Bibeau, Steckler, & Glanz, 1988). The ecological model assumes that not only individual factors and processes affect behaviour; rather, this model incorporates consideration of socio-cultural and physical environmental factors affecting and being affected by the individual's behaviour (McLeroy et al., 1988). The ecological model organises these factors into different levels of influence, namely individual (e.g. characteristics of the individual and knowledge), interpersonal (e.g. family or work group) institutional or organizational (e.g. worksite), community (e.g. family, neighbourhood and local voluntary agencies) and public policy (McLeroy et al., 1988).

The use of theory for intervention development helps to explain and promote change in behaviour (Michie & Abraham, 2004). Using theory makes it possible to identify the mechanisms that might make an intervention work or fail to work. Although theory is applicable in all populations, it is essential to understand the characteristics of the target group. For example, according to the Guide for Health Promotion Practice of the National Cancer Institute (National Institutes of Health, 2005), race and ethnicity may differ in terms of: a) morbidity and mortality of certain illnesses, b) the prevalence of certain risk behaviours, and c) the determinants of health behaviours. In addition, health theories can work at different levels of influence, as the ecological model proposes (National Institutes of Health, 2005).

1.3.1 Systematic design of behaviour change interventions

Different protocols have been designed to guide the systematic development of behaviour change interventions. The planning protocols most commonly used in health studies are the Medical Research Council (MRC) framework for the development of complex interventions (Campbell et al., 2000), the National Institute for Health and Clinical Excellence (NICE) guidance on effective behaviour change interventions (National Institute for Health and Clinical Excellence, 2007), the Behaviour Change Wheel (Michie, 2014), and Intervention Mapping (Bartholomew et al., 2016) .

Intervention Mapping (IM) is the protocol for planning, implementing and evaluating interventions. This was the protocol chosen to guide this thesis. This decision was taken on the basis that IM is has a problem-driven and ecological approach (Bartholomew et al., 2016). IM consists of six steps fully described in Appendix 1. Briefly these steps are: (1) needs assessment; (2) development of matrices of change; (3) programme plan;

(4) development of components and materials; (5) plan for implementation; and (6) plan for evaluation.

Needs assessment consists of gathering theory-based and evidence-based data to understand the health behaviour of interest and identifying the behaviour determinants and the characteristics of the community. This holistic protocol has been successfully used to guide the development of several health interventions among school children and adolescents (Ezendam, Oenema, van de Looij-Jansen, & Brug, 2007; Reinaerts, Crutzen, Candel, De Vries, & De Nooijer, 2008; Singh et al., 2006; Wyatt, 2013) . The adaptation of interventions rather than development from scratch can provide important advantages including using previous successful interventions as a platform and adding information to the state of the art regarding intervention development. From IM, "IM to adapt" is derived, which is a subset of steps that guides the adaptation of existing interventions. Similarly to IM, IM to adapt has been successfully used to adapt an intervention to new settings (Gillison et al., 2012; Koutoukidis et al., 2018; Tortolero et al., 2005).

1.3.2 School-based interventions

Among children and adolescents, the school is a logical setting for health interventions because this is an important physical and social context for this age group. In the most recent systematic review of school-based interventions for obesity prevention, 1,553 programmes were identified (Brown & Summerbell, 2009). The emerging popularity of these interventions is due the different opportunities for learning and practicing health behaviours within this context. For example, children and adolescents spend a considerable amount of time in school (Fung et al., 2012; Silveira, Taddei, Guerra, & Nobre, 2013). Schools generally provide opportunities to learn and practice health behaviours during class, namely health education subjects and physical education (PE). Extra-curricular opportunities for this are also diverse, such as breaks, competitive and non-competitive sports, school outdoor trips, and active commuting to and from school (Budd & Volpe, 2006; De Bourdeaudhuij et al., 2011; Fung et al., 2012). Most schools, and especially those in HIC, have access to infrastructure for PA (e.g. playgrounds) and eating facilities (De Bourdeaudhuij et al., 2011). School children are influenced by the modelling behaviours of their teachers and peers (Brown & Summerbell, 2009; Khambalia, Dickinson, Hardy, Gill, & Baur, 2012). Data from literature reviews have shown that although school-based intervention success is inconsistent - mainly because

the heterogeneity of school-based interventions - there is a potential for obesity prevention (Brown & Summerbell, 2009; Visiedo et al., 2016).

A positive impact of school-based interventions in supporting health behaviours among school children has been seen in some countries. For instance, this was the case for PA promotion among school children in Slovenia (Sember et al., 2018). According to the Global Matrix of Report Cards of PA, Slovenia has been ranked top in the provision of opportunities for PA and PA levels among children and adolescents (Aubert et al., 2018). While it is not possible to claim causal effects from the data, several characteristics of school provision in Slovenia are suggested to underpin this advantage: based on nationally-representative data, all schools in Slovenia provide access to regular PE, sports days, nature programmes and extra-curricular sporting activities to all school children, and at national level around 80% of children and adolescents are reported to meet the PA recommendations (Sember et al., 2018). Conversely, in Mexico, almost 80% of children and adolescents do not accumulate 60 minutes of self-reported MVPA per day (Medina et al., 2018), and schools seem to provide insufficient levels of opportunities to reverse this trend (Argumedo et al., 2020; Galaviz et al., 2018).

Despite the reported poor lifestyle behaviours among Mexican adolescents and high levels of obesity/overweight, only a few strategies have been developed in the school setting to enhance adolescents' health. Table 1-1 summarises the interventions for obesity provision that have been documented in Mexico. Firstly, the data show that children have received the most attention in this regard; secondly, that none of the interventions achieved BMI changes. Therefore, there is a need to develop a school intervention in Mexico to improve adolescents' lifestyles and prevent obesity. This intervention should be developed systematically and grounded in theory.

Table 1-1 Existing school-based interventions in Mexico

Program	**Sample Characteristics**	**Intervention type**	**Components**	**Length**	**Mediating variables**	**Outcomes**
Nutrition on the Go (Shamah et al., 2012)	Age 10-12, N=1020, 60 schools, State of Mexico	Diet PA	Education Physical Environment	6 months	Self-efficacy	No changes in BMI. Significant reduction on the probability of shifting from overweight to obese.
School-based intervention program on obesity risk factors in Mexican children (Safdie, Jennings-Aburto, et al., 2013; Safdie, Levesque, et al., 2013)	Age mean 9 years old, N=830, 21 schools, Mexico City	Diet PA Sedentary behaviours	Education Physical Environment	2 years	Social cognitive theory. Theory of Planned behaviour. Health belief model. Social market theory	No significant changes in BMI, MVPA, screen time. Significant reduction in video gaming Reduction of SSBs consumption
FIFA 11 for Health (Barriguete Melendez et al., 2014)	842 children	PA	PA	11 weeks	Not reported	Increase knowledge

Note. PA=Physical activity, SSBs=Sugar sweetened beverages, BMI=Body Mass Index, MVPA=moderate to Vigorous Physical Activity

1.4 Thesis aim

The overarching purpose of this thesis is to explore some of the lifestyle determinants of obesity among Mexican adolescents, and to design a theoretical and evidence-informed PA intervention prototype using Intervention Mapping and grounded in SDT.

1.5 Thesis outline

A mixed method, pragmatic approach will be used to address the research aims (Patton, 2015). Obesity and its determinants will be analysed from two paradigms. One paradigm refers to the use of positivist lenses to *discover* what influences adolescents' health, using validated scales and objective observations (presented in Chapters 2 and 3). The other lens used, rather than reporting the *reality* of the participants as stipulated by a realistic approach (Popper, 1994) has sought to explore the adolescents' *perceived reality* within their particular context and circumstances, as in the constructivist tradition (Kant, 1787). Thus, a relativist ontology has been assumed in Chapter 4, in which the author's subjectivity is acknowledged when drawing conclusions. Chapter 5 presents the main expression of the overarching pragmatic approach of this thesis. In this chapter, data from both approaches are triangulated to direct the thesis towards practical and real-world opportunities to help adolescents to sustain a healthy lifestyle and to prevent obesity.

Chapter 2 reports an empirical study of a sample of adolescents living in Mexico City. The aim is to address a gap in the literature and the need for more evidence on the direction and strength of the association between lifestyle behaviours and obesity among adolescents living in low and middle-income countries, particularly in Mexico. Chapter 3 presents a theoretical exploration of the role of motivation in predicting PA behaviour. PA has consistently been reported as obesity-protective behaviour and a pillar for general health, wellbeing and even academic achievement. Via a qualitative exploration and using focus groups, Chapter 4 expands the information gained in Chapter 2 and 3, to explore adolescents' perception of potential barriers to and facilitators of PA and healthy eating, as well as their understanding of these behaviours.

Chapter 5 presents the process of developing a PA school-based intervention through selecting and tailoring a successful intervention to Mexican secondary schools, based on the data and research conducted in Chapters 2-4, following an Intervention Mapping

approach. The IM techniques provide structure and sequence to the formal process from a socio-ecological perspective.

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Chapter 2 The association between physical activity, sleep, diet, screen time, and obesity in Mexican adolescents

2.1 Pre paper commentary

The first aim of this thesis is to explore some of the determinants of obesity among Mexican adolescents to design an intervention for obesity prevention. In line with the ecological model (McLeroy, Bibeau, Steckler, & Glanz, 1988) the present chapter is dedicated to exploring the degree of association between lifestyle behaviours and obesity among adolescents living in Mexico City. Although other childhood obesity determinants, including those at different levels of influence, are important to study (including family obesity, genetic disorders, endocrine disorders, or social deprivation; (Lobstein, Baur, & Uauy, 2004)), this chapter is focused on four lifestyle behaviours; screen time, physical activity (PA), sleep, and diet.

The selection of the behaviours studied in this chapter was based on those behaviours that have been shown to have strong associations with obesity among other populations in past work, and where there is limited country-specific research available. First, there is existing evidence of the association between child and adolescent obesity and screen time (Borghese et al., 2014; Katzmarzyk et al., 2015), PA (Ekelund et al., 2004; Katzmarzyk et al., 2015; Menon, Philipneri, Ratnasingham, & Manson, 2019), and sleep (Chen, Beydoun, & Wang, 2008; Katzmarzyk et al., 2015). Less consistently, diet has also been linked to obesity (LaRowe, Moeller, & Adams, 2007; Malik, Schulze, & Hu, 2006). Second, there is limited data available regarding these behaviours among Mexican adolescents, especially using objective measures of PA and sleep (INSP, 2016). Device measured estimates of PA and sleep provide a more comprehensive assessment of body movements (Butte, Ekelund, & Westerterp, 2012). Third, the evidence suggests these behaviours can be modifiable via behaviour change interventions in school settings, as reported for increasing PA (Khambalia, Dickinson, Hardy, Gill, & Baur, 2012; Love, Adams, & van Sluijs, 2019),

decreasing screen time (Smith et al., 2014), increasing fruits and vegetable intake (Brown & Summerbell, 2009) and increasing sleep time (Blake et al., 2018).

This chapter provides a contribution to three broad gaps in the existing literature. This chapter provides objective measurements of PA and sleep, rather than self-reported data for a sample of Mexican adolescents (Arrona-Palacios, Garcia, & Valdez, 2015; Del Carmen Morales-Ruán, Hernández-Prado, Gómez-Acosta, Shamah-Levy, & Cuevas-Nasu, 2009). This is the first study conducted in Mexico in which accelerometer-based data will be monitored using a 24-hour period of wear-time, an approach that has been demonstrated to be effective in increasing wear-time compliance during data collection (Tudor-Locke, Barreira, Schuna, Mire, Chaput, Fogelholm, Hu, Kuriyan, Kurpad, Lambert, Maher, Maia, Matsudo, Olds, Onywera, Sarmiento, Standage, Tremblay, Zhao, Church, Katzmarzyk, et al., 2015). Finally, this chapter assesses determinants of obesity among adolescents living in low and middle-income countries (LMIC) using behavioural measures that have been validated in LMIC but that can be directly compared with findings in high-income countries (HIC).

2.2 Statement of Authorship

<table>
<tr><td colspan="4">This declaration concerns the article entitled:</td></tr>
<tr><td colspan="4">Association between physical activity, sleep, diet, screen time, and obesity in Mexican adolescents</td></tr>
<tr><td colspan="4">Publication status (tick one)
Draft manuscript [X] Submitted [ ] In review [ ] Accepted [ ] Published [ ]</td></tr>
<tr><td>Publication details</td><td colspan="3">The data that support the findings of this study are available from Dr Fiona B Gillison (sppfbg@bath.ac.uk) upon request.</td></tr>
<tr><td colspan="4">Copyright status (tick the appropriate statement)
I hold the copyright for this material [X] Copyright is retained by the publisher, but I have been given permission to replicate the material here [ ]</td></tr>
<tr><td>Candidate's contribution to the paper (provide details, and also indicate as a percentage)</td><td colspan="3">The candidate predominantly executed the…
Formulation of ideas: 60% in conjunction with the supervisory team I proposed the research questions.
Design of methodology: 60% in conjunction with the supervisory team, I decided the study design and the use surveys and accelerometer-based methods to collect data.
Experimental work: 90% I conducted all data collection, data cleaning, and data analysis. I had the support of the supervisory team to clarify questions during the whole process.
Presentation of data in journal format: 80% I drafted this paper and it was critically revised by the supervisory team.</td></tr>
<tr><td>Statement from Candidate</td><td colspan="3">This paper reports on original research I conducted during the period of my Higher Degree by Research candidature.</td></tr>
<tr><td>Signed</td><td></td><td>Date</td><td>27/09/19</td></tr>
</table>

The association between physical activity, sleep, diet, screen time and obesity in Mexican adolescents

2.3 Abstract

Background: By 2016, approximately 36.3% of Mexican adolescents were classified as obese or overweight. Diet, sleep duration, physical activity, and screen time have been associated with obesity. The purpose of this study is to examine the independent relationships between modifiable lifestyle behaviours (diet, sleep duration, physical activity, and screen time) and obesity and overweight among 13-15-year-old adolescents in Mexico City. **Methods**: A cross-sectional study with a sample of 320 adolescents from six secondary schools in Mexico City. Participants completed an online survey to measure socio-economic status, screen time and diet. A subsample of 172 participants wore an accelerometer (ActiGraph GT3X and GT3X+) for seven days to monitor sleep and physical activity. **Results**: The path analysis model was just identified and none of the lifestyle variables were associated with participants' BMI z-scores. 41.3% of participants were found to be obese/overweight. Accelerometer data showed *M*=46.33 minutes per day spent doing moderate to vigorous physical activity and *M*=8.1 hours of uninterrupted sleep time per night. Participants reported *M*=7.12 hours per day of screen time. **Conclusions:** More research is necessary to clarify the direction and strength of MVPA, screen time, diet and sleep time behaviours, and BMI z-scores. These behaviours need to be improved among Mexican adolescents.

Key words: Accelerometers, obesity, adolescents, sleep, diet, physical activity, screen time.

2.4 Introduction

Obesity and overweight have affected the health of more than 300 million children and adolescents worldwide (WHO, 2016). Obesity leads to an increased risk of chronic health issues such as Type 2 diabetes, cardiovascular disease and different types of cancer (Bray, Kim, & Wilding, 2017). Psychological and social consequences of obesity include stigmatisation, low self-esteem, body dissatisfaction, peer rejection, discrimination, depression and anxiety (Bray et al., 2017; Lobstein et al., 2004; Spruijt-Metz, 2011). As childhood obesity is a determinant of obesity in adulthood, this condition affects the individual's entire life span (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008).

Obesity is a multifactorial condition and to date, consensus about its aetiology has not been reached (Ross, Flynn, & Pate, 2016). Multinational and large sample studies based on adolescents' self-reported data have shown a positive association between obesity, low sleep levels (Garaulet et al., 2011), lower physical activity and higher TV viewing time (Janssen et al., 2005). Other multinational studies have used accelerometers to monitor PA and have found an association between low Moderate to Vigorous Physical Activity (MVPA) and obesity (Riddoch et al., 2005). Conversely, the evidence about the association between diet and obesity was mixed (Hoare et al., 2017; LaRowe et al., 2007; Malik et al., 2006). The current evidence about the association of these lifestyle behaviours and obesity is mostly based on cross-sectional data from adolescents living in high-income countries (e.g. Europe, United States) (Garaulet et al., 2011; Janssen et al., 2005; Riddoch et al., 2005). Less data is available about adolescents living in middle and low-income countries, with a few exceptions such as the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE), which reported data from children living 12 in countries at different levels of development (Katzmarzyk et al., 2013). ISCOLE findings among 6,025 children (ages 9-11 years) also support the association between obesity and low levels of objectively measured MVPA, short sleep duration, and high TV viewing time but not diet (Katzmarzyk et al., 2015).

The few studies collecting data from adolescents living in middle and low-income countries (particularly in Latin America) have demonstrated mixed findings. A positive association between screen time and BMI was identified in boys but not in girls for a sample of 546 Colombian adolescents (Arango et al., 2014). Contrary to expectation, self-reported PA and

diet were found to be not related to obesity among 825 Brazilian adolescents (Souza, de Andrade, & Santos, 2016). Among 712 Mexican school children and adolescents (aged 9-16 years), an association between obesity, self-reported PA and TV viewing was identified (Hernandez et al., 1999), whereas an association was reported between obesity and screen time in boys but not in girls in a sample of 9,132 participants (Lajous et al., 2009). Active commuting and outdoor play were found to be negatively associated with obesity markers in a sample of 1,803 Mexican adolescents (Parker et al., 2016). In addition to the fact that the findings in studies about adolescents living in high-income countries are mixed, this evidence is further limited due to the use of self-reported data and different instruments to measure behaviour that might make comparison with other populations difficult (e.g. adolescents living in high-income countries). Therefore, there is a need for more research about the association between these lifestyle behaviours using more accurate measures of PA and sleep as well as scales that facilitate a comparison with adolescents living in different contexts.

It has been shown that a high proportion of adolescents in Mexico lead obesity-risk based lifestyles. According to the National Health Survey 2016 (ENSANUT) (INSP, 2016), 80% of adolescents spend 2 or more hours a day on screen time, and only 17.2% of children (aged 10-14) and 61% of adolescents (aged 15-19) accumulate 60 minutes of MVPA per day. ENSANUT also showed a low intake of fruit and vegetables and a high intake of sugar sweetened beverages (SSBs) (83.9% of children and adolescents were shown to drink them regularly). In another study, 500 children (aged 12-14) self-reported an average of 8 hours of sleep (Lechuga, Escandón, Pérez, Yáñez, & Moctezuma, 2016). In addition to the poor lifestyle, a high prevalence of obesity has been identified in this group, where 13.9% of adolescents (aged 12-19 years) were classified as obese and 22.4% as overweight in 2016 (INSP, 2016).

2.4.1 The present study

Existing research suggests that a link exists between diet, physical activity, screen time and sleep behaviours, and the development of obesity in adolescents. There is a lack of information about this association among Mexican adolescents, and there is evidence of poor lifestyles and high prevalence of obesity within this group. The present study aimed to

assess the independent relationships between objectively measured physical activity, sleep, and self-reported screen time and diet, and obesity among Mexican adolescents.

2.5 Methods

2.5.1 Participants

All adolescents aged between 13-15 years enrolled at five secondary state and one private schools in Mexico City were eligible to take part. The research ethics committee of the University of Bath provided ethical approval (EP 15/16 277 see Appendix 2). Access into state schools and the list of candidate schools was facilitated by the Mexican Public Education Department (SEP), and access to the private school was achieved through directly approaching the headteacher. Following obtaining school agreement and written consent from the headteachers (see Appendix 3 and 4), a letter was sent home to parents seeking passive consent (see Appendix 5). Also, verbal consent was obtained from students (see Appendix 6 and 7) prior to study participation.

2.5.2 Measures

Anthropometry. To measure participants' anthropometry, a standard protocol was followed in line with past work (Katzmarzyk et al., 2013). Standing height was measured using a portable stadiometer (Seca 217, Hamburg, Germany); participants were asked to take and hold a deep breath, and the measurement was then taken while participants were standing upright with their arms hanging at their sides, feet together and with the head aligned in the Frankfort plane. Participants were asked to remove footwear and any hair ornaments. To measure body weight, a digital scale was used. Participants were asked to remove footwear and socks, heavy accessories and empty their pockets when their weight was measured. Measurements of height and weight were repeated twice, a third measurement was obtained if there was a difference in the first two height measurements of more than 0.5 cm, and a difference in weight measurement of more than 0.5 kg. The average of the two closest measurements of height and weight was used for analysis. BMI was calculated using the standard formula: body mass (kg)/height (m squared). BMI z-scores were estimated using the World Health Organization (WHO) growth reference chart for girls and boys aged between 5-19 years old (WHO, 2007) and participants were

classified as overweight if their z- score was >+1SD and obese if their z- score was >+2SD (de Onis, Onyango, Borghi, & Siyam, 2007).

Socio-economic status. Participants' socio-economic status was measured with a component score of Economic, Social and Cultural Status index (ESCS) used in the Programme for International Student Assessment (OECD, 2009). This instrument consists of 17 items designed to be answered by 15-year-old students. The ESCS has been validated in Mexico and internationally and provides a sensitive assessment of socio-economic status. The index is composed by (a) the highest occupational status of parents; (b) the highest educational level of parents; and (c) the availability of 13 different household items at home, including cultural possessions (e.g. books of poetry, works of art), educational resources (e.g. a desk to study, calculator), and wealth household items (e.g. microwave).

The highest occupational status of either parent was mapped according to the International Socio-economic Index of Occupational Status (ISEI) (OECD, 2009). The ISEI consists of four major categories: white-collar high-skilled, white-collar low-skilled, blue-collar high-skilled and blue-collar low-skilled (OECD, 2009). The highest educational level of parents was classified according to the International Standard Classification of Education (ISCED) (OECD, 2015), which includes categories from "no education" to "post-graduate". The index was coded in line with estimated years of schooling in Mexico into 6, 9, 12, 15 and 16 years. The items measuring the highest occupational status of either parent, the years of schooling and the availability 13 household items were then subjected to Principal Component Analysis (PCA) using one-factor solution and Varimax rotation. The final socio-economic status was obtained as a component score for the first principal component with zero being the average score and the standard deviation of one.

Diet. A food frequency questionnaire (FFQ) was used. This questionnaire is the 23-item Health Behaviour in School-aged Children Survey (HBSC) adapted for the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) project (Katzmarzyk et al., 2013). The scale has demonstrated acceptable validity for assessing food consumption from the children's most common food groups, and its Spanish version has been validated with Colombian children (Saloheimo et al., 2015). Participants were asked, "How many times do you usually eat <food item>?". The response options were: never, less than once a week, once a week, 2-4 days a week, 5-6 days a week, once a day,

every day, every day, more than once. It is important to consider was that tortillas (corn bread) were not included int the FFQ, even though these are the basis of the Mexican cuisine that may represent an important contributor to the total energy intake and could be allocated to the Bread group. This decision was made on the basis that: (1) many dishes tortilla-based use deep frying cooking methods, and (2) because the intake of tortillas could be indefinite within a single meal.

Consumption frequencies were converted into weekly portions as follows : 'never' into 0, 'less than once a week' into 0.5, 'once a week' into 1, 'on 2-4 days a week' into 3, 'on 5-6 days a week' into 5.5, 'every day' into 7, and 'more than once a day' into 10 portions a week (Mikkilä et al., 2015). Next, 22 of 23 Items were subjected to PCA (juice was excluded from the analyses due to low validity). Two-factor solution and Varimax rotation were used. The component loadings indicate two dietary patterns. In pattern 1 loadings for crisps, French fries, ice cream, fried food, fast food, sweets, energy drinks, soda, bread, sport drinks, and diet soda, were strong (>.5). In pattern 2 the component loadings of vegetables, green vegetables, orange vegetables, fruit, whole grain products, meat alternative products, cheese, were strong (>.5). These loadings allow to consider pattern 1 as "unhealthy" and pattern 2 as "healthy" (Mikkilä et al., 2015).

Screen time Items from the adapted Youth Risk Behaviour Surveillance System (YRBSS) (Centers for Disease Control and Prevention, 2012) were used to assess screen time use. This questionnaire has been validated in Spanish as part of the ISCOLE Lifestyle questionnaire study (Katzmarzyk et al., 2013). Participants were asked how many hours they typically watched TV, played video games and/or used the computer per weekday, and per weekend day. The response options were: 0, <1, 1, 2, 3, 4 and 5 or more hours per day. Screen time was determined by adding together the mean of TV viewing and the mean of playing video games/computer use without considering the use of tablets or smartphones (Wilkie, Standage, Gillison, Cumming, & Katzmarzyk, 2016). The daily amount of TV viewing was computed by a weighted mean of hours/day of TV viewing as in the formula [(hours of TV on weekdays x 5) + (hours of TV on weekend days x 2)]/7. The same formula was used for playing video games/computer use (Borghese et al., 2015).

Physical activity and sleep. Accelerometers GT3X and GT3X+ were used to measure these behaviours (Robusto & Trost, 2012). A 24-hour waist-worn accelerometer protocol

was followed. This protocol has been shown to increase wear-time compliance (Tudor-Locke, Barreira, Schuna, Mire, Chaput, Fogelholm, Hu, Kuriyan, Kurpad, Lambert, Maher, Maia, Matsudo, Olds, Onywera, Sarmiento, Standage, Tremblay, Zhao, Church, Katzmarzyk, et al., 2015). Participants wore the device on their right hip in line with the mid axillar line for 7 days and nights (i.e., including wearing the device in bed). Data were recorded in 1sec intervals by using the "idle sleep mode" filter. For model GT3X, a 30 Hz sampling rate was used, and for model GT3X+, the sampling rated was 80 Hz. Total sleep episodes were analysed as follows; a sleep episode comprised the period of time from the first 5 consecutive minutes of sleep to the first 10 or 20 consecutive minutes of wake time between 7:00 p.m. and 5:59 a.m. Non-wear time was considered if 90 consecutive minutes of 0 activity counts were identified, and participants were excluded from the analysis if this was the case (Tudor-Locke, Barreira, Schuna, Mire, Chaput, Fogelholm, Hu, Kuriyan, Kurpad, Lambert, Maher, Maia, Matsudo, Olds, Onywera, Sarmiento, Standage, Tremblay, Zhao, Church, & Katzmarzyk, 2015).

The ActiLife software (version 6.6.3) was used to extract participants' data from the devices. Cases were considered valid when the device recorded data from ≥10 hours of wear-time, ≥ 4 days and at least 1 weekend day (Tudor-Locke, Barreira, Schuna, Mire, Chaput, Fogelholm, Hu, Kuriyan, Kurpad, Lambert, Maher, Maia, Matsudo, Olds, Onywera, Sarmiento, Standage, Tremblay, Zhao, Church, & Katzmarzyk, 2015). Evenson's cut off points were used to determine MVPA (≥574 counts per 15s) (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008). Sleep time was considered to be the time from sleep onset to the end of sleep, including minutes of wakefulness estimated using an automated algorithm developed for the ISCOLE project (Barreira et al., 2015; Tudor-Locke, Barreira, Schuna, Mire, & Katzmarzyk, 2014). Sleep was considered valid when the device recorded data from ≥3 nights of sleep including a Friday or Saturday night. Each minute was given a "probability of sleep" score as determined by Sadeh's algorithm (Sadeh, Sharkey, & Carskadon, 1994). A sleep period was identified only when ≥160 minutes had elapsed between its beginning and end. Multiple sleep periods (≥ 160 minutes) were allowed during each 24-hr noon-to-noon day, but only sleep periods that began between 7 pm and 6 am were considered.

2.5.3 Procedure

After consent and assent had been obtained from participants and their parents, the participants answered the self-reported measures (in the form of an online survey) (Appendix 9) in the schools' computer centre with support of a teacher and a research team member. Following this, anthropometrical measures were taken, and pre-set accelerometers were allocated to groups selected by the headteacher according to the school day and the teachers' plans. The accelerometers where allocated on a first come first serve basis, while preserving a sex and age balance (selecting a similar number of girls and boys by convenience according to who was available on the device allocation day). Students received written and verbal instructions, and parents received written instructions on how the students should wear and use the accelerometer for a 7-day period (e.g. sleep with the device).

2.5.4 Statistical analysis

Data were first screened for missing values. All data was complete as all of the responses were set as required to move to the next question in the online survey. Standardized z-scores larger than 3.29 and Mahalanobis' distances greater than $\chi 2\ (7) = 18.47\ (p < .001)$ were used to identify multivariate outliers (Tabachnick & Fidell, 2007). One multivariate outlier and one univariate outlier were identified, and multivariate asymmetry was identified after testing for normal distribution. Therefore, outliers were preserved, and analyses were performed using 5000 bootstrap replications (Byrne, 2013). Bootstrapping is an approach for handling the violation of the normality assumption by creating multiple subsamples from an original dataset (Efron & Tibshirani, 1993). Given that only a subsample of participants was provided with accelerometers, results are reported from both the full sample and the subsample. First, using self-reported data only (diet, screen time, BMI z-score, SES) in the full sample, demographics and correlations were obtained. Secondly, a subsample including self-reported data (diet, screen time, BMI z-score) and accelerometer-based data (sleep time and MVPA) was used to describe sleep duration and PA, as well as obtain the correlations, and also for the main analysis (to identify associations between the four behaviours and BMI z-scores). Self- reported data from the full sample and the subsample were compared using a two-sample t-test for continuous variables and $\chi 2$ tests for categorical variable. Given that this research is one of the first

times in Mexico that these 4 behaviours have been measured objectively, and since international (Hallal et al., 2012) and national (Medina, Jauregui, Campos-Nonato, & Barquera, 2018) trends indicate sex disparities on PA, differences across gender were also computed. A high positive correlation was identified between sleep time and valid accelerometer wearing time in the subsample (r=-.72, p=.01). Values of tolerance and Variance Inflation Factor (VIT) of the independent variables did not violate multicollinearity assumptions (tolerance >.10 and VIF<10), and collinearity was not found.

Path analysis was performed to examine the associations between sleep (min/night), screen time (hours/day), healthy diet score, unhealthy diet score and MVPA (min/day) with BMI z-scores using the subsample data. Analyses were adjusted for sex, socio-economic status and accelerometer wear-time (min/day). Path analysis was conducted using IBM SPSS Amos version 24 (Arbuckle, 2017). Conventional criteria were used to assess the fit of the hypothesised model with the observed data using the indexes: CFI > .90, RMSEA < .06, SRMR < .08 (Hu & Bentler, 1999).

2.6 Results

Participants were recruited from five state secondary schools and one private school in Mexico City. Parents' passive consent was obtained for 345 students. 20 students did not provide assent and five dropped out, resulting in a full sample of 320 participants (166 males and 154 females; *M* age=13.66 years; SD=1.01). 131(subsample) out of 320 participants formed the analytical sample by providing valid sleep and physical activity data (63 males and 68 females; *M* age=13.5 years; SD=1) (see Figure 2-1).

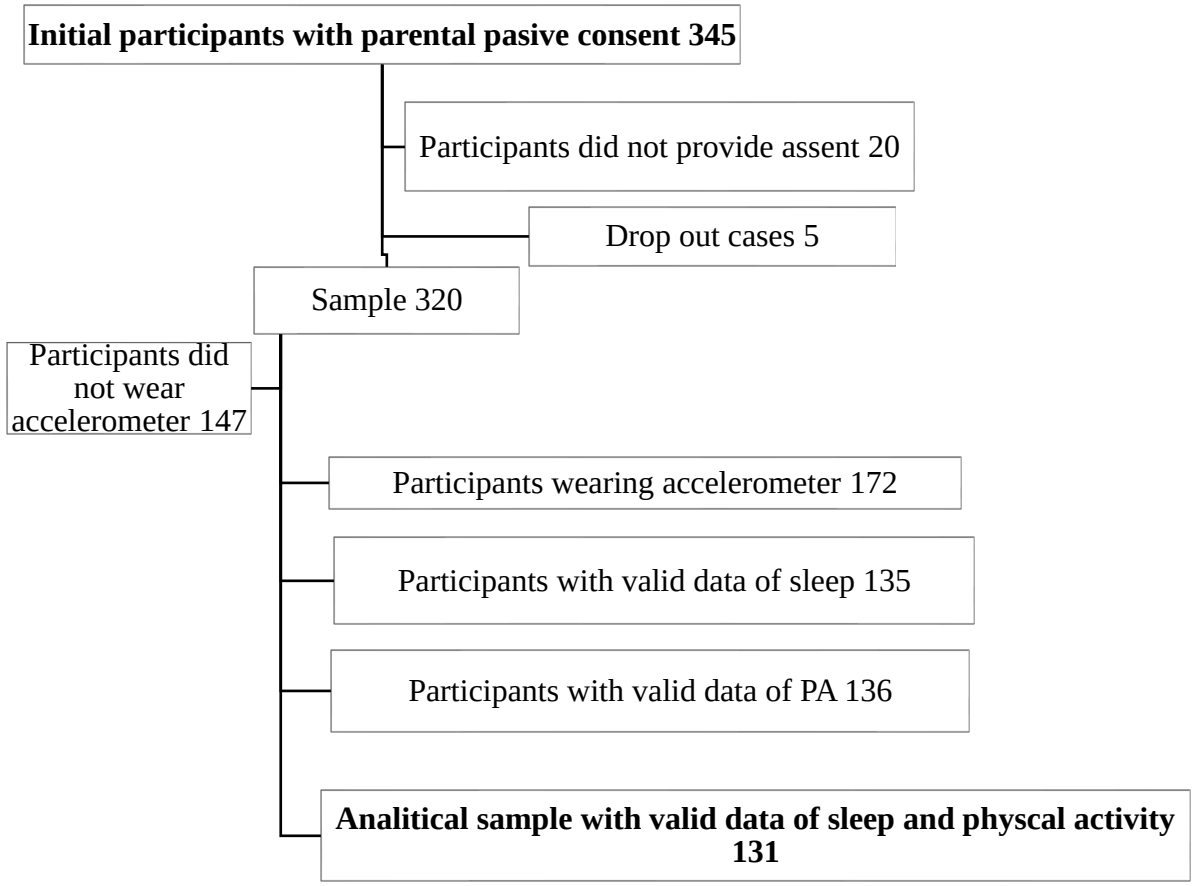

Figure 2-1. Study selection process

Participants from the full sample and the subsample did not differ in terms of BMI z-score, healthy diet, unhealthy diet, and socio-economic status. Both samples differed on screen time (see Appendix 10), which was significantly lower (t= .257, p=.01) among the participants from the subsample ($M_{ScreenTime}$=6.7, SD=2.24) than those from the full sample ($M_{ScreenTime}$=7.4, SD=2.3). Within the full sample, 28.8% of participants were classified as with overweight and 17.54% with obesity, 0.9% had two or less hours of screen time a day, and 49.7% of the participants' parents had a university degree and high occupational status (see Table 2-1). Accelerometery data showed an average of 8.2 hours of sleep per night and 47.11 minutes of MVPA per day. A total of 9.7% of participants accumulated 60 minutes of MVPA per day and 42.2% slept a minimum of 8 hours per night. The intra-class correlation showed that 13% of BMI z-scores variability was explained by the school level, thus, 87% of the variability was at the individual level.

Table 2-1. Demographic variables of the analytical sample by sex

Full sample data (N=320)	Total	Boys	Girls	t/x2	p
Categorical variables (N, %)					
Overweight-obesity (% z-scores>1SD)	132(41.3)	73(22.8)	59(18.4)	.83	.36
Overweight (% BMI z-score>1SD<2SD)	76(28.8)	36(13.6)	40(15.2)	.03	.86
Obese (% BMI z-score>2SD)	56(17.5)	37(11.6)	19(5.9)	4.8	.02
Healthy screen time (% <2h ST)	3(0.9)	3(1.8)	0(0)	1.20	.27
Parent university degree (%>15y schooling)	159(49.7)	88(27.5)	71(22.2)	1.26	.26
Parent high occupation status (% white-collar)	159(49.7)	76(23.8)	83(25.9)	1.79	.18
Parent low occupation status (% blue-collar)	119(37.2)	69(21.6)	50(15.6)	2.45	.11
Continuous variables (M, SD)					
Socio-economic status a	.00(1.00)	-.04(.99)	.04(1.00)	-.85	.39
BMI z-score a	.72(1.25)	.72(1.39)	.73(1.07)	-.07	.93
Screen time (hours/day, mean SD)	7.12(2.29)	7.41(2.30)	6.82(2.24)	2.30	.02
Unhealthy diet score (median)a	-.28(.99)	-.31(1.00)	-.23(1.00)	.00	1.00
Healthy diet score (median)a	-.16(.99)	-.02(1.00)	-.19(1.00)	.00	1.00
Subsample data (N=135)					
Categorical variables (N, %)					
Active (>60min MVPA/day)	31(22.8)	20(14.7)	11(8.1)	2.6	.10
Minimum sleep (>8 hours/night)	84(62.2)	39(28.9)	45(33.3)	.11	.73
Recommended sleep (>10 hours/night)	5(3.7)	2(1.5)	3(2.2)	.00	1.00
Continuous variables (M, SD)					

Accelerometer wear-time (min/day)	926.66(58.66)	928.63(71.60)	924.69(42.31)	.39	.69
MVPA (min/day)	47.11(18.66)	51.39(18.20)	42.83(18.25)	2.74	.00
Sleep time (hours/night)	492(61)	486(63.62)	498(52.40)	-1.16	.24

Note. MVPA=moderate to vigorous physical activity, ST=screen time, a= positive values represent healthier/higher and negative values less healthy/lower.

