CHILDHOOD OBESITY AND FAMILY INFLUENCE ON CHILDREN'S NUTRITION INTAKE, PHYSICAL ACTIVITY PATTERNS, AND BMI Z-SCORES IN OMAN

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ABSTRACT

Basma Al Yazeedi: Childhood Obesity and Family Influence on Children's Nutrition Intake, Physical Activity Patterns, and BMI z-scores in Oman
(Under the direction of Diane C. Berry)

Childhood Obesity is a public health problem. It poses a significant health risk, which has been demonstrated to track into adulthood and decreases children's physical and psychosocial well-being. The purpose of this study was to examine the relationship between weight status, nutrition intake, and physical activity patterns of Omani middle age children and explore the familial factors that influence them. The sample of the study consisted of 204 Omani mother-child dyads. The mean age of children was 7.74 years (SD ± 1.16). Among examined children, 17.4% were either overweight or obese, and more than 72% of mothers were found to be overweight or obese.

Weak associations between children's nutrition and physical activity pattern and obesity were found. Main familial factors that showed influence on children's nutrition intake were parental education level, family income, and family nutrition and physical activity patterns. Children's physical activity patterns as reflected by moderate to vigorous physical activity (MVPA), screen time, and sleep time were found to be influenced by maternal BMI, parental education level, and working status, as well as family nutrition and physical activity patterns. Interestingly, the results of the study indicated that child's BMI z-score were strongly associated with maternal BMI and parental education level, particularly the mothers'.

This dissertation work is dedicated to my parents, Mohammed and Laila, whose prayers for my success never stopped. They are my source of power for my achievements. This work is also dedicated to my beloved husband, Yahya, who has been a continued source of support. I am thankful for having him in my life. This work is also dedicated to my children, Elias and Azzam, who are a great blessing and source of joy in my life.

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LIST OF ABBREVIATIONS

AAP	American Academy Of Pediatrics
ADHD	Attention Deficit Hyperactivity Disorder
AND	Academy of Nutrition and Dietetics
ASA24	Automated Self-Administered 24-Hour
ATLS	Arab Teens Lifestyle Study
BAR	Behaviorally Anchored Rating
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BP	Blood Pressure
CDC	Center for Disease Control and Prevention
CLASS	Children's Leisure Activities Study Survey
FAO	Food and Agriculture Organization
FFS	Fish Feeding Study
FFQ	Food Frequency Questionnaire
FNDDS	Food and Nutrient Database for Dietary Surveys
FNPA	Family Nutrition and Physical Activity
FTOFat	Mass and The Obesity-Associated gene
G	Gram
GCC	Gulf Cooperation Council
GI	Glycemic Index
IOT	International Obesity Task Force
IRB	Institutional Review Board
IT	Information Technology

Kcal	Kilocalorie
MOE	Ministry Of Education
MOH	Ministry Of Health
MVPA	Moderate to Vigorous Physical Activities
NCI	National Cancer Institute
NHANES	National Health and Nutrition Examination Survey
NIH	National Institute of Health
OMR	Omani Rial
OPAL	Obesity Prevention and Lifestyle
OR	Odd Ratio
Oz	Ounce
RA	Research Assistants
RMR	Resting Metabolic Rate
SD	Standard Deviation
SE	Standard Error
SES	Socioeconomic Status
TV	Television
UAE	United Arab Emirates
US	United States
USDA	United States Department of Agriculture
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

Statement of the Problem

Childhood Obesity is a global public health concern. It poses a significant health risk, which has been demonstrated to track into adulthood (Kelsey, Zaepfel, Bjornstad, & Nadeau, 2014; Li et al., 2015; World Health Organization [WHO], 2014) and decreases children's physical and psychosocial well-being. Prediabetes, type 2 diabetes, asthma, cardiovascular disease, nonalcoholic fatty liver disease, obstructive sleep apnea, polycystic ovarian syndrome, orthopedic complications, increased rates of cancer, and dental issues have been identified as comorbidities in children with obesity (Kelsey et al., 2014; ÖNSÜZ & Demir, 2015; Park, Falconer, Viner, & Kinra, 2012; Pulgaron, 2013; Sahoo et al., 2015; WHO, 2014). Psychosocially, children with weight problems, are reported to struggle to make friends, suffer from somatic complaints, develop depressive symptoms, have a negative body image and low self-esteem, have sleep problems, and decreased academic performance (Harrist et al., 2016; Karnik & Kanekar, 2012; Pulgaron, 2013).

In addition to the impact of obesity on children's general health, the economic burden of obesity has also been reported in the literature (Lytle, 2012; Vellinga, O'Donovan, & De La Harpe, 2008). In Oman and other neighboring countries (e.g., Gulf Cooperation Council [GCC]), the burden of non-communicable diseases including obesity has increased from 1990-2010 according to the Global Burden of Disease Study 2010 (Lozano et al., 2013). Worldwide, overweight and obesity account for 0.7% to 2.8% of healthcare costs and individuals with obesity were found to have medical costs that were approximately 30% greater than their normal-weight peers (Withrow & Alter, 2011). An Australian study found that 10-years old children with normal weight accumulated fewer health care costs while children with obesity accumulated higher health care costs (Clifford et al., 2015). Increased health care cost differences between normal and overweight children were evident as early as 4-years old (Clifford et al., 2015).

Definition of Childhood Overweight and Obesity

The WHO describes overweight and obesity as abnormal or excessive adiposity accumulation that presents a risk to health (WHO, 2014). Body mass index (BMI), weight in kilograms divided by the square of height in meters, is the measure used to assess weight status (Krebs et al., 2007). In children, BMI values vary with age and gender. Therefore, they are usually converted into BMI percentiles or BMI z-scores, which represent a measure of weight, adjusted for height, gender, and age to ascertain whether the child is underweight, normal weight, overweight or obese (Flegal & Ogden, 2011). BMI percentiles refer to the percentage of observations that fall below the value of a variable (Wang & Chen, 2012), while BMI z-score denotes the number of standard deviation (SD) units above or below the mean (de Onis et al., 2007).

In the United States (U.S.), the Center for Disease Control and Prevention (CDC) 2000 growth charts are the chosen reference to define weight status in children (Krebs et al., 2007). According to the CDC growth 2000 reference for children and adolescents 2-to-19 years of age, normal weight is defined as a BMI percentile between the 5^{th} and just below the 85^{th} percentile, overweight is between the 85^{th} and just below the 95^{th} percentile, and obesity is at or above the 95^{th} percentile (Kuczmarski et al., 2000).

The WHO Growth Reference is an international growth reference (de Onis et al., 2007) and is typically used to estimate school children's growth status in Oman (Musaiger, 2011;

Ministry of Health [MOH], 2015). According to 2007 WHO growth charts for children and adolescents age 5-to-19 years, normal weight is identified as a z-score between -2 and 1, overweight is between greater than 1 and 2, and obesity is at greater than 2 (de Onis et al., 2007).

Prevalence of Childhood Obesity

The prevalence of overweight and obesity in children is increasing rapidly. From 1980 to 2013, the worldwide prevalence of childhood overweight and obesity increased by 47.1% (Ng et al., 2014). In Oman, the rate of childhood obesity is increasing as well (Al-Saeed, Al-Dawood, Bukhari, & Bahnassy, 2007; Osman, Muscati, Ganguly, Khan, & Al-Sharji, 2004). From 2012 to 2015, the rate of overweight and obesity in Oman increased from 3.5% to 4.8% among children in the first grade (i.e., 6 - 7 years), from 12.8% to 15.5% among children in the seventh grade (i.e., 12 - 13 years) and from 12.5% to 17.2% among children in the tenth grade (i.e., 15 - 16 years; MOH, 2012, 2015). The prevalence of obesity is increasing, which indicates an urgent need for intervention with children at a younger age before the problem escalates.

Targeting Middle Childhood for Obesity-Related Research

Middle childhood (i.e., 5 - 10 years) is an excellent age to deliver obesity-related programs. Huston and Ripke (2006) stated, "although the preschool years establish the base for future development, experiences in middle childhood can sustain, magnify, or reverse the advantages or disadvantages that children acquire in the preschool years" (p. 2). Several theories support intervention in this age group. The Eccles Expectancy-Value Model (Eccles et al., 1993) described the importance of parental support on children's accomplishments and motivation (Partridge, Brustad, Babkes Stellino, & Horn, 2008). Children's motivation and personal beliefs about their capability of actively participating with others arise during middle childhood (Eccles et al., 1993). Erikson (1982) as well hypothesized that middle childhood is a significant time to shape values and beliefs about proficiency and capabilities in different life domains. Also, parents have more influence over their children's environment during middle childhood than they do in the adolescent years (Huston & Ripke, 2006).

Middle childhood is characterized by physical, cognitive, social, and contextual changes (American Academy of Pediatrics [AAP], 2008). Physically, they start the initial stages of puberty (Huston & Ripke, 2006). Cognitively, they begin to develop reasoning and skills at self-reflection (Simpkins, Fredricks, Davis-Kean, & Eccles, 2006). Socially, they can establish relationships with peers and develop a sense of self-awareness, self-regulation, and self-confidence (Huston & Ripke, 2006). Also, they can understand and comply with rules and assume accountability for their tasks (AAP, 2008). Contextually, they start to broaden their experiences beyond home (AAP, 2008; Huston & Ripke, 2006). At this stage of life, children's behaviors and beliefs are highly influenced by their environment (Huston & Ripke, 2006).

Etiology of Childhood Obesity

Obesity was described by Brockmann, Arends, Heise, and Dogan (2017) as, "a complex trait, determined by many genes and influenced by environmental factors" (p. 481). The factors contributing to obesity indicate that they are not isolated and they influence each other. The literature has identified genetic, perinatal and postnatal, and environmental factors, which are described in more detail below.

Genetic Factors

Significant correlations between children BMI percentile and their parents BMI are frequently reported (Dev et al., 2013; Pachucki, Lovenheim, & Harding, 2014). Recent studies have described the relationship between genetics and childhood obesity (Classen & Thompson, 2016; Elks et al., 2012; Llewellyn, Trzaskowski, Plomin, & Wardle, 2013; Tang, Jin, Zhou, & Lu, 2016). One systematic review reported that the genetic contribution to BMI might have greater influence during childhood than adulthood (Elks et al., 2012).

The best explanation for genetic vulnerability to obesity can be made through fat mass and the obesity-associated (FTO) gene, as the risk of obesity was found to be associated with variations in this gene (Granot, 2015). A recent meta-analysis reported a confirmed association between increased risk of childhood obesity and one of the genotypes named rs17782313 (Tang et al., 2016). Another study found that mothers' FTO rs9939609 and LEPR rs1137101 gene polymorphisms had a direct impact on newborns birth weight and BMI percentile (Marginean et al., 2016).

Interactions between genetics and the environment have also been documented in recent research. A large-scale meta-analysis study reported a possible link between the FTO gene, adiposity, and protein intake, but surprisingly not with total energy or other macronutrient intake (Qi et al., 2014). This finding was supported by the del Mar Bibiloni et al. (2015) study that reported that children with overweight and obesity had higher energy intake from protein, which was positively associated with BMI, compared to non-overweight children. Moreover, the interaction between socioeconomic status (SES) and the FTO gene was documented in research (Foraita et al., 2015), which infers the influence of children's social environment on the FTO gene. An individual's genetic susceptibility to obesity, therefore, must be balanced with a healthy lifestyle and protective health behaviors.

Perinatal and Postnatal Factors

Interestingly, women's health during pregnancy influences their children's risk of developing obesity. For example, maternal obesity, excessive weight gain during pregnancy, and maternal smoking were reported as major contributors to obesity in their offspring (Granot, 2015; Portela, Vieira, Matos, de Oliveira, & Vieira, 2015; Trandafir & Temneanu, 2016; Ziyab, Karmaus, Kurukulaaratchy, Zhang, & Arshad, 2014). In addition, infant formula, cesarean section delivery, maternal intake of antibiotics during pregnancy, and introduction of antibiotics early in an infant's life were found to increase children's risk of developing obesity (Ajslev, Andersen, Gamborg, Sørensen, & Jess, 2011; Portela et al., 2015; Song, Dominguez-Bello, & Knight, 2013). The association of these factors with infant obesity can be explained partially by gut microbiota flora, which has been recently identified as a contributing factor to obesity. Researchers have found that the microbiota of lean individuals is much more diverse than that of those with obesity (DiBaise, Frank, & Mathur, 2012). Microbiota effects nutrient and energy homeostasis and consequently the control of body weight (Granot, 2015). Intake of antibiotics during pregnancy and cesarean section delivery may alter maternal and offspring exchange of microbiota, which may disturb the microbial colonization of the infant's gut (Lemas et al., 2016; Mueller et al., 2015). Similarly, infant formula and antibiotics administered during the first year of life may also alter the infants' gut microbiota flora, which may predispose them to obesity later in life (Ajslev et al., 2011; Azad, Bridgman, Becker, & Kozyrskyj, 2014; Mueller et al., 2015).

Environmental Factors

The imbalance between energy intake and energy expenditure is identified as the etiology of obesity (Harpaz, Tamir, Weinstein, & Weinstein, 2017; Razina, Runenko, & Achkasov, 2016). A complex physiological control system is involved in the mechanism by which the body achieves energy balance (Hill, Wyatt, & Peters, 2012). Humans take in energy in the form of proteins, carbohydrates, fats, and alcohol (Hill et al., 2012). Kilocalorie, calories for short, is the unit used to measure the amount of energy in food that is ingested (Nestle & Nesheim, 2012). The US Department of Agriculture (USDA) refers to the Wilbur Atwater values for calorie counts with one gram of protein and carbohydrate equal to four calories and one gram of fat equal to nine calories (USDA, 2010). According to 2015 - 2020 dietary guidelines for

Americans, children during middle childhood age (i.e., 5 - 10 years) require an estimated amount of 1,200 to 2,000 calories per day based on their age, gender, and activity level (USDA, 2015).

At middle childhood age, energy expenditure is represented by basal metabolic rate (BMR), metabolic response to food, and physical activity, in addition to negligible expenditure through growth (i.e., 1 - 2 percent) (Food and Agriculture Organization [FAO], 2001; Hill et al., 2012; Westerterp, 2013). The resting metabolic rate (RMR) is the amount of energy necessary to fuel the body at rest, and the thermic effect of food is the energy cost of absorbing and metabolizing food consumed (Hill et al., 2012). BMR accounts for a large part of daily energy expenditure with up to 70 percent, followed by the physical activity and lastly the metabolic response to food, which increases total energy expenditure by about 10 percent of the BMR (FAO, 2001). Among these processes, physical activity is more frequently measured in research to estimate energy expenditure. Activity energy expenditure for children ranges between 60 and 80 kJ/ kg (Westerterp, 2013). In children, physical activity may be assessed by a variety of methods including direct observation, questionnaires, physiological markers such as heart rate and motion sensors in addition to different devices such as pedometry and accelerometry (Aparicio-Ugarriza et al., 2015; Pate, O'Neill, & Mitchell, 2010; Westerterp, 2013).

When there is high-energy intake and low energy expenditure, a positive balance will result, and extra energy will be stored as adipose tissue (Cuthbertson et al., 2017). With the accumulation of adipose tissue in the body, body weight increases and when it exceeds certain standardized limits, it manifests as overweight or obesity. High-calorie intake may be accumulated through food that is concentrated with calories or an increase of food ingested (Anderson et al., 2016) or both. Research has indicated that children with obesity have a higher energy intake compared to their non-obese counterparts (Ha et al., 2016; Kuźbicka & Rachoń, 2013). In a study with participants with obesity between 5 - 17 years of age, two-thirds have experienced overeating (Anderson et al., 2016). Children sometimes consume high sugar and fat commercial food including candies, chips, and sugary drinks (Kuźbicka & Rachoń, 2013; Schneider, Jerusalem, Mente, & De Bock, 2013; Tate et al., 2015), which are nutrient deficient (Pan et al., 2014). Low energy expenditure through low levels of physical activity happens in children when they are not engaging in physical play or sports (Janssen, 2014). Innately, children enjoy physical play as it is part of their normal development (Herrington & Brussoni, 2015), however, over time children have decreased physical activity and increased sedentary activity (Kaushal & Rhodes, 2014).

These environmental factors are modifiable, particularly for children in their middle years. Therefore, the work of this dissertation study has focused on energy balance represented by energy intake through the caloric intake and energy expenditure through the level of physical activity.

Nutrition Intake and Physical Activity Pattern in Children in Oman

Studies focused on children with overweight and obesity in the Middle East region were congruent with the earlier discussion on the environmental contribution to obesity and reported that the intake of calorie dense food and decreased physical activity were two of the major causes of overweight and obesity in children (Badran & Laher, 2011; Mirmiran, Sherafat-Kazemzadeh, Jalali-Farahani, & Azizi, 2010; Musaiger, 2011). In Oman, few studies have examined nutrition intake and or physical activity level among children (Kilani, Al-Hazzaa, Waly, & Musaiger, 2013; Musaiger, 1994; Musaiger, 1996). However, none have included children in middle childhood.

In 1994, Musaiger examined BMI percentile and dietary patterns of Omani adolescent girls aged 11 to 18 years. The study demonstrated a greater rate of underweight (24%) compared to overweight and obesity (12%, Musaiger, 1994). Musaiger (1994) also found that children with overweight and obesity more frequently ate a western diet and adolescent girls with overweight more frequently skipped breakfast compared to adolescent girls who were underweight or normal weight. Two years later, Musaiger (1996) detailed the food habits of preschool children, adolescent girls, and mothers in two main regions in Oman. He documented a decrease in breastfeeding duration and early introduction of formula and commercial baby food compared to two decades earlier (Musaiger, 1996). Also, Musaiger (1996) indicated that participants' food consumption was trending toward a diet consisting of high fat, high cholesterol, high- refined sugar, and high sodium.

Kilani and colleagues (2013) examined the lifestyle habits of Omani adolescents aged 15 to 18 years. Study findings indicated unhealthy dietary habits, a high prevalence of total daily screen time (mean 2.9 hours per day for males and 3.7 hours per day for females), shorter duration of sleep (mean 6.7 hours per day), and low levels of physical activity especially among females (Kilani et al., 2013).

Nutrition intake and physical activity level findings in children from other GCC countries were similar. In a group of six to ten years old children from the United Arab Emirates, researchers found a high percentage of participants reported excessive caloric intake (38% of boys and 43% of girls) and low levels of physical activity, especially among females and those living in urban communities (Ng, Zaghloul, Ali, Harrison, & Popkin, 2011a). Another study conducted in Saudi Arabia carried out with primary school-age children (7 - 12 years) documented a high intake of carbohydrates and protein, a large percentage of regular breakfast consumption (72%), and an acceptable intake of canned juice (average 4 times per week) and fast food (average 1.6 times per month) (Farghaly, Ghazali, Al-Wabel, Sadek, & Abbag, 2007).

It is essential to keep in mind that children's lifestyle behaviors are guided and influenced by other environmental contexts they live within, including the home and community (Classen & Thompson, 2016; Granot, 2015; Karnik & Kanekar, 2012; Martin, Saunders, Shenkin, & Sproule, 2014). The home environment directly influences children's nutrition intake and physical activity levels through their interactions with their families (Clark, Goyder, Bissell, Blank, & Peters, 2007), while community and societal norms affect the family (Caprio et al., 2008), which in turn affect child behaviors. To better understand the nature of children's nutrition and physical activity patterns, it is important to explore the contributing factors within the home and community contexts.

Home

Home is the primary environmental context that impacts children's lifestyle behaviors especially during the middle childhood period of life. Unlike adolescence where youth begin to exhibit separation from their family and ask to go out with peers unaccompanied (Kumanov & Agarwal, 2016), children during middle childhood are still connected to their home and families. At the same time, they gradually start to make their choices about what to eat (AAP, 2008). Therefore, it is important to promote healthy lifestyle behaviors during middle childhood.

At home, parents create an environment for their children that either promote or do not promote the development of healthy nutrition and physical activity behaviors (Scaglioni, Salvioni, & Galimberti, 2008). Particularly during middle childhood, parents' beliefs and practices significantly promote or discourage children's participation in activities such as sports (Simpkins et al., 2006). The support provided to children by families during this period of life is crucial to refining the lifestyle pathway they adopt during their adolescence and adult life (Huston & Ripke, 2006). Decreased child physical fitness has been found to correlate positively with parental obesity in Oman (Hassan & Al-Kharusy, 2000), which infers parental obesogenic behaviors.

Parenting style regarding weight-related behaviors has been associated with children's nutrition and physical activity attitudes (Clark et al., 2007; Taylor, Wilson, Slater, & Mohr, 2011). Parental restrictive feeding for weight control (Dev et al., 2013), negative parent modeling regarding nutrition and physical activity behaviors, and using food as an incentive were found to significantly increase the risk for childhood obesity (Mazarello Paes, Ong, & Lakshman, 2015). Also, time limitations due to working status and the absence of nutritional awareness have been identified as factors involved in young children's obesogenic diets (Mazarello Paes et al., 2015).

A national study completed in Oman found that preschool children's mothers with high-ranking jobs had lower levels of nutrition knowledge as well as more unhealthy food-related attitudes compared to non-working mothers (Al-Shookri, Al-Shukaily, Hassan, Al-Sheraji, & Al-Tobi, 2011). Another study from Saudi Arabia found that the rate of obesity was higher among school children of mothers with higher levels of education compared to the school children of mothers with lower education levels (Al-Saeed et al., 2007). These findings indicate decreased awareness of obesity in the region that is not necessarily associated with parental job rank or educational level.

Community

Multiple community factors can affect the family dynamics, which consequently influence childhood nutrition and physical activity behaviors. Family dynamics are affected by the community context it lives within and the social norms practiced by the people in the community (Al-Qaoud, Al-Shami, & Prakash, 2010; Caprio et al., 2008). In general, the nutrition intake and physical activity patterns in Oman, as well as other GCC countries, is shifting from a traditional healthy lifestyle to a less healthy lifestyle (e.g., nutrition and physical activity), which has been attributed to urbanization, social, and health care system factors.

Urbanization. Oman like other countries in the GCC has experienced a marked shift in economic status secondary to the discovery of abundant oil reserves over 40 years ago (Abdul-Rasoul, 2012; Musaiger, 2004, 2011; Ng et al., 2011a), which resulted in improved health services and a major decline in communicable diseases, but an increase in lifestyle non-communicable diseases including obesity (Ganguly, Al Shafaee, Al Lawati, Dutta, & Duttagupta, 2009). An increase in individual income and openness to a western lifestyle and the global market with urbanization has resulted in moving away from traditional healthy nutrition and physical activity patterns (Abdul-Rasoul, 2012; Mena, Gorman, Dickin, Greene, & Tovar, 2015; Musaiger, 2004, 2011).

Since food has become more affordable in Oman and despite the fact that the size of families has decreased in Oman (average life birth per women dropped from 10 in 1980 to 4 in 2015) (Hill, Muyeed, & al-Lawati, 2000), the amount of food prepared for the family has increased (Musaiger, 2002). Until the 1970s, family's main sources of nutrition were farms which produced fruits, vegetables, whole-wheat grains, legumes, and raised cattle, poultry, and fish (ALNohair, 2014; Musaiger, 1991). With urbanization, a broad range of restaurants serving fast food and convenience food stores have become available mainly in the urban communities (Musaiger, 2011), where obesity rates are higher in countries similar to Oman (Al-Saeed et al., 2006). Fast food such as pizza, burgers, sandwiches, and French fries have increased in popularity in Oman (Kilani et al., 2013). An increased intake of fast food has started to replace some of the traditional food served to families (Musaiger, 1994, 2002). Pita pockets and commercial bread (Glycemic index [GI] ranged from 56.6 ± 20.4 to 62.8 ± 12.2) has for the most part become more popular than Rekhal, which is an Omani traditional thin whole wheat bread that has a lower GI (39.1 ± 7.5) (Ali, Al-Nassri, Al-Rasasi, Akhtar, & Al-Belushi, 2010). Food stores are mainly providing energy dense low nutrient food items including sugared drinks, juice with high fructose corn syrup, candy, and chips (Osman et al., 2004). Unfortunately, they are some of the most requested snacks for children in Oman, which substitute other healthy meals (Osman et al., 2004).

Before urbanization, processed food items were not readily available due to the limited exposure to global markets. The introduction of processed food ingredients into cooking such as processed flour, sugar, salt and saturated fat has increased after urbanization (Mirmiran et al., 2010; Musaiger, 2002), which has shifted traditional dishes into less healthy ones.

Also, to the increased disposable income that families now enjoy in Oman, women in increasing numbers are going to work (Al Riyami, Afifi, & Mabry, 2004; Mohamed et al., 2004). This had a direct impact on family food preparation since many families can now afford to hire full-time housemaids, mainly from South Asia and East Africa to do the cooking and cleaning (Brochmann, 1987; Serour, Alqhenaei, Al-Saqabi, Mustafa, & Ben-Nakhi, 2007). Housemaids from other countries also provide the opportunity for family members to experience a variety of new foods, some of which may be healthy or unhealthy, and are a further shift away from traditional meals (Ng, Zaghloul, Ali, Harrison, Yeatts, et al., 2011b).

A decrease in physical activity and an increase in sedentary behaviors has also been occurring in Oman with urbanization (ALNohair, 2014). Before increased urbanization, there was limited technology, and people were physically active in the context of their activities of daily living such as farming and fishing (Serour et al., 2007). After urbanization, most families hired immigrant workers mainly from South Asia to run the farms and sometimes the fishing operations as well (Birks, Seccombe, & Sinclair, 1988; Kapiszewski, 2006). Also, domestic house tasks were taken over by full-time housemaids (Brochmann, 1987; Birks et al., 1988; Serour et al., 2007), which further enhanced inactivity especially for females who are culturally the ones in charge of domestic tasks. Several, though dated, studies have found that hiring full-time housemaids who take over the cooking and cleaning for the family have been found to have a significant association with obesity in the region (Al-Isa, 1999; Al-Shammari, Khoja, Al-Maatouq, & Al-Nuaim, 1994). However, in Oman, a study reported there was no significant association between the number of house helpers and boys physical fitness measures (Hassan & Al-Kharusy, 2000), which may not be necessarily true for females.

Hiring workers to do the daily tasks family used to do have been combined with the availability and affordability of technology (e.g., televisions [TV], computers and cell phones) has increased sedentary activities (Al-Isa, 1999). Also, cars increasingly became affordable and soon were the preferred option for transportation compared to walking or cycling (Mabry, Winkler, Reeves, Eakin, & Owen, 2013; Serour et al., 2007). Leisure time activities for 9 to 11 years old Omani boys and their parents were previously documented at 6.8 hours per week with 3.2 hours per day of television and video games and 0.82 hours per week for fathers' exercise and 0.2 hours per week for mothers' exercise (Hassan & Al-Kharusy, 2000).

In general, young male and female students enjoy ball games including football (i.e., soccer), basketball, and volleyball as after-school activities (Youssef, Al Shafie, Al-Mukhaini, & Al-Balushi, 2013). Also, public parks and outdoor playgrounds are widely available in Oman (Al-Hasni, 2014). However, no data describing the times spent practicing these activities or playing outdoors is available, particularly for middle age children.

Social. GCC countries are family-centered communities and tend to have frequent social gatherings, which involve sharing food among family members and friends (Badran & Laher, 2011; Serour et al., 2007). As a sign of generosity for families with increased wealth, food is prepared in large amounts, and people are encouraged to eat larger portion sizes (Badran & Laher, 2011). Meat and rice are the standard meal in social gatherings, which is high in fat, protein, and carbohydrates (Musaiger, Ahmed, & Rao, 1998). Since the eating patterns of children at middle childhood age usually resemble the eating patterns of their parents (Clark et al., 2007; Taylor et al., 2011), they are at risk for increased caloric intake resulting from this social trend.

In the Arab community, females are less active compared to males, which is attributed to some cultural restrictions (Mabry et al., 2013). However, barriers to physical activity among female Omani youth were described as a lack of energy, interest in other activities, lack of encouragement, worries about looks, and time constraints from academic responsibilities and family obligations (Youssef et al., 2013).

Health Care System. Resources informing parents about their children's weight status and the consequences of overweight and obesity are limited in Oman. In Oman, there are no scheduled child medical check-ups beyond age 18 months, which is the time that infants complete their immunizations. School physical check-ups including weight status measurements are only done for children at first, seventh or tenth grade (MOH, 2015). However, these measurements are completed at school settings without the parents being present, and the results are not necessarily shared with the parents. As a result, the parents' may have a distorted perception of their children's weight status. A Kuwaiti study found that 97% of mothers of preschool children with overweight were unable to correctly perceive their children's weight status (Al-Qaoud et al., 2010). Multiple other studies reported a distorted perception of children's weight status in the GCC region as well (Abalkhail, Shawky, & Ghabrah, 2002; Al-Sendi, Shetty, & Musaiger, 2004; Musaiger, bin Zaal, & D'Souza, 2012). Mothers who do not have a clear understanding of their children's weight status and underestimate the health risks of overweight and obesity tend to overfeed their children (Hirschler, Calcagno, Clemente, Aranda, & Gonzalez, 2008), which consequently leads to obesity.

Purpose of the Study

Childhood obesity is relatively new in Oman and has not to date been adequately examined, particularly in children during middle childhood. The purpose of this study was to examine the relationship between weight status, nutrition intake, and physical activity patterns of Omani middle age children and explore the familial factors that influence them. The sample of the study involved 1st to 4^{th-}grade Omani children (age ~ 6 - 10 years) and their mothers.

Research Questions

Question 1. What is the relationship between BMI z-scores and nutrition intake and physical activity patterns of 1st to 4th-grade Omani children?

Question 2. What are the familial factors that influence the BMI z-scores, nutrition intake, and physical activity patterns of 1st to 4th-grade Omani children?

The results of this study have provided baseline data on the average BMI z-scores, nutrition intake, and physical activity patterns of middle age Omani children and the relationship between them. Also, it clarified the familial factors that influence BMI z-scores, nutrition intake, and physical activity patterns of Omani children during middle age, which can be targeted for future culturally sensitive interventions. Therefore, the results of this study will highly impact the children health care system in Oman.

Conceptual Framework

The conceptual framework underpinning this study was the ecological model by Davison and Birch (2001) (Figure 1.1). The Davison and Birch (2001) ecological model of predictors of childhood overweight was created based on Bronfenbrenner's Ecological Systems Theory (Bronfenbrenner, 1986; Bronfenbrenner & Morris, 1998). Consistent with the Ecological Systems Theory (Bronfenbrenner, 1986; Bronfenbrenner & Morris, 1998), development occurs as a result of interactions between the child's characteristics and procedures in the family and the school, which themselves are influenced by the community and society characteristics (Bronfenbrenner, 1986; Bronfenbrenner & Morris, 1998). Bronfenbrenner (2009) has defined the ecology of human development as "the scientific study of the progressive, mutual accommodation between an active growing human being and the changing properties of the immediate setting in which the developing person lives" (p.21).

Guided by the ecological model, Davison and Birch's (2001) conceptual framework reflects a comprehensive and systematic mean of assessing the predictors of childhood obesity. This framework underpins the complexity of childhood obesity. Recognizing that most public health challenges such as childhood obesity are too complex to be adequately understood from a single level analysis, the ecological model includes a more comprehensive approach that integrates multiple levels of influence to impact health behaviors (Robinson, 2008).

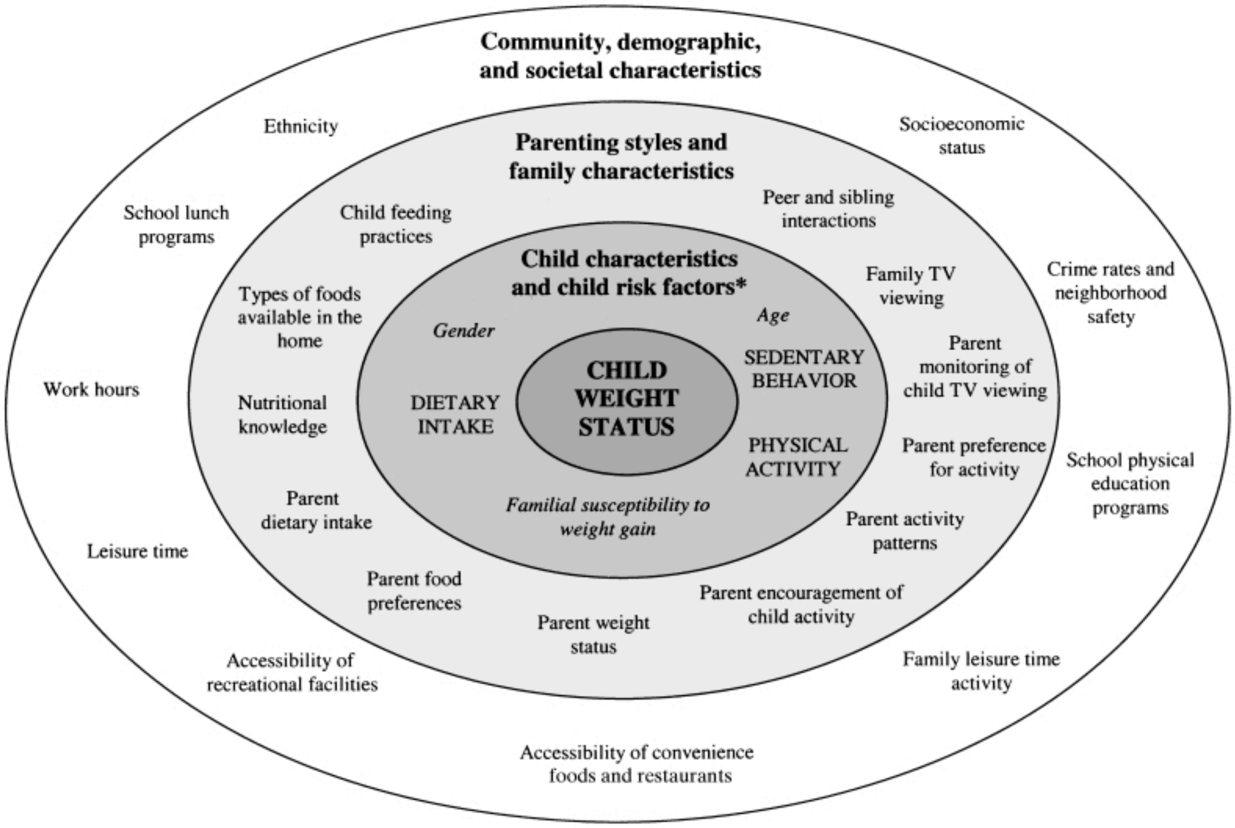

Figure 1.1. Davison and Birch (2001) Ecological Model of Childhood Overweight Predictors

Davison and Birch's (2001) framework allows the researcher to evaluate the factors influencing children's nutrition and physical activity patterns, main obesity determinants, through examining multiple factors within three main contexts. These contexts were described as children's characteristics, parenting styles and family characteristics, and community and societal characteristics (Davison & Birch, 2001). Since the study aimed to understand the family impact on childhood obesity, the study conceptual framework was restricted to the parenting styles and family characteristics.

Parenting Styles and Family Characteristics

Davison and Birch (2001) explained that children's nutrition intake and physical activity patterns are molded by parenting styles and other family characteristics. Parent's nutrition knowledge, types of foods parents make available for their children, parental modeling of particular eating behaviors, and parent child-feeding practices were identified as pathways by which parents may shape children's dietary practices (Clark et al., 2007; Davison & Birch, 2001; Taylor et al., 2011). Similarly, variables including parental preferences of activity, movement pattern, and encouragement of their children's activity influence their children's activity patterns (Davison & Birch, 2001).

Significance of the Study

In Oman, childhood overweight and obesity continues to escalate. It is imperative to understand the problem through a cultural lens. The Omani government is aware of the escalating childhood obesity problem and is encouraging the development of programs to prevent overweight and obesity in children (Times of Oman, 2011). To date, there have been no research studies in Oman that have examined nutrition intake and physical activity behaviors in middle age Omani children.

The Academy of Nutrition and Dietetics (Academy of Nutrition and Dietetics [AND], 2016) indicated that early childhood and school-based obesity primary prevention programs should integrate approaches that focus on nutrition intake and physical activity using a system level strategy targeting the multilevel structure of the socio-ecological model as well as interactions and relationships between levels (Hoelscher, Kirk, Ritchie, & Cunningham-Sabo, 2013). Multilevel ecological approaches aiming to improve nutrition and physical activity behaviors as prevention strategies have demonstrated positive, long-lasting weight effects in children (Simon et al., 2014). Before developing future interventions, it is important to understand children nutrition and physical activity patterns at multiple ecological levels. The findings of this study provide valuable data necessary to design future intervention studies to prevent and manage overweight and obesity in middle age Omani children within the family context. Therefore, it is imperative to understand middle age children's nutrition and physical activity patterns and the family factors influencing them about the increasing overweight and obesity epidemic in Oman.

Chapter Summary

This chapter has provided an overview of the childhood overweight and obesity problem and definitions. It specifically examined the problem for middle age children (i.e., 5 to 10 years). The chapter discussed the etiology of childhood obesity focusing mainly on the environmental factors. Home and community environmental factors that directly and indirectly influence children's nutrition and physical activity behaviors have been explored. The role of parents in shaping their children's nutrition and physical activity patterns was explained. Also, the chapter clarified the nutrition and physical activity status in Oman and how they were influenced by multiple community factors including urbanization, social, and health care system factors. This chapter also outlined the purpose of the study, the conceptual framework, and the significance of the research.

CHAPTER 2: LITERATURE REVIEW

Introduction

Childhood overweight and obesity is a contemporary disease that constitutes a major risk to public health. Its incidence is particularly high in developed countries compared to developing countries (Ng et al., 2014). However, a substantial rise in overweight and obesity was recently reported in children and adolescents 2-to-19 years of age in developing countries from 1980 (8.1% in boys, 8.4% in girls) to 2013 (12.9% in boys, 13.4% in girls) (Ng et al., 2014).

Childhood underweight has been a long-term problem in Oman. In 2016, the rates of severe underweight and underweight ranged between 11 to 17% among school-age children in Oman (Ministry of Health [MOH], 2016). However, most recently child overnutrition has emerged as a serious public health concern resulting in childhood overweight and obesity (MOH, 2016). The 2016 MOH report demonstrated that among about 50,000 first grade children examined in Oman, 3.7% were overweight and 2.1% were obese (MOH, 2016). Among a total of about 36,000 seventh grade children, 9.7% were overweight, and 6.7% were obese (MOH, 2016). Further, a total of 34,400 tenth grade children were examined, and 10.6% were overweight, and 7.8% were obese (MOH, 2016).

