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Factors Influencing Childhood and Adolescent Obesity in the Arab Gulf States: A Systematic Review

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Abstract

Background: About one third of the population in the Arab Gulf States are overweight and obese. Among children and adolescents, however, the prevalence of obesity is at rates higher than those reported worldwide.

Objectives: The present study aims to systematically review and evaluate factors related to and affecting childhood and adolescent overweight and obesity in the Arab Gulf States.

Methods: We conducted a comprehensive and systematic search in PubMed, Ovid MEDLINE(R), Embase and Embase Classic to identify studies reporting on the risk factors of overweight and obesity in children and adolescent in the study region.

Results: We examined 22 studies and identified 12 reports to be included into this systematic review. The reviewed studies were from six Arab gulf States (Saudi Arabia, United Arab Emirates, Kuwait, Oman, Bahrain and Qatar) and examined 9,723 children. Approximately 30 different risk factors were identified from the selected studies. These were generally falling under six main risk factors including unhealthy eating habits, sedentary lifestyle, family-related factors, (particularly mother physical activities and food habits), child feeding practices during infancy, child sleeping pattern and low intake of or deficiency in micronutrients important for growth.

Conclusion: This study further establishes several of the universal-and regional-specific risk factors that influence the increased prevalence of childhood and adolescent overweight and obesity in the Arab Gulf States. Consideration of these risk factors is critical for developing effective policies and practices that address this public health concern to curb and reverse the rise in its prevalence within the Gulf Region.

Keywords: childhood obesity, Arab Gulf states, diet, behaviour

1. Introduction

Over the past four decades, mean body mass index (BMI) and obesity in children and adolescents aged 5–19 years have shown a significant worldwide increase (NCD Risk Collaborators, 2017). As estimated lately by the World Health Organization (WHO), more than 38 million children under the age of 5 are overweight or obese and over 340 million children and adolescents aged 5-19 are in this high weigh category (World Health Organization [WHO], 2020). According to the World Obesity Federation (NCD Risk Collaborators, 2017, World Obesity Federation, 2021), the global age-standardized prevalence of obesity has increased by about 8.5-fold in both boys and girls. Many high-income countries have recently experienced plateaued rates of this high BMI levels in children and adolescents. However, in many parts of Asia, overweight and obesity rates in children and adolescents are showing increased rates (NCD Risk Collaborators, 2017; World Health Organization, 2020). Middle East is presently the second highest region in obesity rates worldwide, with as much as 75% of the population being obese or overweight. The majority of these rates arise from the Arab Gulf States with combined overweight and obesity rates of approximately 30% on the population (Samara et al., 2019). The prevalence of obesity in the Arab Gulf States among children and adolescents, ranges from 5% to 14% in males and from 3% to 18% in females (ALNohair, 2014). These rates are higher than those reported worldwide in the same age population (NCD Risk Collaborators, 2017). In addition to endogenous factors (e.g., genetic predisposition), changes in food consumption, socioeconomic and demographic factors, physical activity, and urbanization are among the exogenous risk factors proposed to contribute to the increased prevalence of obesity in the region (Samara et al., 2019; ALNohair, 2014; Al-Muhaimeed et al., 2015).

Childhood and adolescence overweight and obesity can be associated with a number of adverse health