Food consumption frequencies from the full sample are presented in Table 2-2 and the diet factor loadings are displayed in Appendix 11. Participants reported frequent consumption of energy-dense and sugar-dense food products (juice *M*= 4.54 portions per week, soda *M*= 3.97, crisps *M*=3.00, sweets *M*= 3.72, fried food *M*=2.62). Similarly, a frequent consumption of low-energy and low-sugar food items was reported (green vegetables *M*=4.50, orange vegetables *M*=5.03, vegetables *M*=5.70, fruits *M*=6.08, meat alternatives *M*=4.75). Overall, boys' diet was higher in SSBs (soda, juice, energy drinks, and sports drinks) and fat (fried food) than the girls' diet.

Table 2-2. Consumption of different food groups per week (N=320)

Food item (portions/week)	Total	Boys	Girls	t	p
Crisps	3.00(3.23)	3.06(3.43)	2.93(3.02)	.37	.71
French fries	1.88(2.91)	2.07(3.09)	1.67(2.71)	1.22	.22
Ice cream	2.46(3.12)	2.75(3.33)	2.15(2.86)	1.71	.08
Fried food	2.62(3.15)	3.04(3.28)	2.15(2.94)	2.54	.01
Fast food	2.18(2.87)	2.15(2.90)	2.20(2.82)	-.14	.88
Sweets	3.72(3.19)	3.53(3.23)	3.91(3.15)	-1.06	.28
Energy drinks	1.65(3.05)	2.12(3.39)	1.15(2.47)	2.91	.00
Soda	3.97(3.43)	4.42(3.47)	3.49(3.33)	2.45	.01
Bread	4.29(3.29)	4.86(3.41)	3.67(3.05)	3.28	.00
Sport drinks	2.69(3.31)	3.47(3.57)	1.85(2.78)	4.50	.00
Diet Coke	1.56(2.76)	1.82(2.92)	1.28(2.51)	1.73	.08
Whole Milk	5.26(3.80)	6.04(3.70)	4.42(3.73)	3.89	.00
Fish	2.61(2.98)	3.00(3.11)	2.19(2.77)	2.46	.01
Other Milk Products	5.29(3.48)	5.88(3.35)	4.65(3.53)	3.18	.00
Green Vegetables	4.50(3.56)	4.60(3.76)	4.39(3.36)	.52	.60
Orange Vegetables	5.03(3.41)	5.29(3.36)	4.75(3.45)	1.41	.15
Vegetables	5.70(3.31)	5.90(3.40)	5.49(3.20)	1.09	.27
Fruit	6.08(3.31)	6.43(3.19)	5.70(3.41)	1.95	.05
Meat Alternative	4.75(3.35)	5.29(3.33)	4.16(3.28)	3.06	.00
Whole Grain products	4.42(3.49)	4.61(3.48)	4.21(3.50)	1.01	.31
Cheese	4.32(3.39)	4.77(3.32)	3.84(3.42)	2.46	.01
Skimmed Milk	2.55(3.50)	2.69(3.50)	2.39(3.49)	.76	.44
Juice	4.54(3.50)	5.06(3.58)	3.98(3.33)	2.78	.00

Correlations between study variables from the full sample are displayed in Table 2-3. BMI z-scores were negatively correlated with the unhealthy diet score (r=-.15, 95% CI= -.26, -.04), screen time was positively correlated with unhealthy diet score (r=.14, 95% CI= -.01, -.27), healthy diet score was positively correlated with socio-economic status (r=.17, 95% CI= .06, .28).

Table 2-3. Pearson correlations of the study variables from self-reported data (N=320)

Variable		1	2	3	4	5
1	BMI z- score	-	.00 (-.09, .10	-.15** (-.26,-.04)	.09 (-.01, .20)	.01 (-.09, .13)
2	Screen Time		-	.14** (.01-.27)	-.08 (-.20, .03)	-.04 (-.15, .06)
3	Unhealthy diet			-	.00 (-.14, .13)	-.14** (-.25, -.03)
4	Healthy diet				-	.17** (.06, .28)
5	SES					-

Note. Results based on 5000 bootstrap samples, 95% CIs reported in brackets.
** p < 0.01 level, two-tailed. *p < 0.05, two-tailed. BMI=Body Mass Index, SES=socio-economic status.

Correlations between study variables from the subsample including accelerometer-based data are displayed in the Table 2-4. BMI z-scores were not correlated with any of the studied lifestyle behaviour variables. MVPA was positively correlated with unhealthy diet (r=.21, 95% CI= .06, .35) and negatively correlated with socio-economic status (r=-.26, 95% CI= -.39, -.12). Unhealthy diet was negatively correlated with socio-economic status (r=-.18, 95% CI= -.33, -.02).

Table 2-4. Pearson correlations of the study variables with accelerometer data (N=131)

Variable		1	2	3	4	5	6	7	8
1	BMI z-score	-	.01 (-.14, .18)	-.02 (-.19, .15)	-.10 (-.26, .05)	-.13 (-.30, .04)	.04 (-.12, .22)	.06 (-.10,.22)	.04 (-.10,.20)
2	Screen Time (hours/day)		-	-.04 (-.20, .11)	.00 (-.18, .18)	.11 (-.08, .31)	-.08 (-.25, .09)	-.04 (-.20, .11)	.06 (-.08, .22)
3	Sleep (min/night)			-	.05 (-.11, .20)	.14 (-.01, .28)	.06 (-.10, .23)	-.12 (-.27, .03)	-.72** (-.83, -.60)
4	MVPA (min/day)				-	.21* (.06, .35)	.12 (-.06, .30)	-.26** (-.39,-.12)	.12 (-.02, .26)
5	Unhealthy diet (score)					-	.00 (-.20, .20)	-.18* (-.33,-.02)	-.22 *(-.39, .03)
6	Healthy diet (score)						-	.20* (.03, .37)	-.03 (-.20, .12)
7	SES (score)							-	.05 (-.12, .22)
8	Wear-time (min/night)								-

Note. Results based on 5000 bootstrap samples. 95% CIs reported in brackets. ** p < 0.01 level, two-tailed. *p < 0.05, two-tailed. MVPA=Moderate to Vigorous Physical Activity, BMI=Body Mass Index, SES=socio-economic status.

Results from the path analysis including all variables from the subsample are displayed in Figure 2-2. The path model is a just-identified model; thus, model fit information is not reported. None of the behavioural variables demonstrated an effect on BMI z-scores.

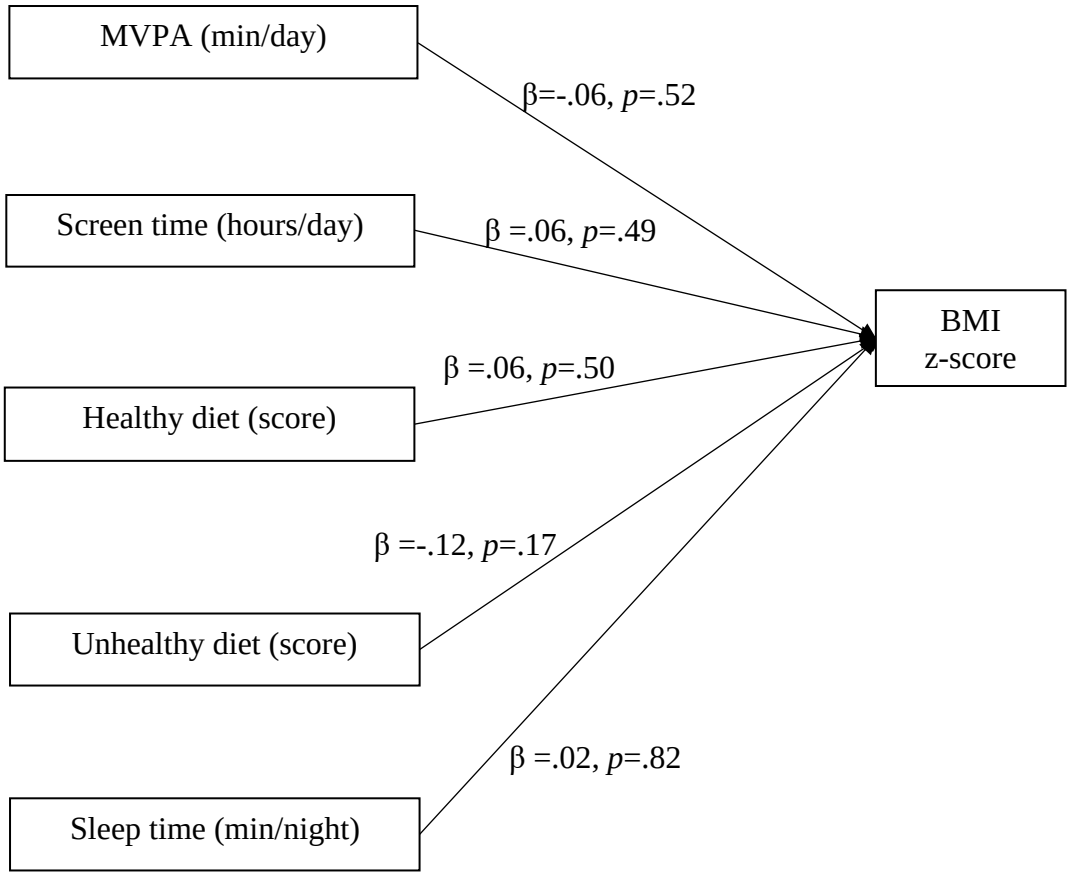

Figure 2-2. Standardised regression weights of all the proposed lifestyle exogenous variables predicting BMI z-scores.

Note. Accelerometer wear-time, sex and socio-economic status were included in the model as exogenous variables, these paths are excluded from the figure to facilitate its interpretation. The model was also tested using Treuth cut-off points (Treuth et al., 2004), but showed a lack of effect of the lifestyle variables on BMI z-scores.

Results from the path analysis including self-reported variables from the full sample are displayed in Figure 2-3. The path model is a just-identified model; thus, model fit information is not reported.

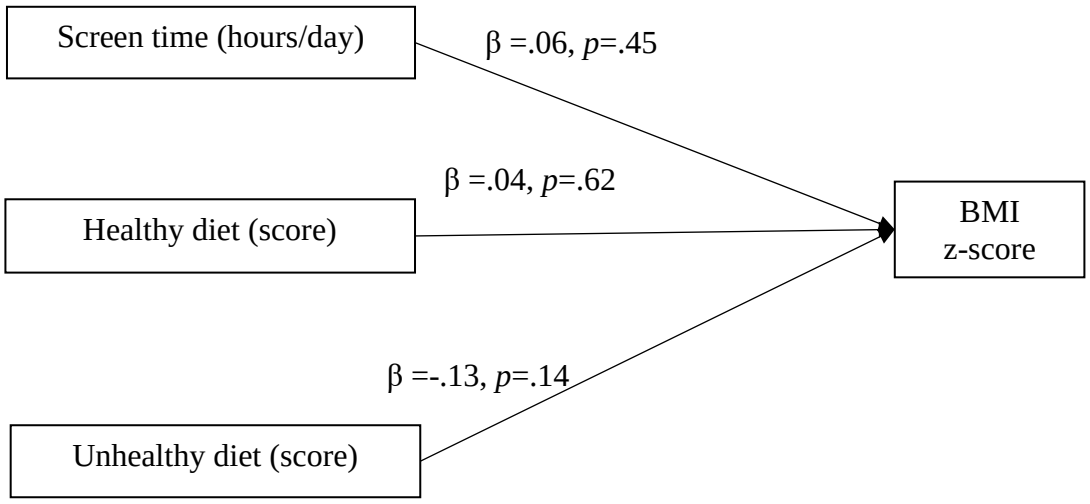

Figure 2-3. Standardised regression weights of self-reported exogenous variables predicting BMI z-scores.

Note. Sex, and socio-economic status were included in the model as exogenous variables, these paths are excluded from the figure to facilitate its interpretation.

2.7 Discussion

The present study aimed to assess the independent relationships between objectively measured physical activity, sleep, and self-reported screen time and diet, and obesity among Mexican adolescents. The model was just-identified; diet, MVPA, sleep and screen time were found to be not related with BMI z-scores among the participants of this study. These results suggest that other lifestyle behaviours or factors at different levels of influence (e.g., interpersonal, environmental) could have a stronger effect on adolescents' BMI z-scores. Of the 320 participants, 17.5% were classified as obese, with the results showing overall poor lifestyle behaviours.

2.7.1 Association between lifestyle and obesity

Different conditions might help to explain the findings of this study. It was found that self-reported screen time and PA were not associated. This result is in line with a study of a sample of 563 Kenyan children (aged 9-11). Using the same ISCOLE questionnaire to measure sedentary time (Katzmarzyk et al., 2013), no association between screen time and BMI z-scores was found. Kenyan children's' screen time was shown to be relatively low on weekdays and weekends (1.75 hours and 4.25 hours respectively) (when comparing to Mexican adolescents), and around 67.9% of children were found to meet the screen time recommendation on weekdays (Wachira, Muthuri, Ochola,

Onywera, & Tremblay, 2018). By contrast, previous studies have reported a relation between screen time and BMI z-scores among Mexican (Lajous et al., 2009), Iranian (Hatami et al., 2014), Spanish (Muntaner-Mas, Vidal-Conti, Cantallops, Borras, & Palou, 2017; Vicente-Rodríguez et al., 2008) and United States adolescents (Kenney & Gortmaker, 2017). The nature of how screen time was measured might explain this discrepancy, as in the current study, the usage of smart phones or tables was not examined. Smart phone and tablet usage could have affected the amount of screen time reported. In addition, other studies focused on TV viewing only (Hernandez et al., 1999) and previous studies have shown that TV viewing but not computer use is related to increased weight (Janssen et al., 2005). A second explanation could be related to age, as a study reported that lower screen time is associated with lower age (Christofaro, De Andrade, Mesas, Fernandes, & Farias, 2016).

MVPA was found not associated with BMI z-scores. Previous cross-sectional studies have reported an association between MVPA and BMI (Ekelund et al., 2004; Gomes et al., 2015; Wilkie et al., 2016), which was not supported by the present study findings. A possible explanation of this is probably that adolescents engage more with other intensities of PA (e.g. light). Another possible explanation could be that other behaviours but not MVPA have a stronger effect on adolescents' BMI.

Healthy and unhealthy diet scores were not related with BMI z-scores, in line with previous research (Janssen et al., 2005; Katzmarzyk et al., 2015; Wilkie et al., 2016). These results provide more evidence on the need for more measures of diet, that consider cultural and traditional characteristics of participants cuisine in more detail in order to explore which diet conditions might influence adolescents' body weight. Similar to this, no association was found between sleep and BMI z-scores, which was also the case in a study of 567 Canadian children using accelerometery data (McNeil et al., 2015). However, the same study also reported a significant association between BMI z-scores and sleep efficiency (McNeil et al., 2015). It is probable that the quality of sleep (which was not measured in this study) may have a stronger effect on BMI z-scores than sleep time alone.

Since the results of the Path analysis showed no association between the independent studied variables and BMI z-scores, results of the correlations may help to find other possible explanations. MVPA was negatively correlated with socio-economic status for the present study sample. It could be suggested that adolescents from households with higher economic and educational conditions accumulate less PA. This finding supports

previous evidence on international trends, which show a decrease of physical activity associated with higher income (Manyanga et al., 2018). It is probable that the less active participants have access to other forms of leisure time activities (e.g. piano classes) or use automobile transportation more than their counterparts. However, these results differ from a large multinational study on PA correlates from 142,118 adolescents living in low and middle-income countries which revealed that food insecurity as a proxy measure of SES was associated with less PA (Vancampfort et al., 2019). Substantial differences exist in terms of the SES measures in both studies. For instance, Vancampfort et al. (2019) measured SES using a single item "During the past 30 days, how often did you go hungry because there was not enough food in your home?". Comparatively, in the present study SES was measured based on parental education and occupation as well as household items reflecting wealth, culture, and education. Therefore, it is probable that the educational component might moderate the association between SES and PA.

It was also found that screen time was positively correlated with unhealthy diet scores. This finding is consistent with past research in Mexican children (aged 9-16 years), which reported that those children who watch more TV programmes, consume more snacks (Hernandez et al., 1999). Socio-economic status was correlated with healthy diet scores, suggesting that Mexican adolescents with access to preferable socio-economical and educational conditions may have healthier eating choices than their counterparts with low SES and worse educational conditions. These findings are consistent with findings of an association between food insecurity and low diet quality among 4,635 Mexican children and adolescents (Rodríguez, Mundo-Rosas, Méndez-Gómez-Humarán, Pérez-Escamilla, & Shamah-Levy, 2017).

2.7.2 Participants' lifestyle

Obesity and overweight prevalence was 41.13% among participants, which is above the national average (36.3%) and close to the average in Mexico City (41.6%) (Shamah-Levy et al., 2018). Results from ISCOLE reported highest rates of obesity among Chinese boys (34.9%) and lowest levels among Finnish (3.2%) and Colombian girls (3.6%) (Katzmarzyk et al., 2015). In the present study, 17.5% of participants were classified as obese, which is at a similar level as US boys (17.9%) (Katzmarzyk et al., 2015). Overall, this result supports that obesity is a problem among school children in Mexico City that warrants prompt attention.

A key finding of this study was the evidence of adolescents' lifestyle based on accelerometery. Adolescents did not engage in enough PA, as approximately 77.2% of participants did not accumulate 60 minutes of MVPA per day. Boys were more active than girls (51.39 min/day vs 42.83 min/day), which is in line with previous accelerometer-based data from 6,413 children and adolescents (aged 4-18 years old), showing 55% more MVPA per day in boys than girls (Sherar et al., 2011). Levels of MVPA among children in the ISCOLE study, which used the same PA monitoring protocol as the present study, ranked from the highest levels of around 81min/day among Kenyan and Finnish boys to bottom levels among Chinese and Indian girls (38min/day and 40 min/day respectively) (Katzmarzyk et al., 2015). Accelerometery results from the present study showed that Mexican adolescents accumulated 47.11min/day of MVPA, which are rates similar to Brazilian and Portuguese girls (48 min/day and 47min/day respectively) and Chinese boys (49min/day) reported in the ISCOLE study (Katzmarzyk et al., 2015). Other research has also shown low MVPA levels among adolescents, such as a study in which Singaporean adolescents showed around 24min/day MVPA (this was measured with accelerometers) (Lye Ching Ting, 2015). The latter findings are also consistent with worldwide trends (Hallal et al., 2012). Approximately 39.8% of the participants did not sleep a minimum of 8 hours per night, revealing the need to improve this behaviour among youth.

Screen time was found to be high in the present study, with adolescents reporting an average of 7.12 hours per day of screen time and less than 1% of the participants spending two or less hours a day on these behaviours (a percentage similar to the screen time of Brazilian adolescents (Christofaro et al., 2016)). A frequent consumption of SSBs was identified in the participants' diet, particularly among boys. Although a frequent intake of fruit and vegetables was reported, this was not every day. Similar patterns have been previously documented among other adolescents living in LMIC (Vancampfort et al., 2019).

The unhealthy diet score was positively correlated with MVPA. Previous qualitative studies among Mexican school children have identified a general perception that drinking fresh water only necessary when exercising (Theodore et al., 2011). However, there is no further evidence about this view among Mexican adolescents. Contrary, the consumption of the sugary beverages has become popular among adolescents and youth adults. The results of this study suggest that active participants are eating more unhealthy food options, and a possible explanation of this finding is based on the

consumption of energy and sports drinks. Overall, boys were more active than girls. However, the frequency of energy and sports drinks intake was also significantly higher in boys than girls. Energy and sports drinks levels of sugar are above the recommendations and marketing campaigns are promoting their consumption among athletes (Duchan, Patel, & Feucht, 2010). It is possible that the participants of this study consume this sort of beverages as a result of being more active; further studies should explore this potential association.

2.7.3 Study limitations

This is the first study to report on the multivariate predictors of BMI z-scores incorporating objective measurement of physical activity among Mexican adolescents. However, some limitations should be noted. The sample with accelerometer-based data was small, limiting the power of the study. The cross-sectional design of this study limits the generalisability of the results. Despite the fact that a high frequency of juice intake (4.15 proportions per week) was found, this food item was removed from the diet score for the analysis because previous studies had identified low validity of juice within the FFQ (Mikkilä et al., 2015). Although comparable with other studies, the screen time measures did not explicitly enquire about smart phone or tablet usage, which have recently increased as a means for viewing content across the world (Aubert et al., 2018). Therefore, the measure of screen time used in this study may have underestimated the time spent on these activities. There was a significant difference in screen time between the participants who were included (who wore accelerometer and provided valid data had lower screen time) and excluded (who did not wear the accelerometer had higher screen time) from the analytical sample with 6.7 vs 7.2 hours of screen time respectively.

2.8 Conclusion

More research is necessary to clarify the direction and strength of associations between MVPA, screen time, diet, sleep behaviours and BMI z-scores. Lifestyle behaviours need to be improved among Mexican adolescents. Further strategies for obesity prevention should explore other factors than these lifestyle behaviours influencing paediatric obesity.

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2.9 Closing Commentary

The main purpose of this chapter was to identify the strongest obesity determinants among the participants to direct the intervention focus. Given that the results of this cross-sectional study did not show an association between the studied lifestyle behaviours and obesity, it might not be necessary to address any of the studied behaviours to reduce obesity. In addition, it could be important to explore any other obesity determinants for the development of obesity prevention interventions. However, among the studied behaviours, PA provides multiple independent benefits to adolescents' health (Biddle, 2015; Crone, Smith, & Gough, 2005; Janssen & Leblanc, 2010; Tyson, Wilson, Crone, Brailsford, & Laws, 2010) and quality of life (Wu et al., 2017). Given the current evidence that it is possible to increase MVPA levels through school-based interventions from under 5 to 45 extra minutes per week (Dobbins, Husson, Decorby, & Larocca, 2013), PA might represent the most likely behaviour that could be changed throughout a behaviour change intervention in school settings (e.g. rather than sleep). Therefore, the subsequent chapters of this thesis will be concentrating on exploring factors associated with adolescents' PA participation.

The results of this chapter provide data for this group of participants that support the existing literature of the large proportion of adolescents affected by obesity/overweight. 41.3% of participants of this study were found classified with obesity and overweight. Next, this chapter supports previous evidence that Mexican adolescents' lifestyle is poor, given that 39.8% do no sleep a minimum of 8 hours per night, 77.2% do not accumulate 60 minutes of MVPA, only 0.9% do not exceed two hours of screen time a day, and the consumption of SSBs is frequent. These findings provide evidence for further studies exploring this lifestyle in Mexico.

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Chapter 3 The association between the satisfaction of psychological needs, motivation, physical activity and sedentary time among Mexican adolescents

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3.1 Pre paper commentary

PA has shown a number of independent benefits to overall adolescents' health and quality of life (Biddle, 2015; Crone, Smith, & Gough, 2005; Janssen & Leblanc, 2010; Tyson, Wilson, Crone, Brailsford, & Laws, 2010; Wu et al., 2017). Motivation has been associated with PA engagement for longer in life (Teixeira, Carraca, Markland, Silva, & Ryan, 2012). Self-determination theory (SDT) is a human motivation theory which explains that the individual motivation at different levels of quality (rather than quantity) is a predictor of performance in different areas of life (e.g. academic engagement and PA participation) (Deci & Ryan, 2008). Based on data from the same participants as in Chapter 2, this chapter explores the psychosocial mechanisms underpinning adolescents' PA engagement.

The understanding of the psychosocial mechanisms underpinning adolescents' motivation towards PA will provide valuable information on potential PA determinants among Mexican adolescents, specifically to facilitate the selection of the strategies needed to change that behaviour. This is the first study to attempt to investigate these factors in a sample of Mexican adolescents.

3.2 Statement of Authorship

<table>
<tr><td colspan="4">This declaration concerns the article entitled:</td></tr>
<tr><td colspan="4">The association between the satisfaction of psychological needs, motivation and physical activity and sedentary time among Mexican adolescents</td></tr>
<tr><td colspan="4">Publication status (tick one)
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<tr><td>Publication details</td><td colspan="3">The data that support the findings of this study are available from Dr Fiona B Gillison (sppfbg@bath.ac.uk) upon request.</td></tr>
<tr><td colspan="4">Copyright status (tick the appropriate statement)
I hold the copyright for this material [X] Copyright is retained by the publisher, but I have been given permission to replicate the material here [ ]</td></tr>
<tr><td>Candidate's contribution to the paper (provide details, and also indicate as a percentage)</td><td colspan="3">The candidate predominantly executed the…
Formulation of ideas: 60% in conjunction with the supervisory team I proposed the research questions.
Design of methodology: 60% in conjunction with the supervisory team, I decided the study design and the use surveys and accelerometer-based methods to collect data.
Experimental work: 90% I conducted all data collection, data cleaning, and data analysis. I had the support of the supervisory team to clarify questions during the whole process.
Presentation of data in journal format: 80% I drafted this paper and it was critically revised by the supervisory team.</td></tr>
<tr><td>Statement from Candidate</td><td colspan="3">This paper reports on original research I conducted during the period of my Higher Degree by Research candidature.</td></tr>
<tr><td>Signed</td><td></td><td>Date</td><td>27/09/2019</td></tr>
</table>

The association between the satisfaction of psychological needs, motivation, physical activity and sedentary time in Mexican adolescents

3.3 Abstract

Background: Regular physical activity (PA) is important for attaining and maintaining health and wellness. However, evidence has shown that PA levels decline during adolescence. In Mexico, around 80% of children and 35% of adolescents do not meet the recommended levels of physical activity. Grounded within self-determination theory, the purpose of this study was to test a mediation model of adolescents' daily PA and sedentary time. **Methods:** Mexican adolescents (n=320) participated in this study by completing a standardised questionnaire; a subsample of 172 participants wore an accelerometer to monitor PA over a 7-day period. The factor structure of the proposed associations was tested via Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM). Path analysis was used to test the model with PA and sedentary time. **Results**: The path analysis results had good fit with the data for MVPA, but poor fit for sedentary time. Relationships among parents', friends' and PE teachers' need support and autonomous motivation were mediated by participants' perceptions of psychological need satisfaction. Autonomous motivation did not have a predictive effect on daily MVPA or sedentary time**.** **Conclusions**: The role of important others is important for Mexican adolescents' autonomous motivation for physical activity, but autonomous motivation alone is not sufficient to predict physical activity behaviour. Further interventions to increase PA behaviours should consider other interpersonal or environmental factors influencing adolescents' behaviour.

Keywords: Physical activity, sedentary time, adolescents, accelerometer, self-determination theory, physical education teacher, family, friends.

3.4 Introduction

Regular engagement in physical activity (PA) improves psychological and physical health. Physical health outcomes which could be improved by PA engagement might be cardiorespiratory and muscular fitness, bone health, metabolic health, and body composition, in addition to psychological outcomes such as reduced depression and anxiety (Tyson et al., 2010; U.S. Department of Health and Human Services, 2008). Despite these positive outcomes, rates of PA decline in adolescents aged between 13 and 18 years (Dumith, Gigante, Domingues, & Kohl, 2011; Sallis, 2000), which coincides with a period within the lifespan where sedentary time increases (Alberga, Sigal, Goldfield, Homme, & Kenny, 2012; Biddle, Gorely, Marshall, Murdey, & Cameron, 2004; Tanaka, Reilly, & Huang, 2014). Adolescence is an important transition time for the development of autonomy and identity (DiClemente, William, & Lynn, 1996), in which the social context plays an essential role.

The effect of social support on PA could be examined from different angles. For instance, in terms of the provider of social support (e.g. mothers, friends or teachers) or the type of support such as tangible (e.g. pay club membership fee) or intangible (e.g. encouragement) factors (Gillison et al., 2017). In a recent study of the correlates of PA among adolescents from 48 low and middle-income counties (LMIC), a lack of friends' support and low parental support were shown to be associated with less PA (Vancampfort et al., 2019). Self-determination theory (SDT) provides a guidance framework for gaining more detailed understanding of the extent to which the perceived support of three basic psychological needs by the social context is associated with PA behaviour (Ryan & Deci, 2017). This study will extend research in this area by examining the relationship between parents', peers', and physical education teachers' psychological need support, PA and sedentary time, in line with the Self-Determination Theory (SDT).

3.4.1 Motivational processes and physical activity

The SDT framework explains individuals' motivation and its link with performance. According to SDT, three basic psychological needs are the basis for healthy functioning, namely autonomy (i.e., to feel the ownership of one's behaviour), competence (i.e., to interact with the social environment effectively and express one's capacities), and relatedness (i.e., to feel connected with others). When needs are met, behaviour is

integrated (e.g. high quality of engagement) but when needs are frustrated, only partial integration of behaviour can take place, resulting in highly rigid engagement (i.e., low quality) (Ryan & Deci, 2017). The satisfaction of the three psychological needs is determined by the need support from the social context (Ryan & Deci, 2000; Vallerand, 1997).

SDT differentiates types of motivation for a given behaviour. Motivation lies on a continuum from autonomous to controlled, depending on how highly integrated PA behaviour is within the self (Standage & Ryan, 2012). Autonomous regulation of PA behaviour includes intrinsic motivation (i.e. authentic engagement in activities of inherent satisfaction and enjoyment apart from consequences) and identified regulation (i.e. engagement in activities because of the value given and reasons important to the sense of self such as to maintain health). Motivation for PA behaviour that is not highly integrated with the self is termed controlled motivation. It comprises introjected regulation (i.e., engagement in activities because of self-imposed sanctions such as guilt and pride) and external regulation (i.e., engagement in activities because of external consequences such as rewards or avoiding punishment) (Deci & Ryan, 2002). Within SDT, autonomous motivation contributes to engaging with activities with excitement and interest which in turn leads to persistence, creativity and wellbeing (Ryan & Deci, 2000).

Autonomous motivation has been identified as an important correlate of adolescent PA (Owen, Astell-Burt, & Lonsdale, 2013). A systematic review and meta-analysis reported that autonomous motivation among children and adolescents was positively associated with PA during PE and leisure time, whereas by contrast, controlled motivation was negatively associated with PA (Owen, Smith, Lubans, Ng, & Lonsdale, 2014). Cross-sectional studies which use accelerometer-based PA data also support the association between autonomous motivation and PA behaviour. In a study of 739 Belgium adolescents' PA, a positive association between autonomous motivation towards PA and moderate to vigorous physical activity (MVPA) were found, as well as a negative association between controlled motivation for PA and physical education (PE) engagement (Aelterman et al., 2012). Congruent findings were reported among 61 Australian adolescents, whose autonomous motivation towards PE was positively associated with MVPA during PE and leisure time (Owen et al., 2013).

The social context is essential for the provision of psychological need support; the immediate social context of adolescents includes parents, teachers and friends. Evidence supports the view that autonomy support from PE teachers positively predicts autonomous motivation for PE (Standage, Gillison, Ntoumanis, & Treasure, 2012), effort and persistence in PE (Standage, Duda, & Ntoumanis, 2005), leisure time PA (Bagoien, Halvari, & Nesheim, 2010; Hagger et al., 2009), and MVPA (Wang, 2017). Recently, research has been published, which explores the role of PE teachers' support for competence and relatedness in addition to autonomy support (Curran & Standage, 2017). For example, adopting a teaching style that supports all three basic needs increased perceived autonomy support among 699 Flemish students (Aelterman, Vansteenkiste, Van den Berghe, De Meyer, & Haerens, 2014). Psychological need support for autonomy, relatedness and competence from PE teachers positively predicted need satisfaction, which in turn positively predicted autonomous motivation and objectively measured MVPA in a sample of 539 British adolescents (Emm-Collison, 2016).

Parents' and peers' need support also has been shown to affect adolescents' autonomous motivation towards PA. A positive association between parental autonomy support and children's self-reported leisure-time PA among 840 adolescents living in four European countries has been shown (Hagger et al., 2009). A positive association between autonomy need support from parents and sports coaches, and autonomous motivation of 335 adolescents (athletes) was shown in a study conducted in the United States (US) (Amorose, Anderson-Butcher, Newman, Fraina, & Iachini, 2016). Similarly, autonomy support from mothers and PE teachers predicted autonomous motivation, which in turn predicted self-reported leisure-time PA of 161 US adolescents (McDavid, Cox, & Amorose, 2012). Peer need support for autonomy, relatedness and competence positively predicted autonomous motivation and objectively measured MVPA among 539 British adolescents (Emm-Collison, 2016). Autonomy support from parents, peers and PE teachers was positively associated with accelerometer-measured MVPA among 255 Chinese adolescents, and this association was mediated by need satisfaction and autonomous motivation (Wang, 2017). Collectively, the above mentioned evidence supports the notion that PE teachers', parents', and peers' psychological need support will foster psychological need satisfaction, autonomous motivation, and PA behaviour.

There is evidence supporting the view that low autonomy support, low psychological need satisfaction and low autonomous motivation may predict sedentary behaviour. Among 105 British adolescents athletes, coaches' autonomy support positively predicted autonomous motivation, and conversely, the coaches' controlling style positively predicted controlled motivation (Fenton, Duda, Quested, & Barrett, 2014). Lastly, autonomous motivation negatively predicted objectively measured sedentary time (Fenton et al., 2014). The perception of inadequate support for autonomy, competence, and relatedness from PE teachers was associated with assigning less value to the activity, boredom, and disinterest among 162 British male adolescents (Jackson-Kersey & Spray, 2016). Among 539 British adolescents, perceived need support has also been shown to negatively predict need frustration which in turn, positively predicted controlled motivation and amotivation, whereas autonomous motivation negatively predicted objectively measured sedentary time (Emm-Collison, 2016). Therefore, while autonomy support, need satisfaction and autonomous motivation appear instrumental in the development of PA, it appears that the opposite is the case for sedentary behaviour.

Cultural differences might have an impact on the perception of psychological need support. For example, a stronger relationship between autonomy support for PE and perceptions of competence among Hong Kong Chinese students was shown than for British students (Taylor & Lonsdale, 2010). As the examination of the associations between need support and, PA and sedentary behaviour has been conducted mostly in adolescents living in high-income countries (e.g. England, Australia) (Emm-Collison, 2016; Fenton et al., 2014; Hagger et al., 2009; Standage, Gillison, & Treasure, 2007), it is important to explore whether the perceived need supports vary across cultures and contextual environments. In Mexico, only 61% of adolescents (aged 15-19 years) meet the recommended 60 minutes of moderate to vigorous physical activity (MVPA) per day (Medina, Jauregui, Campos-Nonato, & Barquera, 2018) and 80% exceed two hours of screen time per day (INSP, 2016). The evidence for SDT principles within Mexican populations have not been examined to a large extent (Zamarripa, Duarte, Morquecho, Perez, & Castillo, 2018). A few exceptions have shown that need support is positively correlated with need satisfaction and positive affect towards PE among 72 Mexican adolescents (Calva-Vite et al., 2007). Another study using a sample of 734 Mexican adolescents found that need support from PE teachers positively predicted autonomous motivation in PE, which in turn positively

predicted self-reported wellbeing and negatively predicted ill-being (Zamarripa, Castillo, Tomás, Tristán, & Álvarez, 2016). Therefore, more research is needed to fully understand whether the psychological need support from the social context reflects an effect of PA behaviour among adolescents in LMIC such as Mexico.

3.4.2 The present study

The current study sought to extend extant research by examining the interplay of psychological need support, psychological need satisfaction, motivation, and objectively measured MVPA and sedentary time of Mexican adolescents. Specifically, a process model guided by SDT (see Figure 3-1) was tested. Psychological need support from PE teachers, peers and parents was expected to positively predict psychological need satisfaction for PA. In turn, psychological need satisfaction for PA was expected to positively predict autonomous PA motivation, and negatively predict controlled PA motivation. Autonomous PA motivation was expected to positively predict MVPA and negatively predict sedentary time, whereas controlled PA motivation was expected to negatively predict MVPA and positively predict sedentary time.

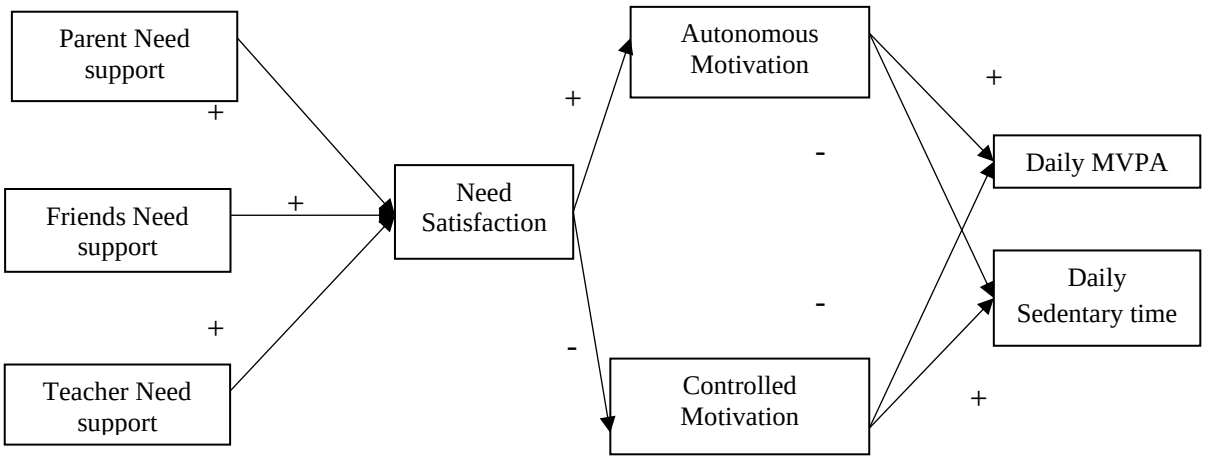

Figure 3-1. Hypothesised model of associations between need support, need satisfaction, motivation, daily MVPA and sedentary time.