Despite this alarming development, little is known about overweight and obesity in Omani children to date. For example, a search for manuscripts using the terms *Oman* and *childhood obesity* revealed no manuscripts in the past ten years. Also, a search for review manuscripts focused on childhood obesity-specific to countries in the Gulf Cooperation Council

(GCC), Oman's sister countries, were limited (Abdul-Rasoul, 2012; Ng et al., 2011a). The GCC countries include a political and economic association of six countries including Saudi Arabia, United Arab Emirates, Kuwait, Qatar, Bahrain, and Oman. They are homogenous in many aspects of origin, culture, traditions, language, geographic characteristics, and economic status (Torstrick & Faier, 2009). The 2016 Global Nutrition Report (International Food Policy Research Institute, 2016) indicated that these six countries were among the top 20 with the largest percentages of overweight and obesity in adults out of 190 countries around the world.

Also, countries in the GCC have witnessed a rapid increase in childhood obesity (Musaiger, 2011; Osman et al., 2004). A recent review indicated that the prevalence of obesity was 8 to 9% among Saudi and Kuwaiti preschoolers and up to 40 to 46% among Kuwaiti adolescents (Ng et al., 2011a). One literature review identified some of the contributing factors, which included family history, sedentary lifestyle, urbanization, increased income, family dietary patterns, poor knowledge about food choices, lack of physical activity, and the perception of greater weight as a sign of high social class and beauty (Abdul-Rasoul, 2012). Also, other organizational factors including policies related to nutrition and physical activity practices in the school system were noted (Abdul-Rasoul, 2012). An additional search for manuscripts related to the risk factors of childhood overweight and obesity in the GCC was also inclusive of other Eastern Mediterranean countries (Mirmiran et al., 2010; Musaiger, 2004, 2011).

Therefore, a review of the literature was conducted using PubMed, Medline, and Google Scholar databases to find articles published from January 1, 2007, through January 1, 2017. The search terms used for each of the GCC countries included *child, obesity, overweight, risk factor, and the countries name (i.e., Saudi Arabia, Kuwait, United Arab Emirates, Bahrain, Qatar, Oman)*. Inclusion criteria included manuscripts written in English, clinical trials studies that examined childhood overweight or obesity risk factors, targeted children five to ten years old, and were conducted in either Saudi Arabia, Oman, United Arab Emirates (UAE), Qatar, Bahrain, or Kuwait. This review examined children in middle childhood (5 - 10 years of age), because research has indicated that interventions targeting children in middle childhood compared to adolescents may have better outcomes (Eccles et al., 1993; Erickson, 1982; Huston & Ripke, 2006; Partridge et al., 2008). There was a limited amount of published research conducted on childhood obesity in the GCC region. Therefore, to increase the number of eligible articles, studies focusing on children in middle childhood that also included other age groups were reviewed. Systematic reviews, literature reviews, meta-analysis, dissertations, and non-peer reviewed articles were excluded.

A total of 478 manuscripts were screened for eligibility (PubMed and Medline [n = 61]), Google Scholar [n = 417]). After screening the titles, a total of 33 manuscripts were retrieved for abstract screening (PubMed and Medline [n = 22]), Google Scholar [n = 11]). After reviewing the abstracts, 22 articles were excluded (PubMed and Medline [n = 11]), Google Scholar [n = 11]), because they did not meet inclusion criteria. These studies were excluded because the participants ages did not include children five to ten years of age (n = 8), the ages of the participants were not clear, and a full-text article was not found (n = 1), did not study obesity risk factors (n = 2), analyzed data older than 10 years (n = 4), conducted in a country other than the GCC (n = 1), was not a research study (n = 1), was a literature review (n = 1), was a dissertation study (n = 2), was not a peer-reviewed study article (n = 1), and was a duplicate (n=1). With full-text review, four manuscripts were excluded. Two articles analyzed data that were older than ten years, and the other two manuscripts have indicated that the studies were done in countries other than the GCC.

Another study from the reference list was found to be eligible for review and so was added. Therefore, a total of eight manuscripts were available for review. A Prisma diagram detailing the search strategy for eligible articles for review is presented in Figure 2.1. Extraction of the primary author name, publication date, study design, study purpose, setting, sample details, data collection measures, and results was performed for each of the included manuscripts. Table 2.1 provides a summary of the study articles reviewed.

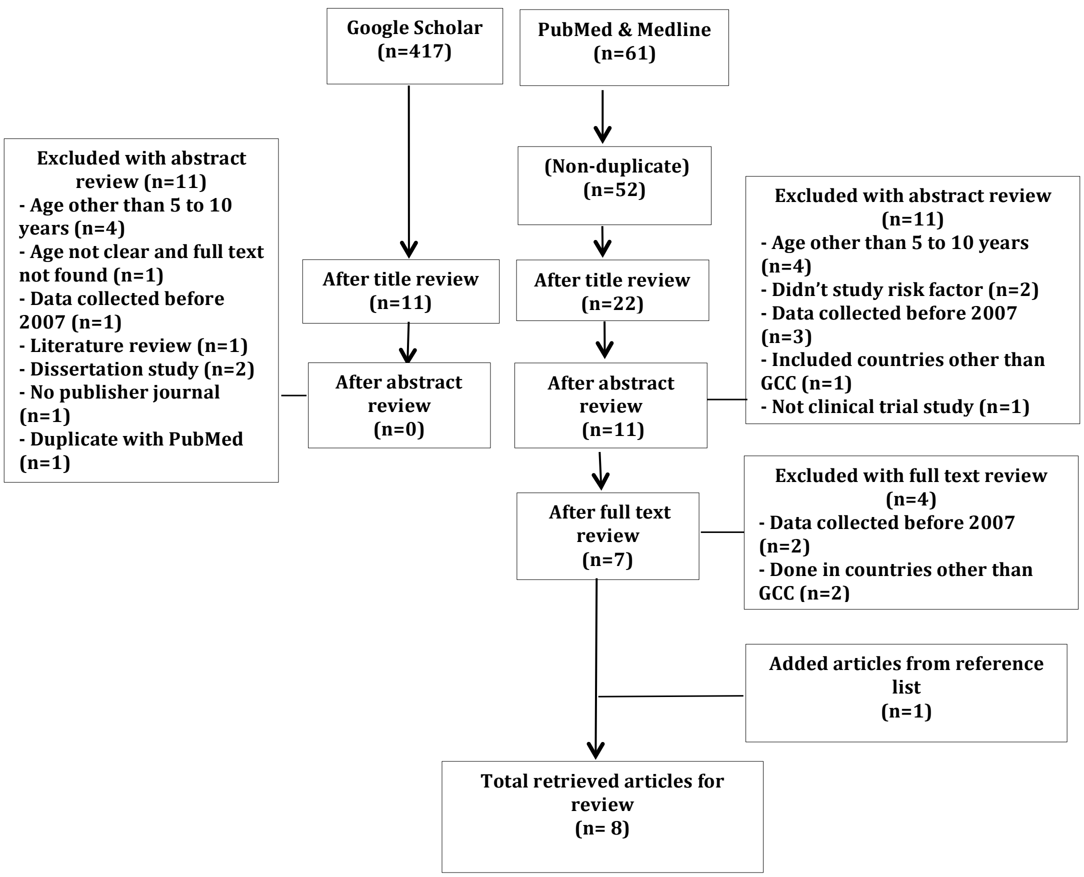

Figure 2.1. Prisma Diagram

The reviewed study manuscripts were published between 2010 and 2015, and all were cross-sectional. Among them, three were completed in Saudi Arabia (Al Alwan, Al Fattani, & Longford, 2013; Al-Hussein, Tamimi, Al Banyan, Al-Twaijri, & Tamim, 2014; Al-Muhaimeed, Dandash, Ismail, & Saquib, 2015), two in the Emirates (Al Junaibi, Abdulle, Sabri, Hag-Ali, & Nagelkerke, 2013; Ng et al., 2011b) and three in Kuwait (Al-Isa, Campbell, & Desapriya, 2010; Al-Refaee et al., 2013; Jackson, Al Hamad, Prakash, & Al Somaie, 2011). No eligible study articles were retrieved from Oman, Qatar or Bahrain.

The data collection process of the studies reviewed was completed in settings including schools (n = 6), pediatric outpatient department (n = 1), and home (n = 1). Although the search inclusion criteria specified children age 5-to-10 years of age, many of the retrieved manuscripts had mixed age groups. Two studies had participants 6-to-10 years of age (Al-Isa et al., 2010; Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015), one manuscript had participants 2-to-10 years of age (Al-Refaee et al., 2013) and the remaining five manuscripts had participants 5-to-19 years of age (Al Alwan et al., 2013; Al-Hussein et al., 2014; Al Junaibi et al., 2013; Jackson et al., 2011; Ng et al., 2011b) . The sample size of the reviewed studies ranged from 361 to 9,593 participants. However, only two studies were nationally representative (i.e., participants from across the country versus a city) (Jackson et al., 2010; Ng et al., 2011b) and one had only male participant (Al-Isa et al., 2010).

Table 2.1. Reviewed Studies

Author Date	Design Purpose	Setting Sample Measures	Results
Al-Alwan et al., 2013	Cross-sectional design - To provide data about obesity and overweight prevalence - To assess the effect of education and economic status of the parents as risk factors to obesity	Public and private schools in Riyadh, Saudi Arabia - Gender: Male and Female - Grade: Not reported - Age: 6 - 16 years - n = 1212 **Measures** 1- Social and demographic variables questionnaire: Pilot tested	**Prevalence** 1- World Health Organization (WHO) 2007 - Overweight: 21.5% male, 21.3% female, mean 21.4% - Obesity: 17.4% male, 9.3% female, mean 13.4% **Risk Factors** 1- Gender: - A significant relationship between gender and overweight ($p < 0.05$) and gender and obesity ($p < 0.05$) - Males are at higher risk of overweight (females OR = 0.6, $p < 0.05$) and obesity (females OR = 0.5, $p < 0.05$) compared to females 2- Age: - A significant relationship between age and overweight ($p < 0.05$) - Older children (12 years) are at higher risk of overweight compared to younger children (6 years) (Odd Ratio [OR] = 3.53, $p < 0.05$) 3- Income: - A significant relationship between income and overweight ($p < 0.05$). - High-income families are at higher risk for having overweight children compared to low-income families (OR = 3.38, $p < 0.05$) 4- Parental education: - A significant relationship between father education level and overweight children ($p < 0.05$) - A significant relationship between mother education level and both children overweight ($p < 0.05$) and obesity ($p < 0.05$) - Mothers educated to the university level have a higher risk of having obesity children compared to illiterate mothers (OR = 3.7, $p < 0.05$)

Author Date	Design Purpose	Setting Sample Measures	Results
Al-Hussein et al., 2014	Cross-sectional design - To estimate the prevalence of the metabolic syndrome - To compare the usefulness of clinical morphometric measurements in assessing cardio-metabolic risk in children and adolescents	Residential areas for the Saudi National Guard employees schools (Public) in Riyadh, Saudi Arabia. - Gender: Male and Female - Grade: 1st - 12th - Age: 6 - 17 years - n= 2149 **Measures** Questionnaire, not specified	**Prevalence** 1- Center for Disease Control (CDC) - Overweight: 13.8% - Obesity: 14.8% **Risk Factors** 1- Physical activity: Daily sports activity significantly predicted a lower prevalence of obesity (OR = 0.5, $p < 0.05$), but not of overweight 2- Breakfast: Obesity decreased in a linear fashion with increasing weekly frequency of taking breakfast ($p < 0.05$)
Al-Isa et al., 2010	Cross-sectional design - To identify factors associated with overweight and that of obesity among Kuwaiti elementary male school children aged 6−10 years	Not specified type of schools in Kuwait City, Kuwait - Gender: Male - Grade: 1st - 5th - Age: 6 - 10 years - n= 662 **Measures** 1- Designed questionnaire to fulfill the study aim: not pilot tested	**Prevalence** 1- Cole et al., 2000 (International Obesity Task Force [IOTF]) - Overweight: 20.2% male - Obesity: 16.8% male **Risk Factors** 1- Age Risk of overweight significantly higher among age eight (OR = 1.9, $p < 0.05$) and ten (OR = 2.1, $p < 0.05$) compared to six years 2- School level Risk of overweight increased significantly among the fifth (OR = 2.8, $p < 0.05$) level compared to the first level 3-Chronic disease The risk of overweight increased significantly among those with chronic disease (OR = 1.8, $p < 0.05$) compared to who had none 4- Brother's weight status Risk of overweight and obesity increased significantly among those with obese brothers compared to the group who had none 5- Father's working status

Author Date	Design Purpose	Setting Sample Measures	Results
			Risk of overweight (OR = 2.0, $p < 0.05$) and obesity (OR = 2.3, $p < 0.05$) increased significantly when father was not working compared to the group with a working father 6- Number of persons living at home Risk of overweight (OR = 2.6, $p < 0.05$) and obesity (OR = 2.1, $p < 0.05$) increased significantly with a high (≥ 11) number of persons living at home compared to the group with a low (1 - 6) number 6- Dental status The risk of overweight (OR = 0.6, $p < 0.05$) and obesity (OR = 0.4, $p < 0.05$) decreased significantly among those with a history of dental caries and fillings compared to the group with healthy teeth 7- Dieting Risk of overweight (OR = 0.4, $p < 0.05$) and obesity (OR = 0.5, $p < 0.05$) decreased among those who did not diet compared to the group who did 8- Number of times dieted and needing special nutritional program The risk of overweight and obesity decreased significantly among those who dieted once compared to the group who did not need to diet and decreased among those who did not know they needed special diet program compared to the group who did
Al-Junaibi et al., 2013	Cross-sectional design - To estimate the prevalence and determinants of obesity in childhood and adolescence and their association with blood pressure (BP)	Public schools in Abu Dhabi, United Arab Emirates. - Gender: Male and Female - Grade: 1^{st} - 12^{th} - Age: 6 - 19 years - n= 1035 **Measures** 1- IOTF questionnaire (dietary and eating habits, and physical	**Prevalence** 1- CDC - Overweight: 11.6% male, 16.7% female, mean 14.2% - Obesity: 21.4% male, 18.1% female, mean 19.8% **Risk Factors** 1- Gender: The proportion of overweight was significantly higher among females ($p < 0.05$) but not obesity (more in males) 2- Age:

Author Date	Design Purpose	Setting Sample Measures	Results
		activities in the past seven days): culturally adapted but not re-tested 2- adapted questions from the short version of the International Physical Activity Questionnaire: A pilot study was conducted to establish the inter-rater reliability	Mean BMI percentiles significantly increased with age ($p < 0.05$) 3- Dairy: Additional daily dairy consumption is associated with a reduction in BMI by 2.52 percentile points ($p < 0.05$) 4- Parental BMI: Significant correlations between children's BMI percentiles and their mother's and father's BMIs ($p < 0.05$) 5- Fruits (daily): Significantly less in overweight/obesity female children compared to underweight/normal weight female children ($p < 0.05$) 6- Vegetables (daily): Significantly less in overweight/obesity male and female children compared to underweight/normal weight male and female children ($p < 0.05$) 7-Energy dense food: Fast food significantly less in overweight /obesity male children compared to underweight/normal weight male children ($p < 0.05$) 8- Screen time: TV/computer (min) significantly less in overweight/ obesity female children compared to underweight/ normal weight female children ($p < 0.05$) but significantly more in overweight / obesity male children compared to underweight/normal weight male children ($p < 0.05$) 9- Physical activity, family income: - No significant difference between overweight/obesity and underweight/normal children

Author Date	Design Purpose	Setting Sample Measures	Results
Al-Muhaimeed et al., 2015	Cross-sectional design - To determine the prevalence of overweight and compare it with the corresponding estimates from earlier published data - To examine the association between children's overweight status and parental and child characteristics	Public schools in Al-Qassim province, Saudi Arabia. - Gender: Male and Female - Grade: 1st – 4th - Age: 6-10 years - n= 874 **Measures** Designed questionnaire filled by parents: Pilot tested	**Prevalence** 1- Cole et al., 2000 (IOTF) - Overweight (Referred to both overweight and obesity): 11.7% male, 29.7% female **Risk Factors** 1- Gender: Overweight was significantly higher in girls than boys ($p < 0.05$) 2- Age: A monotonic increase in the prevalence of overweight and obesity by age in boys but not in girls 3- Mother's age: Significantly associated with children's overweight status ($p < 0.05$). Higher age higher risk, 41 - 50 years compared to younger (127 missing age data) 4- Mother's education, mother's employment, socioeconomic status: Not significantly associated with children's overweight status 5- Have breakfast at home, eat between meals, the number of meals/day, television watching (daily), walk daily: Not significantly associated with children's overweight status 6- Restaurant eating Children with high-frequency intake (two or more times a week) are significantly at higher risk compared to zero frequency (OR = 2.41, $p < 0.05$) 7- Engagement in sports Children with high frequency (more than two hours a day) are significantly at lower risk compared to zero frequency (OR = 0.54, $p < 0.05$)

Author Date	Design Purpose	Setting Sample Measures	Results
Al-Refaee et al., 2013	Cross-sectional design - To screen for overweight using the BMI percentiles	Pediatric Outpatient Department at Al-Adan Hospital, Al-Ahmadi Governorate, Kuwait. - Gender: Male and Female - Grade: Not reported - Age: 2-10 years - n= 361 **Measures** Not applicable	**Prevalence** 1- CDC - Overweight (determined as risk for overweight equal to 85 - 94th percentile): 14.41% - Obesity (determined as overweight equal or more than 95th percentile): 21.33% **Risk Factors** 1- Gender: Not significant overweight difference between the two genders ($p < 0.05$) 2- Age: 54 overweight children (70.13%) were above six years of age, while 23 overweight children (29.87%) where below six years of age, no significance testing
Jackson et al., 2010	Cross-sectional design - To develop smoothed waist circumference percentiles - To examine the percentages of children, at each age, who had waist circumference that exceeded the 90th percentile -To examine the correlation between overall obesity and abdominal obesity	Not specified type of schools in Kuwait. - Gender: Male and Female - Grade: 1st - 12th - Age: 5 - 18.9 years - n= 9593 **Measures** Not applicable	**Risk Factors** 1- Age: BMI values (not mean) increased with age for both male and female children, no significance testing. The BMI means for ages eight, nine and ten years are higher than at other ages 2- Gender: - Mean BMI values of male children are higher at most ages, no significance testing. - Mean waist circumference of male adolescents was significantly higher ($p < 0.05$) than that of female adolescents, not presented in tables

Author Date	Design Purpose	Setting Sample Measures	Results
Ng et al., 2011b	Cross-sectional design - To estimate the prevalence of overweight, obesity, dietary, and activity patterns for adult females, children, and adolescents - To explore how some underlying factors are associated with the shift from a presumably healthier lifestyle to one linked with an advanced stage of the nutrition transition	Urban and rural households in United Arab Emirates. - Gender: Male and Female - Grade: Not reported - Age: 6 - 18 years - n= 731 **Measures** 1- Physical activity with International Physical Activity Questionnaire: Pilot tested 2- Dietary intake with 24-hour dietary recall: Pilot tested	**Prevalence** Cole et al., 2000 (IOTF) - Overweight: 6 - 10 years: 9.1% male, 23.6% female 11 - 18 years: 16.2% male, 20.5% female - Obesity 6 - 10 years: 15.9% male, 17.1% female 11 - 18 years: 11.7% male, 19.7% female **Risk Factors** 1- Family income: - The wealthiest households had the highest caloric intake, whereas households with the 40th to 60th percentile of wealth had the lowest average caloric intake - Inactivity measured by time spent sitting increases with wealth until the 4th wealth quintile

Results

Childhood Obesity Prevalence

Although obesity prevalence was not part of the review aim, seven among the reviewed articles had data on the prevalence of overweight and obesity. Among them, three had specific data for children age 6-to-10 years, which all referred to Cole at al., 2010 (i.e., International Obesity Task Force [IOTF]) to estimate growth status (Al-Isa et al., 2010; Al-Muhaimeed et al., 2015; Ng et al., 2011b). These three studies represented the population from Saudi Arabia, Emirates, and Kuwait. However, only one was nationally representative (Ng et al., 2011b) and another had only male participants (Al- Isa et al., 2010). The mean rate of overweight and obesity among Saudi, Emirati, and Kuwaiti children age 6-to-10 years was 14.2% among male children and 25% among female children (Al-Isa et al., 2010; Al-Muhaimeed et al., 2015; Ng et al., 2011b). These rates suggest a higher incidence of overweight and obesity among female children compared to male children. Table 2.2 provides more detailed data about the prevalence of overweight and obesity among children age 6-to-10 years in Saudi Arabia, Emirates, and Kuwait.

Table 2.2. Prevalence of Overweight and Obesity among Children Ages 6-to-10 Years Old in Some GCC Countries

Study Author, Year (Country)	Overweight	Obesity
Al-Isa et al., 2010 (Kuwait)	- 20.2% Male	- 16.8% Male
Al-Muhaimeed et al., 2015 (Saudi Arabia)	- 11.7% Male - 29.7% Female	
Ng et al., 2011b (Emirates)	- 9.1% Male - 23.6% Female	- 15.9% Male - 17.1% Female

Children Risk Factors for Obesity

Three categories of risk factors for developing childhood obesity were retrieved from this review. These included risk factors related to individual characteristics, familial characteristics and lifestyle behaviors.

Individual characteristics. A significant relationship between obesity and individual characteristics including age, gender, and health status were reported for children of the GCC countries (Al Alwan et al., 2013; Al-Isa et al., 2010; Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015; Al-Refaee et al., 2013; Jackson et al., 2011).

Body mass index (BMI) correlated significantly with age; as age increased, BMI increased as well (Al-Alwan et al., 2013; Al-Isa et al., 2010; Al Junaibi et al., 2013). Al-Alwan et al. (2013) found that 12-years old children from Saudi Arabia (n = 1,212) were at higher risk of developing overweight compared to six years old children (Odd Ratio [OR] = 3.53, $p < .05$). Al-Junaibi and colleagues (2013) found that in Emirati children age 6-to-19 years (n = 1,035) of age; the mean BMI percentiles significantly increased with age ($p < .05$). Furthermore, Al-Isa et al. (2010) examined 662 Kuwaiti male children and found that the risk of overweight was significantly higher among children aged eight years (OR = 1.9, $p < .05$) and ten years (OR = 2.1, $p < .05$) compared to children six years of age. Al-Muhaimeed et al. (2015), Al-Refaee et al. (2013) and Jackson et al. (2010), reported findings related to the relationship between age and childhood obesity, however, they did not report a level of significance. Al-Refaee et al. (2013) reported that among participants who were overweight or obese (n = 52), 70% of them were between six and ten years of age and 30% of them were between two and six years of age. Al-Muhaimeed et al. (2015) documented an increase in overweight and obesity prevalence as age increased among male children age six to ten years old. Among the 9,593 Kuwaiti children age 5-to-19 years, BMI increased with age as well. However, the BMI means for ages eight, nine and ten years were higher than other ages (Jackson et al., 2010).

The results of the relationship between gender and childhood obesity were mixed. Female participants were at a significantly lower risk of developing childhood overweight (OR = 0.6, $p < .05$ for females) and obesity (OR = 0.5, $p < .05$ for females) in the Al Alwan et al. (2013) study. Similarly, Jackson et al. (2011) found that the mean BMI values of male participants age 5-to-19 years were higher than the mean BMI values of female participants 5-to-19 years of age without reporting a level of significance. The level of significance was reported for waist circumference findings in adolescents, and it was significantly higher ($p < .05$) among male adolescents compared to female adolescents (Jackson et al., 2011). Al-Muhaimeed et al. (2015)

found that the prevalence of overweight and obesity was significantly higher among female participants age 6-to 10 years old ($p < .05$) compared to male participants age 6-to-10 years. Al-Junaibi and colleagues (2013) found that the prevalence of overweight was significantly higher among female participants ($p < .05$), but the prevalence of obesity was higher in male participants compared to female participants. However, Al-Refaee et al. (2013) reported no significant relationship between gender and childhood obesity ($p < .05$).

In addition to age and gender, some health-related conditions were found to have a significant relationship with childhood obesity (Al-Isa et al., 2010). Al-Isa et al. (2010) documented that children with a history of chronic disease were at a significantly higher risk of overweight (OR = 1.8, $p < .05$) compared to those with no history of chronic disease (Al-Isa et al., 2010). Interestingly, Al-Isa et al. (2010) also reported that children with a history of dental fillings for dental caries were at a significantly lower risk of overweight and obesity, (OR = 0.6, $p < .05$) and (OR = 0.4, $p < .05$) respectively, compared to children with healthy teeth who did not had a history of dental caries and fillings (Al-Isa et al., 2010).

Familial characteristics. Familial risk factors related to childhood obesity include parental BMI, brother's weight status, family size, mother's age, household income, parental level of education, and father's working status (Al Alwan et al., 2013; Al-Isa et al., 2010; Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015). A positive significant correlation between parental BMI (both maternal and paternal) and children's age 6-to-19 years old and BMI percentiles was reported ($p < .05$) (Al-Junaibi et al., 2013). Moreover, children age 6-to-10 years old with obese brothers were at a significantly higher risk of overweight and obesity compared to children with brothers who were not obese (Al-Isa et al., 2010). The age of obese brothers was not reported. Also, this review identified that having big family size (i.e., ≥ 11) significantly increased the risk of childhood overweight and obesity compared to having a smaller family size (i.e., 1 - 6) (Al-Isa et al., 2010). In the GCC region, the average family size in 2012 ranged between five and eight (Nakono, n.d.). Therefore, it is not uncommon for a family to have 11 or more members compared to societies such as in the United States or Europe.

The older the mother (i.e., 41 - 50 years) was also found to be a significant risk factor for developing childhood overweight ($p < .05$) compared to younger mothers (Al-Muhaimeed et al., 2015). It is important to note that a large amount of data ($n = 127$ out of $n = 878$) in the Al-Muhaimeed study (2015) reported the mother's age was missing.

Family income was another significant risk factor for childhood obesity in the region. Children in high-income families were at three times higher risk of becoming overweight ($OR = 3.38$, $p < .05$) compared to low-income families (Al Alwan et al., 2013). This relationship has been clarified by Ng et al. (2011) who reported that the wealthiest households had the highest caloric intake and physical inactivity levels compared to less wealthy households, which may provide an explanation why these children were at a higher risk of becoming overweight. However, two other manuscripts reported that there was no significant association between family socioeconomic status and childhood obesity (Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015).

Interestingly, high parental level of education was identified as a significant risk factor for the development of childhood overweight in the GCC region (Al Alwan et al., 2013). Al-Alwan et al. (2013) reported that children of mothers with a university degree were at three times higher risk of becoming obese ($OR = 3.7$, $p < .05$) compared to children of illiterate mothers (i.e., never been educated in a school system) (Al-Alwan et al., 2013). However, the risk of overweight and obesity was doubled among children of non-working fathers compared to children of working fathers (Al-Isa et al., 2010). The relationships between childhood obesity and either the mother's level of education or the mother's employment status were not found to be significant in another manuscript (Al-Muhaimeed et al., 2015).

Lifestyle behaviors. This review has identified some behaviors related to diet, physical activity, and screen time that have an association with childhood obesity as well. Inadequate daily intake of breakfast, dairy products, vegetables, and fruits have been shown to have a significant relationship with childhood obesity (Al-Hussein et al., 2014; Al- Junaibi et al., 2013). Interestingly, additional daily consumption of dairy (e.g., a glass of milk) among male and female children and adolescents age 6-to-19 years old were found to be associated with a significant reduction in BMI by 2.52 percentage points ($p < .05$) (Al Junaibi et al., 2013). Although the daily fruit intake among overweight and obese male children was not significantly different from underweight and normal weight male children, female children had a significant negative association between childhood obesity and daily fruit intake (Al Junaibi et al., 2013). The results related to the association between childhood obesity and daily vegetable intake were consistent across genders in Al-Junaibi and colleagues (2013) study, indicating a significant negative relationship between the two variables ($p < .05$).

Both male and female children age 6-to-10 years eating at restaurants two or more times a week were at a higher risk of developing overweight and obesity (OR = 2.41, $p < .05$) compared to children who were not eating at restaurants as frequently (Al-Muhaimeed et al., 2015). Interestingly, Al Junaibi et al. (2013) found that fast food intake was significantly more among underweight and normal weight male children age 6-to-19 years compared to overweight and obese counterparts (mean daily intake was 2.5 in underweight and normal weight children versus 2.2 in overweight and obese children, $p < .05$) (Al-Junaibi et al., 2013). However, there were no significant differences in daily fast food intake for obese and non-obese female participants in the same study (Al-Junaibi et al., 2013). Other dietary behaviors such as having breakfast at home, eating between meals, and the number of meals per day were found to have no significant association with childhood obesity (Al-Muhaimeed et al., 2015).

Al-Isa et al. (2010) examined multiple factors related to dieting and reported some conflicting results. The researchers documented that the risk of childhood obesity significantly decreased among male children age 6-to-10 years who never dieted compared to children who dieted earlier in their life. They also tested the relationship between childhood obesity and variables related to diet. The researchers found that the risk of overweight decreased significantly among those who dieted at least once ($OR = .3$, $p < .05$) compared to those who did not diet ($OR = .5$, $p < .05$) (Al-Isa et al., 2010).

The results of the relationship between childhood obesity and physical activity behavior were inconsistent. Al-Muhaimeed et al. (2015) found that children reporting more than two hours of physical activity a day were at lower risk of developing obesity ($OR = .54$, $p < .05$) compared to children reporting no physical activity. Also, Al-Hussein et al. (2014) found a significant inverse correlation between childhood obesity and daily sports and medium and high vigorous levels of physical activity. Another reviewed manuscript reported no significant association between childhood obesity and physical activity levels (Al Junaibi et al., 2013).

The relationship between obesity and screen time was found to be moderated by the child's gender (Al-Junaibi et al., 2013). Interestingly, Al Junaibi et al. (2013) documented that screen time was significantly less among overweight and obese female children age 6-to-19 years compared to underweight and normal weight female children of the same age. However, the screen time was significantly more among overweight and obese 6-to-19 years old male children compared to underweight and normal weight male children of the same age (Al-Junaibi, 2013). Interestingly, another reviewed manuscript found no significant relationship between daily television watching and childhood obesity among male and female children age 6-to-10 years old (Al-Muhaimeed et al., 2015).

Discussion

Childhood Obesity Prevalence

The mean rate of overweight and obesity combined for children age 6-to-10 years in the GCC (Saudi Arabia, Emirates, Kuwait) during the last ten years was 14.2% among male children and 25% among female children. These rates suggest a higher incidence of overweight and obesity among female children compared to male children. Three-reviewed study articles contained overweight, and obesity prevalence data specific to children age 6-to-10 years and were limited to Saudi Arabia, Emirates, and the Kuwait population. Among these three studies, two were not nationally representative (i.e., study sample recruited from only one city in that country) (Al-Isa et al., 2010; Al-Muhaimeed et al., 2015) and one had only male participants (Al-Isa et al., 2010). Musaiger (2011) reported poor national representative study samples in his latest childhood obesity review, which limited the prevalence estimation of childhood overweight and obesity in the region. Researchers need to create a standardized guide for assessing the prevalence of childhood overweight and obesity in the GCC region to enhance documentation and utilization of the data.

Childhood Obesity Risk Factors

This review of the literature explored the risk factors for overweight and obesity among children age 5-to-10 years in the GCC countries. Many risk factors for childhood obesity were identified, and individual, familial, and lifestyle behavior themes emerged.

Individual characteristics. Individual characteristics including age, gender, and health status were reported to have a significant relationship with obesity among children 5-to-10 years of age in the GCC countries (Al-Alwan et al., 2013; Al-Isa et al., 2010; Al-Junaibi et al., 2013; Al-Muhaimeed et al., 2015; Al-Refaee et al., 2013; Jackson et al., 2011). The reviewed studies that examined the relationship between age and childhood obesity agreed that the risk of childhood obesity increased with age (Al-Alwan et al., 2013; Al-Isa et al., 2010; Al-Junaibi et al., 2013; Al-Muhaimeed et al., 2015; Al-Refaee et al., 2013; Jackson et al., 2011). This is congruent with findings from other review papers completed in the GCC and Middle East region (Mirmiran et al., 2010; Musaiger et al., 2012). Other studies conducted in the GCC region for children older than ten years also agreed that BMI increased as age increased (Amin, Al-Sultan, & Ali, 2008; El-Bayoumy, Shady, & Lotfy, 2009; Taha, Ahmed, & bin Sadiq, 2009). Children growing into adolescence (i.e., >10 years) usually tended toward unhealthy eating behaviors such as skipping breakfast and eating outside of the home, which partly explains why BMI increases with age (Kumanov & Agarwal, 2016; AAP, 2008). There was no significant association reported between age and BMI in other GCC studies (Al-Hazzaa, Abahussain, Al-Sobayel, Qahwaji, & Musaiger, 2012; Musaiger, Al-Roomi, & Bader, 2014; Washi & Ageib, 2010).

The results examining the relationship between gender and childhood obesity in this review were mixed. Several studies reported a significant positive association between childhood obesity and both male gender and female gender (Al-Hazzaa et al., 2012; El-Bayoumy et al., 2009; Farghaly et al., 2007; Washi & Ageib, 2010). However, no significant association between gender and childhood obesity was reported in the GCC literature (Al-Haifi et al., 2013; Kilani et al., 2013).

A U.S. review has identified some environmental, hormonal, and genetic factors that explain the differences in obesity presentation among male and female children age 0 to 18 years (Wisniewski & Chernausek, 2009). The review reported that girls compared to boys have a higher fat mass, have a unique distribution of fat, are predisposed to more family and environmental factors that result in obesity, and are less sensitive to the effects of insulin (Wisniewski & Chernausek, 2009). The review also indicated that boys in contrast to girls were more physically active, had more opportunities for physical activity, were protected from the obesity-genesis effects of some gene variants, and had lower leptin levels (Wisniewski & Chernausek, 2009).

One of the reviewed study articles reported that a child's history of chronic disease was a risk factor for childhood obesity (Al-Isa et al., 2010). However, Al-Isa and colleagues (2010) study was cross-sectional, and so the direction of causality was not clear. Also, specific chronic diseases leading to childhood obesity were not identified in the Al-Isa et al. (2010) study. More frequently in the GCC literature, chronic endocrine and cardiovascular diseases were identified as health consequences of childhood obesity (Aldhafiri et al., 2012; Al-Hussein et al., 2014; Eapen, Mabrouk, & Yousef, 2010; Jackson, Al-Hamad, Prakash, & Al-Somaie, 2010; Taha et al., 2009; Washi & Ageib, 2010). A study conducted in Turkey for children age 5-to-15 years found that the rate of overweight and obesity was significantly higher ($p < .05$) among children with Attention Deficit Hyperactivity Disorder (ADHD) compared to children with no history of ADHD (Gungor, Celiloglu, Raif, Ozcan, & Selimoglu, 2016). The authors of the paper suggested that the relationship between ADHD and obesity could be explained by the irregular eating habits behavioral problems associated with ADHD (Gungor et al., 2016).

Interestingly, this review indicated that a child's history of having dental caries and having dental fillings compared to children not having dental caries was a protective factor against childhood obesity (Al-Isa et al., 2010). However, there was no clear explanation regarding this relationship in the study findings. A clear relationship between childhood obesity and dental caries has been documented in the literature suggesting that dental caries are a health consequence of childhood obesity (Bener, Al Darwish, Tewfik, & Hoffmann, 2013).

Familial characteristics. The relationship between childhood obesity and parental BMI values has been well studied in the global literature (Abdul-Rasoul, 2012; Hassan, El-Masry, Farid, & Khalil, 2016; Parrino et al., 2016). However, only one study documented a significant relationship between childhood obesity and an increased BMI values in parents in the GCC countries (Al Junaibi et al., 2013). Al-Junaibi and colleagues (2013) conducted a study in the UAE and documented a positive significant correlation between both maternal and paternal BMI and their 6-to-19 year old children's BMI percentile ($p < .05$). Another study conducted in Kuwait reported a significant relationship between obesity in children 6-to-10 years of age and having an obese brother (Al-Isa et al., 2010). Similarly, a study conducted in the U.S. found that having an obese younger (OR = 5.4, Standard Error [SE] = 1.9) or elder (OR = 5.6, SE = 1.9) sibling among children younger than 18 years old was strongly associated with obesity (Pachucki et al., 2014). Interestingly, this relationship was more strongly linked between same gender siblings (Pachucki et al., 2014).

The relationship between childhood obesity and parental obesity can be explained by a genetic and environmental approach. A genetic link between parental overweight and obesity and childhood obesity has been well documented in the literature (Classen & Thompson, 2016; Elks et al., 2012; Llewellyn, Trzaskowski, Plomin, & Wardle, 2013; Tang, Jin, Zhou, & Lu, 2016). The fat mass and obesity-associated (FTO) gene accountable for obesity has been found to be inherited from parents and in particular female parents (Classen & Thompson, 2016; Marginean et al., 2016). The risk of obesity was found to be associated with variations in this gene (Granot, 2015). A meta-analysis study documented a confirmed relationship between increased risk of childhood obesity and one the FTO genotypes named rs17782313 (Tang et al., 2016).

Environmentally, parents established an environment for their child at home that either promotes or does not promote the development of healthy nutrition and physical activity habits (Scaglioni, Salvioni, & Galimberti, 2008). Children's nutrition and physical activity behaviors are shaped by parents and practices are formed in the home environment (Anderson Steeves et al., 2016; Clark et al., 2007). Parental restrictive feeding for weight control (Dev et al., 2013), negative parent modeling regarding nutrition and physical activity practices, and using food as an incentive were found to significantly increase the risk for childhood obesity (Paes, Ong, & Lakshman, 2015). Also, time limitations due to working status and the absence of nutritional knowledge have been identified as factors involved in young children's obesogenic diets (Paes et al., 2015). In Oman for example, decreased child physical activity level has been found to correlate positively with parental obesity (Hassan & Al-Kharusy, 2000), which infers parental obesogenic behaviors.