consequences throughout the life-course. Short-term effects are known to include adverse psychosocial consequences and lowers educational attainment (World Health Organization, 2016; Lobstein et al., 2004; Caird et al., 2014; Quek et al., 2017). However, the lifelong overweight and obesity (Singh et al., 2008) and the earlier onset of a wide range of chronic conditions (World Health Organization, 2016; Lobstein et al., 2004; Must et al., 1992; Abdullah et al., 2011; Park et al., 2012) are among many long-term adverse outcomes of overweight and obesity. Indeed, compared to adults, children and adolescents are more vulnerable to food marketing and to obesogenic foods (Kraak et al., 2016). Exposure reduction can, therefore, be considered as a critical measure in protecting children and adolescents from the harm of the obesogenic food environment (World Health Organization, 2016; Kraak et al., 2016). Certainly, the increased prevalence of overweight and obesity have led the Gulf Arab states – over the past few years – to adopt number of country- and community-based health promotion strategies similar to those implemented in many western countries (Stockmarr et al. 2016; Panter et al., 2018; Swinburn & Wood, 2013; Ackermann et al., 2015). More investigation and information are, however, needed from within the region on the dietary habits of this age group in order to substantiate comprehensive health promotion initiatives for an effective country- and community-based programs of prevention and health education (Aluttis et al., 2014). The present study was, therefore, undertaken to systematically examine the dietary patterns in the school-age children in the GCC countries as an attempt to provide knowledge that may assist in developing more effective public health programs aiming to curb the childhood and adolescence overweight and obesity rates in the region.

2. Methods

2.1 Literature Search

The present systematic review was undertaken and reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses; see Appendix A, Table A1) statement (Liberati et al., 2009). A search was conducted in Ovid Medline, Embase, Embase classic and PubMed databases using a search strategy as described in Appendix A (Tables A2 and A3). Briefly, the following search terms (MeSH) were used: “diet”, and “Emirates”, “Oman”, “Kuwait”, “Bahrain”, “Qatar” and “Saudi”, and “childhood obesity” or “children obesity”. Article publication search was from the inception of the databases to February 18, 2021. Only English language articles were included. Review papers, letters to the editor, case-reports, editorials, conference abstracts, and duplicate studies were excluded. Overall, studies were considered eligible if they meet the selection criteria for full-text screening (see Appendix A, Tables A2). The main criteria to select the studies in this review was the focus on the relationship between a particular dietary or behavioral pattern and childhood obesity in the Arab Gulf countries. Also, the reference lists in the selected studies were manually checked to include relevant reports.

2.2 Inter-Reviewer Agreement

Two reviewers (AB, HA) independently reviewed the identified abstracts to identify those eligible for full-paper review and subsequently, inclusion in the present study. Disagreements regarding study inclusion were resolved by discussion. Percentage agreement and Cohen’s Kappa (κ) statistic and 95% confidence interval (95% CI) were calculated (Cohen, 1989). Interpretation of the agreement between reviewers was based on the following Landis and Koch’s kappa statistic benchmarks: poor (< 0), slight (0.00–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80), and excellent (0.8–1.0). The percentage agreement on inclusion was 93% with a κ of 0.73, i.e., substantial agreement (Landis & Koch, 1977).

2.3 Quality Score Assessment and Data Extraction

The methodological quality of each of the selected studies was assessed from the standpoint of evaluating the factors related to childhood obesity. With some modification, we used the standards tool for evaluating and reporting epidemiologic studies on chronic disease incidence or prevalence, designed to assess population-based prevalence studies (Shamliyan et al., 2013; Badawi et al., 2018). To assess and assign a quality score, each study was rated against each of the ten following criteria: 1) clearly stating the research objective, 2) distinctly defining the study population, 3) homogeneity of the study subjects (e.g., age, gender ratio and origin), 4) sample size and power justification, and 5) considering the potential confounders with clear and adjusted statistical analyses. Each quality criterion was rated dichotomously (yes: high = 1 point; no: low = 0 point). An overall score was calculated by adding all the items rated as high quality. Thus, higher scores indicated stronger method quality. Data extracted from the selected studies included the first author’s name, publication date, country, dates of recruitment, total sample size (divided to males and females), age estimates (from reported mean, median or the mid-point for age range of the highest subject frequency), procedures for case identification and main findings related to diet, behavior and obesity in children and adolescents.