3.6 Method

3.6.1 Participants and procedure

Mexican adolescents (N=320) aged between 12-17 years old were recruited from five state schools and one private school in Mexico City. Of these, 173 adolescents from five state schools were issued with accelerometers on a first come first served basis. Prior to data collection, ethical approval was provided by the research ethics committee of the University of Bath (EP 15/16 277). In loco parentis declaration was obtained from the headteachers, as well as passive consent from parents who received information letters. Additionally, assent was obtained from students who received an explanation letter about the study. All self-report measures were integrated into an online survey and participants answered it in the schools' computer centre with support of a teacher and a member of the research team (Appendix 12). After completing the online survey, participants were asked to wear the accelerometer for seven days, including at least one weekend day and received verbal and written instructions of how to use the device (e.g., do not wear it during water-based activities).

3.6.2 Measures

Psychological need support. The Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ) is a 9-item scale that was used to assess the perception of need support for autonomy, competence and relatedness from an adolescent's parents, friends and PE teachers (Emm-Collison, Standage, & Gillison, 2016). The APNSEQ was professionally translated and back translated from English into Spanish, and the specific wording as it relates to SDT was refined with expert native speaker input. The Spanish version of the scale was piloted in Monterrey, Mexico with 12 adolescents aged between 10 to 17 years old, showing that no adjustment was necessary (see Appendix 13 and 14). In the questionnaire, participants responded to the stem "In my interactions with my family/friends/teacher about exercise" using a 7-point Likert scale from 1 (strongly disagree) through 4 (neither agree nor disagree) to 7 (strongly agree) to options such as "I feel that they understand why I choose to exercise". This scale has demonstrated acceptable reliability when used with a sample British adolescents (α >.68) (Emm-Collison et al., 2016). Scale scoring was performed through computing the average of all items for parents, friends and PE teachers by summing the score and dividing it by the number of items.

Psychological need satisfaction. Perceived autonomy was assessed with the 10-item Perceived Autonomy in Sports Scale (PASS) (Reinboth & Duda, 2006). The Spanish version of the scale has been validated with Spanish athletes (M_{age}=24, SD= 4.7) and has demonstrated acceptable reliability (α=.89) using the stem "In my sport …"(Balaguer, Castillo Isabel, & Joan, 2008). The stem used in the present study was slightly modified to include exercise as follows: "When I am in an exercise or sports session…." (translated into Spanish). The items were scored on a 7-point scale, with higher average item scores reflecting a greater sense of autonomy.

Perceived relatedness was measured using the Perceived Relatedness Scale (Richer & Vallerand., 1998). The scale has demonstrated reliability in both English and Spanish versions. The Spanish version has been validated with Spanish athletes (α=.87) (Balaguer et al., 2008). In the present study, participants were asked to respond to the slightly modified stem "With other people I do sports and exercise with, I feel.." and in its Spanish version "Con otras personas que hago ejercicio me siento…". It used a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The items were scored on a 7-point scale. The overall scale score was obtained by computing the average of all items, with higher scores reflecting a greater sense of relatedness.

The 5-item perceived ability sub-scale of the Intrinsic Motivation Inventory (McAuley & Duncan, 1989) was used to determine the satisfaction of the competence need. The Spanish version has been validated with adult athletes and has demonstrated an acceptable level of reliability (α=.79) (Balaguer et al., 2008). In the present study, the stem was slightly modified to also include exercise, from "I am pretty good in my sport" to "I am pretty good in my sport or when I do exercise". The scoring was on a 7-point scale, computing the average of all items, with higher scores reflecting a greater sense of competence.

Motivation. The Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2) (Markland & Tobin, 2004) was used to measure exercise motivation. BREQ-2 includes 19 items that participants score using 5 points of Likert Scale from 0 = "not true for me" to 5 = " very true for me" for answering questions such as "I exercise because other people say I should". Its Spanish version was validated with Spanish adults, and demonstrated an acceptable level of reliability (Murcia, Gimeno, Camacho, & Murcia, 2007). The questionnaire includes a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly

agree). A second scoring should be performed of the subscales grouping them into two groups, controlled motivation with the formula (average of external regulation + average introjected regulation)/2, while autonomous motivation was with the formula (average of identified regulation + average intrinsic regulation)/2.

Physical activity and sedentary time. Physical activity, sedentary time and time spent asleep were measured using GT3X and GT3X + accelerometers in line with the 24-h accelerometer wear protocol of free-living conditions (Tudor-Locke, Barreira, Schuna, Mire, Chaput, Fogelholm, Hu, Kuriyan, Kurpad, Lambert, Maher, Maia, Matsudo, Olds, Onywera, Sarmiento, Standage, Tremblay, Zhao, Church, & Katzmarzyk, 2015). The ActiLife software (version 6.6.3) was used to extract data from the devices, then time spent sleeping was separated from the different intensities of PA using a fully-automated algorithm (Barreira et al., 2015; Tudor-Locke, Barreira, Schuna, Mire, & Katzmarzyk, 2014). Data were recorded in 1 sec interval and then reintegrated into 15 sec intervals for the analysis. A 30 Hz sampling rate was used for devices GT3X and 80 Hz for models GT3X+, using the filter "idle sleep mode". Data were considered valid when the device recorded data from at least four days and at least one weekend day. Data recorded on the last day of wearing and after seven days of wearing were deleted.(Tudor-Locke, Barreira, Schuna, Mire, Chaput, Fogelholm, Hu, Kuriyan, Kurpad, Lambert, Maher, Maia, Matsudo, Olds, Onywera, Sarmiento, Standage, Tremblay, Zhao, Church, & Katzmarzyk, 2015). Evenson's cut-off points were used to determine PA when the accelerometer counts were as follows: sedentary 0-25, Light 26-573. Moderate 574-1002 and Vigorous > 1003 (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008).

Socio-economic status. The Economic, Social and Cultural Status index (ESCS) component score was used to measure socio-economic status (OECD, 2009). This index includes the parents' highest occupational status and highest educational level, the household items reflecting culture (e.g. paintings), educational resources (e.g. a dictionary), and wealth items (e.g. microwave). The items of every subscale were subjected to Principal Component Analysis (PCA) using one-factor solution and Varimax rotation.

3.6.3 Analytical strategy

The two-step approach developed by Anderson and Gerbing (1988) recommends to first assess the observed variables with their constructs (Confirmatory Factor Analysis), then to

test the hypothesised relations of the latent variables guided by a theory (Confirmatory Structural Model). This two-step method was the approach selected for the present study on account of its advantages compared with a one-step approach. The advantages of the two-step method is that, it is possible to specify the causal relations of the constructs and that it is also possible to assess the model fit. Data from the whole sample was used for this analysis. Path analysis was used to examine the application of the model on PA using latent psychological variables from the full sample in a subsample who wore an accelerometer. Analyses were conducted using with IBM SPSS Amos version 24 (Arbuckle, 2017). Although path analysis does not model error in the manifest variables, this method was considered the most suitable because of the relatively small sample size for MVPA and sedentary time, and the necessity of a minimum case-to-parameter ratio for coefficient stability (Kline, 2005). Conventional criteria were used to assess the fit of the hypothesised mediation model with the observed data. Adequate fit was inferred when Hu and Bentler (Hu & Bentler, 1999) criteria were employed as evidence of good fit: CFI > .90, RMSEA < .06, SRMR < .08. In a separate analysis, indirect effects with bias-corrected bootstrapped (5000 resamples) confidence intervals were used to assess the effect size and statistical significance of any mediation through estimating direct and indirect effects (Mackinnon, Lockwood, & Williams, 2004; Shrout & Bolger, 2002). Analyses were controlled for participants' sex and socio-economic status, and for accelerometer wear time.

3.7 Results

3.7.1 Preliminary analysis

Prior to running the main analyses, the data were screened for missing values. No missing data were found because all responses were required in the online survey. A total of 320 cases provided complete self-reported data and 136 of 176 cases of participants that wore an accelerometer provided valid accelerometer-based data for >4 days and at least one weekend day (Tudor-Locke, Barreira, Schuna, Mire, Chaput, Fogelholm, Hu, Kuriyan, Kurpad, Lambert, Maher, Maia, Matsudo, Olds, Onywera, Sarmiento, Standage, Tremblay, Zhao, Church, Katzmarzyk, et al., 2015) (see Figure 3-2). Standardized z-scores larger than 3.29 ($p < .001$) and Mahalanobis' distances greater than $\chi 2$ (9) =27.87 ($p < .001$) were used to identify univariate and multivariate outliers (Tabachnick & Fidell, 2007). Data displayed multivariate asymmetry (Mardia's multivariate kurtosis coefficient= 127.93; c.f.

=47.68) (Byrne, 2010). Also, five multivariate outliers and 27 univariate outliers were identified. Outliers were preserved during analyses with Maximum likelihood estimation and Bootstrapping method with 5,000 replication samples with replacement used (Efron & Tibshirani, 1993.). CFA and SEM were conducted on the full sample of 320 adolescents (166 boys and 154 girls; M_{age}= 13.66 years; SD=1.01) and the path analysis was conducted on a subsample of 136 adolescents (68 males and 68 females; M_{age}= 13.54 years; SD=1.03).

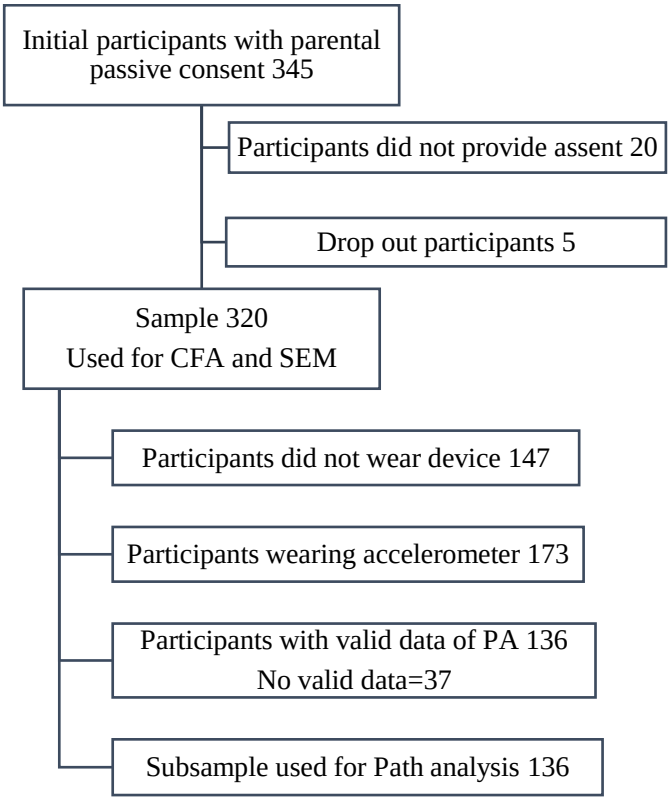

Figure 3-2. Study selection process

Note. CFA=confirmatory Factor Analysis, SEM=structural equation modelling, PA=physical activity

3.7.2 Descriptive statistics and correlations

Descriptive statistics of the sub-sample who wore accelerometers are displayed in Table 3-1 and correlations in Table 3-2. Participants accumulated an average of 47.11 minutes per day of MVPA and 8 hours of sedentary time. Overall boys showed higher levels of MVPA and lower levels of sedentary time than girls.

Table 3-1. Descriptive statistics of variables extracted from accelerometer data by sex

Movement variables	M (SD)	Boys	Girls	t	p	95% CI (lower, upper)
Sedentary (min/day)	580 (81.80)	563 (93.93)	596.62 (64.33)	-2.38	.02	-62.63, -7.12
Light (min/day)	292.18 (55.85)	299.12 (57.45)	285.24 (53.72)	1.45	.15	-6.20, 32.31
Moderate (min/day)	34.75 (12.69)	37.20 (12.81)	32.29 (12.18)	2.28	.02	.69, 9.01
Vigorous (min/day)	12.36 (8.74)	14.20 (8.48)	10.53 (8.67)	2.48	.01	.71, 6.47
MVPA (min/day)	47.11 (18.66)	51.39 (18.20)	42.83 (18.25)	2.74	.00	2.34, 14.38
Total PA (min/day)	339 (65.89)	350.51 (58.50)	328.06 (61.66)	2.00	.05	-.13, 43.98
Accelerometer wake/wear time (min/day)	926 (58.62)	928.63 (71.60)	924.69 (42.32)	.39	.69	15.84,23.55

Note. MVPA= Moderate to Vigorous Physical Activity, PA=physical activity. Results based on 5000 bootstrap samples.

Correlation analyses showed a significant positive relationship between need support and need satisfaction. A significant positive relationship between need satisfaction and autonomous motivation was found. Need satisfaction was positively and significantly associated with controlled motivation in boys but not in girls. Furthermore, there was a significant positive association between controlled motivation and autonomous motivation. Sedentary time was negatively associated with MVPA in girls, but the association was not found to be significant in boys. MVPA and sedentary time were not significantly associated with any of the psychological variables.

Table 3-2. Bivariate correlations between study variables by sex in the subsample

		1	2	3	4	5	6	7	8	9
1	Parents Need Support	-								
	Boys	-								
	Girls	-								
2	Friends Need Support	.62**	-							
	Boys	.59**								
	Girls	.65**								
3	Teacher Need Support	.34**	.42**	-						
	Boys	.30*	.43**							
	Girls	.40**	.41**							
4	Need satisfaction	.64**	.61**	.35**	-					
	Boys	.72**	.70**	.35**						
	Girls	.57**	.36**	.36**						
5	Controlled Motivation	-.01	.21*	.16	.17*	-				
	Boys	.13	.44**	.23	.33**					
	Girls	-.15	-.00	.08	-.02					
6	Autonomous Motivation	.58**	.49**	.28**	.70**	.32**	-			
	Boys	.71**	.61**	.31**	.84**	.37**				
	Girls	.47	.37**	.26*	.51**	.25*				
7	MVPA (min/day)	.04	.03	.11	-.00	.07	.059	-		
	Boys	.03	.14	.07	-.01	-.08	.03			
	Girls	.00	-.07	.18	-.01	.22	.06			
8	Sedentary time (mind/day)	.04	.19*	.013	-.04	-.07	-.08	-.22**	-	
	Boys	.00	.16	.05	-.02	.02	-.05	.07		
	Girls	.15	.25*	-.06	-.05	-.20	-.09	-.57**		
9	Socio-economic status (score)	.17*	.20*	.03	.12	.01	.18*	-.22**	.14	-

Boys	.15	.09	-.01	.13	.04	.22	-.07	.10	-
Girls	.19	.30*	.08	.11	-.03	.13	-.40**	.23	-

Note. MVPA= Moderate to Vigorous Physical Activity

3.7.3 Confirmatory Factor Analysis and Structural Equation Modelling

All subscales (except identified regulation) demonstrated acceptable reliability (>.7) (presented in Table 3-3). The scale was subject to Confirmatory Factor Analysis (CFA) showing factorial validity of the overall model CFA χ2=30.7.90, *df* =89, *p*< 0.00; CFI=0.95; SRMR=.05; RMSEA=0.08 (90% CI=0.07 to 0.09) and the SEM χ2=335.68, *df* =95, *p*< 0.00; CFI=0.94; SRMR=.06; RMSEA=0.08 (90% CI=0.07 to 0.10).

Table 3-3. Descriptive statistics of psychological variables by group and scale reliability

Psychological variables	Subsample M(SD)	α
Parents need support (scale 1-7)	5.92 (1.26)	.79
Teacher need support (scale 1-7)	5.23 (1.92) /1-7	.97
Friends need support (scale 1-7)	5.50 (1.51) /1-7	.82
Need satisfaction (scale 1-7)	5.70 (1.03) /1-7	.73
Autonomous Motivation (scale 1-7)	5.49 (1.19) /1-7	.72
Controlled motivation (scale 1-7)	3.53 (1.74) /1-7	.80

Note. α = Cronbach alpha

3.7.4 Path analysis

Models were tested for MVPA and sedentary time separately (results are presented in Figure 3-3). The hypothesised model for MVPA had adequate fit with the data: χ2=42.52, *df* =19, *p*=.00; CFI=.95; SRMR=.04; RMSEA=.09 (90% CI=0.05 to 0.13). The hypothesised model for sedentary behaviour had adequate fit with data: χ2=48.24, *df*=19, *p*=.00; CFI=.96; SRMR=.04; RMSEA=.10 (90% CI=.07 to .14). In addition to the main outcome variables, light intensity and total PA (collectively light, moderate and vigorous intensity) were tested (Figure 3-4). The hypothesised model for total PA showed poor fit: χ2=44.17, *df* =19, p=.00, TLI=.89; CFI=.95; SRMR=.04; RMSEA=.09 (90% CI=.06 to .13). The model for light intensity PA also showed poor fit: χ2=45.46 df =19, *p*=.00, TLI=.89; CFI=.95; SRMR=.04; RMSEA=.10 (90% CI=.06 to 0.14). The squared multiple correlations from endogenous variables of the final model accounted for 82% of the variance in need satisfaction, 4% in controlled motivation, 47% in autonomous motivation, 16% in light PA, 13% in MVPA, 21% sedentary time and 5% total physical activity.

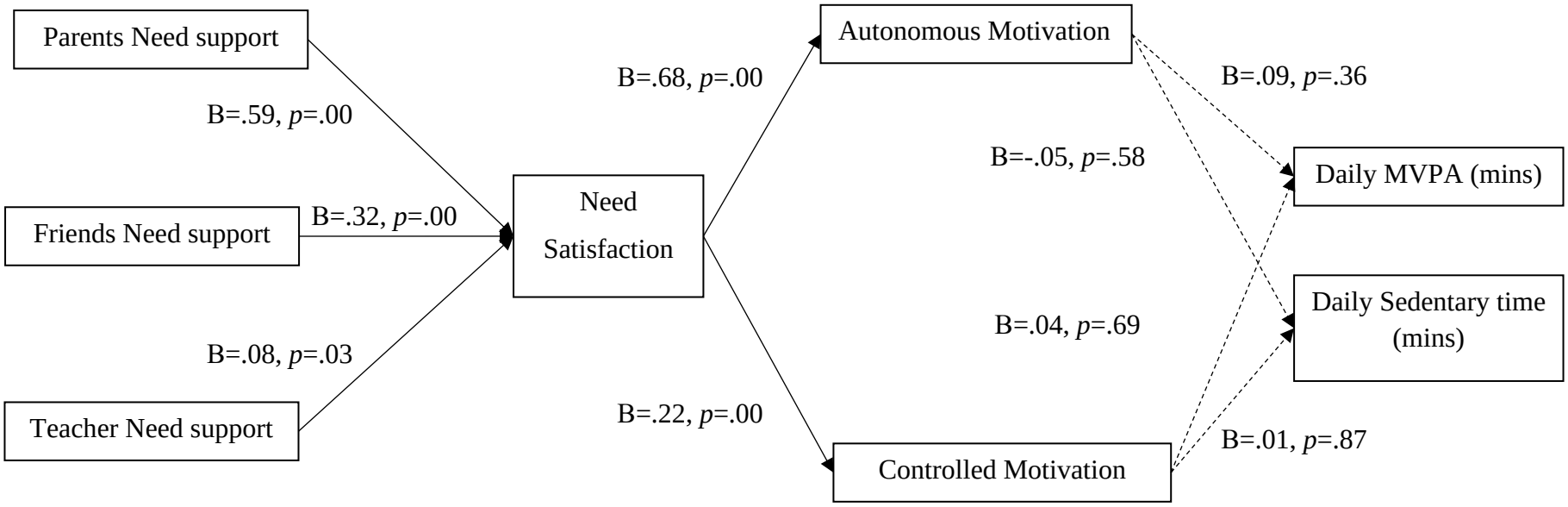

Figure 3-3. Standardised regression weights for the proposed model predicting daily MVPA and sedentary time

Note. Dashes indicate non-significant relationships (p >.05).

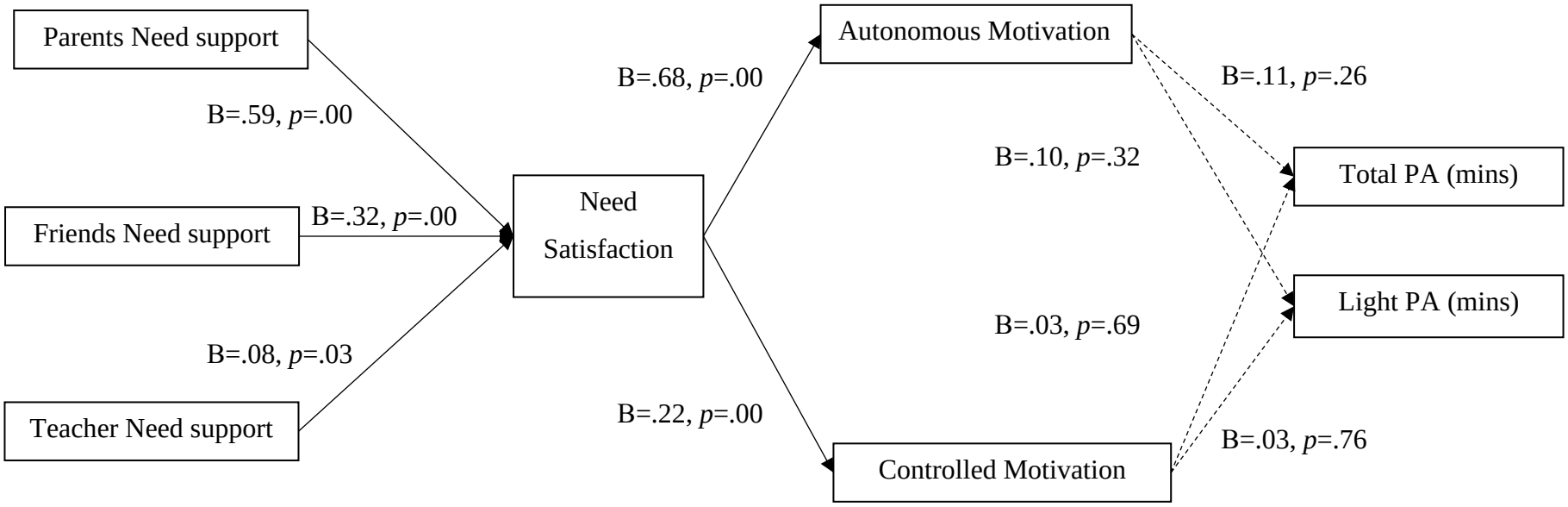

Figure 3-4. Standardised regression weights for the proposed model predicting daily total physical activity and light physical activity

Note. Dashes indicate non-significant relationships (p >.05).

As hypothesised, perceived psychological need support towards PA from parents, friends and the PE teachers positively predicted psychological need satisfaction. Also, in line with expectations, a positive and significant association was found between psychological need satisfaction towards PA and autonomous motivation towards PA. However, contrary to the hypothesis, a significant positive association was identified between psychological need satisfaction and controlled motivation towards PA. Autonomous motivation and controlled motivation towards PA were not significant predictors of either MVPA or sedentary time. The effects of light PA and total PA were not found.

3.7.5 Indirect effects

The indirect effects are displayed in Table 3-5. As stipulated by the theoretical constructs, relationships among parents, friends and PE teachers need support and autonomous motivation were mediated by the participants' psychological need satisfaction.

Table 3-4. Standardised indirect effects for the three outcomes daily total physical activity, light physical activity, MVPA and sedentary time

Indirect Path	Standardized β	Bootstrap bias-corrected 95% CIs		*p*
		Lower	Upper	
Parents --> needs -->				
Controlled Motivation	.13**	.08	.34	.00
Autonomous Motivation	.41***	.37	.65	.00
Friends --> needs -->				
Controlled Motivation	.07**	.03	.16	.00
Autonomous Motivation	.22**	.12	.30	.00
PE Teacher --> needs -->				
Controlled Motivation	.01*	.00	.04	.02
Autonomous Motivation	.06*	.01	.09	.02
Needs --> Autonomous Motivation -->				
MVPA	.06	-.92	.43	.28
Sedentary time	-.03	-.37	.76	.47

Needs --> Controlled Motivation --> MVPA	.01	-.35	.08	.46
Sedentary time	.00	-.87	.51	.73

Note. MVPA= Moderate to Vigorous Physical Activity, PA=physical activity

3.8 Discussion

The purpose of this study was to examine the relationship between psychological need support towards PA from parents, PE teachers, and friends and objectively measured MVPA and sedentary time, mediated by the satisfaction of basic psychological needs and motivation. These relations were analysed in a sample of urban Mexican adolescents. These findings provide evidence for the importance of family, friends and PE teachers in the development of autonomous motivation for physical activity in adolescents. However, contrary to the hypothesised relationships suggested, autonomous motivation alone did not have a significant effect on objectively measured PA or sedentary time.

3.8.1 Relations among psychological need support and motivation

Findings of the present study highlight the importance of the social context on the perceived psychological need support towards PA in a sample of Mexican adolescents. Similarly with past research, this study supports the association between psychological need support towards PA from friends (Emm-Collison, 2016; Koka, 2013), parents (Amorose et al., 2016; Emm-Collison, 2016; McDavid et al., 2012; Vierling, Standage, & Treasurea, 2007) and PE teachers (Barkoukis, Hagger, Lambropoulos, & Tsorbatzoudis, 2010; Hagger et al., 2009; Koka, 2013; Standage, Duda, & Ntoumanis, 2006; Standage et al., 2012; Zhang, Solmon, Kosma, Carson, & Gu, 2011), and need satisfaction.

Participants' perceived need support towards PA from their parents and friends was comparatively higher than need support from the PE teachers. This finding is consistent with previous studies where higher effect of autonomy support from parents was shown than that from PE teachers and peers (Wang, 2017). A possible explanation for this might be the actual relevance of PE and PE teachers to the overall MVPA in Mexico. Gharib et al. (2015) studied the effect of a set of PE teachers' behaviours included

within the System of Observing Fitness Instruction Time (SOFIT) (i.e. promoting fitness, demonstrating or instructing) on MVPA in Mexican children. PE teachers' behaviour did not affect MVPA in boys and only one behaviour "other task" demonstrated an effect on girls, suggesting the limited influence of PE teachers. The relationship between highly trained PE teachers and students' motivation, confidence, and movement skills has been demonstrated (Law et al., 2018). Only small proportion of schools in Mexico have trained PE teachers; as a result, the regular teacher provides the PE lesson most of the time (INSP, 2018). Also, observational studies of PE lessons in Mexico estimated that less than 18% of PE time is spent on MVPA (Gharib et al., 2015) versus the 50% time that is recommended (Centers for Disease Control and Prevention, 2010). Thus, PE teachers or substitute teachers' PA literacy and teaching skills might have an impact on the quality of support perceived by students.

The satisfaction of autonomy, relatedness and competence was shown to be associated with autonomous motivation towards PA. In line with empirical research (Emm-Collison, 2016; Koka, 2013) and SDT principles suggested to be invariant across cultures, this finding is also an important contribution to the state of the art on PA correlates. Therefore, regardless of the environmental and cultural disparities among the current evidence and the results of this study in a sample of Mexican adolescents, the three basic psychological needs are relevant correlates of motivation towards PA. On this basis, need satisfaction and autonomous motivation towards PA should be considered as a key element for further intervention development.

3.8.2 Relationship between motivation and physical activity and sedentary time

Autonomous motivation alone did not significantly predict objectively measured MVPA in the present study. This finding differs from the hypothesised association and some previous studies (Aelterman et al., 2012; Emm-Collison, 2016; Owen et al., 2013; Zhang et al., 2011). Yet, there are also a number of studies that report variation from expected effects; no effect of autonomous motivation on self-reported leisure-time PA has been previously reported in a sample of Estonian adolescents (Koka, 2013), and using objectively measured MVPA in Chinese adolescents (Wang, 2017); there is no clear methodological reason for the difference as a result of the measures used or the study design alone.

One possible explanation of the unexpected result of a lack of association between autonomous motivation and PA could be that participants experienced barriers to acting

on that motivation, whether through lack of opportunity, or potentially through the possibility that they simultaneously experienced what SDT refers to as 'need thwarting' (Ryan & Deci, 2017). Need thwarting is not just a lack of need satisfaction (Gunnell, Crocker, Wilson, Mack, & Zumbo, 2013), this refers to the perceived deprivation or actively frustration of need satisfaction (Bartholomew, Ntoumanis, Ryan, & Thogersen-Ntoumani, 2011; Deci & Ryan, 2000). For instance, relatedness thwarting occurs when an individual´s feel that being active is disproved of, or unimportant to significant others; competence would be thwarted when an individual's attempts to demonstrate capability are undermined; and autonomy could be thwarted when an individual's views are not considered. In the literature, perceptions of need-thwarting experiences are associated with negative consequences including ill-being (Vansteenkiste, Niemiec, & Soenens, 2010), exercise dependency and social physique anxiety in the sport and exercise domain (Bartholomew et al., 2011; Gunnell et al., 2013). There are a number of ways in which existing social or environmental factors in the Mexican context might play a need frustrating role. Low safety perceptions could trigger parents to thwart autonomy of their children if rules introduced for their security, such as prohibiting them from going to the park, are enforced in an authoritarian way leading; if adolescents feel they would have to disobey parents to be active this could thwart both autonomy and relatedness. At school, focusing on passing tests during PE lessons could lead to adolescents' feeling pressure to obey teachers to please them and avoid failing the course, rather than on enjoyment and skill development. Such an approach could thwart all three needs.

The lack of effect of autonomous motivation on physical activity may also be explained in terms of actual barriers and limited opportunities for physical activity in the Mexican context. Despite adolescents feeling intrinsically motivated to be active, unsupportive environments may block their participation. At school, national data in Mexico indicates that over 50% of basic educational state schools do not have a specialist PE teacher (Secretaria de Educacion Publica, 2013) which often leads to PE lessons being restricted to theoretical classroom-based lessons. Other studies in Mexico report that students are not allowed to run or use balls in the playground (Medina, Barquera, Katzmarzyk, & Janssen, 2015) and have reported the existence of policies limiting school breaks only for resting (Safdie et al., 2013). Research in Mexico also suggests limited access for PA opportunities in the neighbourhood. This is supported by a study among 4,079 Mexican adolescents living in two cities at different levels of urbanicity

and associated sports facilities (2.3 per squared kilometre in Mexico City vs 1.01 in Oaxaca); higher levels of self-reported MVPA were reported in Mexico City than Oaxaca (Hermosillo-Gallardo, Jago, & Sebire, 2018). As such, even if residents of the two cities showed equal levels of autonomous motivation, those adolescents living in cities with higher facilities for sports are more physically active.

Safety is another environmental barrier, as data from the 2018 National Victimization Survey indicate that 77% of Mexicans aged over 18 years old consider safety in Mexico to be the largest social problem, and safety concerns are the reason why over 30% of people avoid walking in the streets and why 74% of Mexican parents do not allow to their children to go out (Instituto Nacional de Estadística y Geografía, 2018). These data resonate with the association identified between low safety perceptions and low self-reported MVPA and sports participation among 4,079 Mexican female adolescents (Hermosillo-Gallardo, Sebire, & Jago, 2020). Collectively, this evidence suggests that perhaps motivation was less relevant in the context of the present study participants as they are subject to more barriers to PA than their counterparts (Aelterman et al., 2012; Emm-Collison, 2016; Owen et al., 2013; Zhang et al., 2011). Further studies should consider exploring potential barriers for PA perceived by urban Mexican adolescents.

3.8.2 Study strengths and Limitations

This study presents notable strengths such as objective monitoring of MVPA and sedentary time, the inclusion of the three social agents in the model, and the analysis of the outcomes of a theoretical model of effects for both PA and sedentary time. However, the results are also subject to several limitations. The limitations are relatively small sample size and the cross-sectional design using which is not possible to generalise to create causal inferences as to the direction of effects. The estimation of the psychological constructs using variables developed for and in contexts which differ from the Mexican adolescents is also not optimal. School 3 did not have specialist PE teacher and students were asked to respond to the questionnaire thinking about the substitute teacher who is usually a generalist teacher, which may have had an effect on the outcomes. A significant difference in perceived need support was found at least in one of the schools (F = 11.49, p=.00). Perceived PE teacher need support differed in some schools. In schools 1-2 and 4-6 scores for PE teacher need support were above 6, in school 3 these were above 3. The absence of a PE teacher might affect participants' perceived PE teacher need support towards PA and probably helps to explain the

relatively lower effect from PE teachers need support compared to that of parents and friends.

3.9 Conclusion

Self-Determination Theory provides a useful framework for understanding motivation towards PA. The results of this study suggest that environments supportive of autonomy, relatedness and competence by parents, peers and PE teachers appear conducive to higher levels of autonomous motivation towards PA. Other factors apart from autonomous motivation towards PA need to be explored to understand the participants' PA and sedentary behaviours.

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3.10 Closing Commentary

The present chapter has provided essential information for the overall understanding of Mexican adolescents PA participation and about the direction of the intervention development later in this thesis. PE teachers, friends, and parents were important in providing psychological need support in order to boost motivation among the study participants. Therefore, this socio-contextual factor will be considered for the intervention development in the following thesis chapters. It is possible that other factors may be mediating the association between autonomous motivation and PA, perhaps at different levels of influence (e.g. institutional or organizational) according to the ecological model (McLeroy, Bibeau, Steckler, & Glanz, 1988). As such, additional inputs beyond motivational support that support these determinants are likely to be needed to change behaviour. Key elements for intervention development that arose from this study were that a) many adolescents are already motivated towards PA, which is important preserve, and b) the social context (in the form of need support) is a key component for this.

Collectively these findings highlighted the need to explore other factors that may influence Mexican participants' PA beyond the intrapersonal and interpersonal factors presented in this chapter. The following chapter is therefore a shift on the approach used in Chapters 2 and 3 in order to gain a better understanding of the other factors that may influence PA of Mexican adolescents.

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Chapter 4 “It’s a bit exasperating to be locked up”- an exploration of Mexican adolescents’ perceived barriers and facilitators for physical activity and healthy eating

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4.1 Pre-paper commentary

This thesis is dedicated to exploring some of the determinants of obesity among Mexican adolescents to design an intervention for obesity prevention. Chapters 2 and 3 provide insight into some of the factors associated with obesity, physical activity and sedentary behaviour in Mexican adolescents. Most research in the context of SDT supports the principle that autonomous motivation predicts engagement and persistence on PA behaviour (Teixeira, Carraca, Markland, Silva, & Ryan, 2012). In addition, the socio ecological model (Sallis et al., 2006) and empirical research supports the importance of the physical and social context of children and adolescents PA behaviour (Biddle, Mutrie, & Gorely, 2015). Thus, given the unexpected results reported in previous chapters, this chapter uses a qualitative approach and focus groups to better understand adolescents´ experience.

The present chapter focuses on exploring adolescents’ own views of the factors influencing their PA. The study was designed to allow discussion of influences beyond intrapersonal or interpersonal factors. The aim is to analyse environment and organizational level factors, such as school or neighbourhood. A qualitative design from a phenomenological perspective (Moustakas, 1994) was used to address the research question, which focussed on understanding adolescents’ experiences of their environment (school and neighbourhood).

Information gained from this chapter will be essential for the intervention development as many of the previous hypothesised determinates were not significantly associated with the adolescents’ lifestyle.

4.2 Statement of Authorship

<table>
<tr><td colspan="4">This declaration concerns the article entitled:</td></tr>
<tr><td colspan="4">“It’s a bit exasperating to be locked up”- an exploration of Mexican adolescents’ perceived barriers and facilitators for physical activity and healthy eating</td></tr>
<tr><td colspan="4">Publication status (tick one)
Draft manuscript [X] Submitted [ ] In review [ ] Accepted [ ] Published [ ]</td></tr>
<tr><td>Publication details</td><td colspan="3">The data that support the findings of this study are available from Dr Fiona B Gillison (sppfbg@bath.ac.uk) upon request.</td></tr>
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I hold the copyright for this material [X] Copyright is retained by the publisher, but I have been given permission to replicate the material here [ ]</td></tr>
<tr><td>Candidate’s contribution to the paper (provide details, and also indicate as a percentage)</td><td colspan="3">The candidate predominantly executed the…
Formulation of ideas: 70% in conjunction with the supervisory team I proposed the research questions.
Design of methodology: 70% in conjunction with the supervisory team, I decided the study design and the use focus groups and the secret box methods to collect data.
Experimental work: 100% I conducted all data collection, transcriptions, and data analysis. I had the support of the supervisory team to clarify questions during the whole process.
Presentation of data in journal format: 80% I drafted this paper and it was critically revised by the supervisory team.</td></tr>
<tr><td>Statement from Candidate</td><td colspan="3">This paper reports on original research I conducted during the period of my Higher Degree by Research candidature.</td></tr>
<tr><td>Signed</td><td></td><td>Date</td><td>27/09/2019</td></tr>
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“It’s a bit exasperating to be locked up”- an exploration of Mexican adolescents’ perceived barriers and facilitators for physical activity and healthy eating

4.3 Abstract

The aim of this study was to explore Mexican adolescents’ understanding of PA, and perceived barriers and facilitators of physical activity (PA) and healthy eating. Twelve single-sex focus groups were conducted in six secondary schools. Data were analysed via inductive Thematic Analysis. Three themes were identified: understanding the health-behaviour link, the impact of a restricted life and social factors. Participants understood how PA contributes to multiple dimensions of health and how diet contributes to physical health. Socialising, having fun, and relieving stress were the PA facilitators; knowledge and the desire for healthy food options were the healthy eating facilitators. Participants did not feel that they had adequate facilities, time within current school structures or adequate social support from teachers to enable them to take part in high sufficient PA. Furthermore, they reported neighbourhood safety concerns, and limited family support as the barriers to PA. It was also shown that healthy eating knowledge does not seem to translate into health behaviour. The findings of this study suggest that improvement of opportunities for safe outdoor time, social support and availability of healthy food would be useful to explore as potential PA and healthy eating determinants in adolescents.