This review also found that a large family size (i.e., ≥ 11), which is not unusual in Arab countries (Hill et al., 2000), significantly increases the risk of childhood obesity compared to smaller family size (i.e., 1 - 6) (Al-Isa et al., 2010). However, opposite findings were reported in the GCC literature. In a Saudi Arabian study with participants aged 10-to-14 years of age, children from a smaller family (i.e., six or less) were at a significantly higher risk of being overweight or obese compared to children from a larger family size (Amin et al., 2008). Another study conducted in Bahrain reported no significant association between childhood obesity and family size (Musaiger et al., 2014).

Children of older mothers (i.e., 41 - 50 years) were also found to be at a higher risk for becoming overweight ($p < .05$) compared to children of younger mothers (i.e., < 41 years; Al-Muhaimeed et al., 2015). A fairly old study indicated that only 1.5% of women aged 45-to-49 years in Oman held a secondary (i.e., 12th grade level) or higher level of education compared to 38.7% of women aged 25-to-29 years (Al Riyami et al., 2004). Another Saudi Arabian study described that children of mothers with a low level of education (i.e., < 12th-grade) were at a significantly higher risk of developing obesity compared to children of mothers with a higher level of education (i.e., 12th-grade or higher such as college or university education; Amin et al., 2008). These findings indicate that older mothers are usually less educated compared to younger mothers and so their children are at a higher risk of developing obesity. However, one of the reviewed studies found that high parental level of education was a significant risk factor for developing childhood overweight and obesity (Al Alwan et al., 2013) and another one reported that there was no significant relationship between childhood obesity and mothers' education background (Al-Muhaimeed et al., 2015). The results of the relationship between parental level of education and childhood obesity were also inconsistent in the GCC and Middle East literature. Some have reported a significant positive relationship between high parental level of education and childhood obesity (Hassan et al., 2016; Musaiger et al., 2014) while others documented a significant positive relationship between childhood obesity and low fathers level of education (i.e., primary versus college education) (Lafta & Kadhim, 2004). Further research is needed to clarify whether this relationship is impacted by other factors.

A higher level of parent education can be an understandable risk factor for the development of childhood obesity in the GCC region. A high level of education does not necessarily guarantee a high level of obesity prevention awareness (Al-Saeed et al., 2007). Other social or environmental factors may override the parents' desire to create a healthy environment for their children. At the same time, increased parental level of education would hypothetically secure higher job rank, which ultimately raises the family economic status.

A high family income was found to be a significant risk factor for childhood obesity in this review (Al-Alwan et al., 2013). In the GCC literature, the risk of increased family income on childhood obesity was widely reported (Al-Saeed et al., 2007; Badran & Laher, 2011; El-Bayoumy et al., 2009). A Kuwaiti study found that 89.2% of the examined overweight and obese children belonged to families in the higher social classes (≥ 1,000 Kuwaiti Dinars [i.e. $>3000]/month) (El-Bayoumy et al., 2009). Interestingly, the wealthiest households were found to have the highest caloric intake and rates of inactivity compared to less wealthy households (Ng et al., 2011b). Additional studies examining the pattern of nutrition and physical activity level in families with high income were not found. Alternatively, parents perception of obesity as a sign of high social class and beauty has been reported among families with higher income in the GCC region (Abdul-Rasoul, 2012; Malik & Bakir, 2007). Findings from other reviewed studies conducted in the Emirates and Saudi Arabia indicated that there was no significant association between the childhood obesity and family income (Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015).

Earlier discussion suggested that a higher job rank secured a higher family income and consequently increased the risk for childhood obesity; however, this review found a significant relationship between childhood obesity and non-working fathers (Al-Isa et al., 2010).

Alternatively, Amin et al. (2008) found that children of working parents, especially the mothers, were at higher risk of being overweight and obese compared to children of non-working parents. Another reviewed article reported that there were no significant relationships between childhood obesity and a mother's employment status (Al-Muhaimeed et al., 2015).

Lifestyle behaviors. Childhood obesity risk factors related to diet, physical activity, and screen time were also identified. Daily breakfast intake and daily intake of dairy, fruit, and vegetables were identified as dietary protective behaviors against childhood obesity (Al Junaibi et al., 2013; Al-Hussein et al., 2014). This was congruent with the WHO dietary recommendations for childhood obesity prevention (WHO, 2014). Multiple studies and reviews pertained to the GCC region confirmed the positive effects of daily breakfast intake on maintaining healthy weight among children (Abdul-Rasoul, 2012; Al-Haifi et al., 2013; Al-Hazzaa et al., 2012; Amin et al., 2008; Bin Zaal, Musaiger, & D'Souza, 2009; Kilani et al., 2013; Mirmiran et al., 2010; Musaiger, 2011). However, no significant relationship between regular breakfast intake and childhood obesity was reported in a study conducted among Bahraini adolescents (Musaiger et al., 2014).

The positive effect of fruit, vegetables, and dairy consumption on maintaining a healthy weight in children was documented in the GCC literature as well (Al-Haifi et al., 2013; Al-Hazzaa et al., 2012; Amin et al., 2008; Bin Zaal et al., 2009). Interestingly, other studies in the GCC region had significant opposite results. Amin et al. (2008) reported that a medium intake of vegetables (i.e., 2 - 4 times per week) significantly increased the risk of overweight and obesity among Saudi children age 10 to 14 years old (OR = .8, $p < .05$) compared to vegetable intake once a week. Also, the GCC literature documented that eating fruit more than three times a week were significantly associated with overweight and obesity among Bahraini male adolescents age 15-to-18 years old compared to fruit intake less than four times a week (OR = 1.62, $p < .05$) (Musaiger et al., 2014). More GCC studies reported no significant association between childhood obesity and fruit, vegetable, or dairy consumption (Al-Haifi et al., 2013; Al-Hazzaa et al., 2012; Bin Zaal et al., 2009; Musaiger et al., 2014). These conflicting results could be related to study design, measurement tools, or problems with the data analysis.

The WHO recommends limiting energy intake from total fat and sugar to prevent obesity among children and adolescents (WHO, 2014). Findings from this review were inconsistent with this recommendation. The review indicated, particularly among male children, that fast food intake was significantly less among overweight and obese children compared to underweight and normal weight children ($p < .05$) (Al-Junaibi et al., 2013). Surprisingly, this statement is supported by other GCC studies (Bin Zaal et al., 2009; Kilani et al., 2013; Musaiger et al., 2014). These unusual findings could be related to faults in the study design, measurement tools, or data analysis. However, other studies conducted in GCC countries acknowledge the significant positive association between childhood obesity and high intake of fast food (Al-Haifi et al., 2013; Alghadir, Gabr, & Iqbal, 2016; Amin et al., 2008; Washi & Ageib, 2010). El-Bayoumy et al. (2009) specifically reported that the majority of overweight and obese children in their study (male = 80.9 - 88.4%, female = 87.5 - 92.1%) had an excess intake of fast food. Nevertheless, more GCC studies documented no significant association between the two variables (Farghaly et al., 2007; Musaiger et al., 2014).

Arab dietary patterns, in general, are associated with a reduced risk of overweight and obesity when compared to western dietary patterns (Naja et al., 2015). Similarly, the review identified that Saudi children eating from restaurants, which mainly served western food, were at higher risk for developing overweight and obesity (Al-Muhaimeed et al., 2015). Traditional food cooked in the home has been found to be a protective factor against childhood obesity (Amin et al., 2008). School food, when compared with home food, was also found to be a significant risk factor for childhood obesity (Bin Zaal et al., 2009; Musaiger et al., 2014). However, contradicting results were reported. This research indicated that having breakfast at home compared to not having breakfast at home had no significant association with childhood obesity (Al-Muhaimeed et al., 2015). Also, no significant association between childhood obesity and eating with the family was found among 12 to 17 years old Emirati adolescents (Bin Zaal et al., 2009).

A reviewed study conducted in Saudi Arabia suggested that eating between meals and the number of meals eaten in a day had no significant association with childhood obesity (Al-Muhaimeed et al., 2015). Similarly, there was no significant difference in the number of meals normal weight and obese children aged 7-to-20 years old ate in Saudi Arabia (Farghaly et al., 2007). However, a significant positive relationship between childhood obesity and daily snacking was reported by other studies completed in the GCC and Middle East (Bin Zaal et al., 2009; Fouad, Rastam, Ward, & Maziak, 2006; Lafta & Kadhim, 2004; Washi & Ageib, 2010). Alternatively, Musaiger et al. (2014) documented that snacking between breakfast and lunch as well as between lunch and dinner were significant protective behaviors against overweight and obesity in Bahraini male adolescents age 15-to-18 years old (OR = .22, $p < .05$, OR = .46, $p < .05$ respectively).

The results of the association between childhood obesity and high intake of sugary and soft drinks in the GCC literature were highly inconsistent (Alghadir et al., 2016; Al-Haifi et al., 2013; Al-Hazzaa et al., 2012; Amin et al., 2008; Bin Zaal et al., 2009; El-Bayoumy et al., 2009; Kilani et al., 2013; Musaiger et al., 2014). Al-Ghadir et al. (2015) and Amin et al. (2008)

reported a significant positive association between high intake of sugary or soft drinks and childhood obesity. Also, El-Bayoumy (2009) documented that the majority of overweight and obese children consumed excess soft drinks. In contrast, a significant opposite association indicating a negative association between sugary or soft drinks and childhood obesity was also reported in the GCC literature (Al-Hazzaa et al., 2012; Bin Zaal et al., 2009; Kilani et al., 2013; Musaiger et al., 2014). Al-Haifi et al. (2013) did not find a significant association between childhood obesity and sugary or soft drinks.

A variety of dietary behaviors measures were used. Al Junaibi et al. (2013) used the IOTF questionnaire, which has questions about children's dietary habits in the past seven days. They asked the parents to fill out the questionnaire when the child is younger than ten years old and personally interview the child when he or she is ten years or older. Al Junaibi et al. (2013) had to modify the questionnaire culturally, but no information about the reliability and validity was provided. Al-Muhaimeed et al. (2015) designed a questionnaire to obtain information about children's lifestyle behaviors including dietary habits, and the questionnaire was pilot tested. The questionnaire was designed to be filled out by the parents since the target participants were 6 to 10 years of age (Muhaimeed et al., 2015). Al-Hussein et al. (2014) documented that they asked the parents about the children's lifestyle behaviors, which left the readers with unclear information about the tool they used. Ng et al. (2011) used the 24-hour dietary recall to assess the children's dietary intake.

Considering the dietary behaviors measuring tools used, Ng et al. (2011) did not include conflicting findings in contrast to Al Junaibi et al. (2013) and Al-Muhaimeed et al. (2015). Al-Hussein et al. (2014) had minimal dietary results (i.e., breakfast intake) and so were less likely to contain contradicting results. A systematic review indicated that the 24-hour multiple pass recalls conducted over a total of three non-consecutive days including weekdays and weekend days and used parents as respondents were the most accurate method to assess nutritional intake in children aged 4-to-11 years, whereas the diet history provided better estimates for adolescents aged 16 years of age (Burrows, Martin, & Collins, 2010).

Another behavioral risk factor for childhood obesity identified was the low level of physical activity (Al-Hussein et al., 2014; Al-Muhaimeed et al., 2015). This finding has been widely supported by the GCC and Middle East literature reporting a significant negative relationship between childhood obesity and children physical activity level (Al-Haifi et al., 2013; Al-Hazzaa et al., 2012; El-Bayoumy et al., 2009; Kilani et al., 2013). One study reported no significant association between childhood obesity and physical activity level was found (Al Junaibi et al., 2013), which surprisingly was supported by other studies in the GCC literature (Musaiger et al., 2014; Washi & Ageib, 2010). This finding may suggest that certain levels and frequencies of physical activity influence childhood obesity. For school-age children and adolescents, WHO specifically recommends one hour of daily moderate to vigorous intensity physical activity, which may be accumulated through active play, running, turning or jumping (WHO, 2014).

The results of the relationship between childhood obesity and screen time were conflicting. While no significant relationship between childhood obesity and daily TV watching was reported (Al-Muhaimeed et al., 2015), another study documented an existing relationship that was moderated by child's gender (Al-Junaibi et al., 2013). In the GCC literature, conflicting results were reported as well. Mean BMI was significantly higher among Saudi Arabian children who watched TV for more than two hours a day compared to less than an hour a day (Alghadir et al., 2016). At the same time, different studies conducted in the GCC region reported no significant association between childhood obesity and screen time (Al-Haifi et al., 2013; Al-Hazzaa et al., 2012; Kilani et al., 2013; Musaiger et al., 2014). Also, eating while watching TV was reported to impose no risk of childhood obesity (Bin Zaal et al., 2009; Musaiger et al., 2014).

Summary

In summary, this chapter provided a review of the literature conducted in the GCC countries about the risk factors for childhood obesity in the last ten years. It was intended to be specific for children age 5-to-10 years, but the majority of study articles retrieved had participants from mixed age groups. Three main childhood obesity risk factors groups were identified and included individual, familial, and lifestyle behaviors factors. The dietary, physical activity and screen time lifestyle behaviors risk factors findings were controversial. This controversy raises questions about the reliability and validity of tools used to measure the lifestyle behaviors variables. Future studies in the GCC region need to use reliable and valid measures to strengthen the credibility of data gathered. The inadequacy of healthy lifestyle awareness in the region combined with the urban obesogenic environment available may explain the major part of the childhood obesity problem in the GCC countries. Data about the prevalence of overweight and obesity in children age 6 to 10 years were also retrieved but with some limitations.

CHAPTER 3: METHODS

Introduction

In Oman, childhood obesity is a relatively new problem when compared to other neighboring countries such as Kuwait and Saudi Arabia (Ng et al., 2011a). However, the rates of childhood obesity in Oman in the past years have escalated rapidly (Ministry of Health [MOH], 2012, 2016). In spite of this, childhood obesity literature in Oman is very limited, particularly for children age 6-to-10 years (Kilani et al., 2013; Musaiger, 1994; Zayed et al., 2017).

Obesity is determined by the imbalance between energy intake and energy expenditure (Harpaz et al., 2017; Razina et al., 2016). In research, energy intake is represented by nutritional intake (i.e., proteins, carbohydrates, and fats) (Hill et al., 2012) and energy expenditure is represented by physical activity. The relationship between either nutrition intake or physical activity and obesity is inconsistent in the Omani literature. Several manuscripts have indicated that Omani children and adolescents have maintained a healthy weight status with unhealthy nutritional intake and low levels of physical activity (Kilani et al., 2013; Zayed et al., 2017). In the Gulf Cooperation Council (GCC), of which Oman is a member, some manuscripts had similar results. They reported a non-significant or a positive association between healthy nutritional intake (i.e., more fruit and vegetables and less fast food and sugary drinks) and obesity and a non-significant or positive association between high levels of physical activity and obesity (Al-Haifi et al., 2013; Al-Hazzaa et al., 2012; Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015; Amin et al., 2008; Bin Zaal et al., 2009; Farghaly et al., 2007; Musaiger et al., 2014; Washi & Ageib, 2010).

Nutrition and physical activity patterns among middle-age children (i.e., 5 - 10 years) are highly influenced by their family characteristics (Simpkins, Fredricks, Davis-Kean, & Eccles, 2006). The GCC literature has identified a number of familial factors that associate with childhood obesity including parental body mass index (BMI), parental level of education, parental working status, and household income (Al Alwan et al., 2013; Al-Isa et al., 2010; Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015). However, results from a systematic review that examined 18 review manuscripts suggested that healthy nutrition and physical activity practices of children were related to behavior-specific family variables such as low restrictive control on food choices, high intake of healthy foods and a low intake of unhealthy foods by the family, low pressure to consume foods, and physical activity of siblings compared to variables related to socio-economic status (Cislak, Safron, Pratt, Gaspar, & Luszczynska, 2012). This dissertation study aimed to examine the familial factors influencing children's nutrition and physical activity patterns including maternal BMI, parental education level, parental working status, family income, and family nutrition and physical activity patterns.

Maternal BMI. A significant relationship between childhood obesity and increased BMI values in parents has been well documented in the literature (Abdul-Rasoul, 2012; Hassan et al., 2016; Parrino et al., 2016). A study conducted in Saudi Arabia documented a positive significant correlation between both maternal and paternal BMI and their 6-to-19 year old children's BMI percentile ($p < .05$) (Al Junaibi et al., 2013). However, our study has focused on maternal BMI only.

Parental educational level. A Saudi Arabian study described that children of mothers with a low level of education (i.e., < 12th grade) were at a significantly higher risk of developing obesity compared to children of mothers with a higher level of education (i.e., 12th grade or higher such as college or university education) (Amin et al., 2008). However, a higher level of education does not necessarily guarantee a high level of obesity prevention awareness (Al-Saeed et al., 2007). Some studies completed in the GCC found that high parental level of education was a significant risk factor for developing childhood overweight and obesity (Al Alwan et al., 2013). No significant relationship between childhood obesity and mothers' educational background was also reported (Al-Muhaimeed et al., 2015).

Parental working status. Compared to children of non-working parents, children of working parents, particularly the mothers, were found to be at higher risk for obesity (Amin et al., 2008). No significant relationships between childhood obesity and a mother's working status were also reported (Al-Muhaimeed et al., 2015). Interestingly, a significant relationship between non-working fathers and childhood obesity was documented in the literature (Al-Isa et al., 2010).

Family income. In the GCC literature, the risk of increased family income on childhood obesity was widely reported (Al Alwan et al., 2013; Al-Saeed et al., 2007; Badran & Laher, 2011; El-Bayoumy et al., 2009). A Kuwaiti study found that 89.2% of the examined overweight and obese children belonged to families in the higher social classes ($\geq$ 1,000 Kuwaiti Dinars [i.e., $>3,000]/month) (El-Bayoumy et al., 2009). Other studies conducted in the GCC indicated that there was no significant association between the childhood obesity and family income (Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015).

Interestingly, the wealthiest households were found to have the highest caloric intake and rates of inactivity compared to less wealthy households (Ng et al., 2011b). Also, parents' perception of obesity as a sign of high social class and beauty has been reported among families with higher income in the GCC region (Abdul-Rasoul, 2012; Malik & Bakir, 2007).

Family nutrition and physical activity patterns. Family nutrition and physical activity patterns have been linked to childhood overweight and obesity. Parents create an environment at home that either promotes or does not promote healthy nutrition and physical activity practices among children (Scaglioni, Salvioni, & Galimberti, 2008). Particularly during middle childhood, parents' beliefs and practices significantly influence children's participation in activities such as sports (Simpkins et al., 2006).

Parents shape their children's nutrition and physical activity behaviors and practices (Anderson Steeves et al., 2016; Clark et al., 2007). Parenting style regarding weight-related behaviors has been associated with children's nutrition and physical activity attitudes (Clark et al., 2007; Taylor et al., 2011). Negative parent modeling regarding nutrition and physical activity practices was found to significantly increase the risk of developing childhood obesity (Paes, Ong, & Lakshman, 2015). In Oman, decreased child physical activity levels have been reported to correlate positively with parental obesity (Hassan & Al-Kharusy, 2000), which infers parental obesogenic behaviors.

This chapter describes the procedures used in this quantitative study to examine the relationship between BMI z-score and BMI z-score and nutrition and physical activity patterns among children at the middle-childhood age in Oman. Also, the study aimed to examine Omani children BMI z-score, nutrition intake, and physical activity patterns in relation to maternal BMI, parental education level, parental working status, family income, and family nutrition and physical activity patterns. This chapter details the research aims, philosophical assumptions, data collection procedures and analysis strategies.

Aims

The purpose of this study was to examine the relationship between Omani children's BMI z-score and nutrition and physical activity. Also, the study aimed to examine the Omani children's BMI z-score, nutrition intake, and physical activity patterns in relation to maternal BMI, parental education level, parental working status, family income, and family nutrition and physical activity patterns. The study specific aims were as follows:

Aim 1: Assess the relationship between BMI z- score and nutrition intake and physical activity patterns of 1^{st} to 4^{th}-grade Omani children.

Aim 2: Examine the relationship between the nutrition intake of 1^{st} to 4^{th}-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Aim 3: Examine the relationship between the physical activity patterns of 1^{st} to 4^{th}-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Aim 4: Examine the relationship between the BMI z- score of 1^{st} to 4^{th}-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Philosophical Assumptions

Davison and Birch's (2001) framework provides a comprehensive and systematic means of assessing the predictors of childhood overweight and obesity. Children's nutrition intake and physical activity, two main risk factors for developing childhood obesity, are influenced by children's characteristics, parenting styles and family characteristics, and community demographics and societal characteristics (Davison & Birch's, 2001) (Figure 1.1).

In this dissertation study, the conceptual framework was limited to the parenting styles and family characteristics to understand the family influence on children's BMI z-score and nutrition and physical activity patterns. Davison and Birch (2001) explained that parenting styles and other family characteristics mold children's nutrition intake and physical activity patterns, which are two of the main determinants of childhood obesity.

Parenting Styles and Family Characteristics that Influence Children's Nutrition Intake

Parent's nutrition knowledge, types of foods parents, make available for their children, parental modeling of particular eating behaviors, and parent child-feeding practices were identified as pathways by which parents may shape children's dietary practices (Clark et al., 2007; Davison & Birch, 2001; Taylor et al., 2011).

Parenting Styles and Family Characteristics that Influence Children's Physical Activity

Davison and Birch (2001) have indicated that familial variables including parental preferences for physical activity, movement pattern, and encouragement of their children's activity, family television (TV) viewing, and parent monitoring of their children's TV viewing influence their children's activity patterns.

Design

A quantitative research design was used to answer the study aims (Creswell, 2013). The study has first examined the relationship between 1^{st} to 4^{th}-grade Omani children BMI z- score and nutrition intake and physical activity patterns. Next the influence of a number of family characteristics on children's BMI z-score, nutrition intake, and physical activity patterns through testing multiple relationships were examined.

Institutional Review Board

Approval for this study was obtained from the Institutional Review Board (IRB) at the University of North Carolina at Chapel Hill, North Carolina, United States (U.S.) (IRB Study number 17-2785) and the research ethical committee at the Technical Office for Research and Development at the Ministry of Education (MOE) in Oman. The risks and benefits of participating in the research study have been explained to mothers and children, and all questions were answered before mothers were asked to consent and children were asked to assent.

The participants were assigned unique numeric codes, and no identifying information such as names or birth dates were asked of participants. Data entry was web-based and password protected. All data stored in the computers were password protected. Only the researcher and the dissertation committee members were able to access the data. Incentives were provided to participants (symbolic gift for mothers and stationary tool for child) as an appreciation for their time and efforts.

Settings

In the GCC region, childhood obesity is reported to be more prevalent in urban communities compared to rural communities (Al-Saeed et al., 2007). Therefore, the study participants were recruited from urban communities in Al-Seeb, Bawsher, Fanja, Nizwa, and Ibra provinces in Oman. Most of the people living in Al-Seeb, Bawsher, and Fanja are originally from other areas in Oman, and so recruitment from these provinces enhanced the diversity among study sample. Children's original place of residence was obtained in this study to clarify the sample diversity.

Race is a sensitive topic among Omani population and by law Omani people are not permitted to identify themselves or others by race or ethnicity in public. Identifying people by race or ethnicity is culturally unacceptable and may be perceived as an act of discrimination

(Country Reports on Human Rights Practices: Oman, 2011). Alternatively, people in Oman identify themselves by nationality. In this study, only Omani families were included to reflect results and analysis that were pertinent to the Omani community.

Although the rate of childhood overweight and obesity in Oman is rising rapidly, it is still not dramatically high yet. Nationally, 3.7% of first-grade children are overweight, and 2.1% are obese (Ministry of Health [MOH], 2016). There is no childhood obesity statistical data for children in the 2^{nd} to 4^{th} grade, but data for children in the seventh grade shows that 9.7% are overweight, and 6.7% are obese. No statistical data by area related to childhood obesity are available. Therefore, and to enhance recruitment of children with overweight and obesity, recruitment settings varied between public cycle one schools that include grades from one to four (Rassekh, 2004), non-governmental female community centers, and homes.

In total, study participants were recruited from five public cycle one schools in Al-Seeb (Al-Tafaweq, Al-Mahamed, Al-Nubogh, Al-Mashareq, and Al-Ethra), seven non-governmental community centers in Al-Seeb and Fanja and six home visits in Al-Seeb, Bawsher, Nizwa, and Ibra.

Study data were collected Monday through Thursday during school hours and after school hours. During school hours was anticipated to be more convenient for non-working mothers and after school hours was anticipated to be more convenient for working mothers to participate in the data collection. No transportation arrangements were made in this study as most mothers living in urban community own private cars and can drive.

Sample

The study convenience sample included first to fourth-grade Omani children (6 - 10 years) and their mothers. Inclusion criteria included Omani mothers (18 years and above) who spoke, read, and wrote in Arabic and consented for themselves and gave permission for their child to participate in the study. Omani children (6 - 10 years old and 1^{st} - 4^{th} grade) who could assent for themselves, did not suffer from a chronic illness that restricted his or her nutrition or physical activity patterns, and did not have a sibling already participating in the study were included in the study.

Sample Size and Power

Aim 1. Al-Muhaimeed and colleagues (2015) studied the relationship between overweight status and nutrition and physical activity pattern in 874 Saudi male and female children age six to ten years old. They found a significant negative association between children's overweight status and sports participation (Cohen's d=.43), while a significant positive association between children's overweight status and restaurant eating (d=.31) (Al-Muhaimeed et al., 2015).

Aim 2. Raynor and colleagues (2011) studied the dietary intake of 135 overweight and obese children age four- to nine-year-olds and their parents by asking the parents to complete a three-day food record for them and their children. They found that parent intake of different food groups was positively correlated with the child intake (r ranged from .22 to .45) (Raynor et al., 2011).

Aim 3. One article reported that among children age three to four years, moderate levels of physical activity correlated negatively with maternal BMI ($r = -0.15$) (Sijtsma, Sauer, & Corpeleijn, 2015).

Aim 4. An article from United Arab Emirates (UAE) reported a correlation of .22 between child BMI percentiles and mother's BMI with a sample of 1,035 children and adolescents age 6 to 19 years old (Al Junaibi et al., 2013). Though they didn't examine parent BMI, Al-Isa and colleagues found that having obese brothers were associated with a higher probability of being overweight or obese (d=.26) among male children age six to ten years (Al-

Isa et al., 2010). Al Alwan et al. (2013) examined 1,212 Saudi Arabian children and adolescents age 6 to 16 years and found that children whose parents had higher levels of education or higher income were more likely to be overweight or obese (d=.12, .20 respectively).

Based on the above resources and calculations generated from the G power program, the required minimum sample size was 193. This gave us 80% power to detect a correlation as small as r = .2 or a Cohen's d of .41. The correlation is smaller than most of the published estimates we found, but we may be slightly underpowered for the physical activity outcome and some of the children's weight status comparisons.

Variables and Their Measurement

The study included anthropometric measurements (i.e., height and weight), socio-demographic data survey, health behavior instruments (children nutrition and physical activity pattern and family nutrition and physical activity pattern), and single day dietary recall. Table 3.1 shows the variables and measures used in the study and the data source.

Table 3.1. Summary of Measures

Variables and Their Measures	Respondent
Anthropometric	
Weight	Child/mother
Height	Child/mother
Socio- demographic Data Survey	
Parental education level	Mother for self and child's father
Parental working status	Mother for self and child's father
Family income	Mother for family
Health Behavior Instruments	
Child nutrition and physical activity instrument	Mother for child
Family nutrition and physical activity (FNPA) screening tool	Mother for family
Single day dietary recall	Mother for child

Anthropometric Measurements

Weight. The weight in kilograms (kg) was measured with a calibrated portable weight scale (SECA 877 Class III). Weight was measured twice to the nearest 0.01 kg with minimal clothing and no shoes and averaged.

Height. Height in centimeters (cm) was measured with a freestanding height meter (SECA 213). Height was measured twice with nearest 0.1 cm, and participants were in a rear position with no shoes or head cap.

Weight status. The children's BMI was calculated by a computer as weight in kilogram divided by the square of height in meters (weight in kilograms)/[height (in meters)]^2 (Krebs et al., 2007). Children's BMI z-scores represent a measure of weight and indicate whether the child is underweight, normal weight, overweight, or obese (Flegal & Ogden, 2011). The children's BMI z- score and weight status was identified according to the 2007 WHO growth charts for children and adolescents age 5 to 19 years as follow; severe thinness as a z-score less than -3, thinness as a z-score between -3 and -2, normal weight as a z-score between -2 and 1, overweight as a z-score between greater than 1 and 2, and obesity as a z-score greater than 2 (de Onis et al., 2007, WHO, 2017).

The mother's weight status was identified according to the WHO international classification of adult weight category as follow; underweight as a BMI less than 18.5, normal weight as a BMI between 18.5 and 24.99, overweight as a BMI between 25 and 29.99, and obesity as a BMI is more or equal to 30 (Barba, Cavalli-Sforza, Cutter, & Darnton-Hill, 2004; WHO, 2000, 2017). The same procedures used for the children for measuring weight and height was used for the mothers, and a BMI was calculated by a computer.

Socio-Demographic Data Survey

Demographic data related to the child and his or her family was collected from the child's mother (Appendix A). Questions were related to the child's demographics, parent marital status, parents' educational level and working status, and family income.

Health Behavior Instruments

Child's nutrition and physical activity pattern. Children's nutrition and physical activity pattern was assessed using a questionnaire adapted from the Fish Feeding Study (FFS) (Manuscript in preparation) and filled by mothers. (Appendix B). The FFS questionnaire was developed and validated in Arabic by a team of researchers from the Department of Food Science and Nutrition at Sultan Qaboos University in Oman. Permission has been granted to use the survey (Appendix C). The questionnaire was modified slightly as four items related to fish and salt intake were removed and one item related to the number of sleep hours in a day was added. Also, the dietary recall table was removed (we used a web-based dietary recall program instead) and general information section was removed and combined with the study socio-demographic data survey.

The modified questionnaire included physical activity and nutrition components. Items one to four in the questionnaire asked physical activity questions. The first item asked about the frequency and duration of moderate to vigorous physical activities (MVPA) the child practices in a week and included nine sub items (i.e., physical activities options). The second item asked about the frequency and duration of activities the child spent sitting in a week and included eight sub items (i.e., sitting/sedentary activities options). Answers to the first and second items involved yes or no, how many times a week, and duration in minutes at each time. From these two items, the total MVPA and screen time per week was calculated by multiplying the total number of activities by the total duration of activities.

The questionnaires third and fourth items were related to the child's sleeping habits. Item three asked about the number of night sleep hours in a day and had three answer options, less than nine, nine to eleven, and more than eleven hours (added item). Item four asked if the child takes a nap and the answer options were yes, no, or sometimes.

Items five to seven represented questions related to the child's nutrition intake. The fifth and sixth items asked questions related to eating with the family pattern, and answer options were yes, no, or sometimes. Item seven comprised a short food frequency questionnaire (FFQ) without asking the portion size. The item asked about the frequency of consuming 22 different foods. The answer options to item seven were daily, weekly, monthly, occasionally, and never. Item eight consisted of one-day dietary recall.

Family nutrition and physical activity. Family nutrition and physical activity patterns were assessed with the Arabic version of the Family Nutrition and Physical Activity (FNPA) screening tool (Tami, Reed, Trejos, Boylan, & Wang, 2015). The Arabic version of FNPA is a 10-item Likert scale questionnaire, with number one represents negative or more obesogenic family environment and number four represents positive or less obesogenic family environment. The instrument tests variables related to the family meals, family eating practices, food choices, beverage choices, restriction/reward, screen time, healthy environment, family activity, child activity, and family schedule/sleep routine. The Arabic version of the FNPA was pilot tested among 25 Arab mothers of children aged 6 to 12 years and showed acceptable reliability ($r = .80$, Cronbach's alpha= .58 - .59) and content validity (Tami et al., 2015).

The original FNPA (2007) was developed in English at Iowa State University in partnership with the American Dietetic Association (Ihmels, Welk, Eisenmann, & Nusser, 2009). The FNPA was found to demonstrate good reliability ($\alpha = 0.72$) and reflect essential elements of family behaviors and environment that associate with risks for obesity among children in the first grade (Ihmels et al., 2009). Further validity testing was performed for children with ages ranging between 5 and 18 years and promising findings suggesting that the tool is truly examining the familial risk factors to children overweight were documented (Johnson, Welk, Saint-Maurice, & Ihmels, 2012; Tucker et al., 2016; Kimbo E Yee, Eisenmann, Carlson, & Pfeiffer, 2011).

The FNPA website provides multiple versions of the FNPA screening tool; original FNPA (2007), FNPA Behaviorally Anchored Rating (BAR) Scales, four points 20-item FNPA, and updated FNPA (2017). The developers confirmed that the content was the same despite some of the words change (FNPA, n.d). The Arabic version of the FNPA we used in this study was translated from the FNPA BAR Scales (Appendix D). Permission has been granted to use the tool (Appendix E)

The FNPA has no cut points or thresholds for determining healthy versus unhealthy home environments. A higher total FNPA score reflects more favorable family practices, and a lower total FNPA score reflects less favorable family practices (Ihmels, Welk, Eisenmann, Nusser, & Myers, 2009). Peyer (2016) reported that first-grade school children with FNPA scores in the lowest third were significantly more likely to be overweight or obese than first-grade school children with FNPA scores in the highest third (Peyer, 2016).

Single day dietary recall. The mother was asked to recall the type and amount of food and drinks consumed by the child in the previous 24 hours. To enhance the nutrition intake recall, the mothers were asked to maintain a previous weekday dietary record for their children before they come for data collection (Johnson, Driscoll, Goran, 1996). Also, the mothers were encouraged to take photographs of food eaten by their children with their phone cameras to help recall the portion size.

In this study, dietary recalls were conducted through a structured interview with the child's mother. Considering the differences in the nutrition intake between weekday and weekend, mothers were interviewed Monday through Thursday to collect a weekday dietary recall. The weekends in Oman are Fridays and Saturdays.

The interview was based on the Automated Self-Administered 24-hour (ASA24) Dietary Assessment Tool (ASA24-2016 version) that was developed by the National Cancer Institute (NCI). The ASA24 asks detailed questions about food preparation, portion size, and additions. It is a freely available web-based tool that permits multiple, automatically coded self-administered 24-hour recalls (Thompson et al., 2015). The ASA24 (2016 version) for the U.S. was designed to be completed by respondents in English or Spanish. To adapt the tool for participants in this study, a bilingual (i.e. English and Arabic) research assistants (RA) with background in nutrition science along with the researcher conducted the interview with the child's mother at the site to collect and enter the nutrition information in the system instead of the mother (Zoellner, Anderson, & Gould, 2005). This has addressed challenges including English language proficiency, the availability of internet access at respondents' home, navigating the passes in the program, computer literacy, educational level, and age of respondents (Ettienne-Gittens et al., 2013; Kirkpatrick et al., 2017). The researcher was able to recruit three RAs and they were all nutrition major graduates.

Procedures

School Sites Recruitment

After the study was approved by the ethical research committee at the Technical Office for Research and Development at the Ministry of Education in Oman, the General Directorate of Education in Muscat Governorate sent official letters to public cycle one schools in Al-Seeb province asking them to facilitate the researcher research task (Appendix F). In addition, the researcher received a copy of the letter. With that letter, the researcher approached the public cycle one schools targeted and met with the school principal to discuss the study and schedule the data collection days in that school. Also, the researcher asked for a room in the school to be used for the research, and all school principals in the schools approached were collaborative and supportive. The room was used to receive the potential participants, sign the necessary consent and assents forms, and collect study data. The rooms were checked and arranged before the first data collection day.

Participant Recruitment

The main recruitment strategy used in this study was sending an invitation message to mothers through the social media (i.e., WhatsApp). The invitation message included details about the study, who could participate, what would be involved if a mother and child decided to participate, an overview of any risks or potential benefits, the dates and times of consenting and data collections at each site, and the researchers contact number (Appendix G). In the school setting, the researcher asked the principal and social worker to distribute the invitation through shared WhatsApp forums with the mothers. In addition, the same invitation message was printed and distributed as hard copy invitation letters to mothers through the school children. The researcher with the assistance of school social worker distributed study invitation letters to school children one week before the start of data collection in that school. The researcher briefly and simply explained the study to the children and asked them to hand the letters to their mothers. For the community recruitment, the researcher collaborated with active female members of each community to help to share the invitation message with mothers in each community. Willing participants were asked to come to the specified data collection site during the specified dates and times to sign a consent or assent forms, take the anthropometric measurements, fill out the study questionnaires, and provide child's previous day dietary recall.

Obtaining Mothers Consent and Children Assent

Mothers and children interested in participating in the study were asked to come to the data collection site at the specified dates and times. At the site, the researcher greeted the potential participants and discussed the consent and assent forms (Appendix H & I), the risks and benefits of participating in the study, and answered all questions. Based on the National Institute of Health guidelines (NIH) (NIH, 2016), children participants in our study were required to assent. Then the researcher screened the mother and her child for eligibility according to the study inclusion criteria. When the mother and child were both eligible, the researcher asked the mother to consent and child to assent.

Data Collection

In the recruitment invitation message/ letter, dates and times for data collection were indicated for each site. The data collection was four days a week, Monday through Thursday since Friday and Saturday were the weekends in Oman and Sunday was not an appropriate day for previous weekday dietary recall. In the schools setting, the data collection lasted one to four days during the school hours. However, each community site was visited once (only two sites were visited twice) and the times were mostly after school hours.

Study invitation message and letters were distributed days before the start of data collection in each site. Reminders to mothers were sent throughout the data collection week through the "WhatsApp" forum and school children. There were two separate times a day for data collection to accommodate the circumstances of working and non-working mothers. The first time was during school hours and the second time was after school hours

At each data collection site, the researcher introduced herself to the mothers and then handed a consent form to the mothers and assent form to the children. The researcher gave participants enough time to read through the consent and assent forms and was available for any question or concerns.

After the mother consented and child assented, the researcher assigned a code to each family and directed the mother and her child to the anthropometric measurements station where a trained RA measured the weight and height for both mothers and children and documented them in a coded piece of paper. From the anthropometric station, the mother and child were directed to the questionnaires station where another RA received the participants, entered the code and documented anthropometric measurements in the study questionnaire, and asked the mothers to fill out the rest of the study questionnaire. Researcher and RAs were available to help mothers with filling out the questionnaire when needed.

The study questionnaire included a demographic data survey, child nutrition and physical activity pattern instrument, and family nutrition and physical activity pattern instrument and was introduced to participants as an electronic copy built in with an online survey tool (i.e., Qualtrics program). In our study, we borrowed two laptops from the Information Technology (IT) department of the College of Nursing at Sultan Qaboos University in Oman and were able to have three tablets at the data collection sites. Access to the Internet was arranged by the researcher with portable Internet modem.