3. Results

3.1 Search Results

The systematic literature review process used to conduct the present study is shown in Figure 1. In the initial database search, 38 studies were identified to meet the search criteria and were in the English language. Following deduplication, 36 studies remained. One additional study was identified through reference search, for a total of 37 studies that were screened through abstract review. Of these, 15 studies were excluded during abstract review, according to the inclusion and exclusion criteria (see Appendix 1, Table B2). Briefly, 8 conference abstracts, and 2 review studies were excluded. Additional 5 reports were excluded based on the lack of their relevance to the present study. Full-text screening was conducted on 22 studies. Based on the full-text assessment, 10 reports were further excluded as they were either review articles (1 report), only related to metabolic markers of obesity (1 report), obesity was a cause rather than an outcome (3 reports), the study population was not in healthy subjects (3 reports) or were unobtainable (2 reports). The remaining 12 reports were included in the present study for qualitative and systematic analysis (Al-Muhaimeed et al., 2015; Alshammari et al., 2017; Al-Agha et al., 2020a, 2020b; Alturki et al., 2018; Al-Hazzaa & Albawardi, 2019; Amine & Samy, 1996; Al Amiri et al., 2015; Shaban et al., 2018; Al-Taiar et al., 2018; Al Yazeedi et al., 2020; Fernandez-Luque et al., 2017) and are described in further detail below. With a maximum quality score of 5 and given the quality-score assessment criteria, a good score (≥4 points) was achieved in 25% of the studies (3 studies, 2 from Saudi Arabia and 1 from Kuwait); 50% of the studies were scored as being of fair quality (3 points including 3 studies from Saudi Arabia and 1 study from each of UAE, Kuwait and Oman) and 25% of the studies were scored as low quality (<3 points including 1 study from ach of Saudi Arabia, UAE and Qatar) (Table 1). Ten of the selected studies were cross-sectional (83%) whereas only two (17%) were retrospective studies.

3.2 Population Characteristics

Of the selected studies, six were from Saudi Arabia (n=6,476), 2 from UAE (n=1,238), 2 from Kuwait (n=1,585) and one study from each of Oman (n=197) and Qatar (n=227) (Table 1). No report related to the objective of the present study was found from Bahrain. The total number of subjects from the selected studies was 9,122 children and adolescent with 4,316 boys and 4,806 girls, i.e., 1:1.1 male: female ratio (Table 1). Total number of participants in the 12 selected studies varied by approximately 20-fold as it ranged from 151 to 2,888 subjects. The age ranges varied markedly in the selected studies. Except for one study from UAE (Amine & Samy, 1996) where

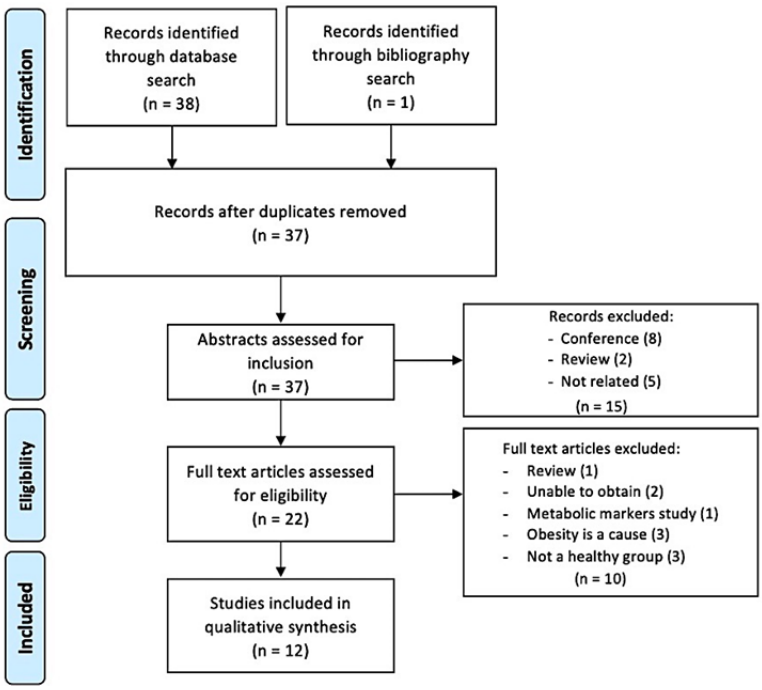

Figure 1. Flowchart of studies selection and systematic literature review process