Keywords: physical activity, healthy eating, adolescents, barriers, facilitators, qualitative.

4.4 Introduction

Poor diet and a decline in physical activity (PA) are associated with obesity and other comorbidities (Bray, Kim, & Wilding, 2017). Globally, the proportion of children and adolescents classified as being overweight or obese has increased in the last four decades (Ezzati et al., 2017). The correlates of diet (Chung, Ersig, & McCarthy, 2017; Sleddens et al., 2015; Story, Neumark-Sztainer, & French, 2002) and PA have been widely examined (Bauman et al., 2012; Biddle, Whitehead, O'Donovan, & Nevill, 2005; de Vet, de Ridder, & de Wit, 2011; Ferreira et al., 2007; Martins, Marques, Peralta, Palmeira, & da Costa, 2017). It has been suggested by research that the factors influencing children's and adolescents' behaviour exist at all levels of influence (e.g. individual, social and environmental) according to ecological approaches (James, Owen, & Fisher, 2008).

There are gaps in the literature in terms of clarifying certain lifestyle correlates, such as perceived barriers for PA (e.g. lack of time). While research suggests a small-to-moderate negative association between perceived barriers and PA (Biddle et al., 2005), other evidence indicates that this association remains inconclusive (Bauman et al., 2012). Most studies investigating the correlates of diet and physical activity have been obtained from adolescents living in upper-middle-income countries (Bauman et al., 2012; McClain, Chappuis, Nguyen-Rodriguez, Yaroch, & Spruijt-Metz, 2009) or in minorities living in these countries (Jonsson, Berg, Larsson, Korp, & Lindgren, 2017). Additionally, as most studies utilised a cross-sectional design, it might be incorrect to assume that similar determinants will be relevant for adolescents living in different contexts. For instance, a study in Norway identified that purchasing food at school and in the local neighbourhood was positively associated with snack and sugar sweetened beverages (SSBs) consumption (Gebremariam, Henjum, Terragni, & Torheim, 2016). In this regard, substantial differences exist in the food environment between Norway and Mexico. In a study conducted in Norway, it was shown that two-thirds of students never buy snacks and SSBs from school or local neighbourhood shops, but instead bring lunch from home (Gebremariam et al., 2016). Conversely, in Mexico, there is evidence showing that most students purchase food/drinks at school (Bonvecchio et al., 2014).

In Mexico, around 36.3% of adolescents have been classified as obese or overweight (INSP, 2016). Around 85% of adolescent girls and 71% of boys exceed the recommended levels of intake of added sugar (>10% of the total energy) (Lopez-

Olmedo et al., 2016). Low intake of fibre has been also documented (Lopez-Olmedo et al., 2016), and only 39.2% of adolescents consume fruits and 26.9% of adolescents consume vegetables frequently (INSP, 2016). In addition to having a poor diet, only 17.2% of children between 10 to 14 years old and 61% of adolescents (15 to 19 years old) meet the recommended 60 minutes of moderate to vigorous physical activity (MVPA) per day guideline (Medina, Jauregui, Campos-Nonato, & Barquera, 2018). Given the limited research into the determinants of physical activity and diet in this population, obtaining a better understanding would be an important first step to tackling these behaviours.

The contextual conditions in Mexico, and particularly in Mexican schools, might influence adolescents' perception of barriers for a healthy lifestyle. Canteens and vending machines are uncommon, food is sold by individual vendors who pay a fee to the schools to get access (Bonvecchio et al., 2014). The products sold are mostly driven by students' preferences, perceived hygiene and low cost; most food available is rich in energy, disregarding other nutritional characteristics (Bonvecchio et al., 2014; Theodore, Arenas, Garcia, & Rivera, 2011). Also, there is evidence that only a small proportion of food and beverages sold at schools meet the statutory nutrition regulations (Perez-Ferrer et al., 2018). Data suggest that Mexican school children are exposed high-energy food and beverages at school (Aceves-Martins, Llauradó, Tarro, Solà, & Giralt, 2016; Dommarco, Campos, Barquera, & Gonzalez de Cosio, 2015).

Additionally, access to PA opportunities for adolescents is poor. The provision of physical education and specialist physical education teachers is not available to all school children (Argumedo et al., 2020; Galaviz et al., 2018). There is also evidence that only 10% of recess time is spent in moderate and intense PA, and students mostly walk or stand during breaks (Medina, Barquera, Katzmarzyk, & Janssen, 2015).

4.5 The present study

The aim of the present study is to: a) explore Mexican adolescents' understanding of healthy eating and physical activity, and b) explore the barriers and facilitators they perceive for these behaviours.

4.6 Method

4.6.1 Study design and philosophy

A qualitative exploratory design was chosen as this facilitates the description and better understanding of adolescents' perspectives of what influences their behaviour (Patton, 2015). An overall pragmatic approach guides this study, which emphasises the nature of the experience rather than the nature of the reality (Morgan, 2017). Thus, in line with a pragmatic worldview, participants´ beliefs and perceptions will be explored within their context and particular circumstances instead of seeking for a "truth". It will be also assumed that participants' perceptions might change over the time, thus their beliefs will be understood as provisional and socially shaped (Morgan, 2017). Focus groups were selected so as to facilitate discussion and generate insights from participants' interactions and the exploration of shared social meanings (Braun & Clarke, 2006). A semi-structured focus group guide was designed to ensure consistency across groups. The guide was organised into five stages: scene-setting and ground rules, individual introductions, the opening topic, discussion and ending the discussion.

4.6.2 Topic Guide

Three topics were introduced to participants, informed by the research questions, the literature review and discussion with experts in the research field (Appendix 15) (Finch, Lewis, & Turley, 2003). The topics were guided by three main questions: what influences how healthy you are (for exploring the understanding of healthy lifestyle); what factors encouraged or discouraged you in the PA you did last week (for exploring the understanding of PA barriers and facilitators); what changes would you like to see at your school that might help you to be more active (exploring the barriers for PA at school). A modified version of the Secret box (Punch, 2002) was used in order to encourage participation and ensure all students had a chance to contribute their initial ideas. This approach consisted of asking participants to anonymously write down their answer to a research question on a card and to then post it in a box. The card content is not shared with others if sensitive topics are explored, as per the original design. However, in the present study the topics were not sensitive, so all cards were read out in order to promote group interaction and discussion.

4.6.3 Participants

Participants were a subsample of a group of adolescents selected from five state schools and one private secondary school in Mexico City (reported in Chapters 2 and 3). Following institutional ethical approval (EP 15/16 277), *in loco parentis* declaration was obtained from the schools' headteacher. The parents received a letter with the study details and asked to provide passive consent. From the total sample with parental consent (n=320), 87% of participants also gave their assent to take part in the focus groups (n=279). Student participants within each school were stratified according to gender and physical activity level, described as high-activity (active for 60 minutes/day on 5-7 days per week) and low-activity (active for 60 minutes/day on 0-3 days per week) to allow purposive sampling. PA had been previously assessed through an online survey via a question obtained from the U.S. Youth Risk Behavior Surveillance System (Centers for Disease Control and Prevention, 2012). Two focus groups per school (12 in total) were run, one for girls and one for boys with high and low activity participants who were invited from the final list according to their availability.

4.6.4 Data collection

Focus groups were conducted in Spanish by the lead author (GA). The focus groups were comprised of 6 to 8 participants and were based on standard protocols (the focus groups took between 29 and 52 minutes) (Gibson, 2007; Ritchie & Lewis, 2003). Single-sex focus groups were chosen to remove gender constraints and expectations (Hollander, 2004; Stewart & Shamdasani, 2007). All focus groups were recorded using a digital voice recorder and transcribed verbatim.

4.6.5 Analysis

Data were analysed using inductive Thematic Analysis (Braun & Clarke, 2006; Braun, Clarke, & Weate, 2016). Verbatim transcriptions in Spanish preserved the participants' expressions in the original language, while codes and themes were developed in English to facilitate the research team communication. Non-significant spelling mistakes or grammatical errors that might decrease readability were corrected or edited to remove unnecessary details. NVivo (QSR International; Version 11 Pro) was used for data management and analysis. The transcripts were first reviewed several times for familiarisation, before coding each meaning unit with a data-driven label. Codes were then explored for interconnections, and related codes were grouped into primary clusters and discussed between the research team members. To encourage reflection and

exploration of alternative explanations and interpretations of the data through critical questioning (Brewer & Sparkes, 2011; Coyle, Gorczynski, & Gibson, 2017), three critical friends were invited to the study. Two bilingual critical friends independently reviewed different transcripts and codes, provided a synopsis of their thoughts and discussed the suitability of codes. The critical friends' review and analysis discrepancies were systematically addressed (Appendix 16). One of the authors (FG), a native English speaker with expertise in qualitative analysis acted as a third critical friend to aid the process of mapping codes to subthemes and themes.

4.7 Results

The total number of participants was 79 students, 39 boys and 40 girls, ranging in age from 11 to 15 years, living in the northern and central areas of the city. Schools were located in areas of Mexico City classified as having a high proportion of people in medium, high and extreme degrees of poverty (Consejo Nacional de Evaluación de la Política de Desarrollo Social, 2012). Also, the schools were located in areas, where approximately 58% of households have one victim of crime (Instituto Nacional de Estadística y Geografía, 2018). The perceived barriers and facilitators that are shared with other adolescents worldwide are listed below. More distinctive perceptions within the context of Mexico are presented within three broad themes (see Table 4-1). The first theme is "Understanding the health-behaviour link" in terms of participants' understanding of a healthy diet and physical activity and how they link them with health. Theme 2 is "Impact of a restricted life", capturing the school and local neighbourhood factors that participants perceived to affect their diet and PA. Theme 3, "Social factors", comprises the degree of perceived social support from friends and parents that adolescents felt they received, and how this influenced their lifestyle. Each theme included subthemes which are presented with illustrative data extracts.

Table 4-1 List of themes and subthemes

Themes	Sub-themes
Understanding the health-behaviour link	Diet and physical activity
	Multidimensional understanding of health
The impact of a restricted life	Outdoor time
	Safety
	Time

	Equipment and access
Social factors	Socialising
	Family

In general, participants agreed that being active is fun, it helps them to relieve stress, and it is a form of distraction and entertainment: *"because when you go out with the skateboard you exercise, you relax and have fun"*. Some mentioned a preference for screen-based activities (e.g. playing videogames or watching videos): *"you entertain yourself another way, like, I'm always on the phone or something".* A few students found themselves physically lacking in the capacity to do some activities or perceived PA as an extra effort, something that is exhausting, causes pain and is difficult to do: *"it's a lot of work for me, […] I'm not good at running nor flexible in my body".* In terms of diet, a few participants expressed that they just eat what they crave, whatever is available, whatever requires less effort to prepare, or expressed their preference for junk food.

4.7.1 Theme I: Understanding the health-behaviour link

Diet and physical activity

Participants' understanding of a healthy lifestyle consisted mainly of two behaviours: being active and eating healthy food. They recognised fruit is healthy as it contains vitamins, and that sport is a healthy thing to do. A few participants also included sleep, rest, attending medical check-ups, and spending time with friends and family as indicators of having a healthy lifestyle.

Across all focus groups, the main examples of healthy food items provided by the participants were fruit, vegetables and salads, with a few students also mentioning drinking fresh juice and fresh water. In contrast, fat, deep fried food, packaged products (e.g. crisps, biscuits, chocolates) and soda were labelled as unhealthy. Although, nobody explicitly referred to the quantity or frequency of consumption in describing what is healthy, most of them broadly referred to a good diet as: *"eat a little bit of everything"*, "*don't undereat or overeat*" , *"eat more if you exercise"*, "*eat less if you do not exercise*", *"eat what it is in the Eat Well Plate guidelines*[1]", "*eat salads*". Eating junk food during adolescence was perceived by a few adolescents *as normal* and

[1] *Note*. The Eat Well Plate guideline used in the UK shares many similarities to the Mexican version with some exceptions as displayed in Appendix 17

somehow expected behaviour because they are young: "*thinking in our age, we like to be eating whatever we find"*. One adolescent mentioned that eating healthily is commonly seen as eating a boring plate of lettuce. Some students perceive the presence of nutrients or food items in some dishes, as adding nutritious qualities to the dishes and turning them into less unhealthy options – regardless of the cooking or preparation method (e.g. adding onion and coriander to tacos). As the quote below illustrates, when participants talk about gorditas (deep fried corn dish) as an example of unhealthy food, they nevertheless consider it is important to eat them because they are rich in carbohydrates which are important for health.

> Boy 1: It's like he said, you can eat everything but some things in fewer quantities because sometimes there are things that have carbohydrates.
>
> Boy 2: Like when you eat gorditas [deep fried corn dish].
>
> ((General laughter))
>
> Boy 1: Carbohydrates too, the body needs them, I mean a balanced diet.

Participants generally agreed that physical activity refers to body movement, although none of them volunteered to specify the recommended amount of PA, frequency or possible types of PA; some students said it is important to be active frequently and it is better to end up tired, sweaty or to burn calories. In contrast to their discussion of diet, none of the participants referred to any guidelines regarding PA. Most participants understood PA as playing sports (the most common example was football) or other forms of active play (e.g. running during school breaks) but some of them also described PA as attending the gym, walking the dog, dancing and dancing to videogames (e.g. Kinect for Xbox), riding a bike, or skateboarding.

> When you play football you keep running, you keep moving, I mean you never stop, then you're putting your body in action.

Multidimensional understanding of health

Participants generally agreed that a healthy lifestyle is good for health and this is the opposite of eating junk food and spending time in front of a TV as illustrated in this quote : *"exercise is healthier than just sitting playing [video games]"*. Students associated being active with several positive outcomes, as well as improving physical

(e.g., body growth and muscular strength), psychological (e.g. stress reliever) and social health (e.g. a way of socialising with family and friends). Students also suggested that being active prevents negative health effects (e.g. obesity, Type II Diabetes). In the case of diet, the only health benefit that students referred to was physical, mainly consisting of the positive effect of eating certain vitamins (e.g. vitamin A is good for the vision), having energy during the day or weight management.

> I think that being healthy is not only physically good, it is also for your whole body and mind.

4.7.2 Theme II: The impact of a restricted life

Outdoor time

Across all focus groups, participants expressed feelings of frustration because of the number of perceived barriers in their school environment to being active or healthy eating. For example, rules such as *"do not run"* during breaks or PE (e.g. preventing children from hitting someone else with balls) were seen as barriers to being active. Beyond school rules, there was a consensus among adolescents from state schools about a lack of PE teachers, which frequently leads to cancellations or lessons being delivered by a substitute teacher who commonly keeps children at their desks in the classroom. Breaks and PE lessons are perceived as short and insufficient, and this makes students feel that they are locked up in the classroom for a long time. Participants consistently expressed wishes for a change in the school day schedule to allow for more breaks and opportunities to be active. When students were asked for ideas of changes in their school to help them to be more active, one girl suggested:

> A change in the timetable, because sometimes […] PE is left until the end of the day, and there may not even be a teacher! And when there are no teachers, the other teachers [substitute teachers] do not want to take you out [to the playground], so it's like what they said, it's a bit exasperating to be locked up all the time and you get very stressed.

Even when the PE lesson did take place, participants perceived barriers to being active due to lesson structure and teaching style. Monotonous and boring PE lessons reduced participants' enjoyment of PA. According to the students' view, a monotonous PE course meant following the same structure throughout the whole academic year (e.g., playing only football), a lack of variety, or constant repetitions of the same activity

(e.g., running several laps across the playground) and a lack of interaction and competition (e.g. a lack of team games).

> Sometimes I don't want to exercise because having to do the same thing over and over again makes me feel lazy, and after a time I just get tired.

The perceived barriers regarding teaching style and personality were based on two main factors. Firstly, participants did not feel that they had the opportunity to input into the class (e.g. choose games or activities).

> Because in PE you do what the teacher says, but then you want to do something, and you can't do it, it must be what the teacher says.

The second factor was academic assessment, as some students reported feeling forced to perform the activity to avoid failing the subject, negatively affecting their PA experience. In other cases, students said that PA during PE was just a subject requirement, but they did not enjoy it at all.

> […]I feel that he [PE teacher] treats you as if you were in the army because he says that he is going to mark you down in everything.

In terms of diet, some school policies were reported to have a negative influence on food intake, especially the length and frequency of the school breaks. Some of adolescents explained that break time (reported as being 20 minutes long) was not long enough to queue to purchase food, eat, play, move and socialise. One student reported that they are not able to finish their lunch in this brief time period.

> Give us more time to eat, because when we buy something if we don't finish then they [the teachers] throw it away.

Safety

Despite the restrictions, participants perceived their school as a safe place. This was the case mainly because students are monitored by the teachers. By comparison, outside the school and in the local neighbourhood, school students and their parents had serious safety concerns. This fear for safety was identified as the largest source of restriction for being active across all focus groups.

> […] where I live it is more insecure and I feel scared to go out sometimes, that's what I mean. I mean, all places can have their downsides but where I live it's less safe.

All participants perceived their surroundings to have high levels of crime (i.e. they have fears of being kidnapped, assaulted or caught up in shootings), unsafe roads (i.e. too much traffic and fast drivers) and unsafe parks (i.e. fights, exposure to drugs and the fear of being kidnapped). These fears are sometimes the result of being actual victims (some students shared that they had previously been victims of robbery) or of what they hear as well as what is said by people around them. For example, one student mentioned that he has heard about some areas, where there is a curfew from 8:00 pm.

The main impact of this fear is that participants opt to stay at home and engage with activities other than PA, as a participant expression illustrates: G: *"it is better to be safe than sorry"*. A second impact that was identified was that participants avoided visiting parks unless someone else could be with the student, increasing their perception of safety. However, opportunities to go to the park with a companion is low for the students, especially since some of them are under the supervision of grandparents –who may be unwilling to take them to the park. In other cases, some students spent most of the time after school alone, as one student explains:

> […] I am alone almost all afternoon from 2 [pm] when I arrive at my house to 6:30 [pm] or almost 7:00 [pm] when my mum arrives. She is afraid if I stay outside the home. That's it, so I don't go to the park alone. I can't.

Aside from the students' own fears they also reported being restricted from going outside by parents or grandparents, as a student explains:

> […] my parents say no [to going to the park] because what if you are attacked or robbed and, we [the parents] don't know, and that's why they don't let me [go to the park].

Time

Lack of time, as a result of home and schoolwork demand, was one of the most common barriers for PA and to eating healthily described. Both at school and outside school hours, academic-related demands were the key restrictions identified. Particularly in state schools, the timetable is perceived as very long, starting too early

and finishing late, being full of classroom activities in which participants must sit down. Also, a few of the students gave the early start as a reason for skipping breakfast. Outside school, the time spent commuting and the homework load is perceived to demand most of the participants' time and limit their opportunities to engage with other activities. Non-academic demands reported were chores at home (e.g., cleaning) or helping parents to run errands.

> We leave [school] at almost 4 o'clock in the afternoon and, well, it takes me about half an hour to get to my house, and I cannot go outside there because then I do homework, as it is almost night-time, and I so do not do much exercise.

Equipment and access

Lack of physical environmental conditions for PA and healthy eating was a consistent barrier reported by most participants. Adolescents from state schools reported that there was a lack of sports facilities and adequate equipment at school, which to an extent discouraged them from being active.

> Sometimes you want to play something but there are no balls, or they are all deflated, or they are all already broken, and you can't play.

Across all focus groups, participants agreed that their school felt small, crowded, and had limited space and provision for PA. For instance, in some schools the playground is shared with the school food stands during breaks. Participants rarely mentioned their participation in sports clubs outside the school; it seems that they do not have much access due to extra expense and time. At the local neighbourhood, PA opportunities are to visit parks, go onto the streets or visit open areas in which adolescents ride their bikes or play sports (mainly football). At home, participants reported being much more restricted as the area is usually too small for activities. The quote below shows that such restrictions foster feelings of stress and frustration.

> I'd say they [authorities] should make the playground bigger so we all could be there, and another [suggestion] is that if it was bigger […] everyone has a place for sports. For example, a place for soccer and gym and I don't know – maybe another place for dancing - because sometimes it happens that while you are playing soccer and you hit someone [with the ball] and they [teachers] are angry

> and stop the activity and say ‘give me the ball’, so to be able to do more exercise (pause).

Regarding diet, most participants highlighted the lack of food variety and how much they perceived being exposed to unhealthy options at school.

> […] that they [food stands at school] ought to sell fruit cocktails, fresh juice, fruit milkshakes or salads in the cooperative [food stands at school], because they only sell crisps, biscuits, and chocolates, and is like we are fed up with always eating the same at school.

4.7.3. Theme III: Social factors

Perceived social factors seemed to be important for the participants in terms of physical activity but influence on diet was not mentioned. Therefore, this theme concerns social support affecting PA.

Socialising

Firstly, participants reported having feelings of connection and that it felt fun to spend time with their friends, if the participants had someone else to play with. Participants considered that even when sometimes being active could be tiring or hard (e.g. during a football tournament), the companionship changes the overall experience to make it fun, exciting and enjoyable. Also, some of the students indicated they felt more comfortable performing the activity with friends, and sometimes PA was considered a means to make new friends.

> Because I like it [playing football], apart from having fun you like to play with your friends.

The competition aspect of PA (mainly playing team sports) was perceived by some participants as encouraging (which can clearly only happen if the PA is practiced with someone else).

> Physical activity because you move around and run with friends to play, which encourages you to win.

Participants did not engage regularly in playing sports or being active with their families (parents, siblings or cousins) but when they did, they mostly walked, ran, rode a bike, used outdoor exercise equipment (available in some parks) and in a few cases

played tennis and football. Sharing such activities with parents was to considered by participants as high-quality time that fosters feelings of family connection.

> Then you go for a walk and it is good for socializing and besides your exercise like that you enjoy more the time to be with your family.

Family

Living in inactive families or families who have a limited interest in PA was also a barrier to being active, as perceived by some participants. One student explained how she wanted her parents to exercise with her, yet this rarely happened. Another student mentioned that her family never have time for these sorts of activities, while a third student indicated that her family does not care whether she does PA or not. In all focus groups, apart from one student who mentioned an uncle who goes to the gym, none of the participants mentioned whether anybody within their family engaged in any kind of physical activity regularly, and it seems that within this participant group there was no PA culture at home. In contrast, some students referred to indoor and screen-based activities as a way of spending time together with their family.

> It [exercising] is not something that we do as a rule, because your parents [don't] encourage you, 'let's go to exercise', they would rather stay and watch TV or whatever. If it were a habit, then I think it would motivate me to do it but it is not.

Another student explained that she does not feel supported by her family to be active because family members have a busy life and end up very tired, giving them no chance to do any form of PA. In this case too, parents suggested spending time together in front of a screen rather than PA as a form of entertainment.

> I think it is important to consider yourself but also other people too. For example, sometimes I would also like to ((er)) practice something with my mum or things like that, but by the time she arrives, like 7:00pm, I know she is also tired as she gets up at about the same time as me at 5:00 am in the morning, does a lot of things […] I mean there are times when she [student's mum] can [exercise with the student] and she tells you 'um no, I don't want to, but what about watching a film instead, and tomorrow we will see if we can do something else.

4.8 Discussion

The purpose of this study was to explore the adolescents' understanding of healthy eating and PA and gain an insight into the perceived barriers and facilitators of these lifestyle behaviours in a group of secondary school adolescents in Mexico City. Three common themes were identified: a) understanding the health-behaviour link, b) the impact of a restricted life, and c) social factors. Overall, participants demonstrated knowledge of the relationships between PA and its physical, psychological and social health benefits as well as physical benefits associated with healthy eating. Most participants showed interest in having more healthy food options at school and seemed to enjoy PA, particularly for socialising, having fun and relieving stress. Performing any type of PA with friends and for the pure enjoyment were the PA facilitators identified. However, these motivators seem to be insufficient for actual or sustained health behaviours because of the perceived environmental and social barriers. Regarding diet, perceived exposure to unhealthy food in the adolescents' environment and personal preferences seem to play a key role. Regarding PA, students perceived themselves to be locked up both in their classroom and at home. Lack of time and lack of social support were identified as barriers to PA.

The expression "*It's a bit exasperating to be locked up"* captures the main finding of the present study within the specific context of urban settings in Mexico. This finding may help to explain the presence of more inactive adolescents in urban (41.1%) than rural areas of Mexico (33%) (Medina et al., 2018). Serious parental and personal safety concerns, the perception of a lack of safe areas to play, added to low parental interest in PA made the participants feel locked up at home. At school, participants felt safe but the perception of restrictive policies, a predominantly desk-based school day, the lack of adequate sports facilities and equipment, insufficient provision of PE and the PE teaching style also increased their feelings of being locked up in the classroom. Since the access to adequate outdoor facilities (Boone-Heinonen, Casanova, Richardson, & Gordon-Larsen, 2010) and outdoor time positively predicts time spent on PA (Ferreira et al., 2007; Gray et al., 2015) and negatively predicts sedentary time (Gray et al., 2015), it is likely that Mexican adolescents' perception of overall limited access to outdoor time and facilities affects their PA participation. In addition, lack of time for PA at school and the home was a common barrier identified across all focus groups mainly related to homework and other household commitments, in line with previous research (Humbert et al., 2006; Stanley, 2013; Van Royen et al., 2015)

Urban Mexican adolescents in this study have a perception of high crime rates in their neighbourhood that is shared with their parents. Participants felt that this prevents them from going out to play. This finding resonate with national data which indicate that 70.1% of Mexican parents prevent their children from going outside due to neighbourhood safety concerns (Instituto Nacional de Estadística y Geografía, 2018). Perceived safety concerns were also a PA barrier for adolescents of a low SES in Canada who were afraid of vandalism (Humbert et al., 2006) and Mexican-Americans living in high crime areas of Chicago, who had witnessed people being assaulted and killed (Stodolska, 2013). The present study findings were that Mexican adolescents described themselves and their parents as being afraid of unsafe parks, unsafe roads and high levels of crime. Given that previous studies support the association between adolescents' PA, low crime incidence (Ferreira et al., 2007) and lower safety concerns (Yu & Woo, 2017), the provision of safe play areas in Mexico city may well contribute to reducing fears and thereby increasing PA levels.

At school, adolescents perceive scarce opportunities for PA; they feel that they are forced to remain locked up in their classroom and perceive limited social support. This perception might negatively impact on adolescents´ physical activity participation and overall wellbeing. In line with SDT, thwarting individual basic physiological needs for autonomy relatedness and competence contributes to ill-being (Ryan & Deci, 2017). This principle has been supported by empirical data from multinational studies, in which need frustration positively predicted depressive symptoms and negatively predicted life satisfaction among 324 Chinese and 324 Belgian adolescents (Chen et al., 2014). According to SDT, these needs can be blocked by the social context (Ryan & Deci, 2017). In the present study, there were examples among participants' comments that suggested that they may have experienced some need thwarting; for example participants indicated some thwarting of autonomy as they had been banned by teachers play in the playground and by parents from going to the park, and some thwarting of relatedness as friends and family discouraged them from being active. In some cases, participants said that they played football in secret at school, suggesting that they do not perceive playing football to be an activity that they can freely choose, and that to do so they have to break the school´s rules. Potential thwarting of relatedness could be experienced by participants when teachers and family indicate that they think physical activity is unimportant, for example by teachers giving priority to curricula and safety in the playground over activity, or parents suggesting that they watch TV instead of

spending time with their children actively. Although exploring need thwarting among Mexican adolescents is beyond the scope of this study, the results set a precedent for further exploration of Mexican adolescents' need frustration within their immediate social contexts.

Environmental factors might also contribute to the participants´ perceptions of being in lockdown, including restrictive school policies and limited facilities for PA. In the present study, participants perceived a lack of adequate facilities for PA at school and inadequate school policies (e.g. spending PE time writing into the classroom) which may affect their PA levels, supporting previous research (Morton, Atkin, Corder, Suhrcke, & Sluijs, 2016). The premise that school policies block schoolchildren's participation in PA has been reported in previous studies, confirming that schoolchildren are not allowed to run or use balls during recess (Jennings-Aburto et al., 2009). Research in Mexican state schools reports a significant decline in MVPA in children during school hours from kindergarten to primary school (Jauregui et al., 2011), consistent with children's reports of constraints to being active in such a setting. However, these represent students view only, and may not be shared with teachers or more objective audits of equipment and facilities, although research suggests that school facilities for PA are a positive correlates for adolescents' PA (de Vet et al., 2011). Little is known objectively about the physical environment in the Mexican schools and their potential impact on adolescents PA, as methods used in previous studies to audit the school environment have not been applied in Mexico (Broyles et al., 2015). Nonetheless, the data that is available suggests there is limited access to adequate facilities and equipment (Argumedo et al., 2020; Galaviz et al., 2018; Safdie, Jennings-Aburto, et al., 2013)

Furthermore, it may be claimed that breaks in Mexican schools are perceived as time spent on other activities rather than playing or moving around. In other contexts like in the UK, the school break from the curriculum activities is commonly called playtime which implies free time for school children to engage in leisure activities (Ridgers, Stratton, & Fairclough, 2006). In Mexico, this break is generally named "recreational time", or "recess" as in the United States, which might have a somewhat different connotation to playtime, but nevertheless implies freedom. However, studies conducted in Mexican state primary schools reported the statutory prohibition of the use of recess for anything other than resting (Safdie, Levesque, et al., 2013). The results of the present study indicate that freedom is rather prescribed, and support the findings of a

previous study in which children described a number of school policies that prevent them from being active during breaks (Safdie, Levesque, et al., 2013).

PE lessons and PE teachers' behaviour resulted in perceived barriers concerning the school curriculum. Some participants perceived their PE teacher's style to be relatively authoritarian and restrictive of the students' input in the class (e.g. choosing activities), which undermined their enjoyment and enthusiasm. The descriptions participants gave of these experiences resonate with the concept of need supportive versus need frustrating environments as set out in SDT (Ryan & Deci, 2017). That is, individual's behaviour can be regulated through either the satisfaction or frustration of three basic psychological needs of autonomy (feeling ownership of actions), relatedness (feeling connected to others) and competence (feeling capable to operate effectively). Needs support has been shown to predict autonomous forms of motivation which in turn facilitate adaptive health and wellness outcomes (Gillet, Berjot, Vallerand, & Amoura, 2012; Ommundsen, 2007), whereas needs frustration created by the PE teacher has been shown to result in lower levels of PA (Curran & Standage, 2017). Empirical research supports these ideas. For example, control from PE teachers has been linked to the disaffection and lower PA in the PE context (Curran & Standage, 2017; Jackson-Kersey & Spray, 2016). Such findings support other qualitative studies showing that lower controlled motivation and higher autonomous motivation in pressure-free supportive environments were important for PA engagement in overweight adolescents (Li, Fenton, Thayer, Russell, & Gray, 2015). The findings of the present study indicate that adolescents perceive a lack of autonomy in PE (frustrating the basic psychological need of autonomy in SDT terms), though further causal investigation would be necessary to substantiate the link.

Key factors identified to counteract the adolescents' perception of being locked up, were the fun component of PA and the social support from family and friends. In line with previous qualitative studies (Casey, Eime, Payne, & Harvey, 2009), this fun component changes adolescents' overall PA experience. The current study finding about social support from family and friends aligned with research on the role of friends (Alsubaie & Omer, 2015; Salvy, 2009) and family (Trost et al., 2003) in developed countries and families from low SES in United States (Wright, Wilson, Griffin, & Evans, 2010). These two key facilitators have been explained in SDT literature in terms of the social connection experienced with friends which facilitates autonomous

motivation for adolescents in sports and PA enjoyment because it satisfies the need to experience relatedness (Fitzgerald, Fitzgerald, & Aherne, 2012; Ryan & Deci, 2017).

The role of family was not only perceived as a facilitator, as in some cases students find their family as a PA barrier. Past research supports the idea that parents generally support and encourage their children to be active (Gillison et al., 2017). The current study found that some Mexican adolescents perceived not only limited support from parents because they are busy as documented in previous studies (Wright et al., 2010), but the participants also perceived a degree of discouragement from parents to partake in PA and an encouragement towards sedentary behaviours.

Main barriers to healthy eating were suggested to be the availability of unhealthy food options in the students' environment and the lack of time during the school break to eat lunch, which supports the findings of previous studies in Mexican state schools (Bonvecchio et al., 2014). Although participants' knowledge about healthy eating seemed to be basic, they were able to distinguish the most obvious healthy and unhealthy food options (e.g. vegetables vs soda). In the present study, despite their health knowledge, students showed a general preference for junk food, and a lack of interest for a lifestyle change (e.g. the belief that healthy eating is something that does not apply to them).The finding of the present study about the view that participants' knowledge was not enough to motivate the uptake of healthy eating is consistent with past research (Croll, Neumark-Sztainer, & Story, 2001; Koehn, Gillison, Standage, & Bailey, 2016; Krølner et al., 2011) and contributes to the literature on dietary educational interventions in which adolescents' knowledge is not translated into behaviour change (Toral & Slater, 2012). Additionally, social aspects of diet seem to be irrelevant for the participants as they did not mention any social influence in their eating choices, which contrasts with previous studies that have reported the influence of peers in unhealthy eating choices (Chung et al., 2017; Koehn et al., 2016). This finding could be linked with Theme 1 findings, when participants associated healthy eating with physical benefits compared to social and mental benefits from PA.

4.8.1 Limitations

The results of this study must be interpreted with caution as all participants lived in urban areas, and perceptions of rural adolescents or those outside the educational system might differ. Two of the schools ran on a regular timetable, whereas four ran on a doubled-up school day (with rotas of different pupils attending morning and

afternoon). Therefore, the different timetables would lead to differences in breaks, lunchtime and availability of food stands/canteens. The focus group guide also directed the discussion; social influences on diet were not explicitly raised, therefore there may be more information that participants had to contribute on this topic if directly addressed.

4.9 Conclusion

Mexican urban adolescents in this study shared a perception of poor access to outdoor time and facilities as a barrier for PA both at school and in their home neighbourhood. Although schools are a valuable opportunity for PA because they are perceived as safe, adolescents did not perceive receiving adequate social support, facilities or timetable to benefit from this. Adolescents' knowledge of healthy eating did not seem to translate into their food choices, and there was little desire to do so. Nonetheless, they noted barriers such as the availability of unhealthy food in their environment exacerbating their poor dietary choices. Enhancing overall outdoor time, addressing perceived safety concerns, PE provision and structure, school policies, availability of high-energy food at school, school timetable, physical facilities and equipment at school and at local neighbourhood may enhance urban Mexican adolescents' lifestyle.

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4.10 Closing commentary

Within the three themes identified in this paper it was possible to highlight different factors influencing participants PA beyond the intrapersonal and interpersonal levels of influence examined in Chapters 2 and 3. The present chapter has shown several perceived environmental barriers for PA that might be worth to consider for the intervention design. Among these, limited opportunities for outdoor time including frequent PE cancellations and perceived neighbourhood concerns were relevant findings that could possibly help to explain why autonomous motivation was found to be insufficient to predict MVPA among participants.

Collectively, the empirical data from studies 1-3 detailed in Chapters 2-4 fulfils the first proposal of this thesis in terms of exploring some of the determinants of obesity among Mexican adolescents, with a particular focus on PA. In addition to the study of individual level predictors of PA, the qualitative results provided a broad idea of the setting and its readiness for a PA intervention (e.g. human resources or physical conditions of schools). Overall, the findings of the three studies support the premise that the context matters and might have an important role in Mexican adolescents´ lifestyle choices. For PA in particular, this impact may be more than has been seen in research in other countries. Thus, while the findings in previous chapters revealed that adolescents overall displayed high levels of autonomous motivation which was predicted by the perceived need support from the social environment, it appears that the context curtailed their ability to act on that motivation. Removing some of the biggest environmental barriers to PA may be only achieved in the long term with considerable investment beyond the domain of health promotion, requiring, for example, significant investment and cultural shift to change pressures on schools and the safety issues that people living in Mexico City face. This is beyond the scope of the present work. Therefore, the final study of this thesis aimed to explore whether despite these barriers, there are some changes that could be made to improve the conditions within schools without the need for significant investment or cultural change. Thus, the focus was to encourage adolescents to make the most of their opportunities to be active in more positive ways, and to improve outcomes for them to some degree. As such, support for autonomous motivation was retained among the modifiable physical and social environmental determinants and policies that were targeted.

Long-term physical activity persistence and wellbeing resulting from autonomous forms of motivation towards PA have been documented (Teixeira et al., 2012), and as such, maintaining at least some autonomously motivated activity while at school may be useful in predicting physical activity in young adulthood. More specifically, autonomous motivation has been associated with long-term physical activity maintenance, whereas controlled motivation has not (Deci & Ryan, 2002; Ryan, Frederick, Lepes, Rubio, & Kennon, 1997). Collectively, the advantages of underpinning the present intervention on SDT principles formed the rationale for such decision. The data gathered provides the required information to move forward with the second thesis aim to design a theoretically and evidence-informed PA intervention prototype ready for testing with Mexican adolescents.

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Chapter 5 Development of "*Lideres en movimiento",* a school-based intervention to promote physical activity among Mexican adolescents

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5.1 Introduction

Worldwide around 80% of adolescents do not meet the recommended levels of physical activity (PA) (Hallal et al., 2012). According to the National Health and Nutrition Survey (ENSANUT) 2016, 35% of Mexican adolescents aged 15-19 years old and 82.5% of children aged 10-14 years old do not accumulate 60 minutes per day of moderate and vigorous physical activity (MVPA) (Medina, Jauregui, Campos-Nonato, & Barquera, 2018). Since children and adolescents spend a considerable amount of their time at school, which also generally has the infrastructure, human resources and curricular and extracurricular opportunities for PA, school is generally considered an ideal setting for PA interventions (Borde, Smith, Sutherland, Nathan, & Lubans, 2017; Lai et al., 2014).