The RAs interviewed the mothers to collect the children's previous-day dietary recall right after the mothers filled out the study questionnaire and most of the time, children were available to assist with the recall. Mothers were asked to report all foods and drinks consumed by their children on the previous weekday from a list of food and drink terms derived from the National Health and Nutrition Examination Survey (NHANES) (Nguyen, Risbud, Chambers, & Thomas, 2016). Few meals that were not recognized by the tool such as Omani meals were matched with the most similar meal available in the program. Those meals and their matches were frequently reviewed with the RAs to maintain consistency in data entering.

Data Management

The participants were assigned unique numeric codes, and no identifying information such as names or birth dates were asked of participants. The consent and assent forms were provided in hard copies, as a handwritten signature was required. All paper data were locked in a file cabinet behind a locked door in the researcher research office. Study data entry was web-based and password protected. Analysis data were stored electronically in password-protected laptops. Only the researcher and the dissertation committee members were able to access the data. No electronic data were saved in the laptops or tablets used for data collection.

Data Analysis

Analysis of Study Variables

Univariate analysis was used to examine each of the study variables through looking at each variable descriptive statistics including mean, standard deviation, and range for continuous variables and frequency tables for categorical/dichotomous variables.

BMI z- score. Children's anthropometric measurement of height and weight were converted to BMI z-scores. In addition to the continuous z-score, we identified weight status based on 2007 WHO growth charts for children and adolescents age 5-to-19 years (categorical variable). For the categorical variable, we had three groups: thin/severely thin (BMI z-score <-3 - -2), normal weight (BMI z-score -2 - 1), overweight/ obese (BMI z-score >1).

Nutrition intake. The short Food Frequency Questionnaire (FFQ) and a single day 24-hours dietary recall provided the child nutrition intake data. The short FFQ provided intake frequency of specific food groups (whole grains, refined grains, vegetables, fruit, meat & alternatives, legumes, milk, dairy, and fat). Each food group intake frequency was described as daily, weekly, monthly, occasionally, or never (categorical variable). The 24-hour recall allowed estimation of single day total calories, macronutrient (carbohydrates, protein, and fat), and main food groups (grains, fruits, vegetables, protein food, and dairy) intake. The ASA-24 program assigns food codes to nutrition information entered from the USDA Food and Nutrient Database for Dietary Surveys (FNDDS). Based on the USDA FNDDS, the USDA MyPyramid Equivalents Database, and the NHANES Dietary Supplement Database available in the ASA24 program, detailed information and analysis were provided about individual-level nutrients and food group estimates. In this study, we focused on children total energy, carbohydrates, protein, fat, and main food group intake (continuous variable). In addition, the children's energy intake was compared with the Omani Guide to Healthy Eating and the 2015-2020 Dietary Guidelines for Americans (MOH, 2009 & USDA, 2015). The energy intake was then described as under, adequate, or over (categorical variable).

Physical activity pattern. Data related to children's MVPA time and screen time per day, in addition to the night sleep time in a day, were gathered from the children nutrition and physical activity pattern instrument. MVPA time in minutes per week and screen time in minutes per week were calculated and divided by seven to represent daily MVPA and screen times (continues variable). The children's MVPA and screen time per day were also described as either adequate or inadequate, depending on how they compare to the WHO recommendations. For school-aged children and adolescents, WHO specifically recommends one hour of daily MVPA and limiting screen time to two hours a day (WHO, 2014). Sleep time was identified from the child's nutrition and physical pattern instrument and was described as categorical.

Maternal BMI. Anthropometric measurement of mother's height and weight were used to calculate maternal BMI values (continuous), and the weight category (categorical) was identified according to the international adult WHO classification.

Parental educational level. The mothers' and fathers' levels of education were identified from the study socio-demographic survey. The mothers' and fathers' level of education was described as do not know how to read and write, reads and writes, primary 1^{st} - 6^{th} grade, preparatory 7^{th} - 9^{th} grade, secondary 10^{th} - 12^{th} grade, diploma, bachelor degree, and postgraduate (categorical variable).

Parental working status. The mothers' and fathers' working statuses were identified from the study socio-demographic survey. The mothers' and fathers' working statuses were described as working in public sector, the private sector, military sector, free business, retired, and not working/housewife (categorical variable).

Family income. The family income per month was identified from the study socio-demographic survey and was described as a categorical variable.

Family nutrition and physical activity pattern. The family nutrition and physical activity pattern score were obtained from summing up the numbers assigned to each of the ten FNPA items. The FNPA score is a continuous variable ranging from 10 to 40 points. Also, two questions related to children eating with the family pattern were described as categorical variables. Table 3.2 details the analysis plan of each study variables.

Table 3.2. Study Variables Descriptive Analysis Plan

Study Variable	Variable type	How to measure	How to score	How to be treated
BMI z-score	Outcome variable (dependent)	Anthropometric measurement of height and weight, converted to z-score and weight status based on WHO standards	(1) z- score (2) Weight category	Continuous Categorical (thinness/ sever thinness [BMI z score <-3 - <-2], normal weight [BMI z score -2 – 1], overweight/obese [BMI z score >1])
Nutrition intake	Outcome variable (dependent)	FFQ from Children Nutrition and Physical Activity Pattern instrument & single day dietary recall	(1) Food group intake frequency (whole grains, refined grains, vegetables, fruits, meat & alternatives, legumes, milk & dairy, fat) (2) Daily total calories, macronutrient (carbohydrates, protein, fat), main food groups (grains, fruits, vegetables, protein food, and dairy)	Categorical (daily, weekly, monthly, occasionally, never) Continuous; Categorical (under, adequate, over)
Physical activity	Outcome variable (dependent)	MVPA, screen time, and sleep time per day from Children Nutrition and Physical Activity Pattern instrument	MVPA & screen time (minutes) per day Sleep time range (hours per night)	MVPA and screen time continuous and dichotomous (adequate, inadequate) Sleep time categorical (less than 9, 9-11, more than 9)
Maternal BMI	Predicting variable (independent)	Anthropometric measurement of height and weight, WHO international classification of adult weight category	(1) BMI (2) Weight category	Continuous Categorical (underweight [BMI< 18.5], normal weight [BMI 18.5- 24.99], overweight/obese [BMI >=25])

Study Variable	Variable type	How to measure	How to score	How to be treated
Parental educational level	Predicting variable (independent)	Socio-demographic data	Level of education	Categorical (do not know how to read and write, reads and writes, primary 1-6th grade, preparatory 7-9th grade, secondary 10-12th grade, diploma, bachelor degree, postgraduate)
Parental working status	Predicting variable (independent)	Socio-demographic data	Working status	Categorical (public sector, private sector, military sector, free business, retired, not working/housewife)
Family income	Predicting variable (independent)	Socio-demographic data	Family income per month in Omani Rial (OR)	Categorical (<500, 500-1000, 1000-3000, 3000 – 5000, > 5000 OMR)
Family nutrition and physical activity patterns	Predicting variable (independent)	Family Nutrition and Physical Activity screening tool (FNPA)	Tool score: 10- 40	Continuous
Eating with family	Predicting variable (independent)	Children Nutrition and Physical Activity Pattern instrument	Two questions related to eating with the family pattern	Categorical (yes, sometimes, no)

Analysis of Study Aims

Aim 1: Assess the relationship between BMI z- score, nutrition intake, and physical activity pattern of 1st to 4th-grade Omani children.

For aim one, bivariate and regression analysis were implemented. A bivariate and multivariate analysis examined the relationship between children's BMI z-scores/weight status and nutrition intake and between children BMI z-scores/ weight status and physical activity. Methods including correlations, t-tests, chi-square test, multiple linear regression, and logistic regression were implemented to test these relationships.

Aim 2: Examine the relationship between the nutrition intake of 1st to 4th-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Bivariate and multivariate analysis was implemented to test individual and multiple relationships under aim two. The bivariate analysis tested the relationship between children's nutrition intake and family factors (maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity pattern) with methods including correlations, t-tests, and chi-square test.

Child nutrition intake was described by both continuous and categorical variables. Therefore, linear and logistic regression models were built to identify the family predictors of children nutrition intake controlling for age and gender.

Aim 3: Examine the relationship between the physical activity patterns of 1st to 4th-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

This analysis proceeded as in aim two, but the outcome was children's physical activity (described with continuous and categorical variables) instead of children's nutrition intake.

Aim 4: Examine the relationship between the BMI z- score of 1st to 4th-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

This analysis proceeded in aim two, but the outcome was children's BMI [continuous] and weight status [categorical]) instead of children's nutrition intake.

Summary

This chapter has detailed the methods used in this quantitative study to examine the relationship between Omani children's BMI z-score and nutrition and physical activity patterns in addition to examining Omani children's BMI z-score, nutrition intake, and physical activity patterns in relation to maternal BMI, parental education level, parental working status, family income, and family nutrition and physical activity patterns. The study aims, philosophical assumptions, design, settings, sample, variables and their measurement, procedures for site and participant's recruitment, data collection and management, and data analysis strategies were discussed.

CHAPTER 4: RESULTS

Introduction

Childhood obesity is a new public health problem in Oman. Descriptive studies are necessary to understand the problem for effective intervention studies. This study examined the weight status, nutrition intake, and physical activity patterns of six-to-ten years old Omani children (grades one to four) and how they were influenced by family factors. Descriptive, correlation, independent t-test, chi-square, and regression analysis results are detailed in this chapter.

Aims

This study had four specific aims. The first aim was to assess the relationship between BMI z- score and nutritional intake and physical activity patterns of first to fourth-grade Omani children. The second aim was to examine the relationship between the nutritional intake of first to fourth-grade Omani children and maternal body mass index (BMI), parental educational level, parental working status, family income, and family nutrition and physical activity patterns. The third aim was to examine the relationship between the physical activity patterns of first to fourth-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns. The fourth aim was to examine the relationship between the BMI z- score of first to fourth grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Descriptive Data Analysis

Recruitment and Settings

In this study, 204 mothers and 204 children (n = 408) were enrolled. Data were collected between December 11th, 2017 and January 24th, 2018. The original plan was to recruit participants from six public cycle one schools (grades one to four) in Al-Seeb province in Oman. However, because of the mothers' low response rate and many children being absent from school three weeks before the end of the semester, a couple of modifications were implemented. A total of four more provinces and two more settings were added. The provinces included Bawsher, Fanja, Nizwa, and Ibra and non-governmental community centers (female Masjids/ Quran schools) and homes were added as data collection settings.

In total, study participants were recruited from five public cycle one schools in Al-Seeb (Al-Tafaweq, Al-Mahamed, Al-Nubogh, Al-Mashareq, and Al-Ethra schools), seven non-governmental community centers in Al-Seeb and Fanja provinces and six home visits in Al-Seeb, Bawsher, Nizwa, and Ibra provinces. Table 4.1 shows the number of enrolled participants from each province.

Table 4.1. The Provinces Reached for Participants Recruitment

Province	Frequency (%)
Al-Seeb	153 (75.0)
Bawsher	3 (1.5)
Fanja	13 (6.4)
Nizwa	12 (5.9)
Ibra	23 (11.3)
Total	204 (100.0)

Sample

A total of 204 dyads (a mother with her child) participated in this study. However, three families were non-Omani, and one family had a child who was four years of age. To comply with the study inclusion criteria, those four mother-child dyads were excluded from the analysis. Also, the electronic questionnaire data for three mother-child dyads were lost, most likely due to an incomplete submission. Therefore, a total of 197 families were included in the final study analysis. See Table 4.2.

Table 4.2. Children's Characteristics (N=197)

General Characteristics	Frequency (%)
Age	
6	32 (16.2)
7	57 (28.9)
8	51 (25.9)
9	45 (22.8)
10	12 (6.1)
Mean (±SD)	7.74 (±1.161)
Gender	
Male	93 (47.4)
Female	103 (52.6)
School Type	
Public	187 (94.9)
Private	10 (5.1)
Grade	
First	47 (24.1)
Second	51 (26.2)
Third	58 (29.7)
Fourth	39 (20.0)
Original Governorate	
Muscat	75 (38.1)
Al-Batina South	8 (4.1)
Al-Batina North	8 (4.1)
Al-Buraimi	2 (1.0)
Al-Dahira	3 (1.5)
Al-Sharqia North	42 (21.3)
Al-Sharqia South	10 (5.1)
Al-Dakhilia	49 (24.9)

Notes. Missing cases within gender (n=1) and grade (n=2), Percent does not include missing cases

The mean age of the children was 7.74 years (SD ± 1.161), and the majority (53%) were female (Table 4.2). Approximately 95% of the children were studying in public schools. Private schools were not used for recruitment. The children from grades one to four ranged from 39 to 58 in each grade level. The majority (38.1%) of children were from Muscat, followed by Al-Dhakhilia (24.9%), and North Al-Sharqia (21.3%) Governorates.

Family Socioeconomic Characteristics

The majority (98%) of the children's parents were married (Table 4.3). Parental educational levels showed that more fathers attained a postgraduate degree (18.9%) compared to mothers (5.6%). Also, more fathers (12.2%) had less than a high school education compared to mothers (8.2%). In general, more mothers had a high school education or held either a diploma or a bachelor degree compared to fathers (36.2% versus 25.0%, 20.4% versus 15.8%, and 29.6% versus 28.1%), respectively.

Approximately half (45.4%) of the mothers identified themselves as homemakers, and 9.7% of the mothers were retired. A majority (93.3%) of fathers reported working in either public, private, military sectors or owned an independent business. Almost half (47.2%) of the families reported earning a monthly income that ranged between $1,000 to $3,000 Omani Rial (OMR), which is equivalent to $2,600 - $7,800 in U.S. dollars (Table 4.3).

Table 4.3. Family Socioeconomic Characteristics (N=197)

Socioeconomic Characteristics	Frequency (%)
Parents Marital Status	
Married	192 (98.5)
Divorced	2 (1.0)
Widower	1 (.5)
Mother's Highest Level of Education	
Can't read or write	1 (.5)
Read and write	3 (1.0)
Primary (1 – 6th grade)	8 (4.1)
Preparatory (7 – 9th grade)	5 (2.6)
High School (10 - 12th grade)	71 (36.2)
Diploma	40 (20.4)
Bachelor degree	58 (29.6)
Postgraduate	11 (5.6)
Father's Highest Level of Education	
Can't read or write	1 (.5)
Read and write	1 (.5)
Primary (1 – 6th grade)	4 (2.0)
Preparatory (7 – 9th grade)	18 (9.2)
High School (10 - 12th grade)	49 (25.0)
Diploma	31 (15.8)
Bachelor degree	55 (28.1)
Postgraduate	37 (18.9)
Mother's Job	
Public sector	70 (35.7)
Private sector	14 (7.1)
Military sector	2 (1.0)
Business	2 (1.0)
Retired	19 (9.7)
Homemaker	89 (45.4)
Father's Job	
Public sector	79 (40.9)
Private sector	43 (22.3)
Military sector	44 (22.8)
Business	14 (7.3)
Retired	12 (6.2)
Not working	1 (0.5)
	2
Family Income (OMR per month)	
Less than 500	14 (7.2)
500 – 1000	78 (40.0)
1000 – 3000	92 (47.2)
3000 – 5000	9 (4.6)
More than 5000	2 (1.0)

Notes. Missing cases within parents' marital status (n=2), mother's highest level of education (n=1), father's highest level of education (n=1), mother's job (n=1), father's job (n=4), and family income (n=2). Percent does not include missing cases

Anthropometric Measurements

All children's weight and height were measured according to an established protocol. However, two mothers refused to be weighed, and one adult was not the child's mother but an aunt who lived with the family, and so her anthropometrics were not collected. Also, six mothers were pregnant during the data collection time, and their anthropometric measurements were excluded. Children's and mothers' weight was measured using the SECA 877 Class III weight scale, while height was measured using the SECA 213 Freestanding Height Meter. Height and weight were measured twice for both the children and their mothers.

For the analysis, we computed the average height and weight, and then BMI and BMI- z-scores based on the 2007 WHO growth reference for children ages 5-to-19 years. The results showed that the mean BMI z-scores of children were -.22 (SD ±1.47) and the mean BMI for mothers (n=188) was 28.7 (SD ±5.5). See Table 4.4.

Table 4.4. Children and Mothers Anthropometric Data (N=197)

	Child			Mother		
	Range	**Mean (±SD)**	**n**	**Range**	**Mean (±SD)**	**n**
Weight (kg)	15.35 - 60.00	25.00 (±7.86)	197	39.80 - 112.00	69.80 (±14.21)	188
Height (cm)	104.2 - 144.8	123.48 (±8.11)	197	140.7 - 171.1	155.88 (±5.36)	190
BMI	9.87 - 32.08	16.13 (±3.36)	197	16.13 - 44.42	28.71(±5.52)	188
BMI z-score	-5.72 - 3.87	-.215 (±1.47)	196	-	-	-

Notes. Missing mothers cases within weight (n=3+6 pregnant), height (n=1+6 pregnant), and BMI (n=9)

Based on the 2007 WHO growth reference for children and adolescents ages 5 to 19 years old, 5.6% of children were severely thin or thin and 17.4% of children were either overweight or obese. Interestingly, more than 72% of mothers were found to be overweight or obese (Table 4.5).

Table 4.5. Children's and Mothers' Body Mass Index (BMI) Classification

Weight Status Classification	Children[1] (n=196) Frequency (%)	Mother[2] (n=188) Frequency (%)
Underweight (thinness/ severe thinness)	11 (5.6)	5 (2.7)
Normal	151 (77.0)	47 (25.0)
Overweight	18 (9.2)	68 (36.2)
Obesity	16 (8.2)	68 (36.2)

Notes. 1-2007 WHO growth charts for children and adolescents age 5 - 19 years (severe thinness as a z-score less than -3, thinness as a z-score between -3 and less than -2, normal weight as a z-score between -2 and 1, overweight as a z-score between greater than 1 and 2, and obesity as a z-score greater than 2), 2-International adult WHO classification (underweight as a BMI less than 18.5, normal weight as a BMI between 18.5 and 24.99, overweight as a BMI between 25 and 29.99, and obesity as a BMI is more or equal to 30).

Nutrition Intake

Children's nutrition intake was assessed using the food frequency questionnaire (FFQ) and a single day (weekday) dietary recall.

Food frequency of intake. Children's food frequency intake was assessed with the FFQ questionnaire (22 food groups). The mothers were asked to select one out of five different frequencies (daily, weekly, monthly, occasionally, never) for each food group (Table 4.6).

The analysis showed that most children were consuming whole grain foods on a daily (35%) or weekly (39%) basis. However, 81% of children consumed refined grains on a daily basis. A total of 73% of children ate vegetables rich in vitamin C (e.g., sweet pepper, tomato sauce, broccoli, beets, and radishes) and 83% ate vegetables rich in vitamin A (e.g., lettuce, cabbage, carrots, pumpkins, squash, and green peas) on a daily or weekly basis. However, 65.8% of children were reported to eat vegetables rich in iron or folic acid (e.g., spinach, parsley, and corchorus) monthly, occasionally, or never. According to the mothers, 88% of children were consuming other kinds of vegetables (e.g., onions, okra, cucumbers, eggplant, and garlic) daily or weekly.

Table 4.6. Food Frequency of Intake (N= 197)

Frequency (%)	Daily	Weekly	Monthly	Occasional	Never
Whole grains	68 (34.9)	76 (39.0)	29 (14.9)	11 (5.6)	11 (5.6)
Other grains	158 (81.0)	29 (14.9)	6 (3.1)		2 (1.0)
Vegetables rich in vitamin C	80 (41.7)	60 (31.3)	14 (7.3)	3 (1.6)	35 (18.2)
Vegetables rich in vitamin A	94 (48.5)	67 (34.5)	10 (5.2)	4 (2.1)	19 (9.8)
Vegetables rich in iron/folic acid	20 (10.5)	45 (23.7)	38 (20.0)	8 (4.2)	79 (41.6)
Other vegetables	139 (72.8)	29 (15.2)	10 (5.2)		13 (6.8)
Fruits rich in vitamin C	62 (32.5)	79 (41.4)	31 (16.2)	9 (4.7)	10 (5.2)
Fruits rich in vitamin A	20 (10.3)	85 (43.8)	59 (30.4)	20 (10.3)	10 (5.2)
Fruits rich in potassium	97 (50.3)	69 (35.8)	10 (5.2)	3 (1.6)	14 (7.3)
Other fruits	91 (46.7)	81 (41.5)	12 (6.2)	5 (2.6)	6 (3.1)
Meat	5 (2.5)	160 (81.2)	19 (9.6)	9 (4.6)	4 (2.0)
Fish	18 (9.2)	166 (85.1)	2 (1.0)	1 (.5)	8 (4.1)
Chicken	29 (14.8)	162 (82.7)	2 (1.0)	1 (.5)	2 (1.0)
Eggs	53 (27.3)	129 (66.5)	7 (3.6)	1 (.5)	4 (2.1)
Nuts and seeds	31 (16.1)	91 (47.2)	48 (24.9)	19 (9.8)	4 (2.1)
Fast preparation products	6 (3.1)	68 (34.7)	73 (37.2)	32 (16.3)	17 (8.7)
Legumes	7 (3.6)	125 (64.4)	31 (16.0)	7 (3.6)	24 (12.4)
Dairy	155 (79.9)	30 (15.5)	6 (3.1)		3 (1.5)
Addition of oil	139 (71.3)	41 (21.0)	5 (2.6)		10 (5.1)
Addition of fat/butter	65 (34.0)	66 (34.6)	17 (8.9)	12 (6.3)	31 (16.2)
Sweets	46 (23.6)	102 (52.3)	34 (17.4)	12 (6.2)	1 (.5)
Soft and sugary drinks	49 (25.0)	56 (28.6)	30 (15.3)	43 (21.9)	18 (9.2)

Notes. Missing cases within whole grains (n=2), other grains (n=2), vegetables rich in vitamin c (n=5), vegetables rich in vitamin a (n=3), vegetables rich in iron/folic acid (n=7), other vegetables (n=6), fruits rich in vitamin c (n=6), fruits rich in vitamin a (n=3), fruits rich in potassium (n=4), other fruits (n=2), fish (n=2), chicken (n=1), eggs (n=3), nuts and seeds (n=4), fast preparation products (n=1), legumes (n=3), milk and milk products (n=3), addition of oil (n=2), addition of fat/butter (n=6), sweets (n=2), soft and sugary drinks (n=1), Percent does not include missing cases

In regards to fruit intake frequency, 74% of children were reported to consume fruit rich in vitamin C (e.g., citrus fruit, pineapple, guava, cherry, and raspberry) on a daily or weekly basis. Similarly, 86% of children were reported to consume fruit rich in potassium (e.g., raisins, dried figs, dates, bananas, and melons) daily or weekly. However, the percent of children eating fruit rich in vitamin A (e.g., mango, papaya, apricot, plum) daily or weekly was lower (54%). Other kinds of fruit (e.g., coconut, grapes, apples, pears, and figs) were consumed daily or weekly by 88% of children.

The majority of children consumed meat (81.2%), chicken (82.7%), and fish (85.1%) at least every week. Approximately 94% of mothers reported that their children ate eggs every day or every week. Much lower percentages were reported for nuts and seeds (47.2%) and legumes (64.4%) every week. However, about 80% of children consumed dairy every day.

Interestingly, more than the half of children (62.2%) were consuming fast prepared food (e.g., canned meat, fish or chicken, shawarma, kebab, frozen ready to eat chicken nuggets or fingers) only monthly, occasionally or never. The percentage of children drinking soft or sugary drinks daily or weekly was approximately half (53.6%). However, more children (76%) were consuming sweets (ready or prepared at home) daily or weekly.

Single day energy, macronutrients, and main food group intake. Children's energy and macronutrient intake in addition to total grains, fruit, vegetables, protein food, and dairy intake were obtained from a previous day (weekday) dietary recall. The dietary recall was collected through an interview with the child's mother based on a web-based dietary recall program called Automated Self-Administered (ASA24) 24 hours dietary assessment tool. The ASA24 U.S. 2016 version was used in this study. The program automatically generates an analysis file containing detailed information about each participant's nutrition intake. From this file, participants' total energy (kilocalorie [kcal]), protein (gram [g]), total fat (g), carbohydrate (g), total grains (ounce [oz]), total fruit (cup), total vegetable (cup), total protein food (ounce [oz])), and total dairy (cup) data were extracted.

The results showed that children's energy intake ranged from 613 to 3,736 kcal a day (m= 1,770, SD ±563.5). The children's mean intake of protein, total fat, and carbohydrate was 65.0, 58.6, and 250.2 grams, respectively. The children's average intake of total grains was 7.6

oz, while the average intake of total protein was 4 oz. The mean intake of total fruit, total vegetable, and total dairy among children was 1.4, 1.5, and 1.3 cups, respectively (Table 4.7).

Table 4.7. Single Day Energy, Macronutrient, and Main Food Groups Intake (N=197)

Nutrition Intake	Range	Mean	Median	Standard Deviation (±SD)
Energy (kcal)	613 – 3736	1770	1694	563.5
Protein (g)	15.4 - 190.4	65.0	61.6	26.6
Total Fat (g)	15.3 - 151.5	58.6	55.4	23.7
Carbohydrate (g)	55.6 - 557.2	250.2	236.4	87.0
Grains (oz)	.58 - 26.4	7.6	7.0	3.9
Fruits (cup)	.00 - 5.5	1.4	1.1	1.2
Vegetables (cup)	.00 - 5.6	1.5	1.3	1.1
Protein Food (oz)	.00 - 18.8	4	3.3	3.0
Dairy (cup)	.00 - 5.1	1.3	1.1	1.0

The total energy intake (kcal) was compared against two dietary guidelines, the Omani Guide to Healthy Eating (Ministry of Health, 2009, Table 4.8) and the 2015-2020 Dietary Guidelines for Americans (U.S. Department of Agriculture, 2015, Table 4.8). To make the energy intake comparison more practical, a range was set (±100 kcal) for each guideline recommended energy intake according to age and gender.

Table 4.8. Recommended Energy Intake Based on the 2015-2020 Dietary Guidelines for Americans and Omani Guide to Healthy Eating

Age/Gender	6 - 8 years	9 - 10 years
Female	1200[1]	1600[1]
	1400[2]	1900[2]
Male	1400-1600[1]	1800[1]
	1400[2]	2000[2]

Notes. 1- 2015-2020 Dietary Guidelines for Americans. 2- Omani Guide to Healthy Eating

The comparison of results indicated that the single day energy intake of 13.3% of children was within the recommended range according to the Omani Guide to Healthy Eating. However, the percentage was higher (20%) when the children’s energy intake was compared to the 2015-2020 Dietary Guidelines for Americans. More than half of children consumed kilocalories above the two guidelines recommendation levels. See Table 4.9.

Table 4.9. Energy Intake Compared to the Guidelines (n=196)

Energy Intake	Frequency (%) 2015-2020 Dietary Guidelines for Americans	Frequency (%) Omani Guide to Healthy Eating
Within Range	39 (19.9)	26 (13.3)
Under	45 (23.0)	68 (34.7)
Over	112 (57.1)	102 (52.0)

Notes. One case missed because child gender was not reported, Percent does not include missing case

Physical Activity Patterns

In this study, the children's physical activity patterns were evaluated using the moderate to vigorous physical activity (MVPA) time, screen time, and night sleep time. The MVPA was assessed by asking the mothers to estimate the frequency (per week) and the duration (in minutes per day) of a number of moderate to vigorous physical activities including riding bicycles, playing football (soccer), basketball, tennis, swimming, jumping rope, and jogging.

Mothers were asked to estimate the frequency (per week) and duration (in minutes per day) of a number of non-active or sedentary behaviors including watching television (TV) or video, playing video games, computer or internet use, school homework, playing inside the house (non-actively), reading, and drawing.

The mothers were also asked about their child's sleep pattern. The first question asked the mothers to select an answer for the number of hours the child sleeps during the night. The answers were less than 9 hours, 9-to-11 hours, and more than 11 hours, which were based on the National Sleep Foundation for the number of night sleep hours for children ages 6-to-11 years (National Sleep Foundation, 2018). The second question asked whether their child naps with possible answers of yes, no, or sometimes.

For the analysis, the frequency of each activity was multiplied by the activity estimated duration (minutes per day). For example, if the mother reported that her child played football four days a week for 60 minutes a day, we multiplied 4 by 60. Then, the time spent on each specific activity in a week were summed to estimate the total child's MVPA time (in minutes) per week. The child's MVPA time (in minutes) per day was calculated by dividing the total MVPA time (in minutes) in a week by seven. The same calculation principle was applied for screen time (TV, video, playing video games, computer, internet). Based on these calculations and analysis output, the children's (n=185) mean MVPA time was 61.41 minutes per day (SD $\pm$ 63.72), while the mean screen time was 63.04 minutes per day (SD $\pm$ 68.55, Table 4.10).

Table 4.10. Children's MVPA and Screen Times Means (N=197)

Activity Pattern	N	Range	Mean	Median	SD
MVPA (minutes per day)	185	0 - 360	61.4	43.6	63.7
Screen time (minutes per day)	187	0 - 364.3	63	38.6	68.6

Notes. Missing cases within active time (n=12), non-active time (n=17), screen time (n=10)

Children's MVPA and screen time data were then dichotomized according to the WHO (2014) recommendations (MVPA = 60 minutes or more a day, less than 60 minutes a day; screen time = 120 minutes or less a day, more than 120 minutes a day). A total of 59% of the children were found to practice MVPA less than 60 minutes a day, which did not meet the recommendation. Only 16% of children had more than 120 minutes of screen time a day, which did not meet the recommendation. A total of 75% of children were reported to sleep for at least nine hours a night, and 45.7% of children were not taking a nap during the day (Table 4.11).

Table 4.11. Children Physical Activity Pattern (N= 197)

Activity Pattern	Frequency (%)
MVPA (minutes per day)	
More or equal to 60	76 (41.1)
Less than 60	109 (58.9)
Screen time (minutes per day)	
Less or equal to 120	157 (84.0)
More than 120	30 (16.0)
Sleep time (hours per night)	
Less than 9	49 (24.9)
9 - 11	143 (72.6)
More than 11	5 (2.4)
Nap	
Yes	36 (18.3)
No	90 (45.7)
Sometimes	71 (36.0)

Notes. Missing cases within moderate-level physical activity (n=12) and screen time (n=10), Percent does not include missing cases

Family Nutrition and Physical Activity Pattern

The family nutrition and physical activity pattern were assessed with the Family Nutrition and Physical Activity (FNAP) score and two multiple choice questions asking children's eating with the family.

Family Nutrition and Physical Activity (FNAP) score. The family nutrition and physical activity pattern were assessed with the Arabic version of the Family Nutrition Physical Activity (FNPA) questionnaire (Tami, Reed, Trejos, Boylan, & Wang, 2015) completed by the mothers. The questionnaire has 10 items, and each item is scored from one to four. The total FNPA score ranges from 10 to 40, with high scores indicating more favorable family nutrition and physical activity pattern. Seventeen mothers had one to three missing items, and the missing items were imputed using the average of the non-missing items. The mean total FNPA score (N=197) was 33.3 (SD ± 3.6) and ranged from 22 to 40 (Table 4.12).

Table 4.12. Family Nutrition and Physical Activity (FNPA) Scores (N=197)

	FNPA score (10-40)
Range	22 – 40
Mean *(±SD)*	33.3 *(±3.6)*
Median	34

Eating with the family. The study questionnaire included two general questions asking the mothers about their child's eating pattern with the family. The first question asked whether the child eats with the family and about 93% of the mothers answered yes, while 7% answered no or sometimes. The second question asked the mothers whether the child eats with the family from the same plate (family size), which is a common norm in Oman, and more than half of the mothers (52.6%) answered yes (Table 4.13).

Table 4.13. Eating with Family (n=196)

	Frequency (%)	
	Eat with family	**Eat with family from one plate**
Yes	182 (92.9)	103 (52.6)
No	2 (1.0)	50 (25.5)
Sometimes	12 (6.1)	43 (21.9)

Notes. Percent does not include missing case

Analysis of Study Aims

The study aims were analyzed with bivariate and regression analysis. A number of statistical tests including correlation, independent t-test, chi-square, multiple linear regression, and binary logistic regression were used to analyze the study aims. Some categories of the categorical variables had small counts in some of the cells. To preserve the ability to draw conclusions based on statistical tests, all categorical variables were recoded to binary variables as shown in Table 4.14.

Table 4.14. Modification of Categorical Variables Categories for Study Aims Analysis

Categorical variables	Before modification	After modification
Child weight status	1. Sever thinness or thinness 2. Normal weight 3. Overweight 4. Obesity	1. Normal weight or under 2. Overweight or obesity
Parental education level • Mother education level • Father education level	1. can't read or write 2. read and write 3. primary 4. preparatory 5. High school 6. Diploma 7. Bachelor 8. Postgraduate	1. Diploma or lower 2. Bachelor or higher
Parental working status • Mother working status • Father working status	1. General sector 2. Private sector 3. Military sector 4. Free business 5. Retried 6. Not working/homemaker	1. Working (general, private, military, free business) 2. Not working (retired, not working/housewife)
Family income	1. less than 500 2. 500 – 1,000 3. 1000 – 3,000 4. 3,000 – 5,000 5. more than 5,000	1. Less than 1,000 2. More than 1,000
Food frequency intake	1. Daily 2. Weekly 3. Monthly 4. Occasionally 6. Never	1. More frequent (daily and weekly) 2. Less frequent (monthly, occasionally or never)
Child sleeping time	1. Less than 9 2. 9 to 11 3. More than 11	1. Less than 9 2. 9 or more
Eating pattern • Eating with family • Eating with family from one plate	1. Yes 2. No 3. Sometimes	1. Yes 2. No or sometimes

Aim 1: Assess the Relationship between BMI z- score and Nutrition and Physical Activity Pattern of 1st to 4th-Grade Omani Children

The relationship between children's BMI z-score and nutrition intake and physical activity patterns were examined separately as follow.

Relationship between children's BMI z-score and nutrition intake pattern. The relationships between children's BMI z-score or weight status and a single day nutrition intake and food frequency of intake were examined.

Children's BMI z-score and single day nutrition intake. Children's BMI z-scores were not significantly associated with nutrition intake. Results indicated that children's BMI z-scores were poorly and non-significantly associated with intake of total energy, protein, total fat, carbohydrate, grains, fruits, vegetables, protein food, or dairy ($r = .00$ to $.08$, all $p > .05$, Table 4.15).

Table 4.15. Pearson's Correlation of Children's BMI z-score with Single Day Nutrition Intake

	Children's BMI z-scores	
	r	**p-value**
Energy (kcal)	.00	.995
Protein (g)	.08	.24
Total Fat (g)	.01	.87
Carbohydrate (g)	-.04	.58
Grains (oz)	.06	.37
Fruits (cup)	-.01	.89
Vegetables (cup)	.07	.31
Protein food (oz)	.05	.46
Dairy (cup)	.03	.69

Notes. N ranged from 185 to 197

A multiple linear regression was used to predict children's BMI z-scores from a single day nutrition intake. To avoid collinearity, three separate models were built. Children's BMI z-scores with energy intake, children's BMI z-scores with macronutrients (protein, fat, carbohydrates), and children's BMI z-scores with main food groups (grains, fruit, vegetables, protein, and dairy) models were calculated, controlling for children's age and gender. There was no significant predictor of children's BMI z-scores found (p > .05, Table 4.16).

Table 4.16. Coefficients of Single Day Nutrition Intake Predictors on Children's BMI z-Scores

	Unstandardized β	SE	p-value
Energy (kcal)	-1.04 E-5	.00	.96
Protein (g)	.01	.01	.17
Fat (g)	.00	.01	.85
Carbohydrate (g)	-.00	.00	.27
Grains (oz)	.03	.03	.37
Fruits (cup)	-.03	.09	.72
Vegetables (cup)	.08	.10	.41
Protein Food (oz)	.03	.04	.49
Dairy (cup)	.03	.11	.76

Notes. Separate models were run for energy, macronutrients (protein, fat, carbohydrates), and food groups (grains, fruits, vegetables, protein food, dairy). Children's age and gender were controlled.

Also, we fit a logistic regression model with children's weight status as the outcome and a single day nutrition intake as the predictors. Similarly, three different models were built (energy, macronutrients, and main food groups). No significant nutrition intake predictor was found for children's weight status (all p > .05, Table 4.17).

Children's BMI z-scores and food frequency of intake. A significant relationship between children's BMI z-scores and the frequency of soft and sugary drink intake was found (p = .01, Table 4.18). The mean BMI z-scores for children reported to consume soft and sugary drinks more frequently was significantly less (m = -.45, SD ± 1.37) when compared to children who were reported to consume soft and sugary drinks less frequently (m = .08, SD ± 1.51). Soft and sugary drinks intake was not significantly associated with children's weight status (p=.052), with higher consumption in normal weight, thin, or severely thin children compared to children with overweight or obesity (Table 4.19). Also, the mean BMI z-scores among children who had fat or butter added to their food more frequently was significantly (p = .02, Table 4.18) lower than the mean BMI z-scores of children who had fat or butter added less frequently. The addition of fat or butter was not significantly associated with children's weight status (p > .05). The relationships between each of the other 20 food groups and both children's BMI z-scores and children's weight status were found to be non-significant (p > .05).

Table 4.17. Coefficients of Single Day Nutrition Intake Predictors on Children's Weight Status

	Unstandardized β	**SE**	**p-value**	**Exp(B)**	**95% C.I for Exp(B)** Lower	Upper
Energy (kcal)	.00	.00	.29	1.00	.999	1.00
Protein (g)	-.00	.01	.72	.997	.98	1.01
Fat (g)	.01	.01	.50	1.01	.99	1.03
Carbohydrate (g)	-.00	.00	.19	.996	.99	1.00
Grains (oz)	-.02	.05	.76	.98	.89	1.09
Fruits (cup)	.05	.15	.75	1.05	.78	1.42
Vegetables (cup)	.16	.17	.33	1.18	.85	1.62
Protein Food (oz)	-.03	.07	.71	.97	.85	1.12
Dairy (cup)	-.10	.21	.65	.91	.61	1.37

Notes. Weight status reference group was overweight or obesity. Separate models were run for energy, macronutrients (protein, fat, carbohydrates), and food groups (grains, fruits, vegetables, protein food, dairy). Children's age and gender were controlled.