Note. The flow diagram describes the systematic review of literature evaluating the factors influencing childhood and adolescent overweight and obesity in the Arab Gulf States. in obesity. Full texts of 22 studies were examined and 12 unique reports were identified to be included into the qualitative analysis.

Table 1. Characteristics of the studies selected to describe factors related to childhood and adolescent obesity in the Arab Gulf States

Country[1]	Study ID	Recruitment period (mm.yy – mm.yy)	Number of study subjects			Age range (years)	Study design	Relevant objective(s)	Quality score (1 – 5)[2]
			Boys	Girls	Total				
Saudi Arabia	Al-Muhaimeed et al., 2015	Six months, 2012	417	184	601	6–10	Cross-sectional	To compare overweight/obesity prevalence data of 2012 with early data (1994-98) and to assess related risk factors.	2
	Alshammari et al., 2017	09.15 – 01.16	700	720	1,420	2–18	Cross-sectional	To estimate the prevalence of overweight/obesity and its associations with nutrient intake and dietary patterns.	3
	Al-Agha et al., 2020a	01.18 – 0.6.18	80	71	151	4–20	Retrospective	To investigate the causative factors of obesity.	4
	Al-Turki et al., 2018	12.15 – 03.16	468	555	1,023	9–12	Multicenter cross-sectional	To provide an in-depth analysis of the relationship between obesity and fast-food consumption.	5
	Al-Hazzaa & Albawardi, 2019	–	1,388	1,500	2,888	15–19	Cross-sectional	To examine the interaction effects of gender with obesity status and lifestyle behaviors.	3
	Al-Agha et al., 2020b	09.17 – 04.18	211	182	393	2–18	Retrospective	To evaluate the association between various environmental factors and anthropometric measures.	3
UAE	Amine et al., 1996	–	–	206	206	19–22	Cross-sectional (females)	To determine the prevalence of obesity among female students.	1
	Al-Amiri et al., 2015	04.11 – 05.11	569	463	1,032	11–17	Cross-sectional	To estimate the prevalence of prediabetes and type 2 diabetes in overweight/obesity status.	3
Kuwait	Shaban et al., 2017	02.15 – 04.15	–	169	169	10–14	Cross-sectional (females)	To assess the association of mother-daughter dyads with respect to health behaviors for healthy eating, physical activity and sedentary lifestyle.	4
	Al-Taiar et al., 2018	02.16 – 0.4.16	694	722	1,416	11–16	Cross-sectional	To estimate the prevalence of vitamin D deficiency in a nationally representative sample of adolescents.	3
Oman	Al-Yazeedi et al., 2020	12.17 – 01.18	93	104	197	6–10	Cross-sectional	To examine the relationship between BMI and lifestyle-related factors (e.g., nutrition, physical activity, screen time and time spent sleeping).	3
Qatar	Fernandez-Luque et al., 2017	09.15 – 08.16	113	114	227	9–12	Case-control study	To examine the feasibility of capturing quantified-self data from social media, wearables, and mobiles within a weight-loss camp.	2

Note. [1]The search did not identify any study from Bahrain. [2]Quality score ranges from 1 (low) to 5 (high), see Methods section.

the study population age ranged from 19 to 22 years, the remaining 11 reports examined children and adolescent in the age rang of 2 to 18 years. The recruitment dates of the participants in the selected studies were between 2012 to 2018, except one report where no recruitment information was obtainable except for the publication date of 1996 (Amine & Samy, 1996).