Despite the potential of schools to deliver health-enhancing interventions, however, evidence suggests limited effectiveness (Brown & Summerbell, 2009; Langford, Bonell, Jones, & Campbell, 2015). A vast number of challenges for interventions targeting behaviour change have been documented, which vary from ineffective designs to inappropriate implementation processes (Moore et al., 2015). Other challenges are related to identifying the essential part of the intervention responsible for the actual behaviour change, namely core elements of active ingredients (Hardeman, Griffin, Johnston, Al, & Nj, 2000).

In order to overcome these challenges, a transparent and systematic intervention design with theoretical foundations would seem to be the logical approach. Existing frameworks facilitate detailed and systematic guidance for the design and development of health interventions, including the MINDSPACE framework (Institute for Government, 2010), the Medical Research Council Guidance (Moore et al., 2015), and Intervention Mapping (Bartholomew et al., 2016). In addition to a systematic and evidence-based approach,

interventions underpinned by theory should ultimately provide more clarity about the causal relationships between those factors influencing behaviours and their mediators. In fact, a meta-analysis of the core elements of physical activity interventions underpinned by theory has shown to have a slightly higher effect size than those with no stated theory (McEwan et al., 2019). Findings from a systematic review of the longer effect of physical activity in school-based interventions suggest that those grounded on theoretical models (and 12 months or more in length) produced more sustainable effects (Lai et al., 2014).

Self-Determination Theory (SDT) has been consistently used to explain peoples' engagement and persistence in PA (Teixeira, Carraca, Markland, Silva, & Ryan, 2012). According to this framework, aspects of the social context can influence individuals' quality of motivation, which in turn can influence behaviour. This process is mediated by the satisfaction of three basic psychological needs, namely autonomy (feeling the ownership of actions), relatedness (feeling connected to important others) and competence (feeling the capability to act efficiently) (Ryan & Deci, 2017). Research shows that high quality motivation (autonomous motivation) in students is an important correlate of PA during PE (Standage, Gillison, & Treasure, 2007) and leisure time (Owen, Astell-Burt, & Lonsdale, 2013).

Despite the potential for promoting PA within schools, school-based interventions have demonstrated only a limited degree of success, and mixed results between studies. According to a systematic review and meta-analysis, school interventions have shown an encouraging increase of 24% on MVPA measured by accelerometers or observations during PE lessons (Lonsdale et al., 2013). However, only limited success was demonstrated in interventions where only accelerometers used and where daily MVPA was measured rather than during PE only. Results from systematic reviews and meta-analyses of school-based PA interventions reported an increase of only 4 minutes of MVPA per day in children (Metcalf, Henley, & Wilkin, 2012) and 2 minutes in adolescents (Borde et al., 2017). A Cochrane review reported that the increase in the amount of time spent physically active varied across studies from under 5 to 45 extra minutes per week (Dobbins, Husson, Decorby, & Larocca, 2013). In summary, while most evidence suggests that school-based interventions to increase MVPA in adolescents using objective monitoring of PA have small or null effects overall (Borde et al., 2017; Love, Adams, & van Sluijs), some do show

meaningful improvements. Thus, understanding the key components of the interventions with successful results is imperative for further improvement.

To date, there are a limited number of school-based interventions addressing lifestyle behaviour change for obesity prevention among the Mexican population.

The RESCATE intervention was implemented in 10 state schools in Mexico City. This intervention was conducted in 495 children (8-10 yeas-old) through change at individual (knowledge), environmental (PE classes) and social level (family) and showed significant increase in self-reported MPA and a decrease in screen time (Colin-Ramirez et al., 2010). Another PA school-based which includes environmental and policy components was implemented in 27 schools and used pedometers to measure PA in both school time and for the whole day (Jennings-Aburto et al., 2011). A significant increase of the steps in the school and school day were identified (Jennings-Aburto et al., 2011). These exceptions are lacking in detailed information regarding the models of change used, they are interventions for children (rather than adolescents) and have demonstrated knowledge improvements but limited improvements on MVPA minutes during the day. This study aims to build on previous research to adapt and improve a school-based intervention aiming to increase PA among adolescents in Mexico.

In addition to the challenges in intervention design and evaluation as set out above, shortcomings persist in the role that state Mexican schools can play in improving health. For instance, adolescents attending state schools in Mexico do not routinely receive the statutory time for PE, which indicates PE should take place two times per week, with each session lasting for at least 50 minutes (INSP, 2018). Studies in 20 schools in Mexico showed that PE actually took place one time per week and for less than 40 minutes (Jennings-Aburto et al., 2009). In addition, during PE students should ideally spend 33%-50% of their time on MVPA, but in Mexico this can be as low as 16-24% (Jennings-Aburto et al., 2009). Further, there is evidence that most of students' break time is spend in light activity or sedentary behaviour (Jennings-Aburto et al., 2009; Medina, Barquera, Katzmarzyk, & Janssen, 2015).

5.1.1 The present study

The aim of this study is to use intervention mapping to:

(a) integrate primary data from the three empirical studies reported in Chapters 2-4 and secondary data from a literature search as the basis of a needs assessment;

(b) translate the needs assessment into a set of requirements and objectives for a bespoke intervention for adolescents <18 years old;

(c) identify potential existing interventions, and select and adapt the most promising for implementation in Mexico.

5.2 Method

Intervention Mapping (IM) (Bartholomew et al., 2016) is a protocol for developing, implementing and evaluating interventions. This protocol will be used to address the study aims. IM is based on the ecological approach (McLeroy, Bibeau, Steckler, & Glanz, 1988) and on the premise that theory and empirical evidence can drive the planner's decisions during the intervention development. The full systematic process of IM comprises six iterative steps outlined in Appendix 1. Briefly these steps are (1) needs assessment; (2) development of matrices of change; (3) programme plan; (4) development of components and materials; (5) plan for implementation; and (6) plan for evaluation (Bartholomew et al., 2016).

Needs assessment consists of identifying the behavioural and environmental needs of a given population and the gaps in provision using theory and empirical-based data (McKenzie, 1993). The development of the Matrices of Change requires the specification of four main elements: Behavioural/Environmental outcomes (BO/EO, the behaviours or environmental conditions that the intervention is proposed to accomplish), the Performance Objective (PO, detailed list of observable actions required to perform that expresses the behavioural/environmental outcome), the Determinants (personal or external factors that influence the BO), and the Change Objectives (refers to what participants must learn/change to meet/maintain the performance objective and are derived by crossover of PO with the determinant of that behaviour).

From IM are derived the steps to adapt a given intervention to new settings, and this approach was selected for this study to systematically adapt an intervention which is based on other interventions' previous successful outcomes (Bartholomew et al., 2016). IM and IM to adapt interventions are grounded in the same principles and are identical in steps 1, 2,

5 and 6. However, IM to adapt also introduces: searching for evidence–based interventions, assessing intervention fit and plan adaptation, and making adaptations which substitute steps 3 and 4 of IM.

IM has been successfully used to replicate interventions. The Dutch Obesity Intervention in Teenagers (NRG-DOiT) (Singh et al., 2006) is an example of how following a systematic protocol of development, makes successful outcomes possible and leads to a clear understanding of how the intervention actually works. The DOiT programme was initially developed among a group of Dutch adolescents, and proved effective in both influencing the expected outcomes (e.g. changes in body composition) and the development process (e.g. documenting each intervention step taken) (Singh et al., 2006; Singh, Paw, Brug, & van Mechelen, 2007). Following the success the programme, it was disseminated across the Netherlands, enabling the preservation of the core intervention elements (van Nassau, Singh, van Mechelen, Brug, & Chin, 2014). A similar approach was used in the Healthy Lifestyles Programme (HeLP,) (Lloyd, Logan, Greaves, & Wyatt, 2011) which through steps 1-4 of IM showed the acceptability and feasibility of the intervention in the community. The programme was designed for obesity prevention among British children through modifications in 3 behaviours, reduce SSBs consumption and TV viewing and increasing healthy snacks consumption. In addition to providing direct benefits to the participants, the detailed reports of these projects provide an important contribution to the state of knowledge of health interventions development.

IM has also proved useful and effective in setting out specific requirements for interventions to be adapted into new settings Gillison et al. (2012), developed Waste the waist, the systematically adapted English version of the Greater Green Triangle intervention aiming to lead to changes in diet and PA in Australian adults (Laatikainen et al., 2007). Using the needs assessment and POs during the development of Waste the waist, a set of criteria were identified to drive the selection of an intervention, which fits with the community needs. Tortolero et al. (2005) adapted a sexual risk reduction program namely Safer Choice originally designed for adolescents attending regular high school (Coyle et al., 2001) The adapted version named Safer Choice 2 was attended by adolescents at risk of dropping out of high school in Texas (Tortolero et al., 2005). One of the most important lessons learnt from this adaptation process was the relevance of identifying the needs of the at-risk adolescents and the community capacity.

Adapting an existing effective intervention approach rather than beginning from scratch was the approach chosen in the present study using Intervention Mapping to adapt. This approach facilitates building on previous experiences and increases the likelihood of success, as the active intervention ingredients are known and tested previously. The present chapter covers steps 1 and 2 of IM and the three extra steps of IM to adapt (searching for interventions, fit assessment, and adaptation).

5.2.1 Step 1. Needs assessment

Needs assessment consists of gathering data about the population needs and the environmental conditions associated with the problem to understand how to best address the health problem (McKenzie, 1993). Collectively, data from the three empirical studies reported in Chapters 2-4 and secondary data from a review of the literature will inform this process.

Data sources

Primary data. Data from 320 adolescents attending secondary school in Mexico City reporting the association between four modifiable lifestyle behaviours: diet, physical activity, sleep and screen time, and obesity (Chapter 2) was included. Data regarding the relationship between parents', peers', and physical education teachers' psychological need support and moderate to vigorous physical activity (MVPA) and sedentary time among 320 adolescents in line with SDT (Chapter 3) was used. Finally, qualitative data collected via 12 focus groups in six secondary schools in Mexico City regarding the perceived barriers to and facilitators of physical activity and healthy eating (Chapter 4) was included.

Secondary data. A literature search including nationally representative data reporting Mexican adolescents' lifestyle that is the National Survey of Health and Nutrition in Mexico 2016 (INSP, 2016) was used. Nationally representative data about the environmental conditions conductive to PA were also selected, namely the Report Card on Physical Activity for Children and Youth (Argumedo et al., 2020; Galaviz et al., 2018) and the National evaluation of schools report conducted by the UNESCO and the National Institute of Public Health (INSP, 2018). To complement nationally represented data, published studies observing Mexican adolescents' PA and the school context will be used. Since there is evidence that 10 minutes of extra MVPA could lead to positive changes in

waist circumference (0.5 cm) (Ekelund et al., 2012) that was considered the criteria for considering the intervention a success.

5.2.2 Step 2. Matrices of change

Step 2, Task 1. State the Behavioural/environmental outcomes

Statements of behavioural or/and environmental aims of the intervention will be formulated and integrated into a set of specific desired Programme Outcomes. To do this, data from needs assessment will be used in terms of the conditions linked to low physical activity among Mexican adolescents and Mexican schools.

Step 2, Task 2 Specify Performance Objectives

The formulation of Performance Objectives for every programme outcome will be derived from answering the following question: What actions do the participants (or environmental agents) in this intervention need to do to perform the behaviour or to make the environmental change?

Step 2, Task 3. Select the Determinants

Behavioural and environmental determinants linked to the health problem are crucial components of IM given that these act as mediators of behaviour change (Biddle, 2015). First, PA determinants will be extracted from both data sources. Second, PA determinants will be evaluated by importance and changeability according to IM (Bartholomew et al., 2016) and methodology from previous studies (Reinaerts, de Nooijer, van de Kar, & de Vries, 2006). Importance of a determinant will be established from the strength of the evidence of a causal link between the determinant and PA, and their match with the primary data. The following codes will be used: "+" (not very important); "++" (important), "+++" (very important). Changeability will be established from the strength of the evidence that the determinant could be changed by a programme delivered at school, using the following codes: "+" (not easy to change); "++" (changeable). Determinants that were scored as both very important and changeable will be selected as essential criteria for the final intervention.

Step 2, Task 4. Specify Change Objectives

Change Objectives resulting from the intersection of the POs and the determinants, as statements of demonstrable behaviours that adolescents should do or know (or how the environment should change) to create a positive change in each determinant (Bartholomew et al., 2016). A matrix of change will be created to map the relationships between Change Objectives, the determinants selected in Task 3, and Programme Objectives. Change Objectives will be stated using action words according to the level of complexity from low (e.g. label or list) to high complexity (e.g. assess or critique) (Bartholomew et al., 2016).

5.2.3 Step 3. Searching for evidence–based interventions

In order to select an intervention for adaptation, a list of candidate interventions was extracted from the most recent meta-analysis on physical activity school-based interventions (Love et al.). This review was selected because the compiled interventions fit with the present study aims, i.e. interventions aiming to increase PA; in school settings, with participants being school children >18 years and objectively measured PA over a 24-hour period; length >4 weeks. Cluster randomized controlled trials were used as they are considered the gold standard for establishing the effectiveness of an intervention (Moore et al., 2015); and objectively measured PA over a 24-hour period. Next, a list of requirements was developed for selecting the intervention to be adapted. After that, all candidate interventions were rated based on whether they met the defined requirements.

Requirements specification

The systematic approach used by Gillison et al (2012) will be followed to outline the requirements that the candidate interventions need to meet in order to be considered for adaptation. That is, two lists of criteria for the intervention selection will be stated. Essential criteria will consist of a fixed list of basic requirements related to best practice in intervention design, and the specific characteristics of the context of Mexico that cannot be changed and must be considered. Desirable criteria will specify a set of preferred criteria changes to which should not necessarily affect intervention outcomes.

Rating candidate interventions

Each intervention will be first broken down into its components (sample characteristics, country, intervention type, components, length, mediating variables, actual effect (min/day)). Second, each intervention will be reviewed and scored according to whether it

meets the essential and desirable criteria. The scoring system coding will be: "✓" clearly described and present, "X" absent, and "?" inadequately described. Each criterion will have the same weight, giving a score of 1 to every ✓. However, meeting the essential criteria will be decisive for selection.

Two researchers independently coded the interventions to decide whether they met the criteria, to increase accuracy and reduce bias. The list of criteria, codes and hard copy of the interventions will be provided an external coder. Disagreements will be discussed and addressed systematically. The interventions meeting all essential and most desirable criteria will be shortlisted. The final consideration in selecting the best fit intervention for the population's needs will be based on: the agreement of the intervention scores with the external coder, and a pragmatic approach based on the knowledge of the context by the lead author (GA). GA will draw on her knowledge of the readiness of the community for the intervention (e.g. most relevant environmental restrictions, economical constrains) and practical implications (e.g. current channels of communication in Mexican schools).

5.2.4 Step 4. Assessing intervention fit

The assessment of intervention fit was conducted by assessing whether the selected intervention components and strategies fit with the Change Objectives. Codes will be used for this evaluation as follows: G=good fit (no substantial adaptations are needed), A=adequate fit (no minor adaptations are needed), P= poor fit (minor or substantial adaptations are needed), and N=Not applicable.

5.2.5 Step 5. Making adaptations

If adequate and poor fit are identified for desirable criteria in the candidate interventions, adaptation will be proposed by identifying which Change Objectives are not targeted and incorporating additional strategies to address them. A search of behavioural change techniques will be conducted to identify which ones could effectively achieve the Change Objectives if associated with behavioural determinants.

5.3 Results

5.3.1 Step 1. Needs assessment

Results from the primary and secondary data are summarised on Table 5-1. Overall, the primary quantitative data from Studies 1 and 2 showed that in this sample of Mexican adolescents, only 20.3% of participants met PA recommendations. Several personal factors influencing adolescents' PA were identified including need support from parents, teachers and friends, enjoyment of PA, and autonomous motivation towards PA. The qualitative study provided insight into these findings, suggestion that the PA components that participants value are sharing the activity with friends, taking part in PA to relieve stress and for socialising. Environmental factors outside the school settings that adolescents felt influenced their overall activity levels included the limited interest of parents in PA, perceptions of unsafe neighbourhoods and parks, lack of time to be active outside school due to homework, house chores and time spent commuting. At school, barriers to PA included existing policies that banned PA opportunities, PE frequently being cancelled or delivered by non-specialist PE teachers, PE being delivered indoors and without actual physical movement, perceptions of not having options during PE, a saturated curriculum with few opportunities for PA, and small and crowded schools. Secondary data also supports this evidence, especially a limited access to overall outdoor PA at school and neighbourhood (Galaviz et al., 2018) .

Table 5-1. Results of primary data for the needs assessment

Study 1	Study 2	Study 3
Association between lifestyle and obesity	Motivation and its association with MVPA supported by the social context	Barriers and facilitators of healthy eating and physical activity
Results		
20.3% Meet 60 minutes of MVPA per day. 0% meet the recommended screen time (≤ 2.0 h /day). 3.9 % sleep 10.0 hours per night. 60% sleep at least 8.0 hours per night. 60.8% were classified as obese or overweight.	Mean of MVPA is 47.11 minutes per day. Mean of sedentary time is 8 hours per day. Boys performed higher levels of MVPA and lower levels of sedentary time than girls. Friends, family and the physical education teacher PA needs support positively predicted PA autonomous motivation. This association was mediated by need satisfaction.	Theme 1: Understanding the health-behaviour link Knowledge of the relationships between PA and its physical, psychological and social health benefits Knowledge of the physical benefits associated with healthy eating. There is interest in having more healthy food options. Enjoyment of PA, particularly for socialising, having fun, and relieving stress. Theme 2: The impact of a restricted life Perceptions of being locked at home for safety concerns Perceptions of being locked in the classroom for school policies, not enough PE and teachers Perception of not enough safe or adequate facilities for PA Theme 3. Social support Perception of limited support from teachers and family for PA

Key findings		
None of lifestyle variables predicted BMI	PA and sedentary time were not predicted by autonomous motivation or controlled motivation	Perceived exposure to unhealthy food in their environment and personal preferences seem to play a key role. Limited outdoor opportunities and lack of time

PA=Physical activity, MVPA=Moderate to vigorous physical activity

Table 5-2. Results of secondary data search for the needs assessment

Correlates	Systematic reviews used in the secondary data search						
	Biddle, Whitehead, O'Donovan, and Nevill (2005)	Sallis, Prochaska, and Taylor (2000)	Ferreira et al. (2007)	Bauman et al. (2012)	Van Der Horst, Paw, Twisk, and Van Mechelen (2007)	Craggs, Corder, van Sluijs, and Griffin (2011)	Teixeira et al. (2012)
Socio-demographic							
Female gender	(-)	**(-)**		(-)	**(-)**	?	
Age	(-)	**(-)**			(-)	?	
Caucasian	(+)	**(+)**		(-)	**(+)**	?	
High parental income	(+)	?	**(+)**		(+)	**(+)**	
High parental education					(+)		
Biological							
High BMI	(-)	?			(-)	?	
Psychological							
Self-efficacy	(+)				(+)	**(+)**	
Achievement orientation		**(+)**			(+)	**(+)**	
Motivation							**(+)**

Perceived Competence	(+)	(+)			**(+)**	**(+)**
Intention				(+)	**(+)**	
Enjoyment	(+)	?		(+)	**(+)**	**(+)**
Body attractiveness	(+)	?			?	
Physical self-wroth	(+)	?		(+)	**(+)**	
Lack of time	(-)					
Perceived barriers				(+)	(-)	
Behavioural						
Previous physical activity					**(+)**	
Taking part in school sports					**(+)**	
Taking part in physical education				(+)		
Participation in organised sports	**(+)**			(+)		
Time spend outdoor			**(+)**			
Screen time	?			(-)	?	
Social						
Social support		**(+)**	**(+)**	(+)	**(+)**	

Peer involvement and support	?	?			(+)	?
Parental involvement and support					(+)	
Active parents	(+)					?
Environmental						
Access				**(+)**		**(+)**
Facilities		(+)		**(+)**	(+)	**(+)**
Community sports Opportunities to exercise		**(+)**				
Neighbourhood crime			**(+)**			
Neighbourhood hazards (e.g. unsafe roads).				**(-)**		
School PE environment						
Land-use mix and residential density				**(+)**		

Note: (+) Positive association, (-) inverse association, Bold=convincing evidence, ?= undefined association, BMI= Body masss index

5.3.2 Step 2. Matrices of change

Step 2, Task 1. State the Behavioural/Environmental outcomes

The Programme Objective was: Adolescents' MVPA will be increased to a minimum of 10 minutes a day. The most rigorous assessment of PA corresponds to whole day of MVPA (Love et al., 2019). Vigorous intensity exercise provides more cardio protective benefits than moderate (Swain & Franklin, 2006), and extra 10 minutes of MVPA could lead to a reduction of waist circumference (0.5 cm) (Ekelund et al., 2012). On average, an intervention duration is around 9 months (ranging from 4 weeks to 28 months) (Borde et al., 2017). Further, according to the WHO Physical Activity and the Sustainable Development Goals 2030 active play, recreation, quality physical education, and supportive school environments are recommended within the schools for long-lasting healthy and active lifestyles. In fact, the Action 3.1 of this plan recommends strengthening the provision of good-quality physical education for girls and boys, including positive experiences and opportunities, participation and enjoyment considering capacity and ability for active recreation, sports and play (WHO, 2018).

As 79.7% of the adolescent participants did not achieve 60 minutes of objectively measured MVPA per day, the programme will have main behavioural outcomes defined as follows:

Step 2, Task 2. Specify Performance Objectives

The Performance Objectives (POs) are presented in Table 5-2.

Table 5-3. Behavioural outcome and the associated Performance Objectives

Behavioural outcome	Associated Performance Objectives
1. Adolescents will increase a minimum of minutes 10 of MVPA a day.	1.1 Adolescents will increase participation on recreational PA at school. 1.2 Adolescents will increase minutes of MVPA during PE. 1.3 Adolescents will increase minutes of MVPA during school day. 1.4 Adolescents will reduce sitting time at school

Step 2, Task 3. Specify the Determinants

The determinants identified through the needs assessment were teachers' PA support, PA opportunities, PA enjoyment, peers' involvement, and school policies. The evaluation of these determinants' importance and the rationale of selection are presented in Table 5-3.

Table 5-4. Judgement of personal and external determinants of physical activity

Source		Judgement		Rationale of selection
Primary data	Secondary data	Important	Changeable	
Preferences for screen time	Sedentary behaviour during the after-school and weekend periods (Biddle, Mutrie, & Gorely, 2015)	+++	+	
Teachers PA support	Social support (Craggs et al., 2011)	+++	++	✓ Important determinant, changeable, teachers are key actors in schools
Parents PA support	Social support (Craggs et al., 2011; Sallis et al., 2000) Parental encouragement(Biddle et al., 2015; Biddle et al., 2005; Ferreira et al., 2007) Parental involvement (Biddle et al., 2015) (Ferreira et al., 2007) Parental facilitation(Biddle et al., 2015; Sallis et al., 2000) Parental attitudes/beliefs (Biddle et al., 2015)	+++	+	
Intentions for PA	PA intentions (Sallis et al., 2000)	+	++	

PA opportunities	Facilities (Biddle et al., 2015) Community sports participation(Biddle et al., 2015; Sallis et al., 2000) Time spend outdoor(Ferreira et al., 2007) Participation in organised sports(Biddle et al., 2005) Opportunities to exercise(Biddle et al., 2015; Sallis et al., 2000) Access(Biddle et al., 2015)	+++	++	✓ Important determinant and meaningful determinant for Mexican adolescents
Neighbourhood crime	Neighbourhood crime(Biddle et al., 2015; Ferreira et al., 2007)	+++	+	
Unsafe roads	Neighbourhood hazards(Ferreira et al., 2007)	++	+	
Fun	Enjoyment (Biddle et al., 2015) Autonomous motivation(Teixeira et al., 2012)	+++	++	✓Important and changeable
Stress reliever	Enjoyment (Biddle et al., 2015; Biddle et al., 2005)	+++	++	
Socialising	Enjoyment (Biddle et al., 2015; Biddle et al., 2005) Need relatedness(Teixeira et al., 2012)	+++	++	✓ Important and changeable
	School PE environment(Biddle et al., 2015)	+	+	
	Seasonal factors(Biddle et al., 2015)	+	+	
Time	Living closer to school(Biddle et al., 2015)	++	+	

School policies	Taking part in school sports (Biddle et al., 2015)	+++	++	✓ Important determinant, meaningful determinant for Mexican adolescents
	Taking part in physical education (Biddle et al., 2015)			
	Policies allowing time spent outdoors at school, field trips and free play (Biddle et al., 2015)			
	Body attractiveness (Biddle et al., 2005)			
	Previous physical activity (Biddle et al., 2015; Sallis et al., 2000)	+	+	
	Sex	+	+	
	BMI (Biddle et al., 2015)	+	+	
	Perceived competence (Biddle et al., 2015; Biddle et al., 2005)	++	++	
	Achievement orientation (Biddle et al., 2015)	++	+	
	Mastery (task) goal orientation (Biddle et al., 2015)	++	+	
	Perceived behavioural control (Craggs et al., 2011)	+	+	
	Self-efficacy (Craggs et al., 2011; Lubans, Foster, & Biddle, 2008)	+	++	

Note. "+" not very important/not easy to change; "++" important/changeable, "+++" very important, "✓" determinant selected.

Step 2, Task 4. Specify Change Objectives

The Change Objectives are outlined in the Matrix of Change presented in the Table 5-4. The needs assessment supported the view that Mexican adolescents enjoy PA more if it is shared with peers. Thus, Change Objectives that facilitate adolescents' enjoyment of PA with the involvement of peers were included. The needs assessment also revealed that autonomous motivation was not a determinant of PA among this sample of participants, but that adolescents already showed a high level of autonomous motivation, which was predicted by needs support. Therefore, in order to preserve this high quality of self-driven motivation, the creation of opportunities for autonomy supportive environments is included within the Change Objectives in line with SDT (Ryan & Deci, 2017). In addition, Mexican adolescents reported that they do not feel listened to, or able to choose activities, which is likely to frustrate autonomous motivation.

As the PA opportunities at school seem to be limited on account of the physical environment (e.g. inadequate equipment) and school policies (e.g. insufficient PE), the Change Objectives included the revision and modification of these policies and environmental conditions.

Table 5-5. Change Objectives of the intervention for the outcome: Adolescents will increase a minimum of 10 minutes MVPA a day.

	Determinants				
POs	Enjoyment	Peers involvement	Teachers PA support	PA opportunities	School policies
PO1. Adolescents will increase participation on recreational PA at school	E.1 Practice the recreational activities at school day	P1. Execute PA with peers	T1. Value the importance of PA T2. Demonstrate interest on support students to be active for their health. T3 Express positive feelings on students' active time during the school day.	O1. Schedule time during the school day for recreational PA. O2. Set up outdoor facilities for PA O3. Arrange equipment for outdoor free play. O4. Organise opportunities for outdoor play.	SP1. Inventory school policies that might reduce/increase PA SP2. Judge the policies that can be removed SP3. Modify school policies that reduce PA SP5. Arrange training for teachers to value PA. SP6. Organise the playground to increase opportunities for play and run. SP7. Inventory of the school equipment for recreational play. SP8. Arrange the availability adequate

					and safe infrastructure for recreational PA. SP9. Modify sign that ban run or play
PO2. Adolescents will increase minutes of MVPA during PE	E2 Practice the PA activities at PE	P2. Execute PA during PE including interaction with peers	T4. Express interest on support students to be active for their health T5. Prepare PE creating autonomous supportive environment. T6. Prepare PE including MVPA opportunities. T7. Prepare PE with focus on PA enjoyment.	O5. Estimate the percentage of cancellation of PE. O6. Solve PE cancelations O7. Manage that PE is spent actively and outdoor O8. Organise activities that ensure all students take part on the activities during PE.	SP10.Schedule PE at least twice a week SP11 Arrange training to teachers for teach PE in autonomous supportive environments. SP12. Inventory of the school equipment for PE. SP13. Arrange the availability adequate infrastructure and equipment for PE.
PO3. Adolescents will increase minutes of MVPA during school day	E.3 Practice the PA opportunities during the school day	P3. Execute MVPA activities with peers	T8. Express interest on support students to be active for their health		SP14 Implement extracurricular activities that promote MVPA

	T9. Schedule active breaks		
PO4. Adolescents will reduce sitting time at school	T10. Use active transitions during PE. T11. Schedule stand up opportunities in the classroom and breaks	O9. Implement activities during school day in which students need to walk or move	SP15 Implement extracurricular activities that promote light/moderate PA

Note. POs= Performance Objectives

5.3.4 Step 3. Searching for evidence–based interventions

Requirements specification

The lists of essential and desirable criteria and their rationale and source are displayed in the Table 5-5. A total of 5 essential criteria and 6 desirable criteria were stated. Overall these criteria crossed primary and secondary data related to the community and setting needs (e.g. limited coverage of specialist PE teachers in Mexican schools) as well as the features of what is an effective PA school-based intervention (e.g. increase MVPA per day, evidenced using accelerometery).

Table 5-6. List of essential and desirable criteria for intervention selection and their rationale

		Essential Criteria	
Intervention content		Primary data	Secondary data
1	Resulted in a meaningful increase of >10 min/day MVPA measured objectively		Self- reported physical activity data is prone to overestimation (Grasten & Watt, 2016; Michie & Johnston, 2012). Time feasible for school-based interventions to increase PA is between 11- 13 minutes more of MVPA per day (Cohen, Morgan, Plotnikoff, Callister, & Lubans, 2015; Kriemler et al., 2010). 10 minutes extra of MVPA are needed to bring about a health benefit (Ekelund et al., 2012).
2	Clearly indicate how theory has been operationalised.		In order to have a clear idea of how an intervention works it is essential understand its causal assumptions (Moore et al., 2015). Interventions that use theoretical models are more likely to effectiveness (Lai et al., 2014). The understanding of how an intervention works facilitates the understanding of the intervention effect and what works for replication (Moore et al., 2015).

			A clear idea of the behaviour change techniques (which ones are effective and then avoid the ineffective ones) will help to achieve behaviour change (Michie & Johnston, 2012).
3	Could accommodate delivery without a PE teacher	Limited PE teachers. PE teachers not professionally trained. Substitute teachers deliver PE.	Insufficient PE teachers in Mexico (Argumedo et al., 2020; Galaviz et al., 2018). Not professionally trained, substitute teachers deliver the class; limited or unqualified PE teachers, PE classes are commonly cancelled (Jennings-Aburto et al., 2009; Safdie et al., 2013).
4	The intervention facilitates PA enjoyment	Enjoyment, having a friend and stress relief are important PA facilitators. Lack of interest in PA.	SDT basis indicate that enjoyment of a given activity facilitates autonomous motivation to engage in it, and adherence (Hagger & Chatzisarantis, 2007; Ryan, Frederick, Lepes, Rubio, & Kennon, 1997). Enjoyment is a mediator of school-based PA interventions (Dishman et al., 2005).
5	Compatible with promoting autonomous motivation	Physical activity need support from family, peers and the physical education teacher is important for Mexican adolescents' perceived need satisfaction and autonomous motivation towards physical activity.	Autonomous motivation will facilitate participants' engagement on PA on account of the following reasons: -Autonomous motivation is a MVPA predictor

			-Needs support from PE teachers has a positive effect on PA participation (Curran & Standage, 2017; Zhang, Solmon, Kosma, Carson, & Gu, 2011). -Needs support from family has a positive effect on PA participation (Amorose, Anderson-Butcher, Newman, Fraina, & Iachini, 2016). -Needs support from friends has a positive on PA participation (Hagger et al., 2009).
		Desirable Criteria	
6	Activities including peers	Socialising is an important facilitator of PA.	Peers have been identified has important to promote healthier diet and exercise among adolescent (Chung, Ersig, & McCarthy, 2017).
7	Facilitates social support	Family, friends and PE teachers are important for adolescents psychological need support. Parents not interested on PA. Parents and PE teacher perceived as no active.	There is an association between PA and peers social support (Chung et al., 2017; Fitzgerald, Fitzgerald, & Aherne, 2012; Lawman, Wilson, Van Horn, & Zarrett, 2012) and family support (Edwardson & Gorely, 2010; McDavid, Cox, & Amorose, 2012).
Design considerations			
8	Does not require activities outside school (parks or neighbourhood)	Existing safety concerns among participants	

9	Feasible cost (avoid high expenses/ equipment/membership)	Schools have a lack of, or lack of adequate sports facilities and equipment. Participants may be unable to pay extra expenses for clubs and memberships	Not all schools in Mexico have the minimum conditions for educational activities (INSP, 2018).
Implementation considerations			
10	Feasibility within school Timetables	Students reported 20 minutes recess per day. PE once a week PE sometimes takes place in the classroom and does not involve physical activity. Students reported that they usually spent PE on free play and this lead that only some students choose what to play (commonly football) and this could be the dynamic of PE along the academic year. Students reported not to being allowed to run or play at school. Students perceive their school small without enough room to play.	90% of time in recess spent in light activity, or sedentary (Medina et al., 2015). Schools have limited space and this need to be shared with other academic activities (Safdie et al., 2013). Statutory PE is twice a week for 50 minutes per class, this could be as little as once a week for less than 40 minutes (INSP, 2018). Only 16-24% of PE time is spent on MVPA (or 12 minutes per week during PE)(Jennings-Aburto et al., 2009). 20% of PE is spent of general content (Jennings-Aburto et al., 2009). Many schools run a ‘double shift’ as response of limited staff, which reduces opportunities for after school activities

			Mostly PE is delivered mostly unstructured based on free play (Jennings-Aburto et al., 2009). Students spent most of the recess walking around the school playground visiting food stands (Jennings-Aburto et al., 2009). School policies and signs against running (Jennings-Aburto et al., 2009). Lack of equipment for physical activity during recess.(Jennings-Aburto et al., 2009) Lack of playground in some schools (Medina et al., 2018).
11	Simple implementation	Teachers are busy Schools are overcrowded	Multicomponent and complex interventions are likely to have poorer implementation fidelity (Love et al.).

Note. PE= physical education, MVPA=Moderate to Vigorous Physical Activity

Rating candidate interventions

The components and scores of the 17 candidate interventions included in the analysis are summarised in Table 5-6.

Table 5-7. List of candidate interventions with components and scores

No.	Program	Sample characteristics	Country	Intervention type	Components	Length	Mediating variables	Effect min/day MVPA
1	Active by Choice Today(Wilson et al., 2005; Wilson et al., 2011)	11.34 (0.5) 24 Middle schools	USA	PA	Education Social	17 weeks	Self Determination Theory	9.11
2	Andrade et al. (2014)(Andrade Tenesaca et al., 2014)	12.0 (0.8) 20 schools	Ecuador	PA and other health behaviours	Education Social Physical	28 months	Social Cognitive Theory, Information-Motivation Behavioural Skills Model, Control Theory, Transtheoretical Model and Theory of Planned Behaviour	Null
3	ATLAS(Smith et al., 2014)	12.7(0.5) 12 Primary schools	Australia	PA and other health behaviours	Education Social	20-week s	Self-	Null

							Determination Theory and Social Cognitive Theory	
4	CHANGE!(Fairclough et al., 2013)	10.6 (0.3) 12 Primary schools	UK	PA and other health behaviours	Education Social	20-week s	Social Cognitive Theory	Null
5	Drummy et al. 2016 (Drummy et al., 2016)	9.5 7 Primary schools	Northern Ireland	PA	Social	12 weeks	No	9.5
6	Healthy School Start 1 (Gisela et al., 2015)	6.2 (0.3) 14 Pre-school class	Sweden	PA and other health behaviours	Education Social	12 months	SCT	Null
7	Healthy School Start 2 (Nyberg, Norman, Sundblom, Zeebari, & Elinder, 2016)	6.3(0.3) 13 Pre-school class	Sweden	Multi-behavioural	Education Social	6 months	Social Cognitive theory	Null
8	HEIA Study (Grydeland et al., 2013)	37 Primary schools	Norway	Multi-behavioural	Education Social Physical	5	Social Ecological Theory	Null
9	KISS (Kriemler et al., 2010)	9.25 (0.43)	Switzerland	PA	Education Social	9	Social Ecological Theory	11

		15 Elementary schools						
10	MOVE Project (Tymms et al., 2016)	11.8 (0.5) 60 Secondary schools	UK	PA	Social	1.5	No	Null
11	NEAT (Dewar et al., 2013; Lubans et al., 2010)	13.2 (0.5) 12 Secondary schools	Australia	Multi-behavioural	Education Social	12	Social cognitive theory	Null
12	Physical Activity 4 Everyone (Sutherland et al., 2016)	12 10 Secondary schools	Australia	PA	Education Social	24	Social Cognitive Theory and Ecological Theory	7
13	SCORES(Cohen et al., 2015; Lubans et al., 2012)	8.5 (0.6) 8 Secondary schools	Australia	PA	Education Social	12	Self-Determination Theory and Competence Motivation Theory	12
14	SPACE (Toftager et al., 2014)	12.5 (0.62) 14 Schools	Denmark	PA	Education Social Physical	24	Social Ecological Model	(-)
15	The Active Smarter Kids Intervention(Resaland et al., 2016)	10.2 (0.3) 60 Elementary school	Norway	PA	Education Social	7	Social Ecological Framework	Null

16	The Bristol Girls Dance Project (Jago et al., 2015)	11.5 18 Secondary schools	UK	PA	Social	5	Self Determination Theory.	Null
17	UP 4 Fun Pilot Intervention(Verloigne et al., 2012)	10.9 (0.7) 10 primary schools	Belgium	PA	Education Social	1.5	Social Ecological Framework.	Null

Note. Data source (Love et al., 2019), PA= Physical activity

Ratings assessment of the 17 candidate interventions is displayed in Table 5-7. From these, four were shortlisted on account of having the top scores. Supporting Children's Outcomes Using Rewards Exercise and Skills (SCORES) (Cohen et al., 2015; Lubans et al., 2012) in Australian school children living in underserved areas of Australia had the highest score (score=9). The following three interventions achieved a score of 8: the Active Teen Leaders Avoiding Screen-time (ATLAS) intervention (Smith et al., 2014) in Australian schoolchildren (score=12); the Norwegian programme The Active Smarter Kids Intervention (score=11) (Resaland et al., 2016); and Active by Choice Today for children in the USA (score=8) (Wilson et al., 2005; Wilson et al., 2011). Among these four interventions only Active by Choice Today and SCORES reported an increase of MVPA>10min. Ultimately, SCORES was selected because it was the only intervention meeting all the essential criteria and most of desirable criteria.