Table 4.18. Children's BMI z-score Means for Soft and Sugary Drinks and Addition of Fat or Butter Frequency of Intake

	N	**Mean BMI z-score (±SD)**	**p-value**
Soft and sugary drink			.01
1- More frequent	104	-.45 (±1.37)	
2- Less frequent	91	.08 (±1.51)	
Addition of fat/butter			.02
1- More frequent	131	-.38 (±1.48)	
2- Less frequent	59	.15 (±1.41)	

Table 4.19. Crosstabulation of Children's Weight Status and Soft and Sugary Drink Frequency of Intake

	Normal or under	Overweight and obesity	χ2	p-value
Soft and sugary drinks			3.772	.052
1- Daily or weekly	91 (87.5%)	13 (12.5%)		
2- Monthly, occasionally or never	70 (77%)	21 (23%)		

Multiple linear regression was used to predict children's BMI z-scores from the 22 foods on the food frequency questionnaire. Also, binary logistic regression was run with children's weight status as an outcome and the 22 foods frequency intake as predictors. None of the 22 items were significant predictors of children's BMI z-score or weight status ($p > .05$).

Relationship between children's BMI z-scores and physical activity patterns. The relationship between children's BMI z-scores or weight status and MVPA, screen time, and sleep time were examined.

Children's BMI z-scores and MVPA. Children's BMI z-scores were not significantly associated with MVPA time ($r = -.04$, $p > .05$, Table 4.20). Also, the mean BMI z-score was not significantly different between children reported to exercise MVPA for 60 minutes or more a day ($m = -.22$, SD $\pm$ 1.46) and children reported to exercise MVPA less than 60 minutes a day ($m = -.22$, SD $\pm$ 1.52; $p > .05$, Table 4.21). The chi-square analysis indicated no significant association between MVPA (dichotomous) and children's weight status ($p > .05$, Table 4.22).

Table 4.20. Pearson's Correlation of Children's BMI z-score with MVPA and Screen Time

	Children's BMI z-score	
	r	**p-value**
MVPA (minutes/day)	-.04	.60
Screen time (minutes/day)	.06	.39

Notes. N ranged from 185 to 197

Children's BMI z-scores and screen time. Children's BMI z-scores were not significantly associated with screen time (r = .06, p > .05, Table 4.20). The mean BMI z-scores were not significantly different among children reported to have 120 minutes or less of screen time a day (m = -.21, SD ± 1.50) and children reported to have more than 120 minutes of screen time a day (m = -.22, SD ± 1.51, p > .05, Table 4.21). There were no significant associations between screen time (dichotomous) and children's weight status (p > .05, Table 4.22).

Table 4.21. Children's BMI z-score Means for MVPA, Screen Time, and Sleep Time

	N	Mean BMI z-score (±SD)	p-value
MVPA (minutes/day)			.99
1- 60 or more	76	-.22 (±1.46)	
2- Less than 60	108	-.22 (±1.52)	
Screen time (minutes/day)			.99
1- 120 or less	156	-.21 (±1.50)	
2- More than 120	30	-.22 (±1.51)	
Night sleep time (hours/day)			.12
1- less than 9	49	-.50 (±1.39)	
2- 9 or more	147	-.12 (±1.49)	

Table 4.22. Crosstabulation of Children's Weight Status with MVPA, Screen Time, and Sleep Time

Variable	Normal or under	Overweight and obesity	$\chi 2$	p-value
MVPA (minutes/day)			.02	.89
1- 60 or more	62 (81.6%)	14 (18.4%)		
2- Less than 60	89 (82.4%)	19 (17.6%)		
Screen time (minutes/day)			.07	.79
1- 120 or less	128 (82.1%)	28 (17.9%)		
2- More than 120	24 (80%)	6 (20%)		
Night sleep time (hours/day)			3.843	.052*
1- Less than 9	45 (91.8%)	4 (8.2%)		
2- 9 or more	117 (79.6%)	30 (20.4%)		

Notes. P-value is from Fisher's exact test due to small cell count

Children's BMI z-scores and sleep time. The mean BMI z-scores were not significantly different between children reported to sleep less than nine hours a night (m = -.50, SD $\pm$ 1.39) and children reported to sleep nine hours or more a night (m = -.21, SD $\pm$ 1.49, p > .05, Table 4.21). However, sleep time almost reached a significant association with weight status (p = .052), with more normal weight, thin, or severely thin children sleeping less than nine hours a night compared to children with overweight or obesity (Table 4.22).

Multiple linear regression with children's BMI z-scores as an outcome and MVPA time, screen time, and sleep time as predictors was calculated. Children's age and gender were controlled. Results indicated that MVPA time, screen time, and sleep time were not significant predictors of children's BMI z-score (Table 4.23). However, binary logistic regression (children's weight status as an outcome) suggested that, after controlling for screen time and MVPA time, sleeping less than nine hours a night among children was significantly associated with the decreased odds of being overweight or obese (OR = .31, 95% C.I.= .10 - .94, p = .04, Table 4.24).

Table 4.23. Coefficients of Physical Activity Pattern Predictors on Children's BMI z-scores

	Unstandardized β	**SE**	**p-value**
MVPA time	-.00	.00	.43
Screen time	.00	.00	.22
Sleep time	.39	.27	.15

Notes. Outcome: BMI z-score. MVPA time and screen time were continues variables. Sleep reference group was at least 9 hours a night

Table 4.24. Coefficients of Physical Activity Pattern Predictors on Children's Weight Status

	Unstandardized β	SE	p-value	Exp(B)	95% C.I for Exp(B) Lower	Upper
MVPA time	-.00	.00	.26	.996	.99	1.00
Screen time	.00	.00	.21	1.00	.998	1.01
Sleep	-1.19	.58	.04	.31	.10	.94

Notes. Outcome: Weight status reference group was overweight or obesity. MVPA time and screen time were continues variables. Sleep time reference group was less than 9 hours a night.

Aim 2: Examine the Relationship between the Nutrition Intake of 1st to 4th Grade Omani Children and Maternal BMI, Parental Education Level, Parental Working Status, Family Income, and Family Nutrition and Physical Activity Patterns

Children's nutrition intake represented by single day nutrition and food frequency of intake were examined against a number of family factors in an attempt to learn whether children's nutrition intake was influenced by the family. The family factors examined included maternal BMI, parental education level, parental working status, family income, and family nutrition and physical activity patterns.

Maternal BMI. The relationship between the children's single day nutrition intake and food frequency of intake and maternal BMI were examined. Children's nutrition intake was considered the outcome.

Single day nutrition intake and maternal BMI. Children's nutrition intake represented by energy, macronutrients, and main food groups (grains, fruit, vegetables, protein, and dairy) intake were poorly and not significantly correlated with maternal BMI ($r = -.01 - -0.14$, all $p > .05$, Table 4.25). Similarly, energy, macronutrients, and main food group intake were not significantly associated with mothers' weight status (all $p > .05$).

Food frequency intake and maternal BMI. The relationship between all 22 items on the FFQ and maternal BMI were examined and found to be not significant (all p > .05). However, children of normal or underweight mothers were consuming meat more frequently compared to children of mothers with overweight or obesity (p = .049, Table 4.26). The association between other food group intake and mothers' weight status were not significant (all p > .05)

Table 4.25. Pearson's Correlation of Children's Single Day Nutrition Intake with Maternal BMI

	Mother BMI	
	r	**p**
Energy (kcal)	-.08	.26
Protein (g)	-.06	.42
Total Fat (g)	-.05	.48
Carbohydrate (g)	-.08	.26
Grains (oz)	-.14	.06
Fruits (cup)	-.01	.94
Vegetables (cup)	.12	.09
Protein Food (oz)	-.09	.25
Dairy (cup)	.04	.58

Notes. N ranged between 188 and 197. \

Table 4.26. Crosstabulation between Maternal Weight Status and Meat Frequency of Intake

	Normal or under	**Overweight or obesity**	**$\chi 2$**	**p-value**
Meat intake			4.04	.049*
1. More frequent	48 (30.6%)	109 (69.4%)		
2. Less frequent	4 (12.9%)	27 (87.1%)		

Notes. * p-value from Fisher's exact test because of small cell count

Parental education level. The relationship between the children's single day nutrition and food frequency of intake and parental education level (mothers and fathers) were examined.

Single day nutrition intake and parental education level. The mean intake of total energy, macronutrient, and main food groups were not significantly associated with mothers' education level (p > .05, Table 4.27).

In regards to fathers' education level, significant differences in mean intake of protein (g), fruit (cup), and dairy (cup) were found between children of fathers with a bachelor or higher education level and children of fathers with a diploma or a lower education level ($p < .05$, Table 4.28). Higher intake was found among children of fathers with a bachelor or higher education level. However, the intake of total energy (kcal), total fat (g), carbohydrates (g), grains (oz), vegetables (cup), protein food (oz) were not significantly associated with fathers' education level ($p > .05$).

Table 4.27. Children's Single Day Nutrition Intake Means by Mother's education Level

	Diploma or lower	Bachelor or higher	p-value
Energy (kcal)	1749 (±528.5)	1804 (±628.4)	.52
Protein (g)	64.8 (±24.3)	65.6 (±30.8)	.85
Total Fat (g)	57.5 (±21.8)	60.6 (±26.9)	.38
Carbohydrate (g)	247.6 (±84.7)	254 (±91.8)	.62
Grains (oz)	7.6 (±3.7)	7.7 (±4.3)	.77
Fruits (cup)	1.3 (±1.2)	1.4 (±1.2)	.58
Vegetables (cup)	1.5 (±1.1)	1.5 (±1)	.71
Protein Food (oz)	4.1 (±2.8)	3.9 (±3.3)	.64
Dairy (cup)	1.2 (±.9)	1.5 (±1.2)	.07

Notes. Diploma or lower (n=127), bachelor or higher (n=69)

Table 4.28. Single Day Nutrition Intake Means by Father's Education Level

	Diploma or lower	Bachelor or higher	p-value
Energy (kcal)	1736 (±522.7)	1793 (±593.7)	.48
Protein (g)	60.8 (±23.1)	69.6 (±29.6)	.02
Total Fat (g)	58.4 (±22)	58.3 (±25.3)	.99
Carbohydrate (g)	246 (±81.8)	252.5 (±90.2)	.60
Grains (oz)	7.5 (±3.4)	7.7 (±4.3)	.79
Fruits (cup)	1.2 (±1.1)	1.7 (±1.3)	.005
Vegetables (cup)	1.4 (±1)	1.6 (±1.2)	.31
Protein Food (oz)	3.7 (±2.5)	4.3 (±3.3)	.13
Dairy (cup)	1.1 (± .8)	1.5 (± 1.1)	.02

Notes. Diploma or lower (n=104), Bachelor or higher (n=92).

Food frequency intake. A higher percentage of children of mothers with a diploma or lower education level consumed vegetables rich in vitamin A more frequently compared to children of mothers with bachelor or higher education level (p = .03, Table 4.29).

Table 4.29. Crosstabulation between Mothers' Education Level and Frequency of Intake of Vegetables Rich in Vitamin A and Fish

Variable	Diploma or lower	Bachelor or higher	χ2	p-value
Vegetables rich in vitamin A			5.04	.03*
1- More frequent	109 (87.9%)	52 (75.4%)		
2- Less frequent	15 (12.1%)	17 (24.6%)		
Fish			4.01	.06*
1- More frequent	121 (96.8%)	62 (89.9%)		
2- Less frequent	4 (3.2%)	7 (10.1%)		

Notes. * p-value from Fisher's exact test because of small cell count

Similarly, a higher percentage of children of mothers with a diploma or a lower education level were eating fish more frequently compared to children of mothers with a bachelor or higher education level (p = .06, Table 4.29). However, the association was not significant. The frequency of intake of other food groups was not significantly associated with mothers' education level (p > .05).

A higher percentage of children of fathers with a bachelors or higher education level were reported to consume meat more frequently (p = .007, Table 4.30). The frequency of intake of other food groups were not significantly associated with the fathers' education level (p > .05). Also, children of fathers with bachelor degree or a higher education level were reported to consume more nuts and seeds more frequently compared to children of fathers with lower education level (p = .02, Table 4.30).

Parental working status. The relationship between the children's single day nutrition intake and food frequency of intake and parental working status (mothers and fathers) were examined.

Table 4.30. Crosstabulation between Fathers' Education Level and Meat and Nuts and Seeds Frequency of Intake

Variable	Diploma or lower	Bachelor or higher	χ2	p-value
Meat			7.39	.007
1- More frequent	80 (76.9%)	84 (91.3%)		
2- Less frequent	24 (23.1%)	8 (8.7%)		
Nuts and Seeds			5.12	.02
1- More frequent	56 (56.0%)	66 (71.7%)		
2- Less frequent	44 (44.0%)	26 (28.3%)		

Single day nutrition intake and parental working status. No significant relationship between children's total energy, macronutrient, and main food group intake and mothers' working status were found (all p > .05, Table 4.31). There was no significant relationship between children's total energy, macronutrient, and main food group intake and fathers' working status (all p > .05, Tables 4.32).

Table 4.31. Single Day Nutrition Intake Means by Mother's Working Status

	Working	Not working	p-value
Energy (kcal)	1740 (±581.2)	1791 (±552.6)	.53
Protein (g)	63.6 (±29.3)	66.3 (±24.4)	.48
Total Fat (g)	57.6 (±24.6)	59.3 (±23.1)	.62
Carbohydrate (g)	246.1 (±85.2)	252.9 (±88.9)	.59
Grains (oz)	7.8 (±4.1)	7.5 (±3.7)	.55
Fruits (cup)	1.4 (±1.2)	1.4 (±1.3)	.87
Vegetables (cup)	1.4 (±1)	1.6 (±1.2)	.23
Protein Food (oz)	3.9 (±3.3)	4.1 (±2.7)	.68
Dairy (cup)	1.2 (±1.1)	1.3 (±.9)	.50

Notes. working (n=88), not working (n=108)

Table 4.32. Single Day Nutrition Intake Means by Father's Working Status

	Working	Not working	p-value
Energy (kcal)	1768 (±557.8)	1773 (±621.8)	.97
Protein (g)	65.7 (±26.8)	55.8 (±16.8)	.19
Total Fat (g)	58.2 (±22.7)	59.7 (±29.6)	.83
Carbohydrate (g)	250.1 (±87.4)	257.9 (±85.7)	.76
Grains (oz)	7.6 (±3.9)	8.1 (±4.1)	.68
Fruits (cup)	1.5 (±1.3)	1 (±1)	.19
Vegetables (cup)	1.5 (±1.1)	1.6 (±1.4)	.81
Protein Food (oz)	4.1 (±3)	3.2 (±1.7)	.32
Dairy (cup)	1.3 (±1)	1.3 (±.8)	.98

Notes. working (n=180), not working (n=13)

Food frequency of intake and parental working status. There was no significant relationship between the children's food frequency of frequency and mothers' or fathers' working status (all $p > .05$). However, mothers' working status demonstrated an almost significant association ($p = .051$) with children's fast food frequency, with a higher percentage of children of non-working mothers consuming fast food more frequently compared to children of working mothers (Table 4.33).

Table 4.33. Crosstabulation between Mothers Working Status and Frequency of Intake of Fast Food

Food frequency	Working	Not working	$\chi 2$	p-value
Fast food intake				
1- More frequent	26 (29.9%)	47 (43.5%)	3.82	.051
2- Less frequent	61 (70.1%)	61 (56.5%)		

Notes. N ranged between 189 and 196

Family income. The relationship between children's single day nutrition intake and food frequency of intake and family income were examined next.

Single day nutrition intake and family income. Independent t-tests showed a significant relationship between family income and the children's intake of carbohydrates (p = .02), grains (p = .009), and dairy (p = .005). Children of families who had a monthly income of less than 1,000 OMR had a higher intake of carbohydrates (g) and grains (oz) and a lower intake of dairy (cup) when compared to children of families with a monthly income of more than 1,000 OMR (Table 4.34). There was no significant relationship between family income and intake of total energy (kcal), total fat (g), protein (g), fruit (cup), vegetables (cup), and protein food (oz) (p > .05).

Table 4.34. Single Day Nutrition Intake Means by Family Income

Nutrition Intake	Less than 1000	More than 1000	p-value
Energy (kcal)	1854 (±546)	1704 (±572.9)	.06
Protein (g)	66.4 (±25.3)	64.3 (±27.8)	.60
Total Fat (g)	60.3 (±21.9)	57.5 (±25.1)	.40
Carbohydrates (g)	266.1(± 88.1)	237 (± 84.6)	.02
Grains (oz)	8.4 (± 4.5)	6.9 (± 3.2)	.009
Fruits (cup)	1.4 (±1.2)	1.4 (±1.3)	.71
Vegetables (cup)	1.6 (±1.2)	1.4 (±1)	.19
Protein Food (oz)	4 (±2.8)	4 (±3.1)	.90
Dairy (cup)	1.1 (± .8)	1.5 (± 1.1)	.005

Notes. Less than 1000 (n=92), More than 2000 (n=103).

Food frequency of intake and family income. Chi square analysis showed that family income was significantly associated with the frequency of intake of fruit rich in vitamin C (p = .04) and nuts and seeds (p = .02), but not with other food groups. The consumption of these food was more frequent among children of families with a monthly income over 1,000 OMR compared to children of families who were earning less than 1,000 OMR per month (Table 4.35).

No significant relationships between family income and frequency of intake of other food groups were found (all $p > .05$). In other words, the frequency of intake of other food groups (not including fruit rich in vitamin C and nuts and seeds) was not significantly different between children of families with a monthly income over 1,000 OMR and children of families who were earning less than 1,000 OMR per month.

Table 4.35. Crosstabulation between Family Income and Fruits Rich in Vitamin C and Nuts and Seeds Frequency of Intake

Food Intake	Less than 1000	More than 1000	$\chi 2$	p-value
Fruits rich in vitamin C			4.24	.04
1- More frequent	59 (67.0%)	81 (80.2%)		
2- Less frequent	29 (33.0%)	20 (19.8%)		
Nuts and seeds			5.82	.02
1- More frequent	49 (54.4%)	72 (71.3%)		
2- Less frequent	41 (45.6%)	29 (28.7%)		

Notes. N ranged between 188 and 195.

Family nutrition and physical activity pattern. The relationship between the children's single day nutrition intake and food frequency of intake and family nutrition and physical activity pattern were examined. The family nutrition and physical activity pattern were represented by the Family Nutrition and Physical Activity (FNPA) score and two questions related to eating with family.

Single day nutrition intake and FNPA score. The FNPA score was significantly correlated with the children's intake of protein ($r = .20$, $p = .005$), fruit ($r = .23$, $p = .01$), protein foods ($r = .18$, $p = .046$) and dairy ($r = .14$, $p = .001$, Table 4.36). There were no significant associations between the FNPA score and total energy, total fat, carbohydrates, grains, or vegetable intake ($p > .05$).

Frequency of intake and FNPA score. The frequency of vegetable intake (except the ones rich in vitamin C, A, iron or folate), fruit (except the ones rich in potassium), meat, eggs, nuts, and seeds were significantly associated with the FNPA score ($p < .05$, Table 4.37). The mean FNPA score was higher in families of children who had a higher intake of these items. The frequency of fast food ($p = .009$) and soft or sugary drink intake ($p = .001$) were also significantly associated with the FNPA score (Table 4.37). Families of children who had a less frequent intake of these items had higher FNPA scores. The remainder had no significant relationship with the FNPA score (p > .05).

Table 4.36. Pearson's Correlation of Single Day Nutrition Intake with FNPA score

	FNPA Score R	FNPA Score p
Energy (kcal)	.13	.07
Protein (g)	.20	.005
Total Fat (g)	.08	.24
Carbohydrate (g)	.11	.13
Grains (oz)	-.002	.98
Fruits (cup)	.18	.01
Vegetables (cup)	.03	.65
Protein Foods (oz)	.14	.046
Dairy (cup)	.23	.001

Notes. N ranged between 188 and 197.

Table 4.37. FNPA Score Means by Food Frequency of Intake

	N	Mean FNPA score (± SD)	p-value
Other vegetables			.02
1- More frequent	168	33.59 (±3.53)	
2- Less frequent	23	31.78 (±3.68)	
Fruits (C)	141	33.85 (±3.29)	.006
1- More frequent	50	32.28 (±3.86)	
2- Less frequent			
Fruits (A)	105	33.85 (±3.19)	.04
1- More frequent	89	32.76 (±4.00)	
2- Less frequent			
Other fruits	172	33.62 (±3.46)	.02
1- More frequent	23	31.74 (±4.05)	
2- Less frequent			
Meat	165	33.73 (±3.38)	.004
1- More frequent	32	31.34 (±4.10)	
2- Less frequent			
Egg	182	33.49 (±3.45)	.03
1- More frequent	12	31.17 (±4.61)	
2- Less frequent			
Nuts and seeds	122	33.91 (±3.08)	.02
1- More frequent	71	32.52 (±4.06)	
2- Less frequent			
Fast Food	74	32.49 (±3.76)	.009
1- More frequent	122	33.88 (±3.43)	
2- Less frequent			
Soft and Sugary Drinks	105	32.52 (±3.80)	.001
1- More frequent	91	34.33 (±3.13)	
2- Less frequent			

Single day nutrition intake and eating with the family. Eating with the family was not found to be significantly associated with the single day nutrition intake. A significant relationship between eating with the family from one plate and grain (oz) intake was found to be significant (p = .04), with a higher mean intake of grains among children who usually ate with the family from one plate compared to children who were sometimes or not eating with the family from one plate (Table 4.38).

Table 4.38. Single Day Grains Intake Means by Eating with Family from One Plate

	Yes	**No or sometimes**	**p- value**
Grains	8.2 (±3.9)	7 (±3.8)	.04

Notes. Yes (n = 103), sometimes or no (n = 93)

Food frequency of intake and eating with the family. A number of significant relationships between food frequency of intake and eating with the family were found. Eating with the family was significantly (p = .02 – .047) associated with more frequent intake of vegetables (except the ones rich in iron or folate and vitamin C and A) and fruit rich in vitamin C and potassium (p = .03 - .04), meat (p = .01), and vegetables rich in vitamin A (p = .05, Table 4.39). Eating with the family from one plate was significantly associated with eating more fish (p = .004) and chicken (p = .02), and nuts and seeds (p =.05, Table 4.40).

Table 4.39. Crosstabulation of Children's Food Frequency of Intake with Eating with Family

Variable	Eating with family Yes	Sometimes or no	χ2	p-value
Vegetables rich in vitamin C			4.99	.047*
1- More frequent	133 (95.7%)	6 (4.3%)		
2- Less frequent	45 (86.5%)	7 (13.5%)		
Vegetables rich in vitamin A			4.49	.050*
1- More frequent	152 (95.0%)	8 (5.0%)		
2- Less frequent	28 (84.8%)	5 (15.2%)		
Vegetables (others)			7.92	.02*
1- More frequent	158 (94.6%)	9 (5.4%)		
2- Less frequent	18 (78.3%)	5 (21.7%)		
Fruits rich in vitamin C			5.46	.04*
1- More frequent	134 (95.7%)	6 (4.3%)		
2- Less frequent	43 (86.0%)	7 (14.0%)		
Fruits rich in potassium			5.86	.03*
1- More frequent	156 (94.5%)	9 (5.5%)		
2- Less frequent	22 (81.5%)	5 (18.5%)		
Meat			7.77	.01*
1- More frequent	156 (95.1%)	8 (4.9%)		
2- Less frequent	26 (81.3%)	6 (18.8%)		

Notes. * p-values from Fisher's exact test because of the small cell count.

Table 4.40. Crosstabulation of Eating with Family from One Plate with Fish, chicken, and Nuts and Seeds Frequency of Intake

Variable	Eating with family from one plate Yes	Sometimes or no	χ2	p-value
Fish			8.63	.004*
1- More frequent	100 (54.6%)	83 (45.4%)		
2- Less frequent	1 (9.1%)	10 (90.9%)		
Chicken			5.75	.02*
1- More frequent	103 (54.2%)	87 (45.8%)		
2- Less frequent	0 (0.0%)	5 (100.0%)		
Nuts and seeds			3.86	.05
1- More frequent	57 (46.7%)	65 (53.3%)		
2- Less frequent	43 (61.4%)	27 (38.6%)		

Notes. * p-values from Fisher's exact test because of the small cell count.

Family predictors of a single day nutrition intake. A multiple linear regression was used to predict children's energy, macronutrient, and main food group intake from maternal

BMI, parental education level, parental working status, family income, and the FNPA score. Children's age and gender were controlled. Nine models were built since there were nine nutrition intake outcomes (Table 4.41). Significant regression equations were found for protein intake (p = .03) and dairy intake (p = .001); none of the other models were significant.

Significant family predictors were found within the protein, carbohydrates, grains, fruit, and dairy intake regression models. The significant family predictors were mothers' education level, fathers' education level, mothers' working status, family income, and FNPA score.

Table 4.41. Model Summary of Family Predictors of Single Day Nutrition Intake after Controlling for Children's Age and Gender

Outcomes	R2	Δ F	Significance Δ F	Significant predictors
Energy (kcal)	.06	1.25	.27	None
Protein (g)	.10	2.01	.03	Father education level, FNPA score
Total fat (g)	.03	.61	.78	None
Carbohydrates (g)	.06	1.19	.31	Family income
Grains (oz)	.06	1.23	.28	Family income
Fruits (cup)	.08	1.71	.09	Father education level
Vegetables (cup)	.07	1.37	.21	None
Protein food (oz)	.05	1.08	.38	None
Dairy (cup)	.16	3.62	.001	Mother's education level, mother's working status, family income, and FNPA score

Notes. Predictors: maternal BMI, mothers' education level, fathers' education level, mothers' working status, fathers' working status, family income, FNPA score. Degree of freedom= 9 (170).

Mothers education level. Mothers' education level was a significant predictor of dairy intake (p = .04, Table 4.42). The model predicted an increase by about a half a cup among children of mothers with a bachelor or higher education level compared to children of mothers with diploma or a lower education level (β = .39, SE = .19, p = .04).

Fathers education level. Father's education level was a significant predictor of children's intake of fruit (p = .02) and protein (p = .04). See Table 4.42. The regression analysis indicated that children of fathers with a bachelor or higher level of education level ate a half cup more fruit compared to children of fathers with a lower education level (β = .47, SE = .20, p = .02). Children of fathers with bachelor or higher education level ate 8.4 more grams of protein compared to children of fathers with a lower education level (β = 8.37, SE = 4.22, p = .04).

Table 4.42. Summary of Significant Coefficients for Family Predictors of a Single day Intake after Controlling for Children's Age and Gender

Family variables	Nutrition intake	Unstandardized β	SE	p-value
Mothers' education level	Dairy	.39	.19	.04
Fathers' education level	Fruits	.47	.20	.02
	Protein (g)	8.37	4.22	.049
Mothers' working status	Dairy	.57	.17	.001
Family income	Dairy	.39	.15	.01
	Carbohydrates	-31.40	13.85	.03
	Grains	-1.60	.63	.01
FNPA score	Dairy	.05	.02	.008
	Protein	1.30	.56	.02

Notes. Maternal BMI is continues variable; mothers/ fathers education level reference group was bachelor or higher; mothers/fathers working status reference group is not working; family income reference group is more than 1000 OMR/month; FNPA score= continues scores 10 to 40. Nine models were built, one for each of the nutrition intake components (energy, protein, fat, carbohydrates, grains, fruits, vegetables, protein food, and dairy)

Mothers working status. Mothers' working status was a significant predictor of children's dairy intake (Table 4.42). The model predicted an increase in dairy intake among children of mothers who were not working by a half of a cup compared to children of mothers who were working (β = .57, SE = .17, p = .001).

Family income. Family income was a significant predictor of children's intake of dairy (p = .01), carbohydrates (p = .03), and grains (p = .01). See Table 4.42. The model predicted that children of families with over 1,000 OMR monthly income consumed .39 cup more dairy, 31.4 grams less of carbohydrates, and 1.6 less ounces of grains compared to children of families with a lower monthly income.

FNPA score. The FNPA score was a significant predictor of children's intake of dairy (p = .008) and protein (p = .02, Table 4.42). With every 1-unit increase in the FNPA score, dairy intake increased by .05 cup and the protein intake increased by 1.3 grams.

Family predictors of food frequency of intake. We fit logistic regression models controlling for children's age and gender with each of the 22 food frequency variables as outcomes and maternal BMI, parental education level, parental working status, family income, and FNPA score as predictors. Results indicated that there were significant associations between the intake frequency of certain food groups and mothers' education level, fathers' education level, family income, and the FNPA score (Table 4.43).

Mothers' education level. Mothers' education level was significantly associated with children's frequency of intake of vegetables rich in vitamin A (p = .005) and fish (p = .03). Results indicated that mother's diploma or lower education level was significantly associated with higher odds of more frequently eating vegetables rich in vitamin A (OR = .18, 95% CI [.05, .60], p = .005) and fish (OR = .06, 95% CI [.01, .75], p = .03) when compared to mother' higher education level (Table 4.43).

Fathers' education level. Fathers' education level was significantly associated with children's frequency of intake of vegetables rich in vitamin A (p = .02), meat (p = .005), and nuts and seeds (p = .03). Results indicated that fathers' diploma or lower education level is significantly associated with higher odds of less frequently eating vegetables rich in vitamin A (OR = 3.07, 95% CI [1.16, 8.15], p = .02), meat (OR = 5.03, 95% CI [1.64, 15.44], p = .005), and nuts and seeds (OR = 2.16, 95% CI [1.06, 4.40], p = .03) when compared to fathers' higher education level (Table 4.43).

Family income. Family monthly income that is less than 1000 OMR was significantly associated with higher odds of less frequently consuming fruits rich in vitamin C (OR = 2.26, 95% CI [1.06, 4.80], p = .04) compared to family income that is more than 1000 OMR per month (Table 4.43).

FNPA score. An increase in the FNPA score was associated with lower odds of less frequently consuming vegetables rich in vitamin C, other vegetables (e.g. onions, okra, cucumbers, eggplant, garlic), other fruit (e.g. coconut, grapes, apples, pears and figs), meat, and eggs (p < .05, Table 4.43). The increase in FNPA score was associated with higher odds of less frequently consuming fast food (OR = 1.12, 95% CI [1.02, 1.22], p = .02) and soft and sugary drinks (OR = 1.19, 95% CI [1.08, 1.31], p = .001).

Table 4.43. Summary of Significant Coefficients for Family Predictors of Food Frequency of Intake after Controlling for Children's Age and Gender

Food Group	Family factor	B	SE	p-value	Exp(B)	95% CI Lower	Upper
Vegetable (vitamin A)	**Mothers' education level**	-1.73	.62	.005	.18	.05	.60
	Fathers' education level	1.12	.50	.02	3.07	1.16	8.15
Vegetables (iron/folate)	**FNPA score**	-.11	.05	.03	.90	.81	.99
Other vegetables	**FNPA score**	-.14	.07	.03	.87	.76	.99
Fruits (vitamin C)	**Family income**	.81	.39	.04	2.26	1.06	4.80
Other fruits	**FNPA score**	-.16	.07	.03	.85	.74	.98
Meat	**Fathers' education level**	1.62	.57	.005	5.03	1.64	15.44
	FNPA score	-.13	.06	.02	.87	.78	.98
Fish	**Mothers' education level**	-2.83	1.29	.03	.06	.01	.75
Egg	**FNPA score**	-.17	.08	.04	.85	.72	.99
Nuts and seeds	**Fathers' education level**	.77	.36	.03	2.16	1.06	4.40
Fast food	**FNPA score**	.11	.05	.02	1.12	1.02	1.22
Soft and sugary drink	**FNPA score**	.17	.05	.001	1.19	1.08	1.31

Notes. Food frequency of intake reference group is less frequent. Mothers' and fathers' education level reference group is diploma or lower. Family income reference group is less than 1000 OMR/month. FNPA score continuous variable

Eating with family predictors of a single day nutrition intake and food frequency of intake. Multiple linear regression with each of the single day nutrition intake as an outcome and eating with the family and eating with the family from one plate as predictors were calculated. Children's age and gender were controlled. Eating with the family and eating with the family from one plate were not significant predictors of any of the single day nutrition intake (all p > .05). Eating with the family from one plate was not a significant predictor of grain intake (p = .06, Table 4.44).

Table 4.44. Coefficient for Eating with Family from One Plate Predictor of Single Day Grain Intake (oz) After Controlling for Children's Age and Gender

	Unstandardized β	SE	p-value
Eating with family from one plate	-1.04	-1.86	.06

Notes. Eat with family from one plate reference group was sometimes or no.

Also, a binary logistic regression with each food frequency as an outcome and eating with the family and eating with the family from one plate as predictors were calculated. Children's age and gender were controlled. Eating with the family was significantly associated with lower odds of less frequent intake of vegetables rich in Vitamin C (OR = .28, 95% CI [.09, .90], p = .03), other vegetables not rich in vitamin A, folate or iron (OR = .14, 95% CI [.04, .52], p = .003), fruits rich in vitamin C (OR = .26, 95% CI [.08 - .84], p = .02), fruit rich in potassium (OR = .29, 95% CI [09 - .97], p = .04), and meat (OR = .25, 95% C.I [.08 - .81], p = .02). Also, eating with the family from one plate was significantly associated with a lower odds of a less frequent intake of fish (OR = .09, 95% CI [.01, .72], p = .02), but not with chicken and nuts and seeds. Summary of significant coefficients are noted in Table 4.45.

Table 4.45. Coefficients of Eating with Family Predictor of Children's Food Frequency Intake

	Food intake	Unstandardized β	Standard Error (SE)	p-value	Exp(B)	95% C.I for Exp(B) Lower	Upper
Eat with family	Vegetables (C)	-1.27	.59	.03	.28	.09	.90
	Vegetables (A)	-1.11	.62	.07	.33	.10	1.10
	Vegetables (Others)	-1.97	.67	.003	.14	.04	.52
	Fruits (C)	-1.36	.60	.02	.26	.08	.84
	Fruits (potassium)	-1.24	.62	.04	.29	.09	.97
	Meat	-1.38	.59	.02	.25	.08	.81
Eat with family from one plate	Fish	-2.42	1.07	.02	.09	.01	.72
	Chicken	-18.27	3956.44	.996	.000	.00	.
	Nuts and seeds	.55	.31	.08	1.73	.95	3.17

Notes. Food frequency of intake reference group was less frequent. Eat with family and Eat with family from one plate reference group was yes.

Aim 3: Examine the Relationship between the Physical Activity Patterns of 1st to 4th Grade Omani Children and Maternal BMI, Parental Educational Level, Parental Working Status, Family Income, and Family Nutrition and Physical Activity Pattern

Children's physical activity patterns represented by MVPA, screen time, and sleep time were examined against a number of family factors in an attempt to learn whether the children's physical activity patterns were influenced by the family. The family factors examined were maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity pattern.

Maternal BMI. The relationship between children's MVPA, screen time, and sleep time and maternal BMI were examined. Children's physical activity patterns were considered the outcome.

MVPA and maternal BMI. The correlation of maternal BMI with children's MVPA was tested. Table 4.46 shows that maternal BMI was not significantly associated with children's MVPA (r = .10, p = .17). There was no relationship between maternal BMI and MVPA per day found (p > .05).

Table 4.46. Pearson's Correlation of Children's MVPA and Screen Time with Maternal BMI

Family variables	**MVPA (minutes/day)**		**Screen time (minutes/day)**	
	r	**p**	**r**	**P**
Mother BMI	.10	.17	.05	.51

Note. N ranged between 176 and

Screen time and maternal BMI. The correlation of maternal BMI with children's screen time was tested. Table 4.46 shows that maternal BMI was not significantly associated with children's screen time (r = .05, p = .51). Also, maternal weight status was not significantly associated with screen time when dichotomized to 120 or less minutes a day and more than 120 minutes a day (p > .05).

Sleep time and maternal BMI. Mean maternal BMI was significantly different between children sleeping less than nine hours a night and children sleeping at least nine hours a night (p = .049), with mothers of children sleeping at least nine hours a night having higher BMI values (Table 4.47). A chi-square test demonstrated that more children of overweight or obese mothers were sleeping at least nine hours a night compared to children of normal or underweight mothers (p = .03, Table 4.48).

Table 4.47. Maternal BMI Means by Sleep Time

	N	Mean Maternal BMI (± SD)	p-value
Sleep time (hours per night)			
1- Less than 9	48	27.36 (±5.55)	.049
2- 9 or more	140	29.17 (±5.45)	

Table 4.48. Crosstabulation between Sleep Time and Maternal BMI

	Less than 9	9 or more	$\chi 2$	p-value
Maternal weight status				
1- Normal or under	19 (36.5%)	33 (63.5%)	4.58	.03
2- Overweight or obesity	29 (21.3%)	107 (78.7%)		

Parental education level. The relationship between children's MVPA, screen time, and sleep time and parental education level (mothers and fathers) were examined.

MVPA and parental education level. The mean minutes of MVPA per day differed significantly between children of mothers with a diploma or lower education level and children of mothers with a bachelor or higher education level (p = .005, Table 4.49). Children of mothers with diploma or lower education level had higher mean minutes of MVPA per day compared to children of mothers with bachelor or higher education level. However, mothers' education level had no significant association with children's adequacy of MVPA a day (at least 60 minutes a day or less than 60 minutes a day, p > .05). The mean MVPA minutes per day were not significantly different between children of fathers with a diploma or lower education level and children of fathers with bachelor or higher education level. The chi-square analysis indicated a significant (p = .03, Table 4.50) association between fathers' education level and children's adequacy of MVPA a day. More children of fathers with a diploma or a lower education level had at least 60 minutes of MVPA a day compared to children of fathers with a bachelor or higher education level.

Table 4.49. MVPA and Screen Time Means by Mothers' Education Level

	N	Mean MVPA minutes per day (±SD)	p-value	N	Mean child screen minutes per day (±SD)	p-value
Mothers' education level						
1- Diploma or less	120	69.5 (± 73.8)	.005	119	67.2 (± 77.8)	.2
2- Bachelor or more	65	46.6 (± 34.5)		67	55.6 (± 48.2)	

Table 4.50. Crosstabulation between MVPA and Fathers' Education Level

	60 or more	Less than 60	$\chi 2$	p-value
Fathers' education level				
1- Diploma or less	47 (48.0%)	51 (52.0%)	4.50	.03
2- Bachelor & higher	28 (32.6%)	58 (67.4%)		

Screen time and parental education level. The mean screen time was not significantly ($p = .2$) different between the children of mothers with diploma or a lower education level and children of mothers with bachelor or higher education (Table 4.49). Similarly, the mean screen time among children of fathers with a diploma or lower education level did not differ significantly from the mean screen time of children of fathers with bachelor or higher education level ($p > .05$). Chi-square analysis also indicated no significant relationship between screen time and mothers' or fathers' education level ($p > .05$).