3.3 Factors Related to Childhood and Adolescent Overweight and Obesity

From the selected studies, 30 different factors were recognized to relate to childhood and adolescent overweight and obesity in the Gulf Arab states (Table 2). These factors were identified in relation to the objectives of the identified reports (Table 1). Low intake of (or deficiency in) critical micronutrients necessary for growth was characterized in three studies (Alshammari et al., 2017; Al-Agha et al., 2020a, 2020b; Al-Taiar et al., 2018) to relate to obesity and overweight. Additionally, unhealthy eating habits (e.g., skipping meals, high intake of fast food – in general – specifically between meals and eating large portions of food) were reported as causative factors in three studies (Al-Muhaimeed et al., 2015; Alturki et al., 2018; Al-Agha et al., 2020a, 2020b). Furthermore, six (Al-Muhaimeed et al., 2015; Al-Agha et al., 2020a, 2020b; Al-Hazzaa & Albawardi, 2019; Amine & Samy, 1996; Fernandez-Luque et al., 2017) of the 12 selected studies reported sedentary lifestyle (e.g., longer screen and game time, limited physical exercise) to be markedly related to childhood and adolescent overweight and obesity in the region. The studies also emphasized on the lifestyle and behavior of the mother and family in their activities and food habits as a major influence in childhood obesity. Those latter factors included: (a) the family habits in eating out; (b) the family participation in child's activities; (c) the family's indoor smoking habits and the exposure of children to passive smoking; (c) the family's high socioeconomic status; (d) the presence of obesity in one or both parents; and (e) the mother's attitude and conduct in physical activity, computer/video game use and TV screen time (Al-Muhaimeed et al., 2015; Al-Agha et al., 2020a, 2020b; Al-Hazzaa & Albawardi, 2019; Amine & Samy, 1996; Fernandez-Luque et al., 2017). Factors related to the child during infancy, e.g., bottle-feeding in the first year of life (Al-Agha et al., 2020b) and the status of obesity during early years of life (Amine & Samy, 1996) together with their sleeping pattern, e.g., increased time spent sleeping at night (Al Yazeedi et al., 2020) and long afternoon napping (Amine & Samy, 1996) were also identified to contribute to the high rates of childhood obesity. One study (Al Amiri et al., 2015) has linked abnormal blood glucose levels to the overweight/obesity status of children in the region.