External coder results are presented in Appendix 18, notes about the evaluation in Appendix 19, and how the disagreements were solved in Appendix 20. Overall, the most common disagreements consisted of criteria interpretation. For example, in criterion 5 "promotion of autonomous motivation", the external coder assigned a code "clearly described and present" to some interventions that provide opportunities for autonomy even though these were not explicitly declared. In contrast, the first coder only considered this criterion when this was clearly stated and SDT grounded. Ultimately, the two coders rated the SCORES intervention (Lubans et al., 2012) with the top score of meeting the essential criteria and the only one meeting all the desirable criteria.

Table 5-8 Ranking of candidate interventions according to meeting selection criteria

Criteria		Candidate Interventions																
Essential		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	>10 min MVPA	✓	×	×	×	×	×	×	×	✓	×	×	×	✓	×	×	×	×
2	Operationalisation of theory	×	×	✓	×	×	×	×	×	×	×	✓	×	✓	×	×	✓	✓
3	PE teacher not essential	✓	✓	✓	✓	✓	✓	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓
4	Fun	✓	×	✓	×	×	×	×	✓	×	×	×	×	✓	✓	✓	✓	✓
5	Autonomous motivation	✓	×	✓	×	×	×	×	×	×	×	×	×	✓	×	✓	✓	×
Desirable																		
6	Peers	✓	×	✓	×	×	✓	×	×	×	✓	×	×	✓	✓	✓	×	×
7	Social support	✓	✓	✓	×	×	✓	✓	✓	×	×	✓	✓	✓	✓	×	×	×
8	Only at school	✓	✓	✓	✓	×	✓	✓	×	×	×	✓	✓	✓	×	✓	✓	×
9	Feasible cost	×	✓	×	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	✓
10	Feasibility with timetable	×	✓	×	✓	✓	×	×	×	×	✓	×	✓	×	×	✓	×	×
11	Simple implementation	✓	×	✓	✓	✓	×	×	×	×	×	×	×	✓	×	✓	×	×
Total Score		8	5	8	5	4	4	2	2	1	3	4	4	9	4	8	5	4
External coder score		8	5	8	7	6	7	7	7	7	7	7	6	11	6	6	9	9

Note. ✓ = explicitly described and present, × = absent, ? = unclear or inadequately described.

SCORES is a 12-month intervention to improve physical activity, cardiorespiratory fitness and fundamental movement skills (e.g. running, jumping, catching, throwing, balancing) among Australian children. It has four main components: student leadership, professional learning workshops for teachers, parental engagement, and also policy and environment. SCORES considers psychological (enjoyment, perceived sports competence), social (support from family, teachers and peers) and physical environment factors (access to facilities and equipment at home and PA opportunities at the local community) associated with participants' PA (Cohen, Morgan, Plotnikoff, Hulteen, & Lubans, 2017). Its model of change is formulated on the basis that social support, feelings of competence and autonomy will predict enjoyment of PA, which in turn predicts PA.

Students can achieve a SCORES leadership accreditation, which qualifies them to facilitate activities in extracurricular breaks for peers. Generalist teachers receive training for teaching PE using techniques based on the SAAFE framework to help them to plan, deliver and evaluate organised PA (Lubans et al., 2017) . The SAAFE principles consist of creating a supportive environment from teachers and peers (Supportive); facilitating active sessions reducing transition periods (Active), with opportunities for the students to make choices and participate in graded tasks (Autonomous); providing all students the same opportunities to experience success (Fair) through enjoyable lessons with a variety of activities (Enjoyable)(Lubans et al., 2017).

In the parental engagement component of SCORES, parents receive information to improve their knowledge and support their children's PA. A school committee is organised to review the school policies, identify, and remove barriers for PA during the school day. Finally, partnerships between school and community organizations are sought.

The SCORES intervention was successful in increasing adolescents' MVPA by >10 minutes per day, as measured with accelerometers. It is underpinned by SDT principles and competence motivation theory. SCORES' model of causal associations and the behavioural change techniques used are made available. In pragmatic terms, SCORES implementation does not rely on the PE teacher only and this is an important factor given the limited number of specialist PE teachers in Mexican schools. Instead, generalist teachers were trained to deliver PE and peers trained to become PA leaders and to organise activities during the school day. The intervention includes aspects

identified as important for Mexican adolescents such as enjoyment, teachers and peer support. SCORES intervention targets adolescents living in low socio-economic areas of Australia, representing a relatively feasible cost for disadvantaged regions, which is similar to the Mexican context, where budget is a barrier for schools. In addition, it does not demand extra staff or important changes in the school infrastructure. SCORES' activities are delivered in the school setting, which is essential in the Mexican context due to adolescents' perceptions of school as safe place to play vs their perceived neighbourhood safety concerns.

5.3.5 Step 4. Assessing intervention fit

The fit assessment between the Change Objectives and SCORES intervention components and strategies is presented in the Table 5-8. Good fit was assigned in Change Objectives relative to enjoyment and peer involvement. Adequate fit was identified in the Change Objectives related to teachers support, PA opportunities and school policies.

Table 5-9. Fit assessment between Performance Objectives for the revised intervention and SCORES

Change Objectives	Fit	SCORE's strategy	SCORE's BCT	Areas not met
E.1 Practice the recreational activities at school day. E2 Practice the PA activities at PE E.3 Practice the PA opportunities during the school day	G	-Student leadership component: students learn how to lead PA while model and enjoy with peers. -Teachers professional training component: teachers receive training for teaching PE using fun strategies.	-Provide instruction -Model or demonstrate the behaviour -Provide contingent rewards -Prompt identification as a role model -Plan social support or social change -Set graded tasks	
P1. Execute PA with peers P2. Execute PA during PE including interaction with peers P3. Execute MVPA activities with peers	G	-Student leadership component: develop leadership skills to lead PA during the school day to peers.	-Provide instruction -Model or demonstrate the behaviour -Provide contingent rewards -Prompt identification as a role model -Plan social support or social change	

			-Set graded tasks	
T1. Value the importance of PA T2. Demonstrate interest on support students to be active for their health. T3 Express positive feelings on students' active time during the school day. T4. Express interest on support students to be active for their health T5. Prepare PE creating autonomous supportive environment. T6. Prepare PE including MVPA opportunities. T7. Prepare PE with focus on PA enjoyment. T8. Express interest on support students to be active for their health T9. Schedule active breaks T10. Use active transitions during PE.	A	Teachers professional training component: PE teachers and generalist teachers receive training to teach supportive, active, autonomous, fair, enjoyable PE	-Provide instruction -Model or demonstrate the behaviour -Time management. -Provide feedback on performance	T1 T2 T11

T11. Schedule stand up opportunities in the classroom and breaks				
O1. Schedule time during the school day for recreational PA. O2. Set up outdoor facilities for PA O3. Arrange equipment for outdoor free play. O4. Organise opportunities for outdoor play. O5. Estimate the percentage of cancellation of PE. O6. Solve PE cancelations O7. Manage that PE is spent actively and outdoor O8. Organise activities that ensure all students take part on the activities during PE. O9. Implement activities during school day in which students need to walk or move	A	Policy and environment component: Development of a school committee and policy review and recommendations. Recommendations: a) Functioning school PA committee b) Two hours of PE per week explicit in the timetabled c) 50% of PE should be spend to MVPA d) FMS and fitness report per year e) Active playgrounds promotion f) Involve family members in school-based PA	-Provide opportunities for behaviour -Provide access to equipment to encourage behaviour	O7 O9

SP1. Inventory school policies that might reduce/increase PA SP2. Judge the policies that can be removed SP3. Modify school policies that reduce PA SP5. Arrange training for teachers to value PA. SP6. Organise the playground to increase opportunities for play and run. SP7. Inventory of the school equipment for recreational play. SP8. Arrange the availability adequate and safe infrastructure for recreational PA. SP9. Modify sign that ban run or play SP10.Schedule PE at least twice a week	A	Policy and environment component: a) Functioning school PA committee (i.e., school committee to meet once a school term). Recommendations: a) Functioning school PA committee b) Two hours of PE per week explicit in the timetabled c) 50% of PE should be spend to MVPA d) FMS and fitness report per year e) Active playgrounds promotion f) Involve family members in school-based PA	-Provide opportunities for behaviour -Provide access to equipment to encourage behaviour	SP6 SP9 SP14 SP15

SP11 Arrange training to teachers for teach PE in autonomous supportive environments.
SP12. Inventory of the school equipment for PE.
SP13. Arrange the availability adequate infrastructure and equipment for PE.
SP14 Implement extracurricular activities that promote MVPA
SP15 Implement extracurricular activities that promote light/moderate PA

Note. G=good fit, A=adequate fit, P= poor fit, N=Not applicable, BCT=Behaviour Change Technique

5.3.6 Step 5. Making adaptations

The proposed adaptations of SCORES needed in order to be implemented in Mexico are presented in Table 5-9. A total of 9 Change Objectives were identified as not included in the SCORES scope. Of these, three were related to teacher support, which is a behavioural determinant. Thus, a review of the existing BCT taxonomies that are validated (Kok et al., 2016; Michie, 2014) was conducted to find BCTs that best fit with the Change Objectives. Two additional BCTs were added to the revised intervention.

The other 6 Change Objectives not included in SCORES were related to the environment, specifically to school policies and PA opportunities. This mismatch reflects the difference in general conditions in Australian and Mexican schools and staff. These differences could be broadly seen in the grades awarded to Australian and Mexican schools in the 2018 Report Card of Physical Activity for children and adolescents, with a top grade in Australia (B+) and almost the lowest in Mexico (D+). This is a multinational evaluation (49 countries) of the PA participation and opportunities given to children and youth in their country (Aubert et al., 2018). The grades refer to the % of school children having access to specialist PE teachers, access to facilities, extracurricular activities and sports, and PE twice a week. Specifically, in Australia most schools have extracurricular activities, PA equipment and facilities and specialist PE teachers (Schranz et al., 2018), conditions which remain being challenges in schools in Mexico. SCORES was designed to target generalist PE teachers, this is assuming an interest and value on PA and having all the basic resources and equipment for PE (Government of Western Australia). Therefore, SCORES was adapted including the BCT of Social reward for those generalist teachers that integrate PA opportunities in and out the classroom. This adaptation is based on the same scheme of rewards proposed in SCORES, but in this case to promote teachers' positive attitudes to PA.

The needs assessment also showed that in Mexico, PE is sometimes delivered indoors and without actual physical activity (i.e., as a desk-based lesson), which was not part of the policy recommendations in SCORES. Therefore, the adapted version added a recommendation that explicitly suggests students spent PE outdoors and actively in order to increase their recreational PA and MVPA.

SCORES did not address the overall Performance Objective 1.4 (Reduce sitting time at school). Therefore, it was proposed that the PE teacher should also lead opportunities to stand up in the classroom.

Table 5-10. Proposed adaptations of SCORES to the Mexican context

Change Objectives	Proposed adaptation	Proposed BCT
T1. Value the importance of PA	Include information on the professional development workshop about the importance of PA for health	4.2 Information about health consequences (Michie, 2014)
T2. Demonstrate interest on support students to be active for their health.	Include also a reward to teachers that demonstrate interest to support their students PA	10.4 Social reward (Michie, 2014)
T11.Schedule stand up opportunities in the classroom and breaks	Reward teachers that include PA opportunities during the classroom.	10.4 Social reward (Michie, 2014)
	Include PA activities led by peers at classroom	-
O7. Manage that PE is spent actively and outdoor	Include in the policies suggested that PE should be delivered outdoor and actively	-
O9. Implement activities during school day in which students need to walk or move	Include PA activities led by peers at classroom	-
SP6. Organise the playground to increase opportunities for play and run.	Include in the policies audit: Analyse the playground distribution and remove barriers for PA.	-
SP9. Modify sign that ban run or play	Include in the policies audit: Organization of the playground to increase PA opportunities	-
SP14 Implement extracurricular activities that promote MVPA	Include in the policies audit: Availability of extracurricular activities with access to all students	-

	If missing, implement extracurricular activities that promote MVPA	
SP15 Implement extracurricular activities that promote light/moderate PA	Include in the policies audit: Availability of extracurricular activities with access to all students If missing, implement extracurricular activities that promote light/moderate PA	-

The resulting adapted intervention was named "*Lideres en movimiento"* in Spanish ("Leaders moving" in English) in order to preserve one of the key components of SCORES, the development of PA leadership skills, which is simultaneously linked with one of the most important determinants identified among Mexican adolescents reported in needs assessment, peers' involvement.

5.4 Discussion

The aim of the present study was to conduct a needs assessment of the Mexican adolescents, integrating primary and secondary data to translate it into requirements and Performance Objectives for a tailored PA intervention, and then to identify potential existing interventions for adaptation through Intervention Mapping. Key PA determinants that are important and changeable among Mexican adolescents to be targeted were identified as: PA enjoyment, peer involvement, teachers' support for PA, PA opportunities and school policies. A set of 5 essential and 6 desirable criteria were developed on this basis, against which a list of 17 candidate evidence-based interventions were rated. From these, the Australian programme SCORES was selected as a platform for its Mexican revised version named "*Lideres en movimiento"*, with 2 additional behaviour change strategies and 6 additional environmental changes.

The needs assessment was used to explore the PA behaviour of the Mexican adolescents and its determinants based on empirical and secondary data. It was also possible to identify several shared PA determinants with children and adolescents from different contexts and countries, for example, PA enjoyment. However, there were also unique conditions dramatically influencing PA participation among Mexican adolescents, such as neighbourhood safety concerns, which were not the same as the experiences of Australian children. This finding is in line with previous intervention adaptation, such as in the Safer choices II programme (Tortolero et al., 2005). In this sexual education programme, the Objectives and POs were subject to several modifications, given that in the original version the population showed fewer risks (e.g. fewer students sexually active, more using condoms, fewer sexual partners) than their counterparts. Overall, IM facilitates the definition of the intervention Outcomes and Objectives, which later were used as a guide to rate the candidate interventions and find the most suitable one within the population needs. The matrix of change provided all the information necessary to identify the gaps between SCORES and "*Lideres en Movimeinto"* and add possible strategies for the Change Objectives as needed.

Collectively, the needs assessment and every step of IM and IM to adapt an intervention were useful in revealing the differences among the PA contexts in deprived areas of a high-income country like Australia and urban adolescents in a middle-income country like Mexico. This finding contributes to the state of the art of intervention development, highlighting the important contribution of formative research.

5.4.1 Study limitations

The present study has several limitations that need to be considered. The primary data used for the need assessment were obtained from a small sample, using a cross-sectional design, limiting the generalisation of results. Most of the secondary data regarding PA in Mexico was generated from studies in which the children's and adolescents' PA was self-reported, which is usually subject to overestimation (Grasten & Watt, 2016). Although interventions based on the best practices were considered, only interventions from a single meta-analysis were included in the revision and also those interventions reported in other languages than English and using other research designs beyond randomized controlled trials given the limitation of these type of design (e.g. inadequate compliance, cost) and the likelihood of missing other non-controllable factors. The present study did not include any consultations with stakeholders, therefore the criteria for interventions selection does not include their input, which may dramatically change the results.

5.5 Conclusion

Considering the low levels of physical activity and the high prevalence of obesity and overweight among Mexican adolescents, it is important to develop effective interventions suitable to the context and resources in Mexican schools. Intervention Mapping proved to be a useful tool for understanding the needs of a group of adolescents, identifying a successful physical activity school-based intervention, and systematically tailoring it to the context of Mexico. The revised intervention may prove effective in Mexico and settings in similar socio-contextual conditions.

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Chapter 6 General Discussion

6.1 Overview

This thesis presented three empirical studies with the intention to increase the understanding of some of the determinants of obesity among a sample of Mexican adolescents and gain information to inform the development of a school-based intervention. The purpose of this chapter is to integrate the key findings of the empirical chapters, knowledge contribution, limitations, and propose further research directions.

6.2 Summary of findings

The first aim of this thesis is to explore some of the lifestyle determinants of obesity among Mexican adolescents. In Chapter 2, data did not support the hypothesised independent associations between four lifestyle behaviours (self-reported diet, screen time, objectively measured MVPA and sleep) and obesity and overweight in a sample of 320 adolescents attending secondary school in Mexico City. PA was selected as the focus of attention in the subsequent chapters, given that the independent health outcomes associated with this behaviour and the limited data available in Mexico about it. Within the sample, 28.8% of the participants were classified with overweight and 17.54% with obesity. In addition, this chapter identified that participants' lifestyles were characterised by low levels of objectively measured MVPA (*M*=46.33 minutes per day) and sleep (*M*=8.1 hours per night), high levels of self-reported screen time (*M*=6.7 hours per day) and frequent intake of SSBs (juice *M*= 4.54 portions per week, soda M= 3.97), and energy-dense and sugar-dense food products (crisps *M*=3.00, sweets *M*= 3.72, fried food *M*=2.62). Only 0.9% had two or less hours of screen time a day, 9.7% accumulated 60 minutes of MVPA per day and 42.2% slept a minimum of 8 hours per night.

Chapter 3 studied the psychological mechanisms underpinning PA by testing a model framed on Self-Determination Theory. The model hypothesised a relationship between psychological need support from physical education teachers, peers and parents and psychological need satisfaction for PA, which in turn, was expected to positively predict autonomous motivation towards PA, and negatively predict controlled motivation towards PA; autonomous motivation towards PA was expected to positively predict

MVPA and negatively predict sedentary time, whereas controlled PA motivation was expected to negatively predict MVPA and positively predict sedentary time. As hypothesised, psychological need support from parents, PE teachers, and friends was associated with autonomous motivation towards PA. This association was mediated by need satisfaction. However, the data did not support the association between autonomous motivation, and MVPA and sedentary time.

Chapter 4 explored the concepts, perceived barriers and facilitators of PA and healthy eating in a subsample of 79 adolescents via 12 focus groups. Three themes were identified: understanding the health-behaviour link, the impact of a restricted life and social support. The themes highlighted several barriers and facilitators of healthy eating and PA perceived by the Mexican adolescents in the study. Overall, the expression *"It's a bit exasperating to be locked up*" captured the main finding of the study; that adolescents wanted to be active but this desire was not something they could easily act on, given the restrictions. The restrictions perceived were from their physical and social environment including, neighbourhood safety concerns (e.g. high crime perceptions, unsafe parks), school policies (e.g. not allowed to run at school), frequent PE cancelations, lack of time because of academic (e.g. homework) and household chores (e.g. cleaning the house, run errands), and poor support from parents (e.g. limited interest on PA). Unhealthy options to eat (e.g. mostly junk food available at school) was a common restriction to having a healthy diet among participants. Other personal factors affecting some of the adolescents' PA and eating were also identified, including the lack of interest in lifestyle change, and preferences for sedentary activities and for junk food.

The second aim of the thesis was to design a theoretical and evidence-informed PA intervention prototype using Intervention Mapping (IM) and grounded in SDT (presented in Chapter 5). IM resulted in a protocol, which was used to identify the needs of the community of interest and to systematically develop the intervention. The requirements and objectives for a tailored PA intervention were informed by findings from studies 1-3. Five main PA determinants were selected as important for the target population and relevant to the school setting, namely PA enjoyment, peer involvement, teachers' support for PA, PA opportunities and school policies. A list of 17 candidate interventions were evaluated against five essential and six desirable criteria developed according to the Mexican adolescents' needs. From these, the Australian programme SCORES (Cohen, Morgan, Plotnikoff, Callister, & Lubans, 2015) was selected as a

platform for the Mexican revised version called "*Lideres en movimiento"* ("Leaders Moving" in English). The comprehensive approach used in this study was essential, when considering the environmental restrictions identified in Chapter 4. The original intervention was modified (to account for Mexican adolescent needs) by including two additional behaviour change strategies and six additional environmental changes.

6.2.1 The importance of the environment in health behaviours

Collectively, results from Chapters 2-4 provide support for the ecological model of health behaviour, which assumes that health behaviours are shaped by factors at different levels of influence, from the individual level to policy level (McLeroy, Bibeau, Steckler, & Glanz, 1988). Results from this thesis suggest that environmental conditions exert a stronger effect on physical activity and weight than individual level factors or may mediate these associations (for the given sample). This conclusion is made on the basis that none of the lifestyle behaviours assessed were associated with BMI z-scores, and that high levels of autonomous motivation did not affect MVPA or sedentary time, which are surprising and seemingly contradictory results compared to much of the previous research conducted mostly in HIC (Emm-Collison, 2016; Janssen et al., 2005; Owen, Smith, Lubans, Ng, & Lonsdale, 2014). It seems that the physical and social environment in Mexico has a stronger impact on adolescents' health behaviours and weight status than individual level factors (such as motivation). More research is needed in LMIC to understand the degree of the influence of the social and physical environment in adolescents' behaviour in comparison with adolescents living in HIC.

The findings of this thesis resonate with the results of a study of the mediating effects in a PA school-based intervention for children living in low-income communities in Australia, the SCORES. This intervention resulted in a successful increase of >10 MVPA min/day per day after 12 months (Lubans et al., 2012) . The evaluation of the intervention analysed the mediators for behavioural change: psychological (enjoyment and perceived competence), social (social support from family, peers and teachers), and physical environment (facilities at home, equipment at home, and parental perceived access to PA opportunities in the local community). Of these, none of the psychological constructs contributed to the intervention effect whereas the physical environment mediated the effect of the intervention on MVPA. Only self-reported parental perceived access to PA opportunities in the local community mediated the effect of the intervention on MVPA (Cohen, Morgan, Plotnikoff, Hulteen, & Lubans, 2017). The results of this study among Australian children may not be directly generalisable to

Mexican adolescents; however, both groups share economic constraints, Therefore, whereas in children and adolescents living in more favoured contexts, factors at the individual level could play an essential role in the lifestyle of adolescents from less favoured contexts (e.g. MVPA levels (Emm-Collison, 2016; Owen, Astell-Burt, & Lonsdale, 2013)). Much of the existing evidence suggests that socio-economic status does not directly influence PA intervention results. However, this is mostly based on studies conducted in European countries (De Bourdeaudhuij et al., 2011). Future work should explore whether this might not be the case for children and adolescents living in LMIC.

The potential influence of the environment on health behaviour can be seen in the case of sedentary behaviour. Screen time has been shown to vary among adolescents living in countries with different levels of income. For example, in Nepal (a LMIC), 78.1% of children and adolescents spend under 2 hours a day on screen time (Subedi et al., 2018), which might be explained by the low access to internet and smartphones in Nepal (Aubert et al., 2018). Similar percentage of screen time has been reported in Sweden (HIC) where 62% of adolescents (aged 11-15 years old) watch screens for under 2 hours a day (Delisle Nyström et al., 2018). The percentage changes for Colombia (LMIC), where only 39.6% of adolescents watch screens for under 2 hours a day (Arango et al., 2014). In this thesis, was found that 0.9% of participants watch screens for under 2 hours a day with an average of 6.73 hours per day. These contrasting percentages might suggest that beyond the access to electronic devices, some local and cultural conditions may influence adolescents' sedentary behaviour.

In line with the ecological model, this thesis' results suggest a complex interaction between behaviour and the environment in which Mexican adolescents' perceived barriers and the actual barriers might negatively affect their PA behaviour and ultimately their body composition. The environment is perhaps more important for influencing Mexican urban adolescents' behaviours than those living in different contexts (e.g. HIC, rural). For example, results from this thesis support previous research highlighting insufficient curricular and extracurricular opportunities for PA in Mexican schools (Gharib et al., 2015; Jauregui et al., 2011; Jennings-Aburto et al., 2009; Theodore, Arenas, Garcia, & Rivera, 2011). One of the main negative aspects within Mexican schools is the insufficient coverage of specialist PE teachers (around 30%) (INSP, 2018), resonating with adolescents' negative perceptions of their access to PE and overall experience with PA identified in this thesis. In addition, one of the few

school-based interventions conducted in Mexico, RESCATE, was effective at increasing self-reported MVPA (Colin-Ramirez et al., 2010). In agreement with the findings of this thesis, the RESCATE intervention targeted both individual and environmental factors (environmental changes and family involvement).

It may be the case that not only the environment is has an effect on adolescents' body weight, so other potential factors at individual level should be explored. Previous studies have focused attention on the association between chronic stress and obesity in adolescents (De Vriendt, Moreno, & De Henauw, 2009). Results in Chapter 4 highlighted several conditions perceived by the participants that might trigger stress, including serious safety concerns, academic demands, and household chores. In addition, participants consistently indicated that PA helps them to relieve stress, which implies they experience stress. Further studies should explore the potential association between stress and obesity in adolescents from LMIC.

6.3 Thesis contribution

6.3.1 Knowledge contribution

This thesis is a contribution to the state of the art of research on Mexican adolescents' health behaviour and obesity. Data from the 320 participants in Chapters 2 and 3 and the 79 participants in Chapter 4 showed that unhealthy physical activity- and dietary-related behaviours are highly prevalent among adolescents. Participants reported spending considerable amounts of time in front of a screen and were not physically active enough to reach the minimum levels of activity recommended for health; girls showed particularly low activity levels. Despite these findings, lifestyle behaviours were unrelated with BMI z-scores. There is evidence from other Mexican adolescents (Del Carmen Morales-Ruán, Hernández-Prado, Gómez-Acosta, Shamah-Levy, & Cuevas-Nasu, 2009) and adolescents worldwide (Riddoch et al., 2005) that physical activity and dietary behaviours are associated with obesity and poor physical (e.g. cardiometabolic risk) (Carson et al., 2016) and mental health (e.g. depressive symptomatology) (Hoare, Milton, Foster, & Allender, 2016). Therefore, both individual lifestyle behaviours and wider environmental factors need to be addressed in future efforts to improve adolescents' health.

Applying the SDT framework in this thesis has contributed to improved understanding of adolescents' PA behaviour. The findings suggest that adolescents require support

from their social circles for health behaviours; more specifically support for their psychological need for autonomy, competence and relatedness in order to feel autonomously motivated towards PA. Results also highlight the school environment as an important contributor to their motivation, given that teachers played a role in adolescents' perception of need support.

The Mexican adolescents' perceived barriers and facilitators of healthy eating and PA increase the understanding of these behaviours. It was identified that participants had a superficial but overall reasonable understanding of healthy and unhealthy behaviours. Participants could differentiate sedentary behaviours, junk and fried food as unhealthy, and body movement and fruit and vegetables intake as healthy. However, knowledge and autonomous motivation towards PA appear to be insufficient for healthy behaviours. The individual preferences (e.g. preference for eating junk food), restriction from the social (e.g. parents do not allow them to go out, teachers do not allow them to run at school) and physical environments (e.g. perceived crime, limited access to safe parks and areas to play) were potential relevant factors affecting participants' health behaviour. Research on the environmental determinants of health behaviours (e.g. PA) will be an important area for future study in Mexico or similar LMIC.

The finding that participants feel safe at school but not in their home neighbourhood was important for informing the intervention. Overall most literature has highlighted the importance of schools as venues for health interventions due to the curricular and extracurricular opportunities for PA and the existing infrastructure for practising health behaviours (Brown & Summerbell, 2009; Fung et al., 2012). This thesis has identified a further reason why schools are suitable sites for obesity prevention and health promotion interventions where public safety is a concern, in that students perceive them to be safe places where they can mix with friends and potentially have fun. This finding might not apply to children and adolescents living in places where safety concerns are not relevant. However, safety concerns could be worth considering when developing health promotion interventions among adolescents living in similar contexts to Mexico. The ISCOLE study has developed a set of indicators of the ways in which schools could contribute to active living, including opportunities for active transportation (Broyles et al., 2015). From this study, factors that influence traffic and safety included: traffic calming measures, road safety signs, school warning signs, and marked pedestrian crossings, among others. Given the broader perspectives of personal safety highlighted

within this thesis, an additional category relating to fear of crime could be appropriate to add if the measures are truly internationally applicable.

6.3.2 Methodological contributions

This thesis provides a contribution to research about the application of methods to measure health behaviours. Standardised methods used in the ISCOLE project (Katzmarzyk et al., 2013) were effectively applied in Chapter 2. The advantage of using the ISCOLE protocol is that it has been validated in HIC and LMIC, including Colombia, which is a country that shares several contextual and cultural conditions with Mexico. The scales used in ISCOLE have been subject to small (e.g. language) adaptations and used among Mexican populations for the current thesis research, available in Appendix 9. These scales can be validated in further work and would be an important asset to the research community.

This thesis adds to the literature on monitoring PA using accelerometers (as well as limitations related to this method). Despite accelerometers being a gold standard for PA monitoring, they are subject to several limitations, which also need to be considered when interpreting the results presented in Chapters 2 and 3. Firstly, accelerometers are unable to record some common activities (e.g. swimming, bicycling) (Adams et al., 2005; Pedišić & Bauman, 2015). Secondly, although there are advantages of using a 24-hour period protocol of accelerometer wear-time (e.g. increasing compliance) (Tudor-Locke et al., 2015), social desirability can influence participants' routines when wearing the device (Pedišić & Bauman, 2015). Thirdly, the use of cut-off points to define PA intensity has several disadvantages, such as the calibration studies to define the cut-off points are mostly cross-sectional; other limitation is that the calibration has conducted with some activities in previous studies but these not capture the complexity of PA behaviour (Butte, Ekelund, & Westerterp, 2012; Pedišić & Bauman, 2015). A methodological contribution of this study is that it highlights the above mentioned limitations of using accelerometery to measure PA. Important differences in MVPA levels were identified according to the cut-off points used: MVPA=46.33 min/day with Evenson's cut-off points criteria (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008) and MVPA=19.08 min/day with Treuth's cut-off points (Treuth et al., 2004). Further research could be directed to more closely examine the thresholds for PA intensities and using other options instead of cut-off points to estimate PA intensity, such as pattern recognition (Pedišić & Bauman, 2015).

Translation, piloting and testing questionnaires was another contribution of this thesis. Given the lack of available scales validated in Spanish to measure psychological need support towards PA, the APNSEQ questionnaire (Emm-Collison, Standage, & Gillison, 2016) was translated into the Spanish spoken in Mexico, back translated, piloted and used among the participants (Appendix 12). Moreover, most of the SES questionnaires available in Mexico are designed to be answered by parents and ask for economic income, which is commonly subject to high non-response (Galobardes, Shaw, Lawlor, Lynch, & Davey Smith, 2006). In addition, all questionnaires used in this thesis were designed to be answered by the students only. To overcome such limitations, another contribution of this thesis was the application of the Programme for International Student Assessment (PISA) questionnaire from the Organisation for Economic Co-Operation and Development (OECD). As Mexico is a member of the OECD, this assessment is periodically conducted among Mexican schoolchildren, providing validated scales according to the regional conditions (OECD, 2009). The scale provides a sensitive measure of SES that includes questions related to parental education and occupation, the availability of household items associated with wealth, culture and education, rather than a single question about income. The results of this thesis indicate that participants with higher socio-economic conditions accumulated lower levels of MVPA, which might be linked not only to economic income but also with education and occupation status. Exploring the influence of education on PA participation among parents and school children might be a further line of investigation to explore.

A relevant methodological contribution of this thesis is the application of the IM protocol to select and tailor a school-based intervention to the context of Mexico. This adds to the body of knowledge on intervention development and on the use of systematic methods for applying theory and empirical data to address a real-world problem. In line with previous interventions adaptations, such as Safer Choice II (Tortolero et al., 2005), IM resulted in a greater understanding of the population and context needed to tailor a successful intervention. The approach used in the development of the Waste the Waist intervention (Gillison et al., 2012) was useful for developing the selection criteria, enabling the systematic identification of a candidate intervention according to the Mexican adolescents' needs. The overall mixed methods design, and pragmatic approach of this thesis highlights the importance of both quantitative and qualitative research approaches for the development of a bespoke intervention according to the Mexican adolescents' needs. Considering the existing

literature suggests that school-based interventions have limited success in increasing MVPA in a 24-hour period (Love, Adams, & van Sluijs, 2019), the school-based intervention proposed in this thesis might be effective if tested, given its comprehensive approach and the use of a successful school-based intervention as a platform.

6.4. Limitations and further lines of research

The findings of this study must be seen in light of three primary limitations. First, the cross-sectional design of the empirical studies, which limit the generalisation of the results. Second, small sample size that limits the possibility of exploring school level associations. Third, the limited number of accelerometers available to monitor PA and sleep; as a result, data from 147 participants out of 320 were not used for the analysis in Chapters 2 and 3. The use of longitudinal designs, larger samples and allocation of accelerometers to every participant could overcome these limitations in further studies. In addition, the availability and feasibility of using direct measures of body fat in further studies will provide a more precise estimation of obesity/overweight than BMI.

Despite the best effort to use a validated protocol for measuring health behaviours, the previous study methods have inherent limitations. Most of the studies focused on sedentary behaviour used screen time as a proxy measure (Biddle, Gorely, Marshall, Murdey, & Cameron, 2004), especially TV viewing (Tremblay, Colley, Saunders, Healy, & Owen, 2010), which can contribute to 70% of sedentary behaviour (Olds, Maher, Ridley, & Kittel, 2010) and has a high prevalence among adolescents (Hoare et al., 2016). However, smartphone, tablets and internet usage has increased among children, adolescents and young adults in the last decades, thus these methods need to also receive attention when monitoring sedentary behaviour (Carson et al., 2016; Hoare et al., 2016). In addition, time spent on non-screen sedentary behaviour (e.g. knitting and sewing, watching live sporting events, social talking (Olds et al., 2010), talking by phone, listening music or just sitting (Biddle, Petrolini, & Pearson, 2014)) is usually understudied and may have an important impact on adolescents' health.

In this thesis, sedentary behaviour was assessed in two main forms: using self- reported screen time as a proxy measure in Chapter 2, which did not include the measure of smart phones or tablets usage; and sedentary time using accelerometers in Chapter 3. Further research should consider a holistic measure of sedentary behaviour complementing self-reported data with objectively measured data and other forms of sedentary time including smart phones and tables usage. Objective measures of screen

time could be used. For example, the TV Allowance™ (Mindmaster Inc., Miami, FL), which can be attached to screens including TV, computer monitors, video game systems, DVD players and VCRs. This device has been used in previous studies showing important differences among parent estimations of their child's TV viewing and objectively measured TV viewing (Robinson, Winiewicz, Fuerch, Roemmich, & Epstein, 2006). Other forms of objective measures of sedentary behaviour include the use of Apps to measure smartphones usage. For example, using the App called "Moment", a study explored the association between smartphone usage and depression and anxiety among undergraduate university students (Rozgonjuk, Levine, Hall, & Elhai, 2018). It has been possible to objectively differentiate smartphone usage in terms of time and frequency usage, showing different effects on each of these two conditions when using this technology (Rozgonjuk et al., 2018).

The Food Frequency Questionnaire (FFQ) was used to measure diet included juice and other sugar sweetened beverages (SSBs), such as sodas; however juice was removed to calculate the diet score given its low validity (Mikkilä et al., 2015). Since most of Mexican adolescents (83.9%) consume SSBs regularly (INSP, 2016) more sensible instruments need to be used to assess SSBs intake in Mexico. In addition, tortillas are the basis of the Mexican cuisine and these were not included in the FFQ. A lack of validated scales in Spanish for measuring diet that include tortillas was identified. Further studies should consider the assessment of diet including such cultural issues.

In this thesis, self- reported perceived barriers for PA were interpreted using a qualitative approach; these findings highlighted the vivid experience of participants' safety concerns and the lack of perceived adequate facilities for PA at school. Using objective measures of PA environmental correlates might provide useful data towards the understanding of this behaviour among adolescents. In school settings, instruments such as the System for Observing Fitness Instruction Time (SOFIT) (McKenzie, Sallis, & Nader, 1992) have been widely used to study PE and PA during recess, classroom, and in sport settings (McKenzie & Smith, 2017). In the neighbourhood environment, spatial measures can be used to measure the natural environment, which is commonly associated with more PA (Keskinen, Rantakokko, Suomi, Rantanen, & Portegijs, 2018); GIS-based index and streets audit can also be used to measure street connectivity, neighbourhood destination access and dwelling density (Witten et al., 2012). Further studies should consider objective assessment of the built environment and examine their association with adolescents' PA.

This thesis developed a bespoke PA school-based intervention for urban Mexican adolescents using IM. However, the proposed intervention has not been tested. A stakeholder consultation should be conducted to consider the feasibility of this intervention in the school settings. A pilot study of *"Lideres en movimeinto"* will then be essential to assess whether adaptations are required before evaluating the intervention in a trial.