Sleep time and parental education level. There were no significant associations between mothers' or fathers' education level and night sleep time found ($p > .05$).

Parental working status. The relationship between children's MVPA, screen time, and sleep time and parental working status (mothers and fathers) were examined.

MVPA and parental working status. There were no significant associations between mothers' working status and children' MVPA found (p > .05). However, a significant difference in the mean MVPA minutes per day was found among children of working fathers and children of fathers who were not working (p = .03, Table 4.51). Chi-square analysis also indicated a significant association between fathers' working status and children's adequacy of MVPA time (p = .008), with more children of fathers not working exercising at least 60 minutes of MVPA a day compared to children of fathers who were working (Table 4.52).

Table 4.51. MVPA and Screen Time Means by Parental Working Status

Family variables	**N**	**MVPA (±SD)**	**p-value**	**N**	**Screen Time (±SD)**	**p-value**
Mothers working status						
1- Working	84	55 (± 46.1)	.20	83	55.5 (± 50.6)	.20
2- Not working	101	66.8 (± 75.1)		103	69.2 (± 80.2)	
Fathers working status						
1- Working	169	58.3 (± 63)	.03	170	61.4 (± 67.4)	.20
2- Not working	13	97.5 (± 65.8)		13	88.1 (± 89.2)	

Table 4.52. Crosstabulation between Fathers' Working Status and MVPA

Family variables	**60 or more**	**Less than 60**	**χ2**	**p-value**
Fathers' working status				
1- Working	64 (37.9%)	105 (62.1%)	7.63	.008*
2- Not working	10 (76.9%)	3 (23.1%)		

Notes. p-value from Fisher's exact test due to small cell count

Screen time and parental working status. There were no significant associations between mothers' or fathers' working status and children' screen time or screen time 120 minutes or less a day were found (all p > .05).

Sleep time and parental working status. Mothers' and fathers' working status were not significantly associated with children's sleep time (all $p > .05$).

Family income. The relationship between children's MVPA, screen time, and sleep time and family income were examined.

MVPA and family income. The mean MVPA minutes per day did not differ significantly between children of families with a monthly income of more than 1,000 OMR and children of families with a monthly income of less than 1,000 OMR ($p > .05$, Table 4.53). Similarly, there was no significant ($p > .05$) association between family income and children's adequacy of MVPA found.

Screen time and family income. The mean screen time of children of families with a monthly income of more than 1,000 OMR did not differ significantly from children of families with a monthly income of less than 1,000 OMR ($p > .05$, Table 4.53). Also, there was no significant relationship between family income and limiting children's screen time to 120 minutes a day (all $p > .05$).

Table 4.53. MVPA and Screen Time Means by Family Income

Family variable	N	MVPA (±SD)	p- value	N	Screen Time (±SD)	p-value
Family income (OMR/month)						
1- Less than 1000	86	67 (± 74.4)	.3	85	59 (± 72)	.4
2- More than 1000	97	56 (± 52.1)		100	67 (±66.1)	

Sleep time and family income. Chi-square analysis indicated there was no association between family income and children's sleep time (p > .05).

Family nutrition and physical activity pattern. The relationship between the children's MVPA, screen time, and sleep time and family nutrition and physical activity pattern were examined. The family nutrition and physical activity pattern was represented by the Family Nutrition and Physical Activity (FNPA) score and two questions related to eating with family.

MVPA and FNPA score. The FNPA score did not correlate significantly with children's MVPA (r = .10, p = .18, Table 4.54). The mean FNPA score was not significantly different between children with at least 60 minutes of MVPA and children with less than 60 minutes of MVPA a day (p = .28, Table 4.55).

Table 4.54. Pearson's Correlation of MVPA and Screen Time with Maternal BMI and FNPA Score

Family variables	MVPA (min/day) r	p	Screen time (min/day) r	P
FNPA	.10	.18	-.20	.006

Note. N ranged between 176 and 187

Table 4.55. FNPA score Means by MVPA, Screen Time, and Sleep time

	N	Mean FNPA (±SD)	p-value
MVPA			
1- 60 or more	76	33.70 (±3.20)	.28
2- Less than 60	109	33.11 (±3.91)	
Screen time			
1- 120 or less	157	33.54 (±3.45)	.03
2- More than 120	30	31.93 (±4.26)	
Sleep time			
1- Less than 9	49	32.10 (±3.56)	.005
2- 9 or more	148	33.76 (±3.54)	

Screen time and FNPA score. The FNPA score correlated significantly with the children's screen time ($r = -.20$, $p = .006$, Table 4.54). Also, the families of children who had 120 minutes or less of screen time a day had a higher mean FNPA score compared to children who had more than 120 minutes of screen time a day ($p = .03$, Table 4.55).

Sleep time and FNPA score. Families whose children who had at least nine hours of night sleep a night had a higher mean FNPA score compared to those of children who had less than nine hours of sleep per night ($p = .005$, Table 4.55).

Eating with family and MVPA. There was no significant relationship between eating with the family or eating with the family from one plate and MVPA was found ($p > .05$).

Eating with family and screen time. Results showed no significant relationship between eating with the family or eating with the family from one plate and screen time.

Eating with family and sleep time. A significant relationship between eating with the family, but not eating with the family from one plate, and sleeping at least nine hours a night was found ($\chi2 = 8.31$, $p = .008$; table 4.56).

Table 4.56. Crosstabulation between Eating with Family and Sleep Time

Family variables	**Less than 9**	**9 or more**	**$\chi2$**	**p-value**
Eating with family			8.31	.008*
1- Yes	41 (22.5%)	141 (77.5%)		
2- Sometimes or no	8 (57.1%)	6 (42.9%)		

Notes. p-value from Fisher's exact test due to small cell count

Family predictors of MVPA and screen time. Multiple linear regression was used to predict daily children's MVPA time in minutes and daily children's screen time in minutes based on maternal BMI, parental education level, parental working status, family income, and FNPA score. Children's age and gender were controlled. The models are summarized in Table 4.57.

Table 4.57. Models Summary. Family Predictors of MVPA and Screen Time after Controlling for Children's Age and Gender

Outcomes	R2	Δ F	df1	df2	Significance Δ F	Significant predictors
MVPA	.10	1.94	9	160	.05	None
Screen Time	.09	1.70	9	162	.09	FNPA score

Notes. Predictors: maternal BMI, mothers' education level, fathers' education level, mothers' working status, fathers' working status, family income, family nutrition and physical activity pattern.

There were no significant predictors of children's MVPA. However, the FNPA score was a significant predictor of children's screen time ($p < .05$).

FNPA score. The model predicted a decrease in children's daily screen time by about 4 minutes for each increased value of the FNPA score (SE 1.53; $p = .01$, Table 4.58).

Table 4.58. Coefficient of Family Predictors of Screen Time after Controlling for Children's Age and Gender

Family factors	Unstandardized β	SE	p-value
Maternal BMI	.14	.99	.89
Mothers' education level	2.23	14.68	.88
Fathers' education level	6.58	11.96	.58
Mothers' working status	12.31	13.39	.36
Fathers' working status	22.44	21.53	.30
Family income	12.75	11.65	.28
FNPA score	-3.96	1.53	.01
Age	7.53	4.60	.10
Gender	4.87	10.79	.65

Notes. Outcome: Screen time. Mothers' and fathers' education level reference group was bachelor or higher. Mothers' and fathers' working status reference group was not working). Family income reference group was more than 1000 OMR/month. Gender reference group was male.

Family predictors of MVPA, screen time, and night sleep (binary outcomes). We fit logistic regression models controlling for children's age and gender with MVPA, screen time, and sleep time as binary outcomes and maternal BMI, parental education level, parental working status, family income, and FNPA score as predictors. Results of the binary logistic regression indicated that maternal BMI ($p = .049$) and fathers' working status ($p = .047$) were significant predictors of children's adequacy of MVPA (Table 4.59). The FNPA score was a significant predictor of children's night sleep (p = .03, Table 4.60).

Table 4.59. Significant Coefficients for Family Predictors of MVPA, Controlling for Children's Age and Gender

					95% CI	
Family factor	**B**	**Standard Error**	**p-value**	**Exp(B)**	**Lower**	**Upper**
Mother BMI	-.06	.03	.049	.94	.88	1.00
Father's working status	1.47	.74	.047	4.36	1.02	18.63

Notes. Outcome: MVPA and reference group was less than 60 minutes a day). Maternal BMI continuous variable. Father's working status reference group was working.

Table 4.60. Significant Coefficient for Family Predictors of Sleep time, Controlling for Children's Age and Gender

					95% CI	
Family factor	**B**	**Standard Error**	**p-value**	**Exp(B)**	**Lower**	**Upper**
FNPA score	.11	.05	.03	1.12	1.01	1.24

Notes. Outcome: Sleep time and reference group was 9 hours or more. FNPA score continuous variable

Maternal BMI. Increased maternal BMI was associated with lower odds of children's inadequate MVPA time per day (less than 60 minutes) (OR = .94, 95% CI [.88, 1.00], p = .049, Table 4.59).

Fathers' working status. Children of working fathers was significantly associated with higher odds of inadequate MVPA per day when compared to children of fathers who were not working (OR = 4.36, 95% CI [1.02, 18.63], p = .047, Table 4.59).

FNPA score. Increase in FNPA scores was significantly associated with higher odds of children sleeping at least nine hours a night (OR = 1.12, 95% CI [1.01, 1.24], p = .03, Table 4.60).

Eating with family predictors of MVPA, screen time, and sleep time. Multiple linear regression with MVPA time and screen time as outcomes and eating with family and eating with family from one plate as predictors were calculated. A binary logistic regression model with MVPA, screen time, and sleep time as binary outcomes and eating with family and eating with family from one plate as predictors were calculated. Children's age and gender were controlled. Results showed that eating with the family was significantly associated with a higher odds for sleeping at least nine hours a night compared to sometimes or not eating with the family (OR = 6.57, 95% CI [1.98, 21.86], p = .002). However, eating with the family from one plate was significantly associated with a lower odds for sleeping at least nine hours a night compared to sometimes or not eating with the family from one plate (OR = -.81, 95% CI [.21, .92], p = .03). See Table 4.61. Eating with family and eating with family from one plate were not significant predictors to MVPA or screen time (p > .05).

Table 4.61. Coefficients of Eating with Family predictor of Sleep time

	Unstandardized β	SE	p-value	Exp(B)	95% C.I for Exp(B) Lower	Upper
Eating with the family	1.88	.61	.002	6.57	1.98	21.86
Eating with the family from one plate	-.81	.37	.03	.44	.21	.92

Notes. Outcome: sleep time and reference group was at least 9 hours a night. Predictor: eat with family pattern reference group was yes

Aim 4: Examine the Relationship between BMI z- scores of 1st to 4th-Grade Omani Children and Maternal BMI, Parental Education Level, Parental Working Status, Family Income, and Family Nutrition and Physical Activity Pattern

Children's BMI z-scores were examined against a number of family factors in an attempt to learn whether the children's BMI z-scores were influenced by the family. The family factors examined were maternal BMI, parental education level, parental working status, family income, and family nutrition and physical activity pattern.

Maternal BMI. Correlation results showed that children's BMI z-scores were positively and significantly associated with maternal BMI (r = .37, p = .001, Table 4.62). As maternal BMI increased, children's BMI z-score increased. Also, the mean maternal BMI differed significantly between normal, thin, or severely thin children and children with overweight or obesity (p = .001, Table 4.63).

Table 4.62. Pearson's Correlation of Children's BMI z-score with Maternal BMI

	Mother BMI	
	r	**p**
Children's BMI z-score	.37	.001

Table 4.63. Maternal BMI Means by Children's Weight Status

	N	Mean Maternal BMI (±SD)	p-value
Children's Weight Status			
1- Normal or under	155	27.99 (±5.14)	.001
2- Overweight or obesity	32	32.34 (±6.00)	

Parental education level. Independent t-tests demonstrated a significant relationship between children's BMI z-scores and both mothers' and fathers' level of education (p = .02, Table 4.64). Children of parents with bachelor or higher level of education tended to have higher BMI z-scores when compared to children of parents with a lower level of education. Also, chi-square analysis showed a significant association between mothers', but not fathers' education level, and children's weight status (Table 4.65). A higher percentage of children with overweight or obesity had mothers with bachelor or higher education level compared to mothers with a diploma or lower level of education.

Table 4.64. Children's BMI z-scores Means by Parental Education Level

	N	Mean BMI z-score (±SD)	p-value
Mothers education level			
1- Diploma or lower	126	-.4 (±1.4)	.02
2- Bachelor or higher	69	.1 (±1.6)	
Fathers education level			
1- Diploma or lower	104	-.4 (±1.4)	.02
2- Bachelor or higher	91	.05 (±1.5)	

Table 4.65. Crosstabulation between Children's Weight Status and Mothers' Education Level

	Normal or thin	Overweight and obesity	χ2	p-value
Mothers' education level			7.57	.006
1- Diploma or less	111 (88.1%)	15 (11.9%)		
2- Bachelor or more	50 (72.5%)	19 (27.5%)		

Parental working status. Neither mother's nor fathers' working status were significantly associated with children's BMI z-scores ($p > .05$). Similarly, there was no significant relationship between mothers' or fathers' working status and children's weight status ($p > .05$).

Family income. Independent t-tests and chi-square analysis indicated there was no significant relationship between family income and neither the children's BMI z-scores nor the children's weight status ($p > .05$).

Family nutrition and physical activity pattern. The relationship between the children's BMI z-score and family nutrition and physical activity pattern were examined. The family nutrition and physical activity pattern was represented by the Family Nutrition and Physical Activity (FNPA) score and two questions related to eating with family.

FNPA score. The relationship between children's BMI z-scores and the FNPA score was poor and not significant (r = .08, p = .28, Table 4.66). Similarly, there was no significant relationship between children's weight status and FNPA scores found (p > .05).

Table 4.66. Pearson's Correlation of Children's BMI z-score with FNPA score

	FNPA score	
	r	**P**
Children's BMI z-score	.08	.28

Eating with family. Results showed no significant relationship between eating with the family (p = .16) or eating with the family from one plate (p = .62) and children's BMI z-scores or children's weight status (Table 4.67). Also, there was no significant relationship between eating with the family (p > .99) or eating with the family from one plate (p = .26) and children's weight status (Table 4.68)

Table 4.67. Children's BMI z-score Means by Eating with Family

	N	**Mean BMI z-score (±SD)**	**p- value**
Eating with Family			.16
1- Yes	181	-.17 (±1.44)	
2- No or sometimes	14	-.74 (±1.69)	
Eating with Family from One Plate			.62
1- Yes	103	-.26 (±1.42)	
2- No or sometimes	92	-.15 (±1.53)	

Table 4.68. Crosstabulation of Children's Weight Status and Eating with Family

	Normal or under	**Overweight and obesity**	**χ2**	**p-value**
Eating with Family			.10	>.99*
1- Yes	149 (82.3%)	32 (17.7%)		
2- No or sometimes	12 (85.7%)	2 (14.3%)		
Eat with Family from One Plate			1.25	.26
1- Yes	88 (85.4%)	15 (14.6%)		
2- No or sometimes	73 (79.3%)	19 (20.7%)		

Notes. p-value from Fisher's exact test because of small cell count.

Family predictors of children's BMI z-scores. A multiple linear regression was calculated to predict children's BMI z-scores from maternal BMI, parental education level, parental working status, family income, and FNPA score. Children's age and gender were controlled. A significant regression equation was found (F (9, 170) = 4.24, p = .001), with an R^2 of .18 (Table 4.69). Among all the family predictors, maternal BMI and mothers' education level were the only significant predictors to children's BMI z-score.

Table 4.69. Model Summary. Family Predictors of Children's BMI z-score After Controlling for Children's Age and Gender

R2	Δ F	df1	df2	Significance Δ F	Significant predictors
.18	4.24	9	170	.001	Maternal BMI, mothers' education level

Note. Outcome: children's BMI z-score. Predictors: maternal BMI, mothers' and fathers' education level, mothers' and fathers' working status, family income, FNPA score

Maternal BMI. The model predicted an increase in children's BMI z-scores by .1 (SE = .02) for each increased unit of maternal BMI (p = .001, Table 4.70).

Mothers' education level. The model predicted that children of mothers with a bachelor or higher education level had a higher BMI z-score by .65 (SE = .28) when compared to children of mothers with a diploma or a lower education level (p = .02, Table 4.70).

Table 4.70. Coefficient for Family Predictors of Children's BMI z-score after Controlling for Children's Age and Gender

Family factors	Unstandardized β	SE	p-value
Maternal BMI	.10	.02	.001
Mothers' education level	.65	.28	.02
Fathers' education level	.23	.23	.31
Mothers' working status	.16	.26	.54
Fathers' working status	-.05	.42	.92
Family income	-.20	.22	.38
FNPA score	.01	.03	.67
Age	.10	.09	.26
Gender	-.11	.21	.59

Notes. Outcome: Children's BMI z-score. Mothers' and father's education level reference group was bachelor or higher. Mothers' and father's working status reference group was not working. Family income reference group was more than 1000. FNPA continues variable. Gender reference group was female

Family predictors of children's weight status. We fit logistic regression models controlling for children's age and gender with children's weight status as the outcome and maternal BMI, parental education level, parental working status, family income, and FNPA score as the predictors. Results of the binary logistic regression indicated a significant association between children's weight status and maternal BMI (p = .001) as well as mothers' education level (p =.02, Table 4.71).

Maternal BMI. Increased maternal BMI was significantly associated with higher odds of having a child with overweight or obesity (OR = 1.16, 95% CI [1.07, 1.26], p = .001, Table 4.71).

Mothers' education level. Being a mother with a diploma or lower education level was significantly associated with lower odds of having a child with overweight or obesity (OR = .24, 95% CI [.08, .77], p = .02, Table 4.71).

Table 4.71. Coefficients for Family Predictors of Children's Weight Status after Controlling for Children's Age and Gender

					95% CI	
Family factor	**B**	**SE**	**p-value**	**Exp(B)**	**Lower**	**Upper**
Maternal BMI	.15	.04	.001	1.16	1.07	1.26
Mothers' education level	-1.41	.59	.02	.24	.08	.77
Fathers' education level	-.20	.47	.67	.82	.33	2.06
Mothers' working status	-.20	.56	.72	.82	.27	2.47
Fathers' working status	1.26	1.19	.29	3.53	.34	36.60
Family income	.32	.47	.50	1.37	.55	3.44
FNPA score	-.02	.07	.74	.98	.86	1.11
Age	.14	.19	.45	1.15	.80	1.67
Gender	.19	.44	.66	1.21	.51	2.89

Notes. Outcome: Children's weight status and reference group was overweight or obesity. Mothers' and father's education level reference group was diploma or lower. Mothers' and father's working status reference group was working. Family income reference group was less than 1000. FNPA continues variable. Gender reference group was male.

Eating with family predictors of children's BMI z-score and weight status. A multiple linear regression was calculated to predict children's BMI z-scores from eating with the family and eating with the family from one plate. Also, binary logistic regression was calculated to predict children's weight status from eating with the family and eating with the family from one plate. Children's age and gender were controlled. The results indicated that eating with the family or eating with the family from one plate were not significant predictors of either children's BMI z-scores or weight status ($p > .05$). See Tables 4.72 and 4.73.

Table 4.72. Coefficients for Eating with Family Predictors of Children's BMI z-scores

	Unstandardized β	Standard Error	p-value
Eating with family	-.66	.41	.11
Eating with family from one plate	.16	.21	.45

Notes. Outcome: children's BMI z-score. Eating with family and eating with family from one plate reference groups was sometimes or no.

Table 4.73. Coefficients for Eating with Family Predictors of Children's Weight status

					95% C.I for Exp (B)	
	Unstandardized β	SE	p-value	Exp(B)	Lower	Upper
Eating with family	.43	.80	.59	1.53	.32	7.36
Eating with family from one plate	-.46	.39	.24	.63	.297	1.35

Notes. Outcome: children's weight status and reference group was overweight or obesity. Eating with family and eating with family from one plate reference groups was yes.

Summary

This chapter has provided details about the current study results. General descriptive results related to children's characteristics, family socioeconomic characteristics, children's and mothers' anthropometric measurements, children's nutrition and physical activity pattern, and family nutrition and physical activity pattern were detailed. In addition, the results of bivariate and regression analysis testing the relationships between children's BMI z-score and nutrition and physical activity pattern in addition to children's BMI z-score, nutrition intake, and physical activity pattern in relation to maternal BMI, parental education level and working status, family income, and family nutrition and physical activity pattern were provided. Children's nutrition intake was assessed with a single day dietary recall and a food frequency questionnaire (FFQ). Children's physical activity pattern was assessed with mothers-reported moderate to vigorous physical activity (MVPA) time, screen time, and sleep duration at night. Family nutrition and physical activity pattern were mainly assessed with the Family Nutrition and Physical Activity (FNPA) screening tool. FNPA can range from 10 to 40, with higher scores indicating more healthy family nutrition and physical activity pattern.

In the current study, a total of 204 families (a mother with a child) were enrolled, but 197 families were included in the final study analysis. The average age of children was 7.74 years, and about 53% of the total children were female. Children participated in this study were originally from different Governorates in Oman, and the majority were originally from Muscat, Al- Dhakhilia, or North Al-Sharqia Governorates.

In this study, more fathers held a bachelor or higher education degrees compared to mothers. Also, the majority of fathers were working, while over 50% of mothers were not working. More than 50% of the families in the study had a monthly income that is over 1,000 Omani Rial (OMR). The families' nutrition and physical activity patterns were generally healthy as the average FNPA score was high (33). Also, the high majority of children were eating with the family, and more than 50% of the children were usually eating with the family from one plate.

In our study, 17.4% of the examined children were classified as overweight or obese, while almost three-quarters of the mothers (72%) were classified as overweight or obese. More than 50% of the children had high total energy intake, and the majority of children had poor fruit and vegetable intake. Also, more than 50% of the children had inadequate MVPA time per day, but the majority of children had limited screen time and adequate sleep time.

Weak associations between BMI z-score and nutrition and physical activity pattern were found among the children. In fact, unusual relationships between BMI z-score and soft and sugary drinks intake, the frequency of fat or butter is added to food, and adequacy of sleep was found. Children's BMI z-scores were negatively associated with soft and sugary drinks frequency of intake and frequency of fat and butter added to food. However, children's weight status was not associated with soft and sugary drinks frequency of intake or frequency of fat and butter added to food. Also, children sleeping at least nine hours a night was found to be a significant predictor of overweight and obesity, controlling for MVPA time, screen time, age and gender.

Children's nutrition intake was mainly associated with parental education level, family income, and the FNPA score. Maternal BMI was not associated with children's total energy, macronutrients, or food group intake. However, children of mothers with underweight or normal weight had a more significant intake of meat compared to children of mothers with overweight or obesity. When other family factors were controlled for with a regression model, mothers' weight status was found not to be a significant predictor of children's meat intake.

Multiple significant relationships between parental education level and children's nutrition intake were found. A higher fathers' level of education was associated with a higher intake of protein (g), fruit (cup), dairy (cup), meat, and nuts and seeds among children. However, a higher mother's level of education was associated with a lower intake of vegetables rich in vitamin A. When other family factors were controlled for, the fathers' higher education level was found to be a significant predictor of more fruit (cup), protein (g), vegetables rich in vitamin A, meat, and nuts and seed intake. In addition, a mothers' higher education level was found to be a significant predictor of a higher dairy (cup) intake, but less fish and vegetables rich in vitamin A. Parental education level was not associated with children's total energy intake, fast food, or soft and sugary drinks intake.

No significant association was found between parental working status and children's nutrition intake. However, when other family factors were controlled for, mother's working status was found to be a significant predictor of dairy (cup) intake. Children of non-working mothers were more likely to consume more dairy (cup) a day compared to children of working mothers.

Increased family income (over 1,000 OMR) was associated with children's intake of more fruit rich in vitamin C, nuts and seeds, and dairy (cup) when compared to a lower monthly income. However, children of families with lower monthly income had a higher consumption of carbohydrates (g) and grains (g). Total energy intake was not significantly different between children of higher income families and children of lower income families. When other family factors were controlled for, a higher family income was a significant predictor of a higher intake of dairy (cup) and fruit rich in vitamin C intake, but not nuts and seeds. Also, higher family income was found to be a significant predictor of a lower carbohydrate and grain intake.

In this study, an increased FNPA scores were significantly associated with a higher intake of protein (g), fruit (cup), protein food (oz), dairy (cup), meat, eggs, nuts and seeds, vegetables (except the ones rich in vitamin C, A, iron or folate), and fruit (except the ones rich in potassium). At the same time, an increased FNPA score was significantly associated with a lower intake of fast food and soft and sugary drinks. When other family factors were controlled for, an increase in FNPA scores were a significant predictor of more protein (g), dairy (cup), vegetable (except the ones rich in vitamin A and C), fruit (except the ones rich in vitamin A, C, and potassium), meat, and egg intake. Also, an increase in the FNPA scores was a significant predictor of eating less fast food and soft and sugary drinks.

In addition, the relationship between children's nutrition intake and eating with the family or eating with the family from one plate was examined. Our study demonstrated that eating with the family was significantly associated with a higher intake of vegetables (except those rich in vitamin A, folate or iron), fruit rich in vitamin C and potassium, and meat compared to sometimes or never eating with the family. Also, eating with the family from one plate was associated with a higher intake of grain (oz), fish, and chicken. When eating with the family from one plate was controlled for, eating with the family was a significant predictor of eating more vegetables (except the ones rich in vitamin A and folate and iron), fruit rich in vitamin C and potassium, and meat intake. Eating with the family from one plate was a significant predictor of children eating more fish when eating with the family was controlled for.

Children's physical activity pattern (MVPA, screen time, night sleep) was found to be associated with maternal BMI, parental education level and working status, FNPA score, but not family income. Increased maternal BMI and overweight or obesity among mothers was significantly associated with an adequate sleep time among children. However, maternal BMI was not associated with children's MVPA or screen time. When other family factors were controlled for, an increase in maternal BMI was associated with a higher odds of children receiving adequate daily MVPA.

The higher a mother's and father's education level was negatively associated with adequate daily MVPA time. However, mothers' and father's education level were not significant predictors of children's MVPA time or adequate MVPA time a day when other family factors were controlled for.

Children of fathers who were not working were exercising longer at MVPA a day and more frequently had adequate MVPA time a day compared to children of fathers who were working. When other family factors were controlled for, fathers not working was a significant predictor of children's adequate MVPA time per day. Mothers working status and family income had no significant relationship with children's MVPA, screen time, or night sleep.

Increased FNPA scores were associated with less screen time a day, more limited screen time, and an adequate night sleep among children. However, an increase in the FNPA score was not associated with children's MVPA time or adequacy per day. When other family factors were controlled for, an increase in FNPA scores was a significant predictor of less screen time a day and an adequate sleep.

Children's physical activity patterns and association with eating with the family and eating with the family from one plate were also examined. Eating with the family was significantly associated with an adequate sleep, but not MVPA or screen time. In a binary logistic regression model including eating with family and eating with family from one plate as predictors to night sleep, eating with the family was a significant predictor to adequate sleep but eating with the family from one plate was a significant predictor to inadequate sleep.

In regards to the relationship between children's BMI z-scores and family factors, maternal BMI and parental education levels were the only family factors associated with children's BMI z-scores. Increased maternal BMI was significantly associated with an increase in children's BMI z-scores and overweight or obesity among children. When other family factors were controlled for, maternal BMI was a significant predictor of increased BMI z-scores among children. Also, mothers with overweight or obesity were a significant predictor of overweight and obesity status among children.

The higher a mother's and father's education level were associated with increased BMI z-scores among children. In addition, a higher mother's level of education was associated with overweight or obesity status among children. When other family factors were controlled for, the higher a mother's level of education was a significant predictor of increased BMI *z*-scores and overweight and obesity status among children. Parental working status, family income, and FNPA scores were not significantly associated with children's BMI *z*-scores or weight status.

CHAPTER 5: DISCUSSION

The focus of this study was to examine the relationship between body mass index z-scores (BMI z-score) and nutrition and physical activity patterns among first to fourth-grade Omani children. Children's nutrition intake, physical activity patterns, and BMI z-scores influenced by multiple family factors were also examined. The family factors examined in conjunction with children's nutrition intake, physical activity patterns, and BMI z-scores included maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Childhood Obesity Prevalence

Childhood obesity is increasing in Oman. The development of overweight and obesity in childhood increases the risk of developing chronic health conditions including prediabetes, type 2 diabetes, and cardiovascular disease later in life (Kelsey et al., 2014). In 2016, 35.4% of Omani children ages 5-to-9 years were overweight, and 18.2% were obese (World Health Organization [WHO], 2018). In our study, 9.2% of Omani children were classified as overweight, and 8.2% were classified as obese. The prevalence of overweight and obesity combined was 17.4%, which is similar to other Gulf Cooperation Council (GCC) countries. For example, the average rate of overweight and obesity among 6-to-10 years old children was 20.7% in Saudi Arabia and 16.5% in Emirates (Al-Muhaimeed et al., 2015; Ng et al., 2011b).

Adults in Oman also have an increased prevalence of overweight and obesity (International Food Policy Research Institute, 2016). In 2016, Oman was ranked 30th worldwide for overweight and obesity, and 62.6% of adults were overweight or obese (WHO, 2017). In this study, Omani mother's mean BMI was 28.7 kg/m^2 (Standard deviation [SD] ± 5.52), which is classified as overweight and the prevalence of overweight and obesity combined was 72.3%. In 2016, gender-specific data suggested that 33.7% of female Omani adults were classified as obese (World Data Atlas, 2018). In this study, 36.2% of Omani mothers were classified as obese.

Aim One: Relationship between BMI z-scores and Nutrition and Physical Activity Patterns

The first aim of this study was to assess the relationship between BMI z- scores and nutrition and physical activity patterns of first to fourth-grade Omani children.

Children's BMI z-scores and Nutrition Intake

Children's nutrition intake data were collected from the single day dietary recall and food frequency questionnaire (FFQ) and were categorized according to food groups as follow; energy and macronutrients, grains, fruit and vegetables, protein sources, dairy, fast food, and soft and sugary drinks. The relationship between children's BMI z-scores and each of the nutrition intake categories are discussed below.

Energy and macronutrients. The recommended daily energy intake for children age 6-to-10 years old ranges from 1,400 to 2,000 kilocalories (kcals) according to the Omani Guide to Healthy Eating and from 1,200 to 1,800 kcal according to the 2015-2020 Dietary Guidelines for Americans (Omani Ministry of Health [MOH], 2009; U.S. Department of Agriculture [USDA], 2015). In this study, children's energy intake ranged from 613 to 3,736 (m = 1770, SD ± 563.5) kcal per day. In fact, over 50% of children had total energy intake more than suggested by both the Omani Guide to Healthy Eating and the 2015-2020 Dietary Guidelines for Americans. Similarly, nutrition intake of 6-to-10 years Emirati children (n = 253) was assessed with a single day dietary recall and findings showed that a large percentage of children (38.2% of boys and 43.2% of girls) consumed more calories than needed based on the Institute of Medicine estimated energy requirements (Ng et al., 2011b). Ng and colleagues (2011b) also reported in their study that the mean total energy intake was 1,649.4 (SD ± 108.6) among female children and 1,696.9 (SD ± 66.7) among male children in a day, which is different than the average energy intake of children examined in our study by 100 kcal or less. A recent study from Mauritius, a country in East Africa reported a 1,522 (SD ± 282.4) average daily energy intake among 6-to-12 years Mauritian children (n = 336) (Bundhun, Rampadarath, Puchooa, & Jeewon, 2018). There was a 250 kcal difference in the average daily energy intake between the Mauritian children and the children in our study. Unlike our study, they assessed children's nutrition intake with a three- day dietary recall (Bundhun et al., 2018). Oman and the United Arab Emirates, versus Mauritius, share many aspects of culture, traditions, and economic status (Torstrick & Faier, 2009), which explains the similar findings of total energy intake among the children from these two countries.

In this study, children's mean protein and carbohydrates intake were 65.0 (SD ± 26.6) and 250.2 (SD ± 87) grams a day, respectively. According to the 2015-2020 Dietary Guidelines for Americans (USDA, 2015), the recommended daily protein intake range from 19 to 34 grams and daily carbohydrates intake is recommended to be 130 grams in this age group, which suggests that the children consumed more protein and carbohydrates than needed. However, according to the Omani Guide to Healthy Eating (MOH, 2009), the children's carbohydrate intake in a day was within the recommended range (192.5 to 375 grams), while the one-day protein intake was above the range (28 to 50 grams) based on age, gender, and activity level. Compared to the 2015-2020 Dietary Guidelines for Americans (USDA, 2015), the Omani Guide to Healthy Eating (MOH, 2009) has wider ranges for children's recommended protein and carbohydrate intake, which could be related to the earlier problem of childhood malnutrition (Alasfoor et al., 2007).

The children's mean fat intake in one day was 58.6 (SD ± 23.7) grams, which is within the Omani Guide to Healthy Eating (MOH, 2009) recommended range (40 to 59 grams) based on age, gender, and activity level. The 2015-2020 Dietary Guidelines for Americans (USDA, 2015) include the percentage of total energy intake from fat recommendations (25 to 35%).

Dissimilar to our study, Ng et al. (2011) reported the daily macronutrient intake of Emirati children (ages 6-to-10 years) as follows: percentage of energy from protein (male = 14.4%, female = 15.3%), fat (male = 26.3%, female = 25.6%), and carbohydrates (male = 60.4%, female = 60.5%). According to the 2015-2020 Dietary Guidelines for Americans (USDA, 2015), children ages 6-to-10 years old should take in 10 to 30% of their total calories from protein, 45 to 65% of their total calories from carbohydrates, and 25 to 35% of their total calories from fat daily. The macronutrient intake among Emirati children ages 6-to-10 years were by the 2015-2020 Dietary Guidelines for Americans.

Our study suggested that there was no significant relationship ($p > .05$) between total energy or macronutrient intake and children's BMI z-scores or weight status. Neither the children's total energy nor macronutrient intake was a significant predictor of either BMI z-scores or weight status. Similar findings were scarce. A recent study examined eating in the absence of hunger at four and a half years and six years of age among 158 children from Singapore and the association with energy intake and body composition (Fogel et al., 2018). They found no significant differences in BMI or body composition between children who ate in the absence of hunger and those who did not eat in the absence of hunger at ages four and a half ($p = 0.41$) or six years of age ($p = 0.40$) (Fogel et al., 2018). In the same study, eating in the absence of hunger was associated with an increased cumulative energy intake among children at age four and a half years ($p < 0.01$) (Fogel et al., 2018). Another study from Greece assessed the nutrition intake of 9-to-12 years old children with a three-day dietary recall. They found that energy and carbohydrate intake were positively and significantly ($p < .05$) associated with children's BMI, but not obesity (Papandreou et al., 2016).

In general, an increase in total energy intake has been linked to an increase in body weight (Ha et al., 2016; Kuźbicka & Rachoń, 2013). However, the findings indicate that the relationship between increase energy intake and obesity among children is not consistent and that other factors could be a part of the equation. The relationship between energy intake and overweight and obesity relies largely on energy expenditure and can be explained by more than just the level of physical activity (Cuthbertson et al., 2017; Hill et al., 2012; Westerterp, 2013). The average physical activity level among children examined in this study was 61.41 minutes per day (SD + 63.72), which is in accordance with the WHO recommendations (WHO, 2014).

Grains. In this study, the mean daily total grain intake of Omani children (6-to-10 years old) was 7.6 ounces (SD ± 3.9). The children's average total of grain intake in a day was in accordance with the Omani Guide to Healthy Eating recommendations (4 cups a day ~ 8 ounces) but above the 2015-2020 Dietary Guidelines for Americans recommendations (6 ounces at the 2000-calorie level) (MOH, 2009; USDA, 2015). Compared to the average total of grain intake a day of children in our study, the daily total of grains intake was less among 9-to-10 years old male (m = 5.03 ounces, SD ± 2.53) and female (m = 4.27 ounces, SD ± 2.27) children from Greece (Manios et al., 2015). However, Manios et al. (2015) collected children's nutrition intake from two consecutive weekdays and one weekend day 24-hour dietary recall, while we collected nutrition intake data from only one-weekday 24-hour dietary recall. Also, cultural food traditions in Oman differ from food traditions in Greece. For example, white rice, a major source of refined grains, is a popular lunch dish in the GCC region and research shows that most school-age children consume white rice almost every day (Amin et al., 2008). Our study demonstrated that 81% of children consumed refined grains daily and only 35% of children consumed whole grains daily. Dissimilar to our study, results of an Irish study based on a seven day weighed food diary nutrition intake assessment indicated that more than 90% of children 5-to-12 years of age consumed whole grains and their mean daily intake per day was 18.5 grams (SD ± 18.2) (Devlin et al., 2013).

Our study found that total grain intake a day had no significant ($p > .05$) relationship with children's BMI z-scores or weight status. Researchers from Puerto Rico analyzed the nutrition intake of 12 years old children ($n = 796$) collected with a one day dietary recall and examined the relationship between diet quality and weight status (Torres, Santos, Orraca, Elias, & Palacios, 2014). Similarly, they did not find a significant ($p < .05$) difference in mean total grain intake between underweight, normal weight, overweight or obese children (Torres et al., 2014).

A longitudinal study ($n = 1,014$) from Canada measured the nutrition intake of four years old children with a 24-hour dietary recall and followed-up at age six years old to examine the dietary factors associated with overweight (Dubois et al., 2011). They found that male children who consumed five or more servings of grain per day at age four years were more likely to be overweight by six years of age compared to those who did not [adjusted OR = 3.20 (95% CI): 1.72–5.97] (Dubois et al., 2011). However, in the same study, the association between a high intake of grain and overweight was no longer significant when the model was adjusted for overweight status at age four years [OR = 1.82 (95% CI): 0.894–3.71; P = 0.09] (Dubois et al., 2011), which infers that a high intake of grain at four years of age was not an independent predictor of overweight at six years of age.