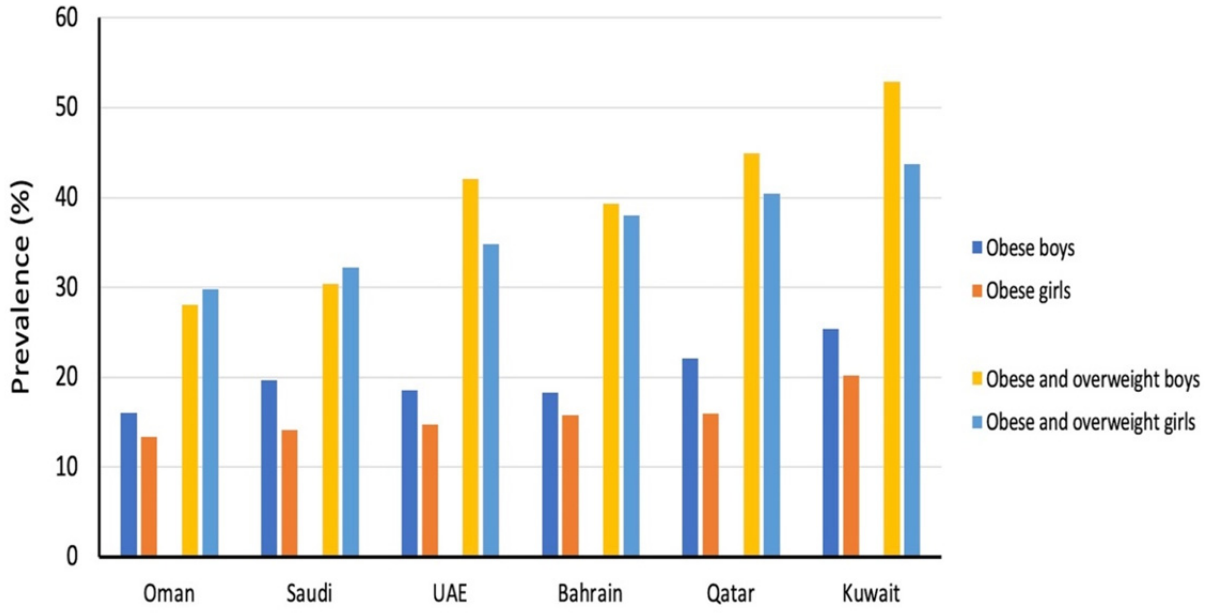

Figure 2. Prevalence of childhood overweight and obesity (%) in the Arab Gulf States

Note. Data was extracted using the 2016 estimates as reported by the World Obesity Federation[3] and using the World Health Organization (WHO) cutoffs (www.who.int/growthref/en).

Table 2. Factors related to childhood and adolescent overweight and obesity in the Gulf region

Country	Study ID	Factor(s)
Saudi Arabia	Al-Muhaimeed et al., 2015	– Eating restaurant food >2 times/week – Engaging in sports <2 hours/day
	Alshammari et al., 2017	– Lower intakes for critical micronutrients necessary for growth.
	Al-Agha et al., 2020a[1]	– Sedentary lifestyle (69%) – Unhealthy diet (72%) – Skipping meals (63%) – Vitamin D deficiency (63%)
	Al-Turki et al., 2018	– High intake of fast food per week – Large portions of food – Families eating fast food together – Families ordering from healthy meal menus (protective)
	Al-Hazza & Albawardi, 2019	– High inactivity level – High screen time
	Al-Agha et al., 2020b	– Bottle-feeding in the first year of life – Playing video games >4 hours/day – Exercise <2 times/week – Exposure to indoor passive smoking – High socioeconomic status
UAE	Amine et al., 1996	– Obesity during early years of life – Obesity in one or both parents – Fast food intake between meals – Limited physical exercise – Long afternoon napping
	Al-Amiri et al., 2015	– Abnormal blood glucose levels
Kuwait	Shaban et al., 2017	– Eating habits, physical activity, computer/video game use, and TV screen time are similar to those of the mother
	Al-Taiar et al., 2018	– Vitamin D deficiency
Oman	Al-Yazeedi et al., 2020	– Increased time spent sleeping at night
Qatar	Fernandez-Luque et al., 2017	– Food habits of the family – Days recorded as inactive – Mother's participation in children's activity

Note. [1]Numbers in parentheses represent the reported prevalence.

4. Discussion

The present study was undertaken to systematically assess factors that may play a role in the increased prevalence of childhood and adolescent obesity in the Arab Gulf States. We identified approximately 30 different factors from the 12 studies selected to be systematically reviewed (Table 2). These factors generally fall under 6 main themes including: (a) unhealthy eating habits (e.g., skipping meals, high intake of fast food between meals, large portions of food); (b) sedentary lifestyle (e.g., longer screen and game time, limited physical exercise); (c) family-related factors, e.g., mother physical activities and food habits (eating out, physical activity, computer/video game use, and TV screen time), high socioeconomic status, participation in child's activities, obesity in one or both parents, and indoor passive smoking; (d) child status during infancy, e.g., bottle-feeding in the first year of life, obesity in

early years of life; (e) child sleeping pattern, e.g., increased time spent sleeping at night and/or long afternoon napping; and (f) low intake of or deficiency in critical micronutrients important for growth (e.g., vitamin D).