6.4 Conclusion

The purpose of this thesis was to explore some of the determinants of obesity among Mexican adolescents and use these in a needs assessment to design a theoretical and evidence-informed PA intervention prototype for Mexican schools. Collectively, results from this thesis suggest that the lifestyle and psychological variables measured were not independently predictive of high BMI z-scores and MVPA respectively within a sample of Mexican adolescent participants. Reducing urban Mexican adolescents' exposure to unhealthy food options and increasing their opportunities and access to safe areas for outdoor play might improve their eating and physical activity behaviours. By using a needs assessment drawing on the qualitative and quantitative evidence, the framework of Self-Determination Theory and the socio-ecological approach, this research was translated into a systematically tailored physical activity school-based intervention adapted to the context of Mexico City. This thesis extends the existing literature on the lifestyles of adolescents from middle-income countries, the psychological mechanisms driving their PA behaviour and their perceived barriers and facilitators to adopting a healthy lifestyle.

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APPENDICES

Table of contents

Appendix 1 Intervention mapping steps, tasks, and products

	Steps	Tasks	Products
1	Needs assessment (assessment of the health problem).	1. Establish working group 2. Conduct needs. assessment 3. Understand the context 4. Establish programme goals	Logic Model of the Problem: a graphic representation of the health problem and its causes.
2	State program outcomes and objectives. Definition of changes that the intervention will produce	1. Specify expected outcomes 2. Specify performance objectives 3. Select determinants for outcomes 4.Develop matrices of change objectives 5. Create model of change	Logic Model of Change: a graphic representation of who, what and how need to be changed to prevent or manage the health problem identified in the previous model. Performance Objectives (PO): a description of the behaviours that need to be performed for change. Change Objectives: changes in the determinants associated with the health problem that need change to reach the PO. Matrix of Change: the overlap between CO and PO
3	Programme plan	1.Create programme content 2.Select a theory and change techniques	

4	Produce the intervention	1.Structure and organization of programme 2.Materials plan 3. Materials pre-test	
5	Plan for implementation	1.Specify users definition 2. Outcomes and performance objectives for implementation 3. Implementation design	Matrices of change for implementation
6	Produce an evaluation plan.	1. Write evaluation questions of effect and process. 2. Specify evaluation design and plan	Evaluation questions

Note. Source Bartholomew et al. (2016)

Appendix 2 Ethics approval confirmation

RE: REACH EP 15/16 277

Emma Dowden

Tue 09/08/2016 14:09

To: Gabriela Argumedo Garcia <G.Argumedo.Garcia@bath.ac.uk>
Cc: Fiona Gillison <F.B.Gillison@bath.ac.uk>

Dear Gabriela,

Thank you for sending your updated REACH application paperwork and responding to the REACH Committee queries. I can confirm this was reviewed and approved by the Committee.

Please inform REACH about any substantial amendments made to the study if they have ethical implications.

Best Wishes,

Emma

UNIVERSITY OF BATH

Emma Dowden, Research Programme Coordinator

University of Bath
Department for Health
University of Bath, Bath BA2 7AY, United Kingdom |
Telephone: +44 (0)1225 383891|
Email: e.dowden @bath.ac.uk

Appendix 3 Head Teacher information sheet (version in English)

Lifestyle, Motivation and Health Project

Dear Mr. /Ms.,

We would like to invite your school to take part in a research study, conducted by my colleagues and me from the University of Bath, United Kingdom. Before you decide whether you would be happy for your students to take part, it is important for you to understand why the research is being conducted and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish.

We are carrying out a study to explore the factors that may affect the health and well-being of young living in Mexico City. For example, we are interested in what affects their motivation to do physical activity, and decide how to spend their free time. Our aim is to design new ways to help young people to live healthier lives, but to do this we first need to understand what their life are like. We think this is important as very little research has been carried out with children and young people in Mexico – most of what we know so far comes from other countries. This study will be one of the first to give us information about Mexican children.

What would a student have to do if they take part?

We will visit your school and ask your students to fill out a questionnaire on the on the computer in two parts, each will take about 15 minutes. We will ask them to wear a physical activity monitor for one week. This is a small electronic gadget (the size of a matchbox), that they wear on their belt day and night, which gives us accurate information on when they are active, relaxing, and asleep. We will also measure their height and weight. Some students will also be invited to come and talk to us afterwards in small discussion groups if they want to.

The name of the school as well as all of the answers and measures that students give us will remain confidential; no one other than the researcher who you will meet will see the

findings and the school name (only its ID number). We will need to record student's name so we can match the questionnaire answers with the activity gadgets, but these will be deleted once we have matched them up. All of the data will be stored in locked cabinets at the University of Bath and on the university's password-protected file server.

PhD student and contact	Fiona Gillison	Thomas Curran	Martyn Standage
Gabriela Argumedo	Senior lecturer	Lecturer	Professor
G.Argumedo.Garcia@bath.ac.uk	F.B.Gillison@bath.ac.uk	T.curran@bath.ac.uk	M.Standage@bath.ac.uk
Tel. 07543202464	Tel. 01225 38 4387	01225 38 3047	01225 38 3087

Appendix 4 Head Teacher "Loco Parentis" Declaration (version in English)

Lifestyle, Motivation and Health Project

On behalf of the students attending _____ School, I fully understand what is involved in this study. Any questions about the research have been answered to my satisfaction. I have been informed that the students are free to withdraw consent and discontinue participation at any time. It has been explained to me that the focus group data will be kept completely anonymous and all information will be treated with the strictest confidence.

Further, should I feel that the students' interests are otherwise being ignored, neglected, or denied, I should inform the Director of Postgraduate Studies of the University of Bath Dr. Emma Rich (e.rich@bath.ac.uk Tel: +44 (0) 1225 38 6638) who will undertake to investigate my complaint

Signed _____

Date _____/_____/_____/

PhD student and contact	Fiona Gillison	Thomas Curran	Martyn Standage
Gabriela Argumedo	Senior lecturer	Lecturer	Professor
G.Argumedo.Garcia@bath.ac.uk	F.B.Gillison@bath.ac.uk	T.curran@bath.ac.uk	M.Standage@bath.ac.uk
Tel. 07543202464	Tel. 01225 38 4387	01225 38 3047	01225 38 3087

Appendix 5 Parents-Passive consent form (version in English)

Lifestyle, Motivation and Health Project

Dear Parent,

The pupils at your son/daughter school have been invited to take part in a research study conducted by my colleagues and me from the University of Bath, United Kingdom. Before you decide whether you would be happy for your son/daughter to take part, it is important for you to understand why the research is being conducted and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish.

We are carrying out a study to explore the factors that may affect the health and well-being of young people like your son/daughter, living in Mexico City. For example, we are interested in what effects his/her motivation to do physical activity, and decide how to spend his/her free time. Our aim is to design new ways to help young people to live healthier lives but to do this we first need to understand what his/her life is like. We think this is important as very little research has been carried out with children and young people in Mexico – most of what we know so far comes from other countries. This study will be one of the first to give us information about Mexican children.

What would my son/daughter have to do if he/she take part?

If your son/daughter take part, we will visit her/his school and ask him/her to fill out a questionnaire on the computer in two parts, each will take about 15 minutes. We will ask him/her to wear a physical activity monitor for one week. This is a small electronic gadget (the size of a matchbox), that your son/daughter wear on her/his belt day and night, which gives us accurate information on when her/his is active, relaxing, and asleep. We will also measure her/his height and weight. Some students will also be invited to come and talk to us afterwards in small discussion groups if they want to.

All of the answers and measures that he/she give us will remain confidential; no one other than the researcher who you will meet will see her/his findings. We will need to record her/his name so we can match your questionnaire answers with the activity gadget, but these will be deleted once we have matched them up. All of the data will be stored in locked cabinets at the University of Bath and on the university's password-protected file server.

IMPORTANT

This research is entirely optional, and your son/daughter schooling will not be affected in any way if they, choose not to take part. Your child will have the option to withdraw at any time, before or during the research, without needing to provide a reason. If you are happy for your son/daughter to take part, then you need to take no further action. However, if you would prefer your child not to take part please complete and return the form attached.

PhD student and contact	Fiona Gillison	Thomas Curran	Martyn Standage
Gabriela Argumedo	Senior lecturer	Lecturer	Professor
G.Argumedo.Garcia@bath.ac.uk	F.B.Gillison@bath.ac.uk	T.curran@bath.ac.uk	M.Standage@bath.ac.uk
Tel. 07543202464	Tel. 01225 38 4387	01225 38 3047	01225 38 3087

REPLY SLIP

PLEASE RETURN TO <INSERT TEACHER NAME>

Please complete and return if you would prefer your child NOT to take part in this research.

(If you are happy for your child to take part you need not send this form back.)

I would prefer my son/daughter _____(name) not to take part in the research.

Please sign below:

Signature …….

Date …….

PhD student and contact	Fiona Gillison	Thomas Curran	Martyn Standage
Gabriela Argumedo	Senior lecturer	Lecturer	Professor
G.Argumedo.Garcia@bath.ac.uk	F.B.Gillison@bath.ac.uk	T.curran@bath.ac.uk	M.Standage@bath.ac.uk
Tel. 07543202464	Tel. 01225 38 4387	01225 38 3047	01225 38 3087

Appendix 6 Information sheet for students (version in English)

Lifestyle, Motivation and Health Project

Dear Student,

We would like to invite you to in a research study conducted by my colleagues and me from the University of Bath, United Kingdom. Before you decide whether you would be happy to take part, it is important for you to understand why the research is being conducted and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish.

We are carrying out a study to explore the factors that may affect the health and well-being of young people like you, living in Mexico City. For example, we are interested in what affects your motivation to do physical activity, and decide how to spend your free time. Our aim is to design new ways to help young people to live healthier lives, but to do this we first need to understand what your life is like. We think this is important as very little research has been carried out with children and young people in Mexico – most of what we know so far comes from other countries. This study will be one of the first to give us information about Mexican children.

What would I have to do if I take part?

If you choose to take part, we will visit your school and ask you to fill out a questionnaire on the on the computer in two parts, each will take about 15 minutes. We will ask you to wear a physical activity monitor for one week. This is a small electronic gadget (the size of a match box), that you wear on your belt day and night, which gives us accurate information on when you are active when you are relaxing, and when you are asleep. We will also measure your height and weight. Some students will also be invited to come and talk to us afterwards in small discussion groups if they want to.

All of the answers and measures that you give us will remain confidential; no one other than the researcher who you will meet will see your findings. We will need to record your

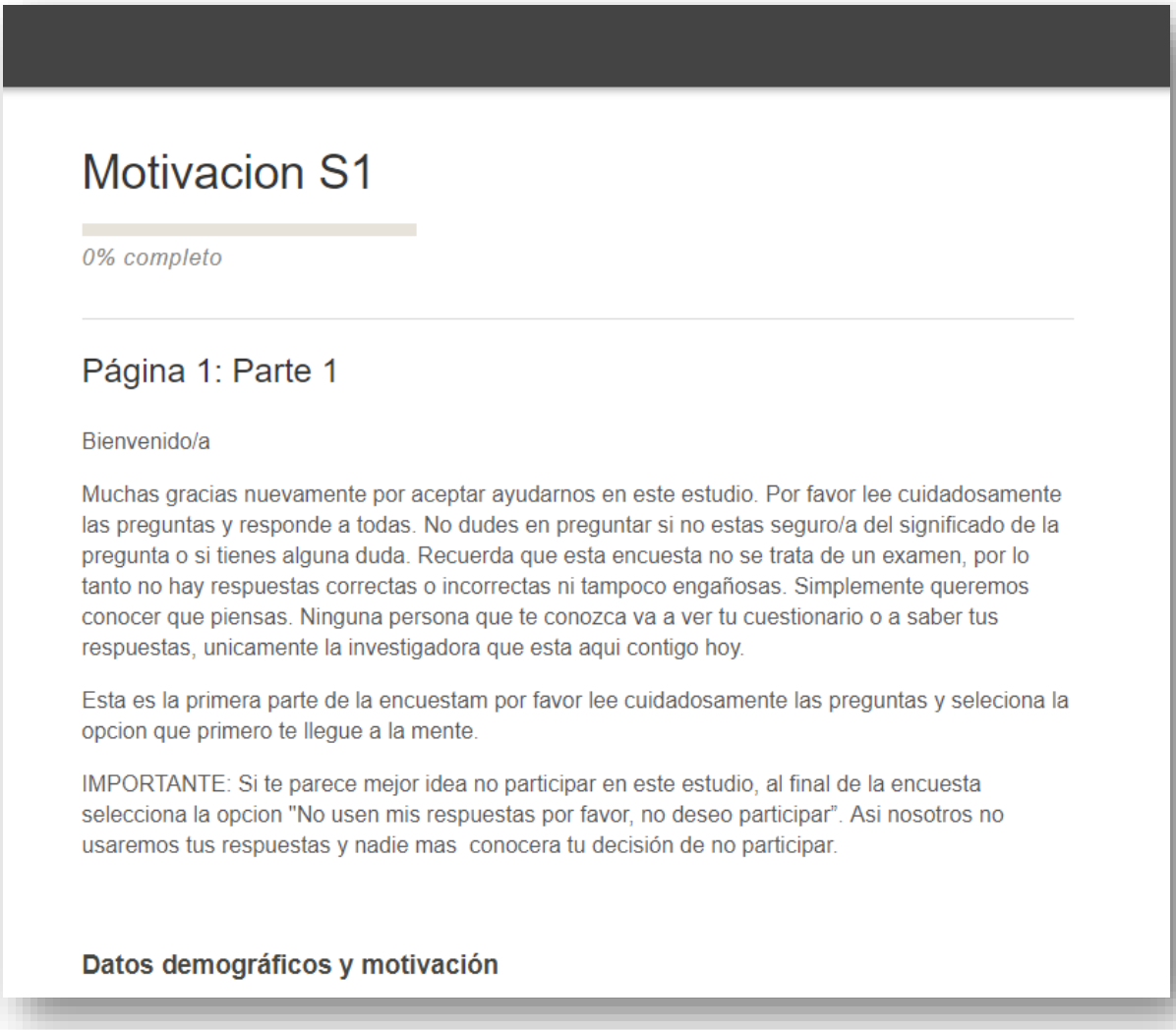
name so we can match your questionnaire answers with your activity gadget, but these will be deleted once we have matched them up. All of the data will be stored in locked cabinets at the University of Bath and on the university's password-protected file server. Please feel free to talk to your parents and teachers about whether or not you are happy to take part.

IMPORTANT

You do not have to take part in this study, and you will not be treated any differently at school according to whether or not you do so. If you do start doing the study, you can also withdraw at any time, before or during the research, without needing to provide a reason.

PhD student and contact	Fiona Gillison	Thomas Curran	Martyn Standage
Gabriela Argumedo	Senior lecturer	Lecturer	Professor
G.Argumedo.Garcia@bath.ac.uk	F.B.Gillison@bath.ac.uk	T.curran@bath.ac.uk	M.Standage@bath.ac.uk
Tel. 07543202464	Tel. 01225 38 4387	01225 38 3047	01225 38 3087

Appendix 7 Students asset Part 1 (version in Spanish)



Motivacion S1

0% completo

Página 1: Parte 1

Bienvenido/a

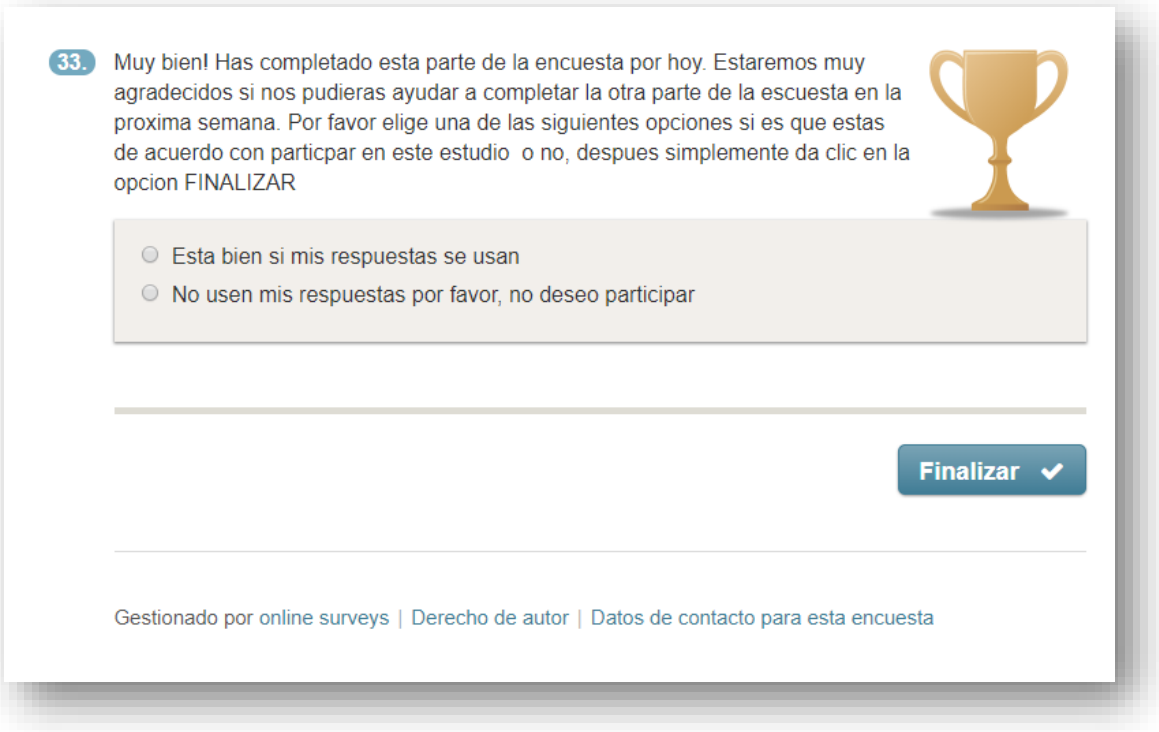
Muchas gracias nuevamente por aceptar ayudarnos en este estudio. Por favor lee cuidadosamente las preguntas y responde a todas. No dudes en preguntar si no estas seguro/a del significado de la pregunta o si tienes alguna duda. Recuerda que esta encuesta no se trata de un examen, por lo tanto no hay respuestas correctas o incorrectas ni tampoco engañosas. Simplemente queremos conocer que piensas. Ninguna persona que te conozca va a ver tu cuestionario o a saber tus respuestas, unicamente la investigadora que esta aqui contigo hoy.

Esta es la primera parte de la encuestam por favor lee cuidadosamente las preguntas y seleciona la opcion que primero te llegue a la mente.

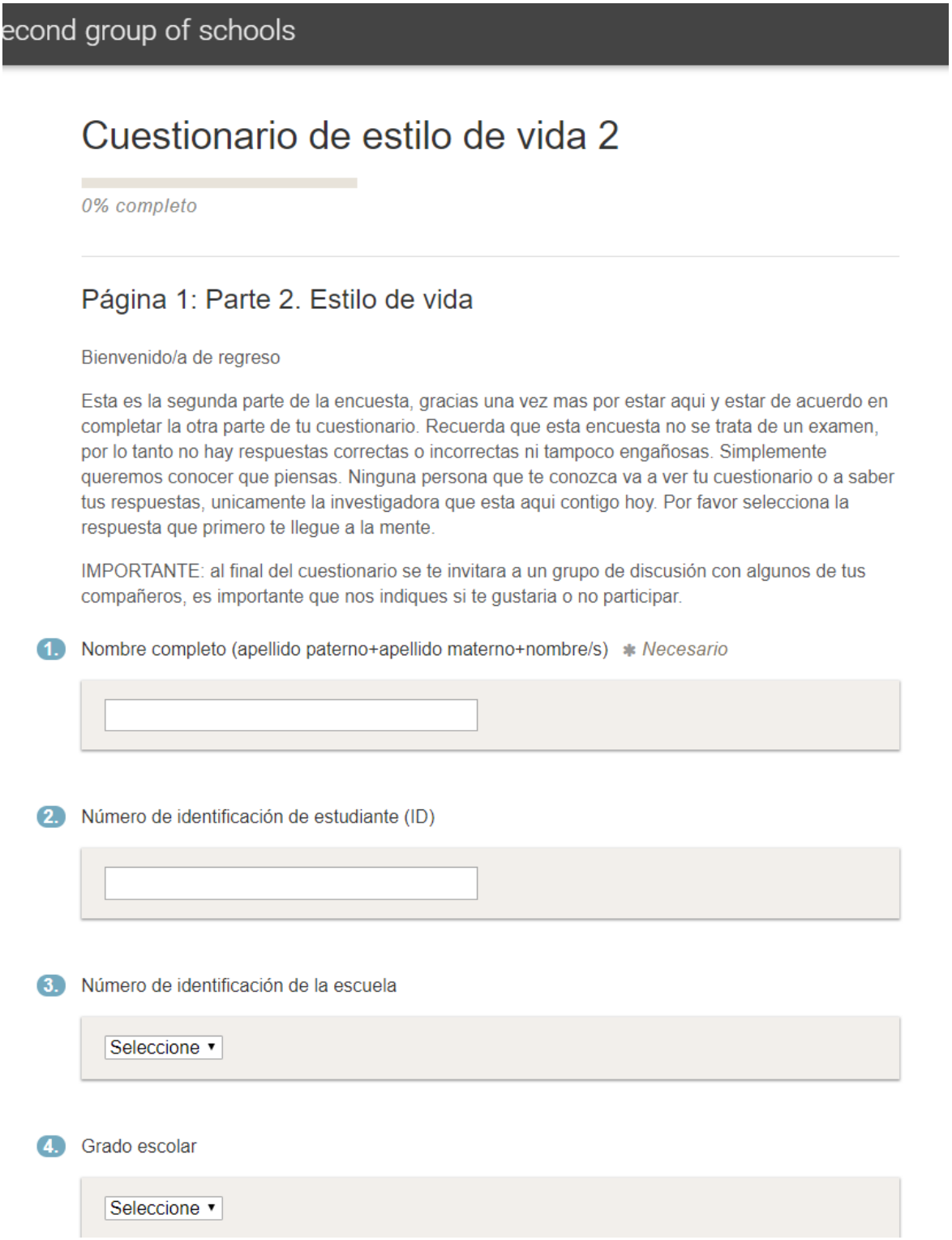
IMPORTANTE: Si te parece mejor idea no participar en este estudio, al final de la encuesta selecciona la opcion "No usen mis respuestas por favor, no deseo participar". Asi nosotros no usaremos tus respuestas y nadie mas conocera tu decisión de no participar.

Datos demográficos y motivación

Appendix 8 Students asset Part 2 (version in Spanish)



Appendix 9 Online survey view used in the Study 1 (in Spanish)



econd group of schools

Cuestionario de estilo de vida 2

0% completo

Página 1: Parte 2. Estilo de vida

Bienvenido/a de regreso

Esta es la segunda parte de la encuesta, gracias una vez mas por estar aqui y estar de acuerdo en completar la otra parte de tu cuestionario. Recuerda que esta encuesta no se trata de un examen, por lo tanto no hay respuestas correctas o incorrectas ni tampoco engañosas. Simplemente queremos conocer que piensas. Ninguna persona que te conozca va a ver tu cuestionario o a saber tus respuestas, unicamente la investigadora que esta aqui contigo hoy. Por favor selecciona la respuesta que primero te llegue a la mente.

IMPORTANTE: al final del cuestionario se te invitara a un grupo de discusión con algunos de tus compañeros, es importante que nos indiques si te gustaria o no participar.

1. Nombre completo (apellido paterno+apellido materno+nombre/s) ✱ *Necesario*

2. Número de identificación de estudiante (ID)

3. Número de identificación de la escuela

Seleccione ▾

4. Grado escolar

Seleccione ▾

4. Grado escolar

Seleccione

5. En un día escolar, ¿cuántas horas viste televisión?

Seleccione

6. En un día escolar, ¿cuántas horas jugaste con juegos de video o en la computadora, o usaste la computadora para cosas que no estén relacionadas con las tareas escolares?

Seleccione

7. En un día escolar, ¿cuánto tiempo estuviste al aire libre antes de entrar a la escuela?

Seleccione

8. En un día escolar, ¿cuánto tiempo estuviste al aire libre **después** de la escuela y antes de la hora de dormir?

Seleccione

9. En un día de fin de semana, ¿cuántas horas viste televisión?

Seleccione

10. En un día de fin de semana, ¿cuántas horas jugaste con juegos de video o en la computadora, o usaste la computadora para cosas que no estén relacionadas con las tareas escolares?

Seleccione

11. En un día de fin de semana, ¿cuánto tiempo estuviste al aire libre?

Seleccione

12. Durante la última semana que fuiste a la escuela, ¿cuántos días recibiste clases de educación física (EF)?

Seleccione

13. Durante la última semana que fuiste a la escuela, la mayoría de este recorrido lo hiciste

Seleccione

14. Durante la última semana que fuiste a la escuela, **¿CUÁNTO TIEMPO** te tardaste en el recorrido de tu casa a la escuela?

Seleccione

15. Durante el año pasado (12 meses), ¿realizaste alguna de las siguientes actividades? (Puedes marcar mas de una opcion si es el caso)

- ☐ Deportes en equipo
- ☐ Clases de danza o artes marciales
- ☐ Clases de arte o música
- ☐ Ninguna de las anteriores

16. Durante la semana pasada (7 días), ¿cuántos días fuiste físicamente activo por lo menos durante 60 minutos diarios? (Piensa en todo el tiempo que estuviste haciendo actividades que incrementaran los latidos de tu corazón y que te hicieran respirar fuerte). ✱ *Necesario*

Seleccione ▾

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

17. ¿Con qué frecuencia durante el último año fuiste activo físicamente (incluyendo juegos activos) en los siguientes lugares? ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 14 respuesta(s).

	Nunca	Una vez al mes o menos	Una vez cada dos semanas	Una vez a la semana	2 ó 3 veces por semana	4 veces por semana o más
Dentro de la casa	☐	☐	☐	☐	☐	☐
En su jardín o zona común o en el camino de entrada a la casa	☐	☐	☐	☐	☐	☐
En la casa, el jardín o en el camino de entrada a la casa de un vecino	☐	☐	☐	☐	☐	☐
En una calle, andén o lote baldío del barrio	☐	☐	☐	☐	☐	☐
Centro de recreación techado	☐	☐	☐	☐	☐	☐
Playa, laguna, río o quebrada	☐	☐	☐	☐	☐	☐
Camino para bicicletas, caminos para caminar y trotar	☐	☐	☐	☐	☐	☐
Cancha de basquetball	☐	☐	☐	☐	☐	☐
Otras canchas/campos de juego (como fútbol, softbol, tenis)	☐	☐	☐	☐	☐	☐
Parque público pequeño o	☐	☐	☐	☐	☐	☐

Otras canchas/campos de juego (como fútbol, softbol, tenis)	☐	☐	☐	☐	☐	☐
Parque público pequeño o parque infantil	☐	☐	☐	☐	☐	☐
Parque público grande	☐	☐	☐	☐	☐	☐
Espacio público al aire libre distinto de un parque	☐	☐	☐	☐	☐	☐
Áreas de la escuela (por fuera del horario escolar)	☐	☐	☐	☐	☐	☐
Áreas de la escuela (dentro del horario escolar)	☐	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

18. Por favor dime la opción que más se ajuste a tu respuesta ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 8 respuesta(s).

	Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
Puedo ser físicamente activo durante mi tiempo libre casi todos los días.	☐	☐	☐	☐	☐
Puedo pedirle a mis padres u otro adulto que hagan actividad física conmigo	☐	☐	☐	☐	☐
Puedo ser físicamente activo durante mi tiempo libre casi todos los días, incluso en lugar de ver TV o jugar con juegos de video.	☐	☐	☐	☐	☐
Puedo ser físicamente activo durante mi tiempo libre casi todos los días, incluso si	☐	☐	☐	☐	☐

Puedo pedirle a mis padres u otro adulto que hagan actividad física conmigo	☐	☐	☐	☐	☐
Puedo ser físicamente activo durante mi tiempo libre casi todos los días, incluso en lugar de ver TV o jugar con juegos de video.	☐	☐	☐	☐	☐
Puedo ser físicamente activo durante mi tiempo libre casi todos los días, incluso si hace mucho calor o frío afuera	☐	☐	☐	☐	☐
Puedo invitar a mi mejor amigo a ser físicamente activo conmigo durante mi tiempo libre casi todos los días	☐	☐	☐	☐	☐
Puedo ser físicamente activo durante mi tiempo libre casi todos los días, incluso cuando me tengo que quedar en casa.	☐	☐	☐	☐	☐
Poseo la coordinación que necesito para ser físicamente activo en mi tiempo libre casi todos los días	☐	☐	☐	☐	☐
Puedo ser físicamente activo durante mi tiempo libre casi todos los días sin importar qué tan ocupado esté mi día	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

19. Existen muchas razones por las que la gente hace actividad física. Por favor dime que tanto aplican las siguientes razones en tu caso. ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 5 respuesta(s).

	Nunca es cierto en mi caso	Algo cierto en mi caso	Algunas veces cierto en mi caso	Cierto en mi caso	Muy cierto en mi caso
Hago ejercicio porque otras personas me dicen que debería hacerlo.	☐	☐	☐	☐	☐
Para mí es importante hacer ejercicio con regularidad	☐	☐	☐	☐	☐
No veo porqué debo preocuparme por hacer ejercicio	☐	☐	☐	☐	☐
Me siento como un perdedor cuando no hago ejercicio en mucho tiempo	☐	☐	☐	☐	☐
Encuentro que el ejercicio es una actividad agradable	☐	☐	☐	☐	☐

20. Durante los días escolares de la semana pasada, ¿usualmente a qué hora apagaste las luces para irte a dormir?

Las horas deben estar en el formato "HH:MM", por ejemplo 15:43.

(hh:mm)

20. Durante los días escolares de la semana pasada, ¿usualmente a qué hora apagaste las luces para irte a dormir?

Las horas deben estar en el formato "HH:MM", por ejemplo 15:43.

(hh:mm)

21. Durante los días escolares de la semana pasada, ¿usualmente a qué hora te levantaste en la mañana?

Las horas deben estar en el formato "HH:MM", por ejemplo 15:43.

(hh:mm)

22. Durante los días del fin de semana pasado, ¿usualmente a qué hora apagaste las luces para irte a dormir?

Las horas deben estar en el formato "HH:MM", por ejemplo 15:43.

(hh:mm)

23. Durante los días del fin de semana pasado, ¿usualmente a qué hora te levantaste en la mañana?

Las horas deben estar en el formato "HH:MM", por ejemplo 15:43.

(hh:mm)

24. Durante la semana pasada, ¿a que hora llegaste a la escuela?

Las horas deben estar en el formato "HH:MM", por ejemplo 15:43.

(hh:mm)

25. Durante la semana pasada, ¿a que hora saliste de la escuela?

Las horas deben estar en el formato "HH:MM", por ejemplo 15:43.

(hh:mm)

26. Durante la semana pasada, ¿cómo calificarías la **calidad** de tu sueño en general? o ¿qué tan **bien** dormiste?

Seleccione

27. Durante la semana pasada, ¿cómo calificarías la **cantidad** de tiempo que dormiste en general?

Seleccione

28. ¿Tienes televisión en tu habitación?

Seleccione

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

29. ¿Usualmente cuántas veces a la semana comes ...? * *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 26 respuesta(s).

	Nunca	Menos de una vez a la semana	Una vez a la semana	2-4 días a la semana	5-6 días a la semana	Una vez al día, todos los días	Todos los días, más de una vez
Frutas	☐	☐	☐	☐	☐	☐	☐
Verduras	☐	☐	☐	☐	☐	☐	☐
Dulces (dulces/chocolate)	☐	☐	☐	☐	☐	☐	☐

(dulces/chocolate)	☐	☐	☐	☐	☐	☐	☐
Refresco regular o bebidas azucaradas	☐	☐	☐	☐	☐	☐	☐
Pan, bolillo o donas	☐	☐	☐	☐	☐	☐	☐
Refresco de dieta o bebidas azucaradas de dieta	☐	☐	☐	☐	☐	☐	☐
Papas fritas de paquete	☐	☐	☐	☐	☐	☐	☐
Papas a la francesa	☐	☐	☐	☐	☐	☐	☐
Verduras color verde oscuro (brócoli, espinaca, acelga, etc.)	☐	☐	☐	☐	☐	☐	☐
Verduras color naranja (zanahoria o jitomate)	☐	☐	☐	☐	☐	☐	☐
Jugos de frutas	☐	☐	☐	☐	☐	☐	☐
Leche baja en grasa (1%, 2%, descremada)	☐	☐	☐	☐	☐	☐	☐
Leche entera	☐	☐	☐	☐	☐	☐	☐
Queso	☐	☐	☐	☐	☐	☐	☐
Otros productos lácteos (yogur, leche con chocolate, flan, etc.)	☐	☐	☐	☐	☐	☐	☐
Pan de grano integral o cereal integral (avena, Musli, etc.)	☐	☐	☐	☐	☐	☐	☐
Sustitutos de la carne (granos, fríjoles,garbanzos, lenteias, tofu	☐	☐	☐	☐	☐	☐	☐

Sustitutos de la carne (granos, fríjoles,garbanzos, lentejas, tofu, huevos, mantequilla de maní, etc.)	☐	☐	☐	☐	☐	☐	☐
Bebidas energizantes (Red Bull)	☐	☐	☐	☐	☐	☐	☐
Bebidas deportivas (Gatorade, Powerade, etc.)	☐	☐	☐	☐	☐	☐	☐
Pescado	☐	☐	☐	☐	☐	☐	☐
Helado	☐	☐	☐	☐	☐	☐	☐
Fritos como alas de pollo, dedos de pollo , empanadas, etc.	☐	☐	☐	☐	☐	☐	☐
Comidas rápidas como pizza, hamburguesas, etc.	☐	☐	☐	☐	☐	☐	☐
Tortillas	☐	☐	☐	☐	☐	☐	☐
Agua simple	☐	☐	☐	☐	☐	☐	☐
Agua de frutas (por ejemplo agua de limón)	☐	☐	☐	☐	☐	☐	☐

30. ¿Usualmente cuántas veces a la semana consumiste los siguientes alimentos **mientras veías televisión**? (Marca una sola casilla por renglón) ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 6 respuesta(s).

	Nunca	Menos de una vez a la semana	Una vez a la semana	2-4 días a la semana	5-6 días a la semana	Una vez al día, todos los días	Todos los días, más de una vez
Papas fritas de paquete o cacahuate	☐	☐	☐	☐	☐	☐	☐
Fritos como alas de pollo, dedos de pollo, empanadas, papas a la francesa etc.	☐	☐	☐	☐	☐	☐	☐
Galletas, pan, chocolates, caramelos o dulces	☐	☐	☐	☐	☐	☐	☐
Helado	☐	☐	☐	☐	☐	☐	☐
Comidas rápidas como pizza, hamburguesas, etc.	☐	☐	☐	☐	☐	☐	☐
Frutas o verduras	☐	☐	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

31. ¿Usualmente cuántas veces a la semana consumiste las siguientes bebidas en tu escuela (Marca una sola casilla por renglón) ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 5 respuesta(s).

	Nunca	Menos de una vez a la semana	Una vez a la semana	2-4 días a la semana	5-6 días a la semana	Una vez al día, todos los días	Todos los días, más de una vez
Agua simple	☐	☐	☐	☐	☐	☐	☐
Jugo de bote	☐	☐	☐	☐	☐	☐	☐
Jugo natural	☐	☐	☐	☐	☐	☐	☐
Agua con fruta	☐	☐	☐	☐	☐	☐	☐
Refresco	☐	☐	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

32. ¿Usualmente cuántas veces a la semana consumiste las siguientes bebidas en tu casa (Marca una sola casilla por renglón) ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 5 respuesta(s).

	Nunca	Menos de una vez a la semana	Una vez a la semana	2-4 días a la semana	5-6 días a la semana	Una vez al día, todos los días	Todos los días, más de una vez
Agua simple	☐	☐	☐	☐	☐	☐	☐
Jugo de bote	☐	☐	☐	☐	☐	☐	☐
Jugo natural	☐	☐	☐	☐	☐	☐	☐
Agua con fruta	☐	☐	☐	☐	☐	☐	☐
Refresco	☐	☐	☐	☐	☐	☐	☐

33. Entre semana ¿Usualmente con qué frecuencia **desayunas**? (desayunar significa comer algo más que un vaso de leche o jugo de fruta)

Más información

Seleccione

34. En fin de semana ¿Usualmente con qué frecuencia **desayunas**? (desayunar significa comer algo más que un vaso de leche o jugo de fruta)

Más información

Seleccione

35. ¿En tu escuela se te otorga desayuno escolar?

Seleccione

36. En la última semana que estuviste en la escuela, ¿más o menos **cuántas veces** a la semana desayunaste o comiste algo en la escuela?

Seleccione

37. Durante la semana pasada, ¿cuántas comidas consumiste (desayuno, almuerzo o comida) que hubiesen sido **preparadas fuera de tu casa** en lugares como restaurantes, locales de comida rápida, puestos de comida, tiendas de comestibles o máquinas expendedoras? (por favor no incluyas comidas ofrecidas como parte del desayuno o almuerzo en tu escuela)

Introduzca un número entero (sin decimal).

Por favor asegúrese de que el número esté entre el 0 y el 20.

La respuesta no debe superar los 2 caracteres.

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

38. ¿Qué tan bien te describen las siguientes afirmaciones? ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 7 respuesta(s).