In the current study, the frequency of whole grain and refined grain intake had no significant ($p > .05$) association with children's BMI z-scores or weight status. In general, whole grain consumption is well known for maintaining healthy weight status and refined grain is linked to overweight and obesity. Analysis of data from the National Health and Nutrition Examination Survey 2001-2012 pertinent to the U.S. population indicated that the whole grain intake was inversely related to BMI and obesity among children 6-to-18 years of age ($n = 15{,}280$, $p < .05$) (Albertson, Reicks, Joshi, & Gugger, 2016). Another study from Malaysia measured whole grain consumption among 9-to-11 year-old children with a 10-item questionnaire and found a significant ($p < .001$) decrease in BMI z-scores for each one standard deviation increase in whole grain consumption (Koo, Lee, Nur Hidayah, & Nurain Hazwani, 2018).

A review of the literature suggested that within the Mediterranean-style food pattern, reducing white bread versus reducing whole grain bread was associated with a lower increase in weight (Serra-Majem & Bautista-Castano, 2015). Also, an Iranian cross-sectional study examined the association between anthropometric measures and white rice consumption among 415 female adolescents (Azadbakht, Haghighatdoost, & Esmaillzadeh, 2016). They used a validated semi-quantitative food frequency questionnaire (SFFQ) to assess participants' nutrition intake. They found that the risk for abdominal obesity was 2-fold higher among female adolescents consuming more than 122.0 grams of white rice a day compared to those consuming less than 71.9 grams of white rice a day (Azadbakht et al., 2016). However, in other studies, the SFFQ was found to overestimate the nutrition intake among children ages 3-to-9 years when compared to dietary recalls or records (Buch-Andersen, Perez-Cueto, & Toft, 2016; Sochacka-Tatara & Pac, 2014).

Fruit and vegetables. The fruit and vegetable intake of children in this study was poor. Results of the FFQ indicated that most children were not eating fruit and vegetables every day. Also, the mean intake of fruit among the children was 1.4 (SD ± 1.2) cup, while the mean intake of vegetables was 1.5 (SD ± 1.1) cup a day. Children at this age require at least 3.0 cups of fruit and 2.5 cups of vegetables daily according to the Omani Guide to Healthy Eating (MOH, 2009). Similarly, 14-to-19 year-old Saudi Arabian adolescents (n = 2,906) had poor fruit consumption with an estimated frequency of fruit intake of only two to three times a week (Al-Hazzaa et al., 2012). Al Junaibi et al. (2013) reported that the mean daily fruit intake ranged from 2.7 (SD ± 1.4) to 3.2 (SD ± 1.5) per day, while the mean daily vegetable intake ranged from 2.9 (SD ± 1.4) to 3.3 (SD ± 1.5) per day among male and female 6-to-19 years old Emirati children (n = 1,541). However, the intake unit was unclear (cup, serving, gram) and they reported inadequate fruit and vegetable intake among the children (Al Junaibi et al., 2013). Al Junaibi et al. (2013) used the International Obesity Task Force (IOTF) questionnaire that asked about dietary habits in the past seven days and was completed by the children or the parents if the child was younger than ten years of age.

The current study found no significant relationship ($p > .05$) between fruit and vegetable single day intake or frequency of intake and children's BMI z-scores or weight status. Fruit and vegetable intake from the dietary recall or FFQ was not significant ($p > .05$) predictors of children's BMI z-scores or weight status.

Al-Haifi et al. (2013) and Al-Hazzaa et al. (2012) conducted studies that were part of the Arab Teens Lifestyle Study (ATLS) (Al-Hazzaa, Musaiger, & Group, 2011), a school-based multicenter collaborative project aimed to examine the association of a number of lifestyle behaviors with obesity among Arab adolescents. The ATLS questionnaire had ten questions designed to assess the frequency of certain food intake in a week. Similar to the current study, there were no significant associations between fruit frequency intake and obesity among 14-to-19-year-old Kuwaiti (n = 906) and Saudi Arabian (n = 2,906) adolescents (Al-Haifi et al., 2013; Al-Hazzaa et al., 2012). Dissimilar to our study, Al-Haifi et al. (2013) and Al-Hazzaa et al. (2012) found a significant inverse relationship between vegetable frequency intake and obesity.

Similar to this study, there were no significant association between vegetable frequency of intake and childhood obesity among 12-to-17 years old Emirati adolescents (n = 661) and 15-to-18 years old Bahraini adolescents (n = 735) (Bin Zaal et al., 2009; Musaiger et al., 2014). Both of these studies used self-reported questionnaires to examine children's nutrition intake (Bin Zaal et al., 2009; Musaiger et al., 2014). Dissimilar to our study, Bin Zaal et al. (2009) found that healthy weight in children was positively associated with fruit intake.

Surprisingly, a significant dissimilar finding was reported by other GCC studies. Amin et al. (2008) reported that the intake of vegetables two to four times a week versus once a week significantly increased the risk of overweight and obesity among Saudi children 10-to-14 years old. Musaiger et al. (2014) also documented that eating fruit four times a week or more compared to less than four times a week was significantly ($OR = 1.62$, $p < .05$) associated with overweight and obesity among Bahraini male adolescents 15-to-18 years of age.

As noticed from the above discussion, the findings related to the relationship between the intake of fruit or vegetables and childhood obesity from the Gulf Cooperation Council (GCC) literature are inconsistent. Further investigation is needed to clarify the factors influencing the fruits and vegetables intake and whether their relationship with childhood obesity is moderated by other factors. For instance, in our study, the non-significant findings related to the relationship between fruit or vegetable intake and childhood obesity can be partially explained by the fact that the intake of fruit and vegetables among examined children were generally poor.

Protein sources. The average protein source food intake among the children was 4.0 (SD ± 3.0) ounces a day. The recommended daily protein food intake is 5.5 ounces at a 2,000-calorie level diet (USDA, 2015). Most children in our study consumed protein such as meat, chicken, fish, eggs, nuts and seeds, and legumes every week. Similarly, 6-to-18 year old Bahraini children and adolescents were found to have only a weekly consumption of protein source food such as meat, children, fish, eggs, and legumes (Gharib & Rasheed, 2011). In general, the GCC communities are known for high red meat intake (Micha et al., 2015) compared to following a vegetarian diet (Al-Taie, Rahal, AL-Sudani, & AL-Farsi, 2015). The global consumption of the major food groups indicated that United Arab Emirates (UAE) had the highest consumption of unprocessed red meat consumption with an estimated individual intake of 96.3 grams per day among adults (Micha et al., 2015).

We found no significant ($p > 0.05$) relationship between protein source food in either the single day intake or food frequency intake and children's BMI z-scores or weight status. Similarly, meat intake was not significantly associated with childhood obesity among male ($p = .6$) as well as female ($p = .9$) Bahraini adolescents in the Musaiger et al. (2014) study. Also, chicken, fish and legume intake were not significantly associated with childhood obesity among 12-to-17-year-old Emirati children in Bin Zaal et al. (2009) study. However, Bin Zaal et al. (2009) found that meat intake was associated with a lower risk of overweight and obesity among 12-to-17-year-old female children (OR = 0.1, $p < 0.05$). Amin et al. (2008) reported that a high intake of meat and eggs significantly ($p < .05$) increased the risk of overweight and obesity among 10- to-14-year-old Saudi Arabian male children.

Dairy. The majority of children in this study (80%) were reported to consume dairy every day. A much lower daily dairy consumption (51.2%) was reported for 6-to-18-year-old Bahraini children and adolescents (Gharib & Rasheed, 2011). The single day dietary recall in our study indicated that the mean dairy intake was 1.3 (SD ± 1.0) cups per day. According to the recommendations, children 6-to-10 year olds require 2.5 to 3.0 cups of dairy per day (USDA, 2015). Dissimilar to our study, 9-to-11-year-old children (n = 40) from England were found to comply with the daily dietary recommendations of 2-to-3 servings per day (Green, Turner, Stevenson, & Rumbold, 2015). The daily dairy intake in Green et al. (2015) study was evaluated with parental weighed food records over four consecutive days.

In this study, there was no significant ($p > .05$) relationship between dairy single day or frequency of intake and children's BMI z-scores or weight status. Studies from the GCC reported no significant association between dairy intake and childhood obesity as well (Bin Zaal et al., 2009; Musaiger et al., 2014). In accordance with the current study findings, a systematic literature review (n = 16) concluded that there was no adequate evidence to support the hypothesis that dairy fat or high-fat dairy foods lead to overweight and obesity (Kratz, Baars, & Guyenet, 2013). However, studies from the United Arab Emirates and Saudi Arabia indicated a significant negative relationship between dairy intake and childhood obesity (Al Junaibi et al., 2013; Amin et al., 2008). Al Junaibi et al. (2013) found that additional daily dairy intake was associated with a reduction in BMI percentile by 2.52% ($p < 0.001$). Amin et al. (2008) found that dairy intake five to six times a week significantly ($p < 0.001$) lowered the risk of childhood overweight and obesity. However, Amin et al. (2008) did not specify the unit of dairy consumption.

Fast food. Interestingly, more than 60% of children examined in this study were found to consume fast food rarely or never. There was no significant relationship between fast food frequency of intake and children's BMI z-scores or weight status ($p > .05$). Similar to our study findings, Farghaly et al. (2007) reported that the frequency of intake of high-calorie food was not significantly ($p > .05$) different among 7-to-20-year-old Saudi children with normal weight or with obesity ($n = 767$). In Musaiger et al. (2014), more children without overweight and obesity consumed fast food four times versus less than four times a week or more compared to children with overweight and obesity, but non-significantly ($p = .054$). Also, the fast food frequency of intake was not significantly different among female children with or without overweight and obesity in the study (Musaiger et al., 2014). Several studies from the GCC found that fast food intake was significantly less among overweight and obese children compared to underweight and normal weight children (Al Junaibi et al., 2013; Bin Zaal et al., 2009). Al Junaibi et al. (2013) found that the fast food intake frequency was significantly less among 6-to-19-year-old male children and adolescents with overweight and obesity compared to their underweight and normal weight counterparts ($p < 0.01$). Bin Zaal et al. (2009) found that the intake of fast food four times or more a week was significantly associated with low risk of overweight and obesity among 12-to-17-year-old female Emirati children ($OR = 0.5$, $p < 0.01$).

Dissimilar to our study, other studies from the GCC reported a significant ($p < .05$) positive association between a high intake of fast food and childhood obesity (Al-Haifi et al., 2013; Alghadir et al., 2016). Fast food was significantly related to a higher BMI ($p < .05$) among 14-to-19-year-old female adolescents in Al-Haifi et al. (2013) study. Also, mean BMI was greater among 12-to-16-year-old adolescents who consumed high-fat fast food more than three times a week compared to their counterparts who consumed fast food less frequently ($p < 0.05$) (Alghadir et al., 2016).

In general, fast food intake has been linked to obesity (Payab et al., 2015). However, in the current study, fast food intake was generally low, most likely due to the fact that they were too young to eat outside of their home with friends (Burke et al., 2007). Also, the Omani culture favors home-made food and families eating from fast food restaurants is not very common. The increasing prevalence rates of overweight and obesity in Omani children may indicate that home-made food in Oman is starting to resemble fast food and warrants further investigation.

In the present study, mean BMI z-scores were higher among children who had fat or butter added to their food less frequently (i.e., monthly, occasionally, or never) compared to children who had fat or butter added to their food more frequently (i.e., daily or weekly) ($p > .05$); however, there was no significant relationship with the children's weight status. During data collection, we noticed that most mothers were referring to the Omani ghee, which is a home-made fat extracted from the milk of locally raised cows. A systematic literature review ($n = 16$) manuscript found no supporting evidence indicating a significant relationship between dairy fat or high-fat dairy foods and obesity (Kratz et al., 2013). In the future, more specific assessment of fat intake is recommended as the research shows that certain types of fat are linked to obesity, such as trans fatty acids (Thompson, Minihane, & Williams, 2011), while others are not.

Soft and sugary drinks. Nearly half (46.4%) of children in this study were reported to consume soft or sugary drinks rarely or never. Interestingly, our study showed that the frequency of intake of soft or sugary drinks was significantly ($p < .05$) associated with children's BMI z-scores but not with weight status ($p = .052$). The direction of the relationship between soft or sugary drink intake and children's BMI z-scores was unusual. The mean BMI z-scores were higher among children who were reported to consume soft or sugary drinks less frequently compared to more frequently ($p < .05$). However, the frequency of soft and sugary drink intake was not a significant ($p = .06$) predictor of children's weight status in our study.

The GCC literature has mixed findings related to the relationship between soft or sugary drink intake and childhood obesity. While no significant relationship between soft or sugary drinks and childhood obesity were found (Al-Haifi et al., 2013), a number of studies reported a significant negative relationship between soft or sugary drinks and childhood obesity (Al-Hazzaa et al., 2012; Musaiger et al., 2014). In Al-Hazzaa et al. (2012) study, overweight and obesity was associated with sugary drink intake three to four days a week (OR = 1.27, 95% CI [1.05–1.53]) as well as less than three days a week (OR = 1.32, 95% CI [1.08–1.62]) compared to five days a week or more. Also, Musaiger et al. (2014) found that the consumption of soft drinks more than four times a week, compared to less, was negatively associated with obesity among Bahraini male adolescents (OR = 0.5, 95% CI [0.34–0.93]).

Dissimilar to our study, a positive association between a high intake of soft or sugary drinks and childhood obesity was also reported in the GCC literature (Alghadir et al., 2016; Amin et al., 2008). Alghadir et al. (2016) reported that the mean BMI was higher among adolescents who consumed soft drinks more than three times a week compared to those who did not consume soft drinks at all ($p < 0.05$). In Amin et al. (2008), male children (ages 10-14 years) with overweight and obesity had a significantly higher daily serving of soft drinks ($p < .01$) as well as sugary drinks ($p < 0.05$) compared to male children without overweight and obesity.

In Oman, children as young as 6-to-10 years old are served their afternoon snack and many times includes sugary drinks from a conveniently located small canteen in the neighborhood (Osman et al, 2004). However, the available sugary drink portion sizes in Oman are usually small (4 – 8 ounces), which could partly explain its non-significant relationship with obesity. However, further investigation is needed to clarify the soft and sugary drinks risk of obesity among middle-age Omani children.

Children's BMI z-scores and Physical Activity Patterns

Children's physical activity patterns were examined through the assessment of moderate to vigorous physical activity (MVPA), screen time, and sleep time. The relationship between children's BMI z-scores or weight status and MVPA, screen time, and sleep time are discussed below.

MVPA. For school-age children and adolescents, WHO recommends one hour of daily MVPA (WHO, 2014). In this study, children's mean minutes of daily MVPA was 61.41 (SD ± 63.7), which is in accordance with the WHO recommendations (WHO, 2014). However, when MVPA time was dichotomized to 60 minutes or more and less than 60 minutes, 59% of the examined children fell under the less than 60 minutes of MVPA a day. This may be related to the wide MVPA time standard deviation (± 63.7).

In this study, MVPA time was not significantly associated with children's BMI z-scores or weight status ($p > .05$). Several studies from the GCC support these findings (Musaiger et al., 2014; Washi & Ageib, 2010). Washi and Ageib (2010) interviewed adolescents in regards to the frequency and type of their regularly performed exercise and documented no significant ($p > .05$) relationship between physical activity and BMI without reporting specific parameters. Musaiger et al. (2014) assessed adolescents' physical activity patterns with a self-reported questionnaire that had items related to lifestyle behaviors. No significant ($p > .05$) difference in the frequency of playing sports weekly (less than five versus more than five a week) was noted among overweight and obese and non-obese male ($p = .53$) and female ($p = .59$) Bahraini adolescents (Musaiger et al., 2014).

Multiple studies conducted in the GCC supported that low levels of physical activity were associated with childhood obesity (Al-Haifi et al., 2013; Al-Muhaimeed et al., 2015). Al-Haifi et al. (2013) used a validated self-report questionnaire to assess the level of physical activity (moderate, vigorous, moderate to vigorous) among Kuwaiti adolescents 14-to-19 years of age. They found that both moderate and vigorous activities were significantly (all $p < 0.001$) associated with a lower BMI among male adolescents while moderate to vigorous activities were significantly ($p < 0.05$) associated with lower BMI among female adolescents. Al-Muhaimeed et al. (2015) found that children ages 6-to-10 years old who engaged in sports for two or more hours a day had lower odds of becoming overweight than those who did not engage in sports (OR = .5, 95% CI [0.25, 1.20], $p < .01$). However, the confidence interval indicated a non-significant relationship. Review manuscripts also suggested a negative relationship between physical activity level and obesity among children and adolescents in the GCC and Middle Eastern countries (Badran & Laher, 2011; Mirmiran et al., 2010).

As indicated by the above discussion, the findings from the GCC literature were inconsistent, and further investigation with more objective measurement tools is needed. Also, other moderating factors such as age and lifestyle behaviors including screen and sleep times should be considered when examining the relationship between physical activity level and childhood obesity. In our study, results showed that children were generally active, which was anticipated at this age group as active play is part of their normal development (Herrington & Brussoni, 2015).

Screen time. The average daily screen time among children examined in this study was 63.04 (SD ± 68.6) minutes per day, which is acceptable according to the WHO recommendations. In this age group, the WHO (2014) suggests that screen time should be limited to 120 minutes per day. In this study, only 16% of children were reported to have more than 120 minutes of screen time a day. Dissimilar to our study, Kilani et al. (2013) examined the lifestyle behaviors (including screen time) of 15-to-18 year old adolescents (n = 802) from Oman. Their results demonstrated high mean screen times in hours per day among male adolescents (m = 2.8 hours/day, SD ± 2.3) and female adolescents (m = 3.7 hours/day, SD ± 2.9).

Our study found that screen time was not significantly associated with children's BMI z-scores or weight status ($p > .05$). Similarly, no significant relationship between screen time and childhood obesity was reported by other GCC studies (Al-Haifi et al., 2013; Al-Muhaimeed et al., 2015; Kilani et al., 2013). Kilani et al. (2013) examined the lifestyle behaviors (including screen time) of 15-to-18-year-old adolescents (n = 802) from Oman and reported no significant ($p > .05$) relationship between screen time and BMI (Kilani et al., 2013). Al-Muhaimeed et al. (2015) also found no significant relationship ($p = .1$) between daily television (TV) watching and overweight status among 6-to-10-year-old children from Saudi Arabia. Another study examined 14-to-19 years old adolescents from Kuwait and found that time spent watching television and time spent on the computer was not significantly related to BMI (Al-Haifi et al., 2013).

Alghadir et al. (2016) conducted a cross-sectional study to determine the relationship between a number of lifestyle behaviors (e.g., duration of daily TV watching) and BMI among 214 children and adolescents from Saudi Arabia (ages 12-to-16 years). They used a self-administered online questionnaire which was completed by the parents. Dissimilar to our findings, they found that the mean BMI was significantly ($p < .05$) higher among children and adolescents who had more than two hours of screen time a day compared to those who had less than an hour a day (Alghadir et al., 2016). Another study conducted in Australia with 70 families evaluated children's (mean age 8.4 [SD ±2.4]) screen time with a modified version of the validated Children's Leisure Activities Study Survey (CLASS) and examined multiple predictors to children's screen time (Lloyd, Lubans, Plotnikoff, Collins, & Morgan, 2014). They found that an increase in children's BMI z-scores was one of the significant predictors to increased screen time ($\beta = .23$, $p < .05$) (Lloyd et al., 2014).

Similar to the relationship between MVPA and childhood obesity, findings from the GCC literature related to the relationship between screen time and childhood obesity were mixed, which infers an existence of moderating factors. In our study, the majority of children were having a healthy screen time behavior (less than two hours of screen time a day). This may indicate that the relationship between screen time and childhood obesity is moderated by age or other environmental factors.

Sleep time. Among the children examined in this study, 75% were complying with the National Sleep Association (2018) recommendations of at least 9 hours of sleep per night for children age 6-to-11 years of age. Interestingly, this study demonstrated that sleeping at least nine hours a night was significantly associated with an increased odds of children becoming overweight or obese ($p < .05$). Dissimilar to our study, Kilani et al. (2013) found no significant association between sleep duration and BMI among Omani adolescents (Kilani et al., 2013).

Other researchers investigated the relationship between sleep length and obesity among 10-to-19 year old Saudi Arabian children and adolescents (n = 5,877). They reported that sleeping seven hours or less a night significantly increased the risk of developing obesity among male (OR = 1.28, 95% C.I [1.09 - 1.50]) and female (OR = 1.38, 95% C.I [1.02 -1.89] participants (Bawazeer et al., 2009). In general, short sleep duration in children has been linked to obesity (Miller, Lumeng, & LeBourgeois, 2015). However, mechanisms such as dietary intake, eating time, and obesogenic dietary behaviors have been identified between sleep-obesity associations (Miller et al., 2015). These mechanisms need to be investigated from a cultural perspective to further understand the relationship between sleep and obesity among Omani children. A deeper understanding of nutrition intake among children should clarify the association of night sleep with children's weight status found in our study. In addition, investigating moderating factors such as age would help in understanding this relationship.

Aim Two: Family Influence on Children's Nutrition Intake

The study second aim was to examine the relationship between the nutrition intake of first to fourth-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Maternal BMI

Children's intake of total energy, macronutrients, and different food groups were examined in relation to maternal BMI. In this study, only meat frequency intake was associated with maternal weight status ($p < .05$), but not BMI. Children of mothers who were underweight or of normal weight were found to significantly ($p < .05$) consume meat more frequently compared to children of mothers with overweight or obesity. Dissimilar to our study, Pei and colleagues (2014) from Germany assessed the food intake of 3,230 school-age children with food frequency questionnaires completed by their parents and examined the associations between children's food intake and maternal BMI and overweight (Pei et al., 2014). They found that maternal overweight was associated with high meat (95% CI [1.19, 1.89]) and egg (95% CI [1.07; 1.60]) intake among school-aged children (Pei et al., 2014). Pei and colleagues (2014) also found that every increase in maternal BMI was significantly associated with an increase of 9.2 kcal total energy intake among children (95% CI [3.7, 14.7]) (Pei et al., 2014).

The current study findings could have been the result of mothers already starting to change their behavior. Mothers with overweight or obesity may have realized the consequences of their weight status and already started to promote healthy lifestyle behavior change in their children. Mixed methods designs should be considered for future research to better understand the relationship between maternal obesity and children's nutrition intake. At the same time, obesogenic diets among children of mothers with higher BMI values could not have been captured in this study secondary to the tools used to collect the children's nutrition intake.

Parental Education Level

This study found that increased fathers' education level was significantly ($p < .05$) associated with a healthier nutritional intake among children. In this study, children of highly educated fathers (bachelors or higher) had a higher intake of protein (g), fruit (cup), and dairy (cup) in a day compared to children of fathers with a lower educational level ($p < .05$). In addition, more children of fathers with a bachelor or higher education level were found to consume more vegetables rich in vitamin A, meat, and nuts and seeds more frequently compared to children of fathers with a lower education level ($p < .05$). In fact, a higher education level of fathers was a significant predictor of protein (g), fruit (cup), vitamin A, meat, and nuts and seeds intake.

A higher percentage of children of mothers with a bachelor or higher educational level were found to consume vegetables rich in vitamin A less frequently compared to children of mothers with a lower educational level. A mothers' higher education level was a significant predictor of less frequent intake of vegetables rich in vitamin A and fish, but more dairy (cup) intake a day ($p < .05$).

Interestingly, our study found no significant association between parental education level and fast food or soft and sugary drinks intake. A recent systematic review (n = 40 manuscripts) investigated the relationships among parental education, family income and dietary patterns among children and adolescents from high, medium and low socioeconomic countries (Hinnig et al., 2018). They found that the association between parental level of education and dietary patterns among children and adolescents varies in high, medium and low socioeconomic countries (Hinnig et al., 2018). Children of highly educated parents living in high socioeconomic countries tended to have a healthy diet, while children of highly educated parents living in medium socioeconomic countries tended to consume an unhealthy diet (Hinnig et al., 2018). According to The World Bank Group, Oman is classified as a country with a high-income economy (The World Bank, 2018). However, the results of the relationship between parents' education level and children's nutrition intake in our study were inconsistent between fathers and mothers. This may indicate that there are other factors moderating the relationship between parental education level and children's nutrition intake such as parent gender.

Parental Working Status

This study found a poor association between parental working status and children's nutritional intake. However, when other family factors were controlled, mothers' working status was a significant predictor of children's daily dairy intake. Mothers' not working status was associated with significant increase in children's dairy intake by about half a cup a day compared to mothers working status ($p < .01$).

Our study finding is consistent with other findings from the literature. An analysis of data from a longitudinal survey on a nationally representative cohort in the U.S. examined the relationship between mothers' average weekly work hours and children's (5th and 8th grade) dietary behaviors evaluated with a food consumption questionnaire (Datar, Nicosia, & Shier, 2014). Datar et al. (2014) found that children of mothers who worked more consumed less healthy food such as fruit, vegetables and milk and consumed more unhealthy foods such as soft drinks and fast food (Datar et al., 2014).

Another study examined the associations between mothers' and fathers' working status and the family food environment using data from a population-based study with a sample of parents of adolescents (n= 3,709) from different sociodemographic groups in U.S. (Bauer, Hearst, Escoto, Berge, & Neumark-Sztainer, 2012). In their study, full-time employed mothers compared to part-time and unemployed mothers spent less time on food preparation and had fewer family meals together ($p < .05$) (Bauer et al., 2012). These findings could indicate that mothers who were not working outside the home spent more time with their children and were better able to monitor their child's nutritional intake throughout the day.

Family Income

In this study, an higher family income was significantly ($p < .05$) associated with a child's healthier nutritional intake. Higher family monthly income (over 1,000 OMR) was significantly associated with more dairy (cup) intake a day and more frequent consumption of fruit rich in vitamin C compared to children of families with a lower monthly income ($p < .05$). Also, carbohydrate and grain consumption among children of families with a higher monthly income was predicted to be 30 grams less and 1.6 ounces less, respectively, compared to children of families with a lower monthly income ($p < .05$).

In general, family income in the GCC has been linked to high energy intake. A cross-sectional study assessed the nutritional intake of a female adult, adolescent, and child from 628 families living in urban and rural households in the United Arab Emirates (UAE) with 24-hour dietary recalls (Ng et al., 2011b). They found that families coming from the wealthiest households had the highest energy intake (Ng et al., 2011b). However, the total energy intake was not significantly different between children of higher income families and children of lower income families in our study.

Our study findings were similar to findings from the U.S. compared to a neighboring country such as UAE. In U.S., family income has been linked to food quality. A cross-sectional study conducted in the U.S. compared the nutritional intake of fourth to sixth-grade children (n = 821) across different levels of household food security (Dykstra et al., 2016). They found that children with low food security compared to their peers with high food security were significantly less likely to consume milk ($p < 0.05$) and more likely to consume candy ($p < 0.05$) (Dykstra et al., 2016).

The current study indicated a change in the influence of family income on children's nutrition intake in the GCC countries and that undesirable shift in the nutrition intake pattern is happening among families with a low level of income. This should be considered by researchers and practitioners planning health promotion programs in the GCC regions and what specific family groups to target.

Family Nutrition and Physical Activity Pattern

Family Nutrition and Physical Activity (FNPA) score. In this study, the general family nutrition and physical activity patterns represented by the FNPA score were significantly ($p < .05$) associated with children's nutritional intake. This study demonstrated that the more that the family ate healthily and were physically active that this was a significantly ($p < 0.05$) associated with an increase in children's intake of dairy (cup) and protein (g) in a day. Also, children of families with healthier nutrition and physical activity patterns were more likely to have a more frequent intake of meat, eggs, vegetables (except the ones rich in vitamin C & A), and fruit (except the ones rich in vitamin C, A, and potassium) ($p < .05$). The more healthy that a family ate and were physically active was significantly ($p < .05$) associated with a lower intake of fast food and soft and sugary drinks. These results further validate the Family Nutrition and Physical Activity (FNPA) questionnaire used in this study to assess the family nutrition and physical activity patterns.

The literature widely supports our study findings. A review of 20 qualitative studies identified a number of parental factors increasing young children's (0 – 6 years) obesogenic diets including negative parent modeling, lack of knowledge, and using food as a reward (Mazarello Paes et al., 2015). Another quantitative study analyzed baseline data from a child obesity prevention intervention trial (320 parent-child dyads) involving at least one parent with overweight and preschool-age children from central North Carolina in U.S. (Vaughn, Martin, & Ward, 2018). They assessed the parent modeling of healthy eating with a questionnaire called "The Comprehensive Feeding Practices Questionnaire" in addition to parents and children's nutritional intake with a three-day dietary recall (Vaughn et al., 2018). They found that parents modeling of healthy eating behaviors was significantly ($p < 0.001$) related to children's diet quality (Vaughn et al., 2018).

The significant association between family nutrition and physical activity patterns and children's nutritional intake emphasized the fact that children's nutrition behaviors are influenced by the environment established in their homes and are reported in research (Anderson Steeves et al., 2016; Clark et al., 2007; Scaglioni et al., 2008).

Eating with family. Our study indicated that eating with the family was significantly ($p < .05$) associated with children's healthier nutritional intake. We found that children who usually ate with their families had a higher odds of eating more vegetables (except those rich in vitamin A, folate or iron), fruit rich in vitamin C and potassium, and meat compared to children who only sometimes or never ate with their families. These findings infer a positive parental modeling behavior.

A population-based study involving 6 to 30-month-old children (n = 366) and their parents from Brazil examined the relationship between parental food intake and their children's food intake (dos Santos Barroso, Sichieri, & Salles-Costa, 2014). The parents' food intake was evaluated with the food frequency questionnaire, while the children's nutrition intake was assessed with two 24-hour dietary recalls (dos Santos Barroso et al., 2014). They found that parental food intake had a positive influence on children's bread and cereal intake (95% C.I [0.003, 0.12]) as well as fruit intake (95% C.I [0.03, 0.16]) (dos Santos Barroso et al., 2014).

Eating with the family from one plate is a traditional and preferable social behavior in Oman. Some parents think that this method of eating gets family members closer and helps children eat more, which was found to be true in this study in relation to grain (oz), fish and chicken intake. Children who ate with their family from one plate compared to children who sometimes or never ate with their families from one plate were found to have a higher daily intake of grains ($p < .05$) and more frequent consumption of fish ($p < .01$) and chicken ($p < .05$).

Eating with the family from one plate was a significant predictor of more frequent fish intake ($p < .05$). However, eating with the family from one plate was not a significant predictor of daily intake of grain or chicken frequency of intake ($p > .05$). We were unable to find other studies discussing the association between eating with the family from one plate, and children's nutrition intake, probably because it is culture specific versus a worldwide habit. The relationship between eating with the family from one plate and children's nutrition intake can be partly explained by the portion size effect aspect. Although shared between the family members, the food is served in a large plate, and research has demonstrated that increasing portion size leads to increased food intake among adults as well as children (English, Lasschuijt, & Keller, 2015). Also, a social or an interaction effect could have mediated the relationship between eating with the family from one plate and food intake and needs to be investigated further.

Aim Three: Family Influence on Children's Physical Activity Patterns

The third aim was to examine the relationship between the physical activity patterns (MVPA, screen time, and sleep times) of first to fourth-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Maternal BMI

In this study, maternal BMI was found to be significantly associated with their children's MVPA and sleep time, but not screen time. Interestingly, increased maternal BMI was significantly ($p < .05$) associated with a higher odds of children to have adequate MVPA exercise (at least 60 minutes a day).

Dissimilar to this study, a relatively old pilot study measured the cardiorespiratory endurance among Omani children ages 9-to-11 years old ($n = 109$) using the time to complete 1.6 kilometers either walking or running in relation to parental obesity (Hassan & Al-Kharusy, 2000). They found that decreased physical activity levels were positively associated with their mothers' level of overweight or obesity (Hassan & Al-Kharusy, 2000). A longitudinal study followed 282 Latino children ages 8-to-10 years and their parents for up to two years and evaluated the effect of a number of maternal factors including BMI on children's percent of MVPA (Butte et al., 2014). Children's percent of MVPA was monitored with accelerometers for three consecutive days, including two weekdays and one weekend day (Butte et al., 2014). They found that a within-group increase in maternal BMI with time was significantly ($p < 0.01$) associated with a decrease in children's percent of MVPA (Butte et al., 2014).

Similar to the inference we made for the results of the relationship between maternal BMI and children's nutrition intake found in our study, the results of the relationship between maternal BMI and children's MVPA could be explained by the possibility that there was a behavior change among mothers. Mothers may have created a healthier physical activity environment for their children after realizing the consequences of overweight and obesity among themselves.

Our study found higher means of maternal BMI among children who slept at least nine hours per night compared to children who slept less than nine hours a night ($p < .05$). Also, more children of mothers with overweight or obesity were significantly ($p < .05$) sleeping at least nine hours compared to children of underweight or normal weight mothers. Literature discussing the relationship between mother's BMI or weight status and children's sleep time were scarce. The relationship between mother's BMI or weight status and children's sleep adequacy may be better explained by other mediating factors.

The current study demonstrated no significant ($p > .05$) association between mothers' BMI or weight and their children's screen time. A cross-sectional Australian study ($n = 70$ families) evaluated children's (ages 5 - 12 years old) screen time with a modified version of the validated Children's Leisure Activities Study Survey (CLASS) and compared it to maternal BMI (Lloyd et al., 2014). Similarly, they reported that children's screen time was not significantly associated with maternal BMI ($p > .05$) (Lloyd et al., 2014). However, Butte et al. (2014) evaluated the effect of maternal BMI on the percent of sedentary time among 282 Latino children ages 8-to-10 years for two years and found a positive relationship between a within-group increase in maternal BMI with time and the children's sedentary time ($p < 0.01$).

Parental Education Level

Our study suggests that MVPA time among children was negatively influenced by parental education level. The study found that children of parents (both mothers and fathers) with a higher education level (bachelors or higher) had significantly ($p < .05$) less MVPA time than children of parents with a lower educational level, which was consistent with the literature. Similar to our study, a study with 10-to-18 years old children of mothers with a higher level of education (tertiary level) spent less time in MVPA compared to children of lower educated mothers (primary or secondary level) (Sherar et al., 2016). Also, Butte et al. (2014) found that maternal education level was negatively associated with the percent of MVPA among 8-to-10 year old children (Butte et al., 2014).

Our study found no significant ($p > .05$) association between parental education levels and children's screen time or sleep time. The findings in this study were supported by another study conducted in Canada that analyzed data from over 2,000 fifth grade children related to their dietary intake, eating behaviors, sleep duration, and sleep quality (Khan et al., 2017). One of their reported findings was a non-significant relationship between parental educational level and children's sleep time (Khan et al., 2017). Another study ($n = 715$) examined the effect of household socioeconomic status (SES) (i.e. highest educational attainment and income) on MVPA, sedentary time, and screen time among 6-to-11 year old children (Tandon et al., 2012). Children's MVPA and sedentary time were measured with accelerometers over three days and screen time was reported by the parents (Tandon et al., 2012). They found no significant association between SES and children's MVPA or sedentary time, while the daily screen time hours differed significantly among children with high SES families (1.7 hours) and children with low SES families (2.4 hour) ($p < .01$) (Tandon et al., 2012).

Another study included 10-to-18-year-old adolescents (n = 12,770) from ten studies from Europe, Australia, Brazil and the U.S. examined the relationships between maternal education and adolescent's physical activity and sedentary time assessed with at least one day of accelerometer wear (Sherar et al., 2016). Sherar et al. (2016) reported that adolescents of higher educated mothers (tertiary level) from Brazil and Portugal had more sedentary time compared to adolescents of lower educated mothers (primary or secondary level) from Brazil and Portugal.

Parental Working Status

In our study, fathers' working status was found to be significantly ($p < .05$) associated with children's MVPA, but not with screen time or sleep time. Children of fathers who were not working were found to have a significantly ($p < .05$) higher odds of exercising at MVPA per day compared to children of fathers who were working. Studies examining similar relationship were not common. In general, fathers who were not working may have more opportunity to be physically active compared to working fathers. Research has shown that parental MVPA was positively associated with child MVPA (Fuemmeler, Anderson, & Masse, 2011).

In this study, there was no significant ($p > .05$) association between mothers' working and any of the children's physical activity variables assessed. Similar findings were reported by a cross-sectional study from Mexico. The study had a sample of 897 children (age 6-12 years) and assessed the children's sedentary lifestyle through four questions related to the frequency and duration of sports in a week, hours of television watched in a day, and hours devoted to playing video games in a day (Vazquez-Nava, Trevino-Garcia-Manzo, Vazquez-Rodriguez, & Vazquez-Rodriguez, 2013). They reported no significant ($p > .05$) relationship between children's sedentary behavior and mothers working status (Vazquez-Nava et al., 2013).

Another study examined the relationship between mothers' average weekly work hours and physical activity among children at grades five and eight (Datar et al., 2014). They assessed children's physical activity with parental report of the number of days per week that the child had at least 20 minutes of vigorous level exercise. The indicator variable was whether the parent or child reported at least five days a week of such duration and level of activity (Datar et al., 2014). They found that children of mothers who worked more hours a week had more screen time ($p < .05$) and slightly more physical activity time compared to children of mothers who worked less (Datar et al., 2014).

Family Income

In this study, there was no significant ($p > .05$) relationship between family income and any of the children's physical activity pattern variables examined. This means that MVPA, screen time, and sleep time were similar across Omani children from different economic levels. Similarly, and as discussed earlier, Tandon et al. (2012) reported no significant association between family SES (i.e., highest education level and income) and children's MVPA or sedentary time. However, a significant difference in screen time was found among children of high and low SES families ($p < .01$), with more screen time among children of low SES families (Tandon et al., 2012).

A large ($n = 1,617,400$) cross-sectional study analyzed physical fitness, anthropometric, and sociodemographic data pertinent to children at fifth, seventh, and ninth grade from eight racial and ethnic groups (Jin & Jones-Smith, 2015). One of their aims was to examine the association between family income and children's physical fitness level (Jin & Jones-Smith, 2015). They found that lower family income was associated with a lower fitness score among children (95% CI [-0.62 to -0.53]) compared to a higher family income (Jin & Jones-Smith, 2015).

Khan et al. (2017) conducted a study in Canada and analyzed data from over 2,000 fifth grade children and examined the association between household income and children's sleep duration. Dissimilar to our study, they found that children with a high household income were more likely to have a higher sleep duration (β = 0.14, 95% C.I [0.04, 0.25]) compared to children with a lower household income (Khan et al., 2017).