	Nunca o casi nunca	A veces	Usualmente o siempre
Como más cuando estoy preocupado	☐	☐	☐
Como cuando estoy enojado/a	☐	☐	☐
Cuando hago algo bien, me premio comiendo algo que me gusta	☐	☐	☐
Como más cuando me siento triste	☐	☐	☐
Como más cuando me siento feliz	☐	☐	☐
Como más cuando estoy aburrido	☐	☐	☐
Como entre comidas, incluso cuando no tengo hambre	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

39. Coloca una marca en la casilla que mejor describe cómo te sentiste la semana pasada. Con cada pregunta lee todas las opciones de respuesta ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 10 respuesta(s).

	No, en lo absoluto	Un poco	Moderadamente	Bastante	Extremadamente
¿Te sentiste en forma y bien?	☐	☐	☐	☐	☐
¿Te sentiste lleno de energía?	☐	☐	☐	☐	☐
¿Te sentiste triste?	☐	☐	☐	☐	☐
¿Te sentiste solo?	☐	☐	☐	☐	☐

¿Te sentiste triste?	☐	☐	☐	☐	☐
¿Te sentiste solo?	☐	☐	☐	☐	☐
¿Tuviste el tiempo suficiente para ti mismo?	☐	☐	☐	☐	☐
¿Pudiste hacer las cosas que quieres hacer en tu tiempo libre?	☐	☐	☐	☐	☐
¿Te trataron justamente tus padres?	☐	☐	☐	☐	☐
¿Te divertiste con tus amigos?	☐	☐	☐	☐	☐
¿Te fue bien en la escuela?	☐	☐	☐	☐	☐
¿Has podido poner atención?	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

40. En general, ¿cómo describirías tu estado de salud?

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 1 respuesta(s).

	Excelente	Muy bueno	Bueno	Regular	Malo
En general, ¿cómo describirías tu estado de salud?	☐	☐	☐	☐	☐

41. Felicidades! Has completado la encuesta y el grupo de investigación valora mucho tu tiempo y colaboración en esta

Appendix 10 Demographic differences of cases with self-reported data between those included and excluded from the analysis

Continuous Variables	M(SD)	Included	Excluded	t	p
BMI z-score (min/day)	.72(1.25)	.82 (1.25)	.64 (1.24)	1.27	.20
Healthy diet score	.00(.99)	-.00 (.95)	.00 (.98)	-.09	.92
Unhealthy diet score	.00(1.00)	-.10 (.93)	.07(1.04)	-1.53	.12
Screen time (hours/day)	7.12(2.29)	6.7(2.24)	7.4(2.30)	-2.57	.01
Socio-economic status	.00(1.00)	-.04(.98)	.03 (1.01)	-.74	.45

Note. BMI=Body Mass Index.

Appendix 11 Factor loadings per food group/item in the two strongest patterns

Food item	Component	
	Unhealthy diet	Healthy diet
Ice cream	.77	.24
Crisps	.77	.00
Fried food	.77	.21
French fries	.73	.26
Fast food	.72	.16
Sweets	.66	.00
Soda	.65	-.07
Bread	.59	.14
Sport drinks	.55	.35
Diet Coke	.53	.30
Other Milk Products	.51	.45
Energy drinks	.49	.31
Whole Milk	.38	.31
Green Vegetables	.08	.83
Vegetables	-.11	.81
Orange Vegetables	.10	.80
Fruit	.04	.69
Whole Grain products	.33	.64
Cheese	.43	.53
Meat Alternative Products	.38	.50
Fish	.48	.50
Skimmed Milk	.21	.45
Variance explained (%)	37.28	12.27

Appendix 12 Online survey used in Study 3

Motivacion S1

0% completo

Página 1: Parte 1

Bienvenido/a

Muchas gracias nuevamente por aceptar ayudarnos en este estudio. Por favor lee cuidadosamente las preguntas y responde a todas. No dudes en preguntar si no estas seguro/a del significado de la pregunta o si tienes alguna duda. Recuerda que esta encuesta no se trata de un examen, por lo tanto no hay respuestas correctas o incorrectas ni tampoco engañosas. Simplemente queremos conocer que piensas. Ninguna persona que te conozca va a ver tu cuestionario o a saber tus respuestas, unicamente la investigadora que esta aqui contigo hoy.

Esta es la primera parte de la encuestam por favor lee cuidadosamente las preguntas y seleciona la opcion que primero te llegue a la mente.

IMPORTANTE: Si te parece mejor idea no participar en este estudio, al final de la encuesta selecciona la opcion "No usen mis respuestas por favor, no deseo participar". Asi nosotros no usaremos tus respuestas y nadie mas conocera tu decisión de no participar.

Datos demográficos y motivación

1. Nombre (apellido paterno + apellido materno + nombre)

2. Número de identificación de estudiante (ID)

3. Número de identificación de la escuela * *Necesario*

4. Grado escolar

Seleccione

5. Fecha de nacimiento (usa el calendario para buscar tu fecha de nacimiento)

Las fechas deben estar en formato "DD/MM/AAAA", por ejemplo 27/03/1980.

(dd/mm/aaaa)

6. Género

Seleccione

7. Código postal (si no conoces tu codigo postal escribe 999)

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

8. ¿Quién vive generalmente contigo (en tu casa)? (Por favor selecciona una opcion en cada fila)

Más información

	Si	No
Mamá (incluyendo madrastra o madre adoptiva)	○	○
Papá (incluyendo padrastro o padre adoptivo)	○	○
Hermano(s) [medio(s) hermano(s) o adoptivo(s)]	○	○
Hermana(s) [media(s) hermana(s) o adoptiva(s)]	○	○
Abuelo(s)	○	○
Otros (por ejemplo primos)	○	○

9. ¿Cuál es el empleo principal de tu mamá? (Por ejemplo, maestra de escuela, ayudante de cocina,

10. ¿Qué hace tu mamá en su empleo principal? (Por ejemplo, da clases a estudiantes de secundaria, ayuda en la cocina de un restaurante, maneja personal de ventas) * *Necesario*

11. ¿Cuál es el máximo nivel de estudios al que llegó tu mamá? (Con certificado)

Seleccione

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

12. ¿Tiene tu mamá alguno de los siguientes certificados de estudios?

	Si	No
Doctorado	○	○
Licenciatura en educación normalista; licenciatura universitaria; licenciatura tecnológica; especialización, o maestría	○	○
Técnico superior	○	○

13. ¿A que se dedica actualmente tu mamá?

Seleccione

14. ¿Cuál es el empleo principal de tu papá? (Por ejemplo, maestro de escuela, ayudante de cocina, gerente de ventas)

15. ¿Qué hace tu papá en su empleo principal? (Por ejemplo, enseña a estudiantes de secundaria, ayuda en la cocina de un restaurante, maneja personal de ventas)

16. ¿Cuál es el máximo nivel de estudios al que llegó tu papá? (Con certificado)

Seleccione

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

17. ¿Tiene tu papá alguno de los siguientes certificados de estudios?

	Si	No
Doctorado	○	○
Licenciatura en educación normalista; licenciatura universitaria; licenciatura tecnológica; especialización, o maestría	○	○
Técnico superior	○	○

18. ¿A qué se dedica actualmente tu papá?

Seleccione

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

19. En qué país tu y tus padres nacieron *(Por favor selecciona una opcion en cada columna)*

Más información

	México	Estados Unidos	Otro país
Tu	○	○	○
Tu mamá	○	○	○
Tú papá	○	○	○

20. Si NO naciste en México ¿cuántos años tenias cuando llegaste a México? *Si eras menor de 12 meses por favor escribe cero (0). Si naciste en Mexico salta esta pregunta y pasa a la siguiente*

21. La mayor parte del tiempo, ¿qué idioma se habla en tu casa

21. La mayor parte del tiempo, ¿qué idioma se habla en tu casa

Seleccione

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

22. De la siguiente lista, indica lo que tienes en tu casa.

Más información

	Si	No
Un escritorio o mesa para estudiar	○	○
Una habitación sólo para ti	○	○
Un lugar tranquilo para estudiar	○	○
Una computadora que puedas usar para tus tareas escolares	○	○
Programas educativos para la computadora	○	○
Una conexión a Internet	○	○
Libros de literatura clásica (p. ej., El Quijote de Cervantes)	○	○
Libros de poesía	○	○
Obras de arte (p. ej., pinturas)	○	○
Libros de consulta para tus tareas escolares	○	○
Libros de referencia técnica	○	○
Un diccionario	○	○
Una lavadora de platos	○	○
Un reproductor DVD	○	○
Servicio de televisión de paga (Sky, Cablevisión, etcétera)	○	○
Línea telefónica	○	○
Horno de microondas	○	○

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

23. ¿Cuántos de los siguientes hay en tu hogar? *(Por favor selecciona una opcion en cada columna)*

Más información

	Ninguno	Uno	Dos	Tres o mas
Telefonos celulares	○	○	○	○
Televisiones	○	○	○	○
Computadoras	○	○	○	○
Autos	○	○	○	○
Cuartos de baño con tina o regadera	○	○	○	○

24. ¿Cuántos libros hay en tu hogar? (no incluye revistas, periódicos o tus libros de texto)

Seleccione ▾

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

25. En las interacciones con mi **familia** en relación con el ejercicio ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 9 respuesta(s).

	Totalmente en desacuerdo	En desacuerdo	Un poco en desacuerdo	Ni de acuerdo ni en desacuerdo	Un poco de acuerdo	De acuerdo	Totalmente de acuerdo
Siento que comprenden por qué elijo hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Siento que me animan a hacer las actividades de ejercicio que quiero	☐	☐	☐	☐	☐	☐	☐

mejorar mis habilidades para hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Me ayudan a sentir que soy capaz de hacer actividades de ejercicio difíciles	☐	☐	☐	☐	☐	☐	☐
Siento que se preocupan por mí	☐	☐	☐	☐	☐	☐	☐
Me siento aceptado por ellos	☐	☐	☐	☐	☐	☐	☐
Me siento valorado por ellos	☐	☐	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

26. En las interacciones con **mis amigos** en relación con el ejercicio ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 9 respuesta(s).

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

27. En las interacciones con **mi profesor de educacion fisica** en relación con el ejercicio ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 9 respuesta(s).

Siento que me animan a hacer las actividades de ejercicio que quiero hacer	☐	☐	☐	☐	☐	☐	☐
Siento que me escuchan cuando hablo de cómo me gustaría participar en actividades de ejercicio	☐	☐	☐	☐	☐	☐	☐
Muestran confianza en mi habilidad para hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Me ayudan a mejorar mis habilidades para hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Me ayudan a sentir que soy capaz de hacer actividades de ejercicio difíciles	☐	☐	☐	☐	☐	☐	☐
Siento que se preocupan por mí	☐	☐	☐	☐	☐	☐	☐
Me siento aceptado por ellos	☐	☐	☐	☐	☐	☐	☐
Me siento valorado por ellos	☐	☐	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

28. Con otras personas que hago ejercicio me siento ✱ *Necesario*

	Totalmente en desacuerdo	En desacuerdo	Un poco en desacuerdo	Ni de acuerdo ni en desacuerdo	Un poco de acuerdo	De acuerdo	Totalmente de acuerdo
Apoyado/a	☐	☐	☐	☐	☐	☐	☐
Comprendido/a	☐	☐	☐	☐	☐	☐	☐
Escuchado/a	☐	☐	☐	☐	☐	☐	☐
Valorado/a	☐	☐	☐	☐	☐	☐	☐
Seguro/a	☐	☐	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

29. En mi deporte o al hacer ejercicio ✱ *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 10 respuesta(s).

	Totalmente en desacuerdo	En desacuerdo	Un poco en desacuerdo	Ni de acuerdo ni en desacuerdo	Un poco de acuerdo	De acuerdo	Totalmente de acuerdo
Me siento libre de expresar mis ideas y opiniones	☐	☐	☐	☐	☐	☐	☐
Me siento libre para hacer las cosas a mi manera	☐	☐	☐	☐	☐	☐	☐
Siento que en buena medida puedo ser yo mismo/a	☐	☐	☐	☐	☐	☐	☐
Tengo muy clara la decisión sobre cuáles son las actividades / habilidades que quiero practicar	☐	☐	☐	☐	☐	☐	☐
Tengo la oportunidad de participar en las							

son las actividades / habilidades que quiero practicar	☐	☐	☐	☐	☐	☐	☐
Tengo la oportunidad de participar en las decisiones sobre las estrategias que se deberían utilizar	☐	☐	☐	☐	☐	☐	☐
Yo puedo dar mi opinión	☐	☐	☐	☐	☐	☐	☐
Siento que mi opinión se tiene en cuenta a la hora de decidir cómo se debe llevar a cabo la práctica/entrenamiento	☐	☐	☐	☐	☐	☐	☐
Siento que soy la causa de mis acciones (como algo opuesto a los sentimientos de que fuerzas o presiones externas gobiernan mis acciones)	☐	☐	☐	☐	☐	☐	☐
Yo realmente me siento muy libre, sin condiciones (como algo opuesto a sentirme controlado o presionado) cuando hago deporte o ejercicio	☐	☐	☐	☐	☐	☐	☐
Siento que mis elecciones y acciones se basan en mis verdaderos intereses y valores	☐	☐	☐	☐	☐	☐	☐

30. Yo hago ejercicio... * *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 19 respuesta(s).

	Totalmente en desacuerdo	En desacuerdo	Un poco en desacuerdo	Ni de acuerdo ni en desacuerdo	Un poco de acuerdo	De acuerdo	Totalmente de acuerdo
Porque los demás me dicen que debo hacerlo	☐	☐	☐	☐	☐	☐	☐
Porque me siento culpable cuando no practico	☐	☐	☐	☐	☐	☐	☐
Porque valoro los beneficios que tiene el ejercicio físico	☐	☐	☐	☐	☐	☐	☐
Porque creo que el ejercicio es divertido	☐	☐	☐	☐	☐	☐	☐
No veo por qué tengo que hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Porque mis amigos/familia/pareja me dicen que debo hacerlo	☐	☐	☐	☐	☐	☐	☐
Porque no me siento bien conmigo mismo si falto a la sesión	☐	☐	☐	☐	☐	☐	☐
Porque para mí es importante hacer ejercicio regularmente	☐	☐	☐	☐	☐	☐	☐
No veo por qué debo molestarme en hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Porque disfruto con las sesiones prácticas	☐	☐	☐	☐	☐	☐	☐
Para complacer a otras personas	☐	☐	☐	☐	☐	☐	☐
No veo el sentido de hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Porque siento que he fallado cuando no he realizado un rato de ejercicio	☐	☐	☐	☐	☐	☐	☐
Porque pienso que es importante hacer el esfuerzo de ejercitarse regularmente	☐	☐	☐	☐	☐	☐	☐

importante hacer ejercicio regularmente	☐	☐	☐	☐	☐	☐	☐
No veo por qué debo molestarme en hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Porque disfruto con las sesiones prácticas	☐	☐	☐	☐	☐	☐	☐
Para complacer a otras personas	☐	☐	☐	☐	☐	☐	☐
No veo el sentido de hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Porque siento que he fallado cuando no he realizado un rato de ejercicio	☐	☐	☐	☐	☐	☐	☐
Porque pienso que es importante hacer el esfuerzo de ejercitarse regularmente	☐	☐	☐	☐	☐	☐	☐
Porque encuentro el ejercicio una actividad agradable	☐	☐	☐	☐	☐	☐	☐
Porque me siento bajo la presión de mis amigos/familia para realizar ejercicio	☐	☐	☐	☐	☐	☐	☐
Porque me pongo nervioso si no hago ejercicio regularmente	☐	☐	☐	☐	☐	☐	☐
Porque me resulta placentero y satisfactorio el hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Pienso que hacer ejercicio es una pérdida de tiempo	☐	☐	☐	☐	☐	☐	☐

¿Tiene problemas con el formato de esta pregunta? Ver en formato sin cuadrícula

31. ¿Generalmente qué tan bueno eres en el deporte o al hacer ejercicio? * *Necesario*

Por favor no elija más de 1 respuesta(s) en cada fila.

Por favor elija al menos 5 respuesta(s).

	Totalmente en desacuerdo	En desacuerdo	Un poco en desacuerdo	Ni de acuerdo ni en desacuerdo	Un poco de acuerdo	De acuerdo	Totalmente de acuerdo
Creo que soy bastante bueno/a en mi deporte o al hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Estoy satisfecho/a con lo que puedo hacer en mi deporte o al hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Soy bastante hábil en mi deporte o al hacer ejercicio	☐	☐	☐	☐	☐	☐	☐
Yo puedo dominar las habilidades deportivas después de haberlas practicado durante un tiempo	☐	☐	☐	☐	☐	☐	☐
No puedo hacerlo (actuar, ejecutar) muy bien en mi deporte o al hacer ejercicio	☐	☐	☐	☐	☐	☐	☐

Appendix 13 Instructions for scales' piloting (Spanish)

UNIVERSITY OF BATH

Proyecto de estilo de vida, motivacion y salud
University of Bath
Department for Health
Claverton Down, Bath BA2 7AY,
United Kingdom

Estimado encuestador:

Te reiteramos nuestro agradecimiento al acceder voluntariamente en colaborar con pilotear el cuestionario anexo. El objetivo de este trabajo es conocer si la versión en el Español (que se habla en México) del *Cuestionario de apoyo a las necesidades del adolescente a la hora de hacer ejercicio* (APNSEQ) es claro y fácil de entender para los adolescentes Mexicanos.

Para ello te pedimos tu colaboración para preguntarle alrededor de 12-14 niños entre 9 y 16 años que contesten el cuestionario de forma anónima. Es ideal si preguntas a niños y niñas que tengan clase de educación física en su escuela.

Lista de consideraciones al aplicar el cuestionario:

1. Revisar si al contestar los niños comprenden las preguntas sin que soliciten ayuda, tomar nota de las preguntas en las que piden ayuda y sobre que piden ayuda.

2. Para que contesten las preguntas, sugerir que piensen en voz alta y preguntarles que es lo que exactamente viene a su mente. Tomar nota sobre lo que mencionan. Por ejemplo: "no entendí esta pregunta", "cuál es la siguiente pregunta", "son muchas preguntas y que aburrido", "la opción para responder no está disponible", "por qué preguntan sobre esto, es una pregunta incomoda".

3. Revisar si ellos entienden todas las palabras incluidas en el cuestionario. Tomar nota de aquellas que no entiendan y es muy importante tomar nota si usan algún sinónimo para explicarla.

4. Cuando los niños estén contestando indagar los motivos de la respuesta elegida. Por ejemplo, esa opción fue su elección o no tuvieron otra opción mejor.

5. Revisar si no consideran claro como contestar las preguntas. Todos los encuestados entienden las preguntas igual.

6. Revisar si los participantes siguen correctamente las indicaciones.

7. Revisar aproximadamente cuanto tiempo tardan en contestar el cuestionario.

8. Observar en que preguntas muestran inseguridad al contestar e indagar si los motivos se deben a la encuesta (por ejemplo, la pregunta no es clara o no conocen a que se refiere).

9. Al final, preguntar si les fue fácil contestarla o hay algo que pudiera mejorar la calidad de la encuesta

Appendix 14 Results from the APNSEQ scale piloting process

Registro para piloteo de ANSEQ

#	Edad	Sexo	Comentarios
1	16	M	1.35 min en contestar, fue sencillo y claro (primer semestre de licenciatura FOD)
2	16	F	2.20 min. En contestar, fue sencillo y claro, (primer semestre de licenciatura FOD)
3	16	F	3.00 min. Se le hizo extenso el cuestionario, siente que son similares item 1 y 3, (primer semestre de licenciatura FOD)
4	17	M	2.05 minen contestar, contesto sin problema, todo claro, (segundo semestre de licenciatura FOD)
5	17	M	2.30 min en contestar, contesto sin problema, todo claro, (segundo semestre de licenciatura FOD)
6	10	F	3,14 min en contestar, contesto sin problema, todo claro, (quinto de primaria)
7	11	F	2,46 min en contestar, contesto sin problema, todo claro (sexto de primaria)
8	11	F	5 min en contestar, hubo duda en los tres últimos ítems, en los cuales no entendía la parte como 'ser aceptada' 'sentir que soy capaz' y 'me siento valorado' donde se le explico dela forma en que si siente que la quieren cuando practica ejercicio, si le dan reconocimiento a su labor deportiva y que la ayudan a sentir que puede realizar la actividad aunque sea un poco difícil. (sexto de primaria)
9	17	M	2.28 minutos en contestar, respondió sin problemas todo muy claro, (primer semestre de licenciatura FOD)
10	17	M	2.27 minutos en contestar, le pareció que el ítem 2 y el 5 son muy parecidos, , (primer semestre de licenciatura FOD)
11	17	F	3.01 minutos en contestar, respondio sin problemas todo muy claro, , (primer semestre de licenciatura FOD)
12	17	F	2.51 minutos en contestar respondio sin problemas todo muy claro, (primer semestre de licenciatura FOD)

Appendix 15 Focus groups topic guide

Stages	Considerations	Intended questions and activities
Scene- setting and ground rules **Time: 3 min.**	Thank for participation	Thank you for coming
	Outline of the research topic	I'm part of a group of scientist that are interested in support the health and well-being young people like you all. First, we need to understand what your lives are like.
	Ground rules	This will be a discussion. There are not right or wrong answers. We want to listen to your opinion. It is not necessary that all agree or disagree. Discussion will be recorded Please do not talk over each other Write your name on the label and add in your chest
Individual introductions **Time: 5 min**	Icebreaker activity	Please introduce yourself, given name is enough You can also tell your favourite hobby or the thing/activity that you enjoy the most and if you enjoy it with someone else or alone (e.g. "my name is Marco and I enjoy playing the guitar with my brother" or "My name is Sophie and I enjoy reading alone in my room")
The opening topic **(Time: 3 min to write and 10 min to discuss).**	Theme 1: Healthy lifestyle Tool: "The box" (Punch, 2002). Card 1.	Card 1. Think about your life last week. Then, write down in the card things that influence how healthy you are, you could include the food that you eat or the activities that you did during the whole day (inside or outside school) as well as how much do you sleep. Please do not include your name, put the card into the box and let's discuss them.

Discussion **(Time: 3 min to write and 10 min to discuss).**	Theme 2: Physical activity Tool: “The box” (Punch, 2002) Card 2.	Card 2. Think about the physical activity that you did last week. Then write down in the card the factors that encourage and discourage you in that moment. (e. g. the activity itself, the people with, time or place). . Please do not include your name, put the card into the box and let’s discuss them.
Ending the discussion **(Time: 10 min)**	Closing ideas Thank you Mention confidentiality	If we could say that we can change something in your school to help you to do exercise: -Tell me two changes that you suggest -Tell me what is the easiest and the most difficult situation to change and why?

Total time expected 30-60 min.

Appendix 16 Discrepancies with external critical friends

Similarities with critical friends

Similarity 1

Critical friend identified that students associate sleep, exercise and diet with a healthy lifestyle and those elements I also added into my code meaning of healthy life.

Similarity 2

Critical friend created a code named "school does no offer popper spaces to do exercise" which is very similar to my code "need more room to play at school". The quotations are quite similar, however I found in her quotations selection that some not only refer to space also school opportunities to exercise (e.g. breaks, need for more PE class, etc)

Similarity 3

Critical friend created a code named "being healthy is own decision" which is very similar to my codes "goal for exercise", "Intrinsic motivation" or "I like exercise"

Similarity 4

Critical friend created a code named "being healthy depends of the economic condition" and its focused on diet only. This code is very similar to mine named "Money to buy food".

Similarity 5

Critical friend created a code named "Being healthy is influence by others" which cover the same elements that my codes included in the cluster "Social and exercise".

Similarity 6

Critical friend created a code named "Being sit is unhealthy" which is very similar to my code "Being sit and don't do anything".

Similarity 7

Critical friend created a code named "Environment is not safe" which is very similar to my code "Outside is not safe"

Similarity 8

Critical friend created a code named "Exercising is healthy" which is very similar to my code "Enjoy what your like doing exercise" or " Exercise instead of be at home all the time" as part of the set "motives to exercise"

Similarity 9

Critical friend created a code named "Frequency of exercising contribute reaching a healthy lifestyle" which is very similar to my code "Exercise frequency is good"

Similarity 10

Critical friend created a code named "healthy diet habits are necessary to have a healthy life" which is very similar to my codes "Healthy diet means" and " Healthy Eating Plate"

Similarity 11

Critical friend created the code "Limitations to be active at school" which is very similar to my codes "School is demanding", "School make me feel tired that is why I don't exercise" or "Need longer breaks to eta, rest or play" part of the set "Barriers to exercise at school".

Similarity 12

Critical friend created the code "Meaning of healthy diet" which is very similar to my codes "Diet is part of healthy life" and " Healthy diet means".

Similarity 13

Critical friend created the code " Mental health involves getting a healthy lifestyle" which is very similar to my code "Complex concept of health"

Similarity 14

Critical friend created the code " Movement means exercise" which is very similar to my code "Movement is exercise"

Similarity 15

Critical friend created the code "Parents do not have time to foster exercise" which is very similar to my code "My family don't do exercise" and "Family don't support me to exercise". Perhaps I need to be more specific in my code and specify time because "support" could be quite ambiguous.

Similarity 16

Critical friend created the code "parents influence the children attitudes related to exercise and healthy habits", which is like my code "My family don't do exercise" and "Family don't support me to exercise". However, I didn't consider healthy habits, so I red again the quote and the one selected by the Critical friend doesn't refer anything related to habits or healthy habits. I find it more focused on exercise.

DISCREPANCES WITH CRITICAL FRIEND

Discrepancy 1

Critical friend 1 added a node that I haven't added named "Hobbies alone or with company".

I didn't add this node because I found it unnecessary for my research questions but for her was something that grabbed her attention.

Discrepancy 2

Critical friend created a node "unhealthy diet as a result of diseases" which is very similar to my code "Exercise to prevent obesity or illness". However, I only saw exercise and she saw diet. She found an very illustrative quote for this.

Discrepancy 3

Critical friend created a node "being healthy implies motivation" and she described the code as follows " Participants explained that personal and social motivation help to develop negative or

positive attitudes related to exercise. If they are criticised by others, they don't feel comfortable to continue doing or could generate the opposite feeling to be challenged to do it". I think this code summarize several codes that I've created and that are in the set of "motives for exercise".

Discrepancy 4

Critical friend created the node "being healthy is related to feelings" and she described the code as follows "They regard that exercise is related to carry out activities that people like and are involve with feelings. If people are happy doing PA that they like then they will continue doing, as a result being healthy". In my case I didn't use the term related with feelings, but I think she is right. Instead I use several codes such as " competition and exercise", "anxiety to eat" or "exercise against stress".

Discrepancy 5

Critical friend created the code "Breakfast is important for a healthy lifestyle" and she described it as follows " Without breakfast they describe don't be able to do more things at school". In my case I create the code "Skip breakfast" and I described as follows " Participants mentioned that they skip breakfast and the effect of this". In general, both codes labels sound different but the meant the same that they sometimes skip the breakfast and that carry on problems for example at school. More in depth it would be inferred that they understand the importance of breakfast every day.

Discrepancy 6

Critical friend created the code "Diet and exercise relationship" and she describes it as follows "Participants explain that diet and PA should be together to mean a real healthy lifestyle". I think this code put together several of the codes that I've created in to the set "healthy meaning", for example: "avoid junk food", "diet is part of healthy life", "energy balance" or "exercise frequency is good".

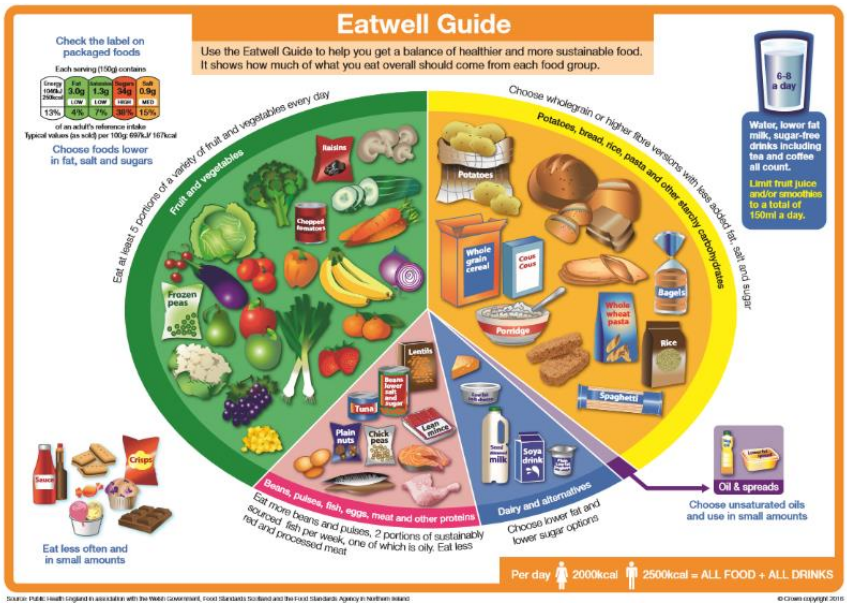
Discrepancy 7

Critical friend created the code "healthy life style is going to the doctor" and I haven't got any code similar. I think this point was far from my research questions and I just skip the point. The quote quite illustrates the point but it's not 100% the same. The text is as follows "Pues cuando vas al doctor, pues que tienes de malo en tu cuerpo y pues te puedes curar"

Discrepancy 8

Critical friend created the code "active and passive hobbies" I didn't create a similar code because this section of the focus group was only and Icebreaking activity. However, I think consider this part is a good point because It will be a way of realizing how the spend their spare time. In any case I'm not sure how this really help me to understand their reasons to be active or not.

Appendix 17 Eatwell plate from Mexico and England



Eatwell plate guide from England

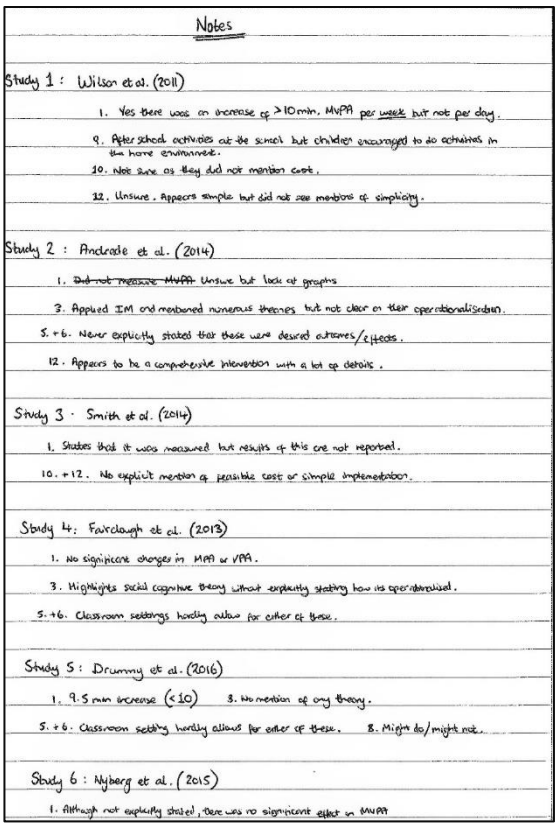
Eatwell plate guide from Mexico

Appendix 18 External coder evaluation of the candidate interventions according to meeting selection criteria.

Criteria		Candidate Interventions																
Essential		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	>10 min MVPA	✓	×	×	×	×	×	×	×	✓	×	×	×	✓	×	×	×	×
2	Operationalisation of theory	×	?	✓	?	×	✓	✓	?	✓	×	?	✓	✓	?	?	✓	?
3	PE teacher not essential	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	×	✓	✓	✓	✓	✓
4	Fun	✓	×	✓	×	×	×	×	✓	×	×	×	×	✓	✓	✓	✓	✓
5	Autonomous motivation	✓	?	✓	×	×	×	?	×	?	×	×	✓	✓	×	×	✓	✓
Desirable																		
6	Peers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	Social support	✓	✓	✓	✓	?	?	?	?	?	✓	?	✓	✓	✓	?	✓	✓
8	Only at school	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	Feasible cost	?	?	?	✓	✓	✓	✓	✓	✓	✓	✓	?	✓	?	?	?	✓
10	Feasibility with timetable	×	✓	×	✓	✓	×	×	×	×	✓	×	✓	✓	×	✓	✓	✓
11	Simple implementation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Inter-rater score		7	5	8	7	6	7	7	7	7	7	6	5	11	6	6	9	9

Note. ✓ = explicitly described and present, × = absent, ? = unclear or inadequately described.

Appendix 19 External coder notes from the evaluation of candidate interventions



Notes

Study 1 : Wilson et al. (2011)

1. Yes there was an increase of >10min. MVPA per week but not per day.
9. After school activities at the school but children encouraged to do activities in the home environment.
10. Not sure as they did not mention cost.
12. Unsure. Appears simple but did not see mentions of simplicity.

Study 2 : Andrade et al. (2014)

1. ~~Did not measure MVPA~~ Unsure but lack of graphs
3. Applied IM and mentioned numerous theories but not clear on their operationalisation.
5. + 6. Never explicitly stated that these were desired outcomes/effects.
12. Appears to be a comprehensive intervention with a lot of details.

Study 3 : Smith et al. (2014)

1. States that it was measured but results of this are not reported.
10. + 12. No explicit mention of possible cost or simple implementation.

Study 4: Fairclough et al. (2013)

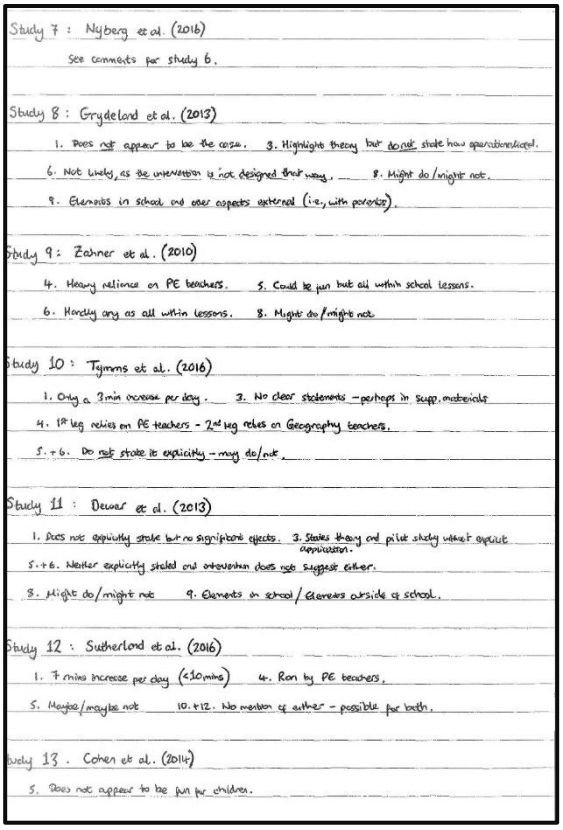
1. No significant changes in MPA or VPA.
3. Highlights social cognitive theory without explicitly stating how its operationalised.
5. + 6. Classroom settings hardly allow for either of these.

Study 5 : Drummy et al. (2016)

1. 9.5 min increase (<10) 3. No mention of any theory.
5. + 6. Classroom setting hardly allows for either of these. 8. Might do/might not.

Study 6 : Nyberg et al. (2015)

1. Although not explicitly stated, there was no significant effect on MVPA



Study 7 : Nyberg et al. (2016)

See comments for study 6.

Study 8 : Grydeland et al. (2013)

1. Does not appear to be the case. 3. Highlights theory but do not state how operationalised.
6. Not likely, as the intervention is not designed that way. 8. Might do/might not.
9. Elements in school and other aspects external (i.e., with parents).

Study 9 : Zahner et al. (2010)

4. Heavy reliance on PE teachers. 5. Could be fun but all within school lessons.
6. Hardly any as all within lessons. 8. Might do/might not

Study 10 : Timms et al. (2016)

1. Only a 7min increase per day. 3. No clear statements - perhaps in supp. materials
4. 1st leg relies on PE teachers - 2nd leg relies on Geography teachers.
5. + 6. Do not state it explicitly - may do/not.

Study 11 : Dewar et al. (2013)

1. Does not explicitly state but no significant effects. 3. States theory and pilot study without explicit application.
5. + 6. Neither explicitly stated and intervention does not suggest either.
8. Might do/might not 9. Elements in school/Elements outside of school.

Study 12 : Sutherland et al. (2016)

1. 7 mins increase per day (<10mins) 4. Ran by PE teachers.
5. Maybe/maybe not 10. + 12. No mention of either - possible for both.

Study 13 . Cohen et al. (2014)

5. Does not appear to be fun for children.

Study 15 : Resaland et al. (2016)

1. No significant increases 3. Mentions SDT approach in regards to teachers.

6. Determined by teachers 8. Might do/might not 10. Unclear/inadequately described

Study 16 : Jago et al. (2015)

1. No significant increases. 10. States that costs are comparable to similar interventions - still seems as though it is costly.

Study 17 : Verloigne et al. (2012)

1. Actually decreased MVPA 3. Inadequately described.

Appendix 20 Systematic solution of coders disagreements

Disagreements	Description	Solution
Criteria 2	Interpretation of operationalization of theory The first time the interventions were evaluated, Criteria 2 was subdivided into 2 criteria namely: use of model of change, enlisted behavioural change techniques. When the external coder evaluates the interventions, he uses the final single Criteria 2.	The rating was considered using the final version of Criteria 2
Criteria 3	Interpretation of the degree of participation of the PE teacher	Agree when PE teacher helps to run the intervention, but he is not essential for this.
Criteria 5	A disagreement on the application of SDT constructs, whether these are needs to the students or teachers.	Agreed to use SDT constructs alongside any part of the intervention
Criteria 10	Interpretation of feasible cost was difficult. It was suggested to reframe the criteria as "Cost clearly stated"	

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