Family Nutrition and Physical Activity Pattern

Family Nutrition and Physical Activity (FNPA) score. Our study found no significant ($p = .18$) association between family nutrition and physical activity patterns represented by FNPA score and children's MVPA. However, we found that the healthier a families nutrition and physical activity patterns were associated with a decrease in daily screen time by 4 minutes ($p < .05$). Also, we found that the healthier a families nutrition and physical activity patterns were associated with higher odds of children sleeping at least nine hours per night ($p < .05$).

A recent Australian study analyzed baseline data from 9-to-11 year old children, their parents, and school principals ($n = 2,466$) for the Obesity Prevention and Lifestyle (OPAL) Evaluation Project to examine the associations between home and school environments and childhood obesity and their mediators (Haddad, Ullah, Bell, Leslie, & Magarey, 2018). Dissimilar to our study, they found a significant positive association between the home physical activity environment and children' physical activity and a non-significant association between school physical activity policy and children's physical activity (Haddad et al., 2018). Their findings further emphasize the influence of the home environment on shaping children's lifestyle behaviors compared to other community contexts.

A study from Germany ($n = 1615$) asked parents to report the number of days per week their children (mean age 7.1, SD ± 0.6 years) engaged in MVPA for at least 60 minutes per day and if their children participated in any organized sports (Erkelenz et al., 2014). Parents were also asked to report the type, frequency, and duration of sports they practiced per week. Similar to our study, they found no significant ($p > .05$) association between parental and children's physical activity levels (Erkelenz et al., 2014). However, parents (both or one) who were physically active had significantly more children engaging in organized sports compared to inactive parents ($p < .01$) (Erkelenz et al., 2014). A manuscript reviewed 30 articles to investigate the parental influence on children's physical activity and screen time behavior and concluded that parental encouragement had a positive effect on children's physical activity level while parental reduced screen time behavior had a positive effect on children's screen time (Xu, Wen, & Rissel, 2015).

The non-significant relationship between FNPA scores and children's MVPA found in our study could be related to the extent FNPA screening tool is sensitive to family physical activity pattern. More investigation is needed to understand the Omani family nutrition and physical activity pattern and how it influences the children's physical activity level.

Eating with family. We did not find a significant ($p < .05$) relationship between eating with the family and MVPA or screen time in our study. However, we found an interesting finding related to eating with the family and sleep time. According to our study results, eating with the family was significantly ($p < .05$) associated with a higher odds for children to sleep adequately at night (at least nine hours). Our study had an unexpected finding in that eating with the family from one plate was associated with a significantly ($p < .05$) lower odds of children sleeping adequately at night.

Similar to our study, Khan et al. (2017) reported that unhealthy eating habits among fifth-grade children such as eating alone were significantly associated with decreased sleep duration ($\beta = -0.09$, 95% C.I [-0.13, -0.05]). However, we did not find other studies discussing the relationship between eating with the family or eating with the family from one plate on children's behaviors and physical activity pattern. Mediating or moderating factors would probably better explain these relationships. In general, eating with the family is a healthy behavior that has been linked to high family functioning (i.e. patterns of interactions between the family members) and higher family functioning, in turn, was found to associate significantly with more physical activity and less sedentary behavior among adolescents (Berge, Wall, Larson, Loth, & Neumark-Sztainer, 2013).

Aim Four: Family Influence on Children's BMI z-score

The fourth aim was to examine the relationship between the BMI z- score of first to fourth-grade Omani children and maternal BMI, parental educational level, parental working status, family income, and family nutrition and physical activity patterns.

Maternal BMI

Our study found that mothers with obesity were strongly associated with childhood obesity. In this study, an increase in maternal BMI was significantly ($p < .01$) associated with a .1 increase in their children's BMI z-score. Also, a mother with overweight or obesity was significantly ($p < .01$) associated with higher odds of having a child with overweight or obesity.

A study ($n = 1{,}035$) from the United Arab Emirates examined the determinants of childhood obesity among 6-to-19-year-old children and adolescents. Similar to our study, they found a significant ($p < .001$) association between maternal BMI and children's BMI percentile (Al Junaibi et al., 2013). Also, Parrino et al. (2016) examined 1,521 Sicilian children (age 9 - 14 years) to understand the factors contributing to obesity among children. In their study, mothers with overweight or obesity were identified as one of the significant risk factors to childhood obesity (OR = 2.33, $p < 0.0001$) (Parrino et al., 2016).

Research has indicated a genetic link between parental obesity and childhood obesity (Classen & Thompson, 2016; Elks et al., 2012; Llewellyn et al., 2013; Tang et al., 2016). The fat mass and obesity-associated (FTO) gene accountable for obesity has been found to be inherited particularly from mothers (Classen & Thompson, 2016; Marginean et al., 2016). Our study has also investigated the influence of family socioeconomic and environmental factors on childhood obesity, which is discussed below.

Parental Education Level

Increased parental educational level, particularly the mothers, was found to be a significant ($p < .05$) risk factor for childhood obesity in this study. We found that children of parents with bachelor or higher educational level were at risk for higher BMI z-scores compared to children of parents with a lower education level. Also, a higher level of education among mothers (bachelor or higher) was significantly ($p < .05$) associated with higher odds of having a child with overweight or obesity.

These findings were similar to several studies from the GCC (Al Alwan et al., 2013; Hassan et al., 2016). Al Alwan et al. (2013) from Saudi Arabia found a significant ($p < .05$) relationship between mothers' and fathers' level of education and obesity among children ages 6-to-16 years (n = 1,212). They also reported a higher risk of having children with obesity among mothers with a university level education compared to mothers who had a lower level of education (OR = 3.7, $p < 0.01$) (Al Alwan et al., 2013). In another cross-sectional study that included 5-to-18-year-old children (n = 154) from Egypt with their parents, fathers with a higher level of education were significantly associated with their children being overweight compared to fathers who had a lower education level ($p < 0.01$) (Hassan et al., 2016).

Alternatively, a cross-sectional study from Saudi Arabia (n = 874) examined the relationship between some parental characteristics and obesity among 6-to-10-year-old children and found no significant relationship between mothers' educational level and childhood obesity (Al-Muhaimeed et al., 2015). In another study from Italy that aimed to understand the relationship between parental education level and childhood obesity with a nationally representative sample of 11-to-15-year-old children, parent's educational level was found to be inversely associated with childhood overweight (Lazzeri et al., 2014). In the same study, children of parents with a lower educational level were more likely to be overweight compared to children of at least one parent with a higher educational level (OR = 1.63, 95% CI [1.38-1.91] male; OR = 2.07, 95%CI [1.70-2.51] female) (Lazzeri et al., 2014).

The relationship between parental education level and childhood obesity seem to be moderated by factors such as the geographic location. In a paper that was part of the International Study of Childhood Obesity, Lifestyle and the Environment, data were collected from 4,752 children ages 9-to-11 years in 12 countries around the world (Muthuri et al., 2016). The paper reported a positive relationship between maternal education level and childhood overweight in countries including Colombia and Kenya and a negative relationship between paternal education level and childhood overweight in countries such as Brazil and the U.S. (Muthuri et al., 2016).

Our study findings supported that the higher a parents' educational level did not necessarily reflect a higher level of obesity prevention awareness. Specific social and environmental factors may override the parents' desire to create a healthy nutrition environment for their children and need to be investigated.

Parental Working Status

According to our study findings, parental working status was not significantly ($p > .05$) associated with childhood obesity. Neither a mother's nor a fathers' working status had a significant effect on children's BMI z-scores or children's weight status. Al-Muhaimeed et al. (2015) examined the relationship between some parental characteristics and obesity among

6-to-10 years old children (n = 874) and no significant relationship was found between mother's working status and childhood obesity. A study (n = 641) from Australia examined the relationship between maternal employment status (not employed, part-time, or full time) and overweight and obesity among 5-to-15-year-old children. Similar to our study, they found no significant ($p > .05$) relationship between maternal employment status and children's overweight and obesity status (Taylor, Winefield, Kettler, Roberts, & Gill, 2012). However, Al-Isa et al. (2010) examined 6-to-10-year-old male children from Kuwait (n = 662) and found that children of fathers who were not working had a significantly higher risk of overweight (OR = 2.0, $p < 0.01$) and obesity (OR = 2.3, $p < 0.01$) compared to children of fathers who were working.

Amin et al. (2008) examined the relationships between some family sociodemographic factors and obesity among 10-to-14-year-old male children (n = 1,139) from Saudi Arabia. They found that children of working parents were at higher risk for overweight and obesity compared to children of non-working parents (OR= 1.85, $p < 0.05$ for mothers; OR = 1.9, $p < 0.05$ for fathers) (Amin et al., 2008).

Another study from Korea has examined the relationship between mothers working hours and childhood obesity among 6-to-18-year-old children and adolescents with a nationally representative sample (n = 3914) (Kim, Park, Choi, & Park, 2018). They found that children and adolescents of mothers who worked more than 69 hours a week had higher BMI values ($\beta = 0.51$, $p < 0.05$) compared to those of mothers who never worked (Kim et al., 2018). These inconsistent findings related to the relationship between parental working status and children's obesity may indicate that there are factors moderating the relationship.

Family Income

Our study results indicated that family income had no significant ($p > .05$) association with childhood obesity (i.e., BMI z-score or weight status). No significant ($p > .05$) association between family income and childhood obesity were also reported by other studies conducted in the Emirates and Saudi Arabia (Al Junaibi et al., 2013; Al-Muhaimeed et al., 2015). Al Junaibi et al. (2013) reported no significant ($p > .05$) difference in the monthly household income between 6-to-19-year-old children and adolescents from the Emirates with overweight or obesity and their counterparts with underweight or normal weight. Al-Muhaimeed et al. (2015) found no significant ($p = .07$) relationship between family socioeconomic status (i.e., low, middle, or high) and overweight status among Saudi 6-to-10-year-old children ($n = 874$).

In general, family income has been linked to childhood obesity in the GCC region (Badran & Laher, 2011), which is different from other countries such as the U.S. where children from low-income families are more susceptible to obesity than children from high-income families (Jo, 2014). A Kuwaiti study found that the majority of overweight and obese children examined (89.2%) belonged to families with a monthly income that is over 1,000 Kuwaiti Dinars (i.e., > 1,285 Omani Rial per month) (El-Bayoumy et al., 2009). Also, Al Alwan et al. (2013) demonstrated that families with a high-income were at higher risk for having children (ages 6-16 years) with overweight compared to families with low-income ($OR= 3.38$, $p < 0.01$). However, as earlier discussion implies, the relationship between family income and childhood obesity in the GCC is not consistent and needs further study.

Family Nutrition and Physical Activity Patterns

Family Nutrition and Physical Activity (FNPA) score. Interestingly, our study indicated no significant ($p > .05$) relationship between family nutrition and physical activity patterns (i.e., FNPA score) and children's BMI z-scores or weight status. Another study from Australia analyzed data from 9-to-11-year-old children, their parents, and school principals (n = 2,466) and had mixed results related to the relationship between home nutrition and the physical activity environment and childhood obesity. They found that the home physical activity environment was negatively associated with their children's BMI ($p < 0.001$), while the home diet environment was not significantly ($p > .5$) associated with children's BMI (Haddad et al., 2018).

Our study has demonstrated high average FNPA scores (m = 33.3, SD ±3.6) among families. The FNPA total score can range from 10 to 40. This may indicate that the FNPA screening tool was not adequately sensitive to the obesogenic family behaviors happening inside Omani homes. Also, the relationship between FNPA scores and childhood obesity could be dependent on certain cultural or environmental factors. Researchers from the U.S. have examined the association between the FNPA screening tool and childhood obesity among two different groups during two different periods and found inconsistent data. A group of researchers documented a significant relationship between the FNPA score and overweight and obesity among ten years old primarily Caucasian (90%) children from a middle-class socioeconomic status (Yee, Eisenmann, Carlson, & Pfeiffer, 2011). However, the same researchers reported no significant association between FNPA score and overweight or obesity in 6-to-13-year-old children (N = 415) from a lower socioeconomic urban community where 49% were Caucasian and 42% were Black (Yee et al., 2015).

Eating with family. This study found no significant ($p > .05$) association between eating with the family and eating with the family from one plate and children's BMI z-scores or weight status. Similarly, Bin Zaal et al. (2009) examined the influence of dietary behaviors in 12-to-17-year old Emirati adolescents ($n = 661$) increased the risk of obesity. They found no significant ($p > .05$) effect of eating lunch or supper with the family on weight status among both male and female participants (Bin Zaal et al., 2009).

In general, eating with the family is generally a healthy behavior that potentially promotes positive family functioning level (i.e. patterns of interactions between the family members) and high family functioning has been associated with a lower odds of developing overweight or obesity (OR = 0.73, 95% C.I [0.60–0.88]) among 6,659 adolescents ages 14-to-24 years in the U.S. (Haines et al., 2016).

The relationship between eating with the family and childhood obesity were found to be complex and moderated by other factors, such as the culture. Among children aged 6-to-11 years living in the U.S., frequent family meals were associated with lower weight status among White children and Black boys, while frequent family meals were associated with obesity among Hispanic boys with low parental education levels (Rollins, Belue, & Francis, 2010).

Synthesis of Aims

In this section, we derive statements about how childhood obesity is influenced by the family in Oman based on the results. Two main familial risk factors to childhood obesity were identified in this study, included increased maternal BMI and mother's higher level of education.

There was a strong relationship between increased maternal BMI and childhood obesity. However, according to our study results, the relationship was not likely to be affected by children's nutrition and physical activity patterns. In fact, increased maternal BMI was found to be associated with healthy nutrition and physical activity behaviors among children, which suggests a behavior change. Other non-environmental factors such as genetics may better explain the relationship between maternal BMI and childhood obesity.

Also, there was a strong relationship between high mothers' level of education and childhood obesity. A mothers' higher level of education was associated with unhealthy nutrition and physical activity behaviors among children. However, those unhealthy nutrition and physical activity behaviors were not associated with childhood obesity. These results should be interpreted carefully as they could be secondary to issues related to the study design and validity of tools used to examine the children's nutrition and physical activity patterns.

Future Research and Policy Implications

This study showed weak associations between children's BMI z-scores and nutrition and physical activity patterns, which could have resulted from issues related to the study design or reliability and validity of tools used to collect children's nutrition and physical activity pattern data. Future research on childhood obesity with longitudinal designs and objective measurement tools are needed to better explain the childhood obesity in Oman.

In the current study, we found multiple associations between children and their families nutrition and physical activity patterns. However, family nutrition and physical activity patterns were assessed mainly with the FNPA screening tool and demonstrated a poor association with childhood obesity. Future research with observational and qualitative study designs is needed to provide a better understanding of the perspectives and cultural characteristics influencing the families' nutrition and physical activity patterns that lead to obesity. The results of such studies can be used to build culturally tailored obesity assessment tools.

This study has examined childhood obesity from the family level. Two strong family factors linked to childhood obesity were identified, increased maternal BMI and mothers' high level of education. Therefore, involving mothers in future childhood obesity prevention or management interventions need to be considered. Also, future research in Oman may examine childhood obesity at the community level and how family, particularly mothers, characteristics are influenced by the community.

The impact of the results of this study may provide much-needed information for the health care system in Oman. This study suggested an increase in the rate of childhood overweight and obesity and nutrition intake behaviors that are less than optimal among Omani children. Oman is a small country with a young population. Therefore, considerable efforts toward children's health including regular comprehensive health care services with families actively involved is a priority.

According to the Omani health care system, school-age children receive the preventive and promotive health care services at the schools within the school-health program. Programs in school settings ensure the reach of service to all children and programs implemented in the school setting showed to be effective (Verrotti, Penta, Zenzeri, Agostinelli, & De Feo, 2014). Investing in preventive and promotive health care services through well-structured and scientific-based school-health programs holds promise in promoting children's general health, which in turn will save future health-related costs resulting from childhood obesity such as prediabetes, type 2 diabetes, and cardiovascular disease.

Limitations

This study has some limitations. The study was cross-sectional with a relatively small sample size (n=197) that were selected conveniently from urban and suburban communities, which limits the generalizability of the study findings. Also, child and family nutrition and physical activity pattern instruments were self-reported and filled out by mothers, which could have added bias.

The FFQ used in this study to assess the frequency of intake of 22 different foods did not provide insight into portion sizes. Also, we were limited to a single day dietary recall due to feasibility issues. In research, multiple pass dietary recall with three non-consecutive days including two weekdays and one weekend is recommended to estimate the nutrition intake among children ages 4-to-11years old (Burrows, Martin, & Collins, 2010). However, there was a question at the end of our study dietary recall interview asking the mothers whether the child's nutrition intake of that day was usual, more than usual, or less than usual. The majority of mothers (92.4%) answered as usual. The ASA-24 program used in this study to collect children's dietary recall had no Arabic version, and we had to adapt the U.S. version with bilingual interviewers with nutrition backgrounds.

In this study, children's MVPA was assessed subjectively with mothers reporting the frequency in a week and duration in minutes per day for a number of MVPA activities, which could have resulted in some bias. Children ages 6-to-10 years are not observed by their mothers all the time. Mothers may miss some activities or misreport the duration of activities. At the same time, researchers have reported that parents tend to overestimate the physical activity level of their children when questionnaires are used (Corder, Crespo, van Sluijs, Lopez, & Elder, 2012). Objective devices such as accelerometers are the "gold standard" for objectively measuring physical activity. Accelerometers can capture and record continuous physical activity information and are usually worn for seven days when the physical activity level is examined (Chu, Ng, Koh, & Müller-Riemenschneider, 2015; Ridgers & Fairclough, 2011). However, this method of assessment is expensive and was not feasible in this study.

Summary

This study demonstrated that the childhood obesity problem is a complex health problem. Some contrary findings were found, which indicate that it is hard to understand childhood obesity from one cross-sectional study. Many aspects and levels are involved in childhood obesity, and this should be carefully considered when interpreting studies. In this study, two familial factors associating with childhood obesity in Oman, maternal BMI and mothers' education level. Omani children's nutrition intake found to be mainly influenced by parental education level, family income, and family nutrition and physical activity patterns. Maternal BMI and parental working status had minor influences on children's nutrition intake. Interestingly, Omani children's physical activity patterns found to be influenced by maternal BMI, parental education level, paternal working status, and family nutrition and physical activity patterns, but not family income. Future research in Oman should be directed toward understanding the family nutrition and physical activity patterns with qualitative study designs and building culturally tailored assessment tools that are sensitive to childhood obesity. Investing in school-health programs holds promise in promoting general children health and controlling childhood obesity.

APPENDIX A. SOCIO-DEMOGRAPHIC DATA SURVEY

General Information (I):

1) Participant code:

2) The school name?
   1. Alnobugh
   2. Alwaha
   3. Almashareq
   4. Alrawae
   5. Almahamed
   6. Almashareq
   7. Other

3) Child gender?

   1. Male
   2. Female

4) Child age in years?

   1. 6
   2. 7
   3. 8
   4. 9
   5. 10

5) Child area of original residence?

   1. Muscat
   2. Al-Batina South
   3. Al-Batina North
   4. Al-Buraimi
   5. Al-Dahira
   6. Al-Sharqia North
   7. Al-Sharqia South
   8. Al-Dakhilia

6) Does the child suffer of a chronic disease?

   1. No
   2. Yes (what?)

7) Parents marital status?

1. Married
2. Widower
3. Divorced

8) What is the relevance of kinship between the child 's parents?

1. First degree (cousins)
2. Second degree (cousins of father or mother)
3. Non-close relationship
4. No relationship

9) What is the mother highest level of education?

1. Read and write
2. Primary (1-6th grade)
3. Preparatory (7-9th grade)
4. High School (10-12th grade)
5. Diploma
6. Bachelor degree
7. Postgraduate

10) What is the mother's job?

1. The public sector
2. The private sector
3. Military sector
4. Free business
5. Retired
6. House wife

11) What is the father highest level of education?

1. Do not know how to read and write
2. Reads and writes
3. Primary (1-6th grade)
4. Preparatory (7-9th grade)
5. Secondary (10-12th grade)
6. Diploma
7. Bachelor degree
8. Postgraduate

12) What is the father’s job?

1. Public sector
2. Private sector
3. Military sector
4. Free business
5. Retired
6. Does not work

13) How much is the family income per month in Omani Rial?

1. Less than 500
2. 500 – 1000
3. 1000 – 3000
4. 3000 – 5000
5. More than 5000

APPENDIX B. CHILDREN NUTRITION PHYSICAL ACTIVITY PATTERN INSTRUMENT

Physical Activity and Sedentary Behavior (I):

1) What are the types and length of activities the child practice?

	Activity	Yes (1) No (2)	How many times a week	Length in minutes / hour at each time
1	Riding bicycle			
2	Football (soccer)			
3	Basketball			
4	Tennis			
5	Swimming			
6	Jump rope			
7	Jogging			
8	Other:			
Total				

Total active time per week: Total number of activities X Total length of activities

2) What are the types and length of activities the child spends sitting during leisure time?

	Activity	Yes (1) No (2)	How many times a week	Length in minutes / hour at each time
1	TV / Video			
2	Video Games			
3	Computer \ Internet			
4	School homework			
5	Play inside the house (non active)			
6	Read			

7 Draw

8 Other

Total

Total <u>sitting</u> time per week: Total number of activities X Total length of activities

3) How many average hours does the child sleeps a day?

    1. Less than 9
    2. 9-11
    3. More than 11

4) Does the child take a nap?

    1. Yes
    2. No
    3. Sometimes

<u>Nutritional Intake (II):</u>

5) Does the child eat with the family?

    1. Yes
    2. No
    3. Sometimes

6) Does the child and the family eat from the same dish?

    1. Yes
    2. No
    3. Sometimes

7) How frequently does the child consume the following food:

Food group	**Daily 1**	**Weekly 2**	**Monthly 3**	**Occasionally 4**	**Never 5**
1. Whole grains (All types of brown bread, whole wheat flour, brown rice, brown pasta, wheat, barley, whole cereals, potatoes with skin)					
2. Other grains (all types of white wheat flour, white rice, cereal, corn flakes, potato without the skin)					
3. Rich vegetables of vitamin C (sweet pepper, tomato sauce, broccoli, beets, radishes)					
4. Vegetables rich in vitamin (a) (lettuce, cabbage, carrots, pumpkins, squash, green peas)					
5. Vegetables rich of iron / folic acid (spinach, parsley, corchorus)					
6. Other vegetable (onions, okra, cucumbers, eggplant, garlic)					
7. Fruits rich in vitamin C (citrus fruit, pineapple, guava, cherry, raspberry)					
8. Fruits rich in vitamin A (mango, papaya, apricot, plum)					
9. Fruits rich in potassium (raisins, dried figs, dates, bananas, melons)					
10. Other fruits (coconut, grapes, apples, pears, figs)					
11. Meat					
12. Fish					
13. Chicken					
14. Eggs					
15. Nuts and seeds					
16. Fast preparation products (canned meat, fish or chicken, shawarma, kebab, frozen ready to eat chicken nuggets or fingers.					
17. Legumes (lentils, fava beans, chickpeas, dried peas)					
18. Milk and milk products (long life, pasteurized or powder milk, yogurt, cheese, sour cream)					
19. Addition of oil (vegetable oil or					

vegetable butter)					
20. Fat, butter					
21. Sweets, candy and chocolate (Ready or prepared at home)					
22. Soft and sugary drink (not 100% juice)					

APPENDIX C. APPROVAL FOR USING CHILDREN NUTRITION PHYSICAL ACTIVITY PATTERN INSTRUMENT

From: Mostafa Waly
Sent: Wednesday, May 31, 2017 4:40 PM
To: Basma AL-Yazidi
Cc: Mostafa Waly
Subject: RE: Semi quantitative FFQ

Dear Ms. Basma,
Thanks for your greeting and I accept to act as a local mentor for your filed work and data collection in Oman. It will be great if you will cc your supervisor for all future communications with each other. This is important to document your research activity.
Please find attached the questionnaire for a similar study I have supervised, and of course it could be tailored based on your specific objectives. The attached questionnaire was written/validated in Arabic as we were targeting Omani children and the questionnaire was sent home and filled up by their parents. You can translate it into English for further discussion with your supervisor.
Thanks for including me in this valuable research.

Mostafa I. Waly, MPH, MSc, PhD
Associate Professor, Department of Food Science and Nutrition
CAMS, Sultan Qaboos University, Muscat, Oman
Office Tel: 00968-24141229 / Cellular Tel: 00968-92089739
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http://scholar.google.ca/citations?hl=en&user=vNRlNUMAAAAJ
http://www.ncbi.nlm.nih.gov/pubmed/?term=waly+M
https://www.researchgate.net/profile/Mostafa_Waly2

APPENDIX D. THE FAMILY NUTRITION PHYSICAL ACTIVITY SCREENING TOOL

FNPA Behaviorally Anchored Rating (BAR) Scales

	1	2	3	4
1 .	My child rarely eats breakfast and we don't typically eat together as a family.	My child does not regularly eat breakfast but we eat together as a family on most days of the week	My child eats breakfast on most days but we don't typically eat together as a family.	My child eats breakfast on most days and we typically eat together as a family.
2 .	Our family regularly eats fast food and we tend to snack between meals on a regular basis and eat while watching TV.	Our family regularly eats fast food but we don't snack much between meals or eat while watching TV.	Our family rarely eats fast food but we tend to snack between meals and eat while watching TV.	Our family rarely eats fast food and we don't snack much between meals or eat while watching TV.
3 .	Our family eats at fast food restaurants and uses prepackaged foods (macaroni and cheese, frozen pizza, and hamburger helper) for our main course. We usually do not eat fruits and vegetables with our main meal.	Our family eats at fast food restaurants and uses prepackaged foods (macaroni and cheese, frozen pizza, and hamburger helper) for our main course. We also consume some fruits and vegetables as side dishes.	Our family eats mostly freshly prepared main courses such as grilled chicken or fish, pasta, and fruits and vegetables. We also consume some side dishes such as rice-a-roni, french fries, or potato chips.	Our family eats mostly freshly prepared main courses such as grilled chicken or fish, pasta, and fruits and vegetables.
4 .	Our family serves mostly soda pop or other sweetened drinks (Kool-Aid or lemonade) with meals and snacks, and we	Our family serves mostly soda pop or other sweetened drinks (Kool-Aid or lemonade) with meals and	Our family regularly serves 100% fruit juice or low fat milk at meals and snacks and we do occasionally serve soda pop or other	Our family regularly serves 100% fruit juice and low fat milk at meals and snacks and we do not serve soda pop or other sweetened

	do not regularly serve 100% fruit juice or low fat milk.	snacks, and we do occasionally serve 100% fruit juice or low fat milk.	sweetened drinks (Kool-Aid or lemonade).	drinks (Kool-Aid or lemonade).
5 .	I/We don't control how much our child eats potato chips, cookies, and candy. Food is often used as a reward for something positive my child has done.	I/We monitor (and restrict) how much our child eats potato chips, cookies and candy. These foods are sometimes used as a reward for something positive my child has done.	I/We monitor (but don't restrict) how much our child eats potato chips, cookies, and candy are eaten These foods are sometimes used as a reward for something positive my child has done.	I/We monitor (but don't restrict) how much our child eats potato chips, cookies, and candy. These foods are rarely used as a reward for something positive my child has done.
6 .	My child watches television or plays on the computer (or with video games) for more than 4 hours each day	My child watches television or plays on the computer (or with video games) for between 2 - 4 hours each day.	My child watches television or plays on the computer (or with video games) for between 1 - 2 hours each day.	My child watches television or plays on the computer (or with video games) for less than 1 hour each day of the week.
7 .	I/We rarely monitor the amount of TV our children watch and allow them to have a TV in their bedroom.	I/We monitor the amount of TV our children watch but allow them to have a TV in their bedroom.	I/We rarely monitor the amount of TV our children watch but we don't allow them to have a TV in their bedroom.	I/We monitor the amount of TV our children watch but we don't allow them to have a TV in their bedroom.
8 .	I rarely participate in physical activity and our family does not play games outside, ride bikes, or	I participate regularly in physical activity (e.g. walking) but our family does not play games outside, ride bikes, or	I rarely participate in physical activity (e.g. walking) but our family plays games outside, ride bikes, or walks	I participate regularly in physical activity (e.g. walking) and our family plays games outside, ride bikes, or walks

	walk together very often.	walk together often.	together fairly frequently.	together fairly frequently.
9.	My child participates in almost no physical activity during his/her free time and is not enrolled in any organized sports or activities with a coach or leader.	My child participates in some physical activity a few days a week (2-3 days) in his/her free time but does not typically participate in any organized sports or activities with a coach or leader.	My child does not participate in physical activity in his/her free time but does participate in some organized sports or activities with a coach or leader a few days a week (2-3 days).	My child regularly participates (i.e. on most days) in physical activity in his/her free time and also participates in sports/activities with a coach or leader.
10.	Our family does not have a daily routine or schedule for our children's bedtime and our children get varying amounts of sleep each night.	Our family does not have a daily routine or schedule for our children's bedtime we follow but our child typically gets at least 10-11 hours of sleep a night.	Our family follows a daily routine or schedule for our children's bedtime but our children tend to get less than 9-10 hours of sleep a night.	Our family follows a daily routine or schedule for our children's bedtime and our child typically gets 11 hours or more of sleep a night.

APPENDIX E. APPROVAL FOR USING THE ARABIC VERSION OF FAMILY NUTRITION PHYSICAL ACTIVITY SCREENING TOOL

Suzan Tami <suzantami@gmail.com>
|
Tue 6/13/2017, 2:24 PM

Dear Dr. Berry,

Thank you for your email and request. I'm sorry for not replying to Basma's email sooner. I already graduated from Texas Tech University 10 months ago, and I rarely check the TTU email. Anyways, attached is the FNPA Arabic version. You are free to use it as long as you cite the pilot study article I published. For further questions, please email me at: suzantami@gmail.com

Best of luck,
Suzan

Suzan H. Tami, PhD
Coordinator of the Food & Nutritional Sciences Department
College of Agriculture & Food Sciences
King Faisal University
Hofuf, Kingdom of Saudi Arabia

APPENDIX F. FACILITATE A RESEARCHER TASK OFFICIAL LETTER

Dears Principals of Cycle One Schools at Al-Seeb Province

Subject: Facilitate a Researcher Task for Basma Mohammed Abdullah Alyazeedi

In regards to the above subject, and the document received from the Technical Office for Studies and Development (# 28171294836) on 26th of November, 2017, I would like to inform that Basma Mohammed Abdullah Alyazeedi, a PhD in Nursing student at The University of North Carolina, Chapel Hill is working on a research study titled "The Family Predictors to Children Nutrition and Physical Activity Pattern Among Omani Children".

And the researcher would like to apply the study instrument on a sample of Cycle One School students (attached study plan, study instrument, and parent consent).

We hereby ask you to facilitate the researcher task with the application of the study instrument according to the guidelines carried out in your school.

Thank you for your cooperation

Regards

Ali Mohammed Sulaiman AlShekili
Director of human resources Directorate

APPENDIX G. INVITATION MESSAGE

* * Invitation to participate in a research study * *

How can I enhance the nutritional and physical activity pattern of my child?

There is a research study on this issue in the Sultanate (Oman), which is carried by an Omani researcher who is a doctoral candidate and is concerned with understanding the nutritional and physical activity pattern of Omani children.

Really?

Yes, but the study is not over, do you want to help finish it and participate in the collection of study data

and can I participate?

Of course, if you are Omani age 18 years or more and able to speak, write, and read in Arabic and you have a child in the first, second, third, or fourth grade age 6-10 years old and suffers from no chronic illnesses affecting his normal diet and physical activity style, and had no brother or sister ever participated in this study.

I think I can participate, where the data collection will be and when will be the data collection date?

There will be multiple data collection sites, this time the data will be collected at ………. school Monday to Thursday on the dates of ……………to……………….

But I'm a working mother, I can't participate during working hours.

Don't worry, there are two different periods of data collection per day, taking into account the circumstances of working mothers as follows:
• Morning from 9 a.m. to 1 p.m.
• Evening period from 3:30 p.m. to 5:30 p.m.

and how will be the nature of my participation in the study?
• Taking weight and height measurements for you and your child (10 mins)
• Filling of an electronic questionnaire (15 minutes)
• An interview to collect the details of the meals your child took on the day before the data collection day (30 minutes)

And do participants have prepare for something specific before coming to the school?

Yes, preferably documenting or photographing the quantity and quality of food and drink the child took on the day before the data collection day to make it easier for you to recall.

What about the confidentiality of the information provided?

The confidentiality of the participants and their children will be preserved and the data will only be used for the study by the study team. Also, no identifying information will be requested and information collected will be related to an ID code.

Will there be a benefit from participating in this study?

The results of this study will have a significant impact on building programs that would enhance the nutritional and physical activity pattern of children, which is of course what matters to every mother, the participants in this study are also entitled to request a report of study results from the researcher at the end of the study.

* * Participating mothers and their children will deserve symbolic gifts (souvenir for mothers/ stationary tool for children) in recognition of their participation and their quest for a successful study.

* * light snacks will be available

We are happy for your cooperation and participation

You can contact the researcher in case you have some questions or want to know more about the study on the next number (97576353)

APPENDIX H. ADULT CONSENT

University of North Carolina at Chapel Hill
Consent to Participate in a Research Study (Adult Participants)

IRB Study # 17-2785
Title of Study: Family predictors to children nutrition and physical activity patterns in Oman
Principal Investigator: Basma Alyazeedi *
Principal Investigator Department: Nursing
Principal Investigator Phone number: (00968) 99641905
Principal Investigator Email Address: basma@unc.edu

Faculty Advisor: Diane Berry
Faculty Advisor Phone Number: (001) 919-843-8561

What are some general things you should know about research studies?

You are being asked to take part in a research study. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research studies are designed to obtain new knowledge. This new information may help people in the future. You may not receive any direct benefit from being in the research study. There also may be risks to being in research studies. Deciding not to be in the study or leaving the study before it is done will not affect your relationship with the researcher.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this research study.

You will be given a copy of this consent form. You should ask the researchers named above any questions you have about this study at any time.

What is the purpose of this study?

The purpose of this research study is to examine Omani child weight, nutrition, and physical activity in relation to maternal Body Mass Index (BMI), parental education level, family income, and family nutrition and physical activity patterns.

How many people will take part in this study?

There will be approximately 200 mothers and 200 children in this research study.

How long will your part in this study last?

About one hour during the data collection day.

What will happen if you take part in the study?

Participation in the study will involve weight and height assessment and filling out an electronic questionnaire with a 30 minutes structured interview.

Questionnaire:

The questionnaires will be web-based and you will be able to complete it online using a secure connection at secure laptops. The questionnaire asks some general information and assesses the child and family nutrition and physical activity pattern. Included in the questionnaire is an online link to Automated Self-Administered (ASA24) Dietary Assessment Tool. A research assistant will interview you at this point to ask questions related to your child dietary intake in the past 24 hours.

What are the possible benefits from being in this study?

Research is designed to benefit society by gaining new knowledge. There is little chance you will personally benefit from being in this research study. However, information obtained from this study can help to shape programs for families to promote their children nutrition and physical activity pattern. We will provide you with the results of the study at the end of the study if you would like.

What are the possible risks or discomforts involved from being in this study?

The primary risks associated with a study of this type are threats to privacy and confidentiality. However, your name and your child name will not be required in this study. Risks will be minimized by use of a secure data server and assignment of unique study ID codes instead of names on all study records.

Participants may experience minor discomfort during measuring their height and weight. The collection of height and weight will be done at the school clinic room and privacy will be maintained. It is possible that parts of the questionnaires used for data collection will contain topics that mothers feel are sensitive and thus could cause some minor distress. However, you have the right to refuse to answer any questions.

How will information about you be protected?

Once you and your child enroll in the study, your child will be assigned a unique study ID number. That number will be used to identify information that are collected as part of this study. All study information will be stored on a password-protected computer that only study staff will have access to.

As part of this research study, you will be asked to fill out questionnaires on line. We will provide access to the page containing the questionnaires. All data will be stored with your child study ID and no one will be able to access your data except the staff associated with the research study. No subjects will be identified in any report or publication about this study.

Will you receive anything for being in this study?

You will be receiving a symbolic gift (souvenir) for taking part in this study and your child will receive a stationary tool.

Participant's Agreement:

I have read the information provided above. I have asked all the questions I have at this time. I voluntarily agree to participate in this research study and give the permission for collecting my child height and weight measurements.

____ __________________

Signature of Research Participant Date

____

Printed Name of Research Participant

____ __________________

Signature of Research Team Member Obtaining Consent Date

____

Printed Name of Research Team Member Obtaining Consent

APPENDIX I. CHILD ASSENT

University of North Carolina at Chapel Hill
Assent to Participate in a Research Study
Minor Subjects (7-14 yrs)

Consent Form Version Date: ______________
IRB Study # 17-2785
Title of Study: Family predictors to children nutrition and physical activity patterns in Oman
Person in charge of study: Basma Alyazeedi
Where they work at UNC-Chapel Hill: School of Nursing

The people named above are doing a research study.

<u>These are some things we want you to know about research studies:</u>
Your parent needs to give permission for you to be in this study. You do not have to be in this study if you don't want to, even if your parent has already given permission.

You may stop being in the study at any time. If you decide to stop, no one will be angry or upset with you.

Sometimes good things happen to people who take part in studies, and sometimes things happen that they may not like. We will tell you more about these things below.

<u>Why are they doing this research study?</u>
The reason for doing this research is to understand how your nutrition and physical activity pattern is shaped.

<u>Why are you being asked to be in this research study?</u>
You are asked to be in this study because you are Omani child and your nutrition and physical activity pattern was determined to be usual.

<u>How many people will take part in this study?</u>
If you decide to be in this study, you will be one of about ***200*** child (400 people in total) in this research study.

<u>What will happen during this study?</u>
This study will take place at ***your school*** and will last about 5 minutes.
During this study we will be measuring your height and weight only.

<u>Who will be told the things we learn about you in this study?</u>
We will not tell anyone about your height and weight measurements. People working on this study will only know.

<u>What are the good things that might happen?</u>
Research is designed to benefit society by gaining new knowledge. You will not benefit personally from being in this research study.

What are the bad things that might happen?
Sometimes things happen to people in research studies that may make them feel bad. These are called "risks." In this study, there are no known risks to you.

Will you get any gifts for being in this research study?
You will be receiving a stationary tool for taking part in this study.

If you sign your name below, it means that you agree to take part in this research study.

Sign your name here if you want to be in the study	Date

Print your name here if you want to be in the study

Signature of Research Team Member Obtaining Assent	Date

Printed Name of Research Team Member Obtaining Assent

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