It is well established that obesity is chiefly attributed to atypical patterns in dietary practices and physical activity that leads to an imbalance between energy intake (increase) and energy expenditure (decrease) (Hill et al., 2012). In addition to dietary habits and sedentary lifestyle, genetic predisposition (Thaker, 2017), environmental factors (e.g., high energy/high fat foods, fast food consumption, television watching, "super-sized" portions) and socioeconomic status (Brantley et al., 2005) are also known to markedly influence the risk of overweight and obesity. Obesity is therefore viewed as the ultimate outcome of a complex interaction of biology, behavior, and environment (Brantley et al., 2005). The prevalence of obesity in the Arab Gulf States is a major public health concern where childhood and adolescent overweight and obesity have reached epidemic levels (Samara et al., 2019) and can be associated with adverse health consequences throughout the life-course (NCD Risk Factor Collaboration, 2017) including greater risk and earlier onset of chronic disorders such as cardiovascular diseases, chronic kidney diseases and type 2 diabetes (Lobstein et al., 2004; Must et al., 1992; Abdullah et al., 2011; Park et al., 2012). This array of chronic non-communicable diseases has been proposed to occur at a younger adulthood ages than of the previous generations (Sahoo et al., 2015). Moreover, it is well documented that overweight children are more likely to become obese adults (Caballero, 2002). Additionally, childhood obesity is well-known to result in adverse psychosocial consequences such as negative emotional effects, poor self-esteem and lowers educational attainment that can lead to a reduced quality of life throughout the adulthood (World Health Organization, 2016; Lobstein et al., 2004; Caird et al., 2014; Quek et al., 2017; Sahoo et al., 2015).

Trends in the prevalence of overweight and obesity in children and adolescents documented in individual Arab Gulf countries as reported by the World Obesity Federation (World Obesity Federation, 2021), as shown in Figure 2, indicates Qatar and Kuwait to have the highest rates in region (prevalence of overweight and obesity between 42.7 and 48.2%) and followed by Bahrain and UAE (38.4 to 38.6%) with the lowest regional prevalence rates in Oman and Bahrain (29.8 and 38.6%). The regional prevalence of obesity in 2016 varied from 16.1% to 25.4% in boys and from 13.3% (Oman) to 20.2% (Kuwait) in girls (World Obesity Federation, 2021). On the other hand, within the same above reporting period (i.e., 2016), the global prevalence of obesity was 7.8% in boys and 5.6% in girls (NCD Risk Factor Collaboration, 2017) . This significant difference between the global and regional rates illustrates the extent of childhood and adolescent obesity and overweight as a major regional public health problem.

The present study has identified a set of factors that influenced childhood and obesity in children and adolescents in the Arab Guld States that are similar to those characterized worldwide. These factors included unhealthy dietary habits (Al-Muhaimeed et al., 2015; Alturki et al., 2018; Al-Agha et al., 2020a) similar to what have been observed in many world countries including skipping meals (Kim et al., 2012), eating large food portions (Livingstone & Pourshahidi, 2014) or increased consumption of fast Western food from fast-food outlets and restaurants (replacing the traditional home cooked foods) particularly between meals (Zhao et al., 2017). In general, a positive association has been suggested between these unhealthy dietary habits and weight gain in children but with limited and mixed evidence. For example, with respect to the consumption of fast food, while some studies have shown a significant association with increased BMI (Rosenheck, 2008; Thompson et al., 2004), others failed to report such an effect (French et al., 2001; Boutelle et al., 2007). Similarly, practices associated with sedentary lifestyle observed in the selected studies such as longer screen and game time and limited physical exercise (Al-Muhaimeed et al., 2015; Al-Agha et al., 2020a, 2020b; Al-Hazzaa & Albawardi, 2019; Amine & Samy, 1996; Al Amiri et al., 2015; Fernandez-Luque et al., 2017) that are linked with increased prevalence of child obesity in the Arab Gulf States, were also extensively implicated in many developed and developing countries worldwide (Robinson et al., 2017). The effect of bottle-feeding on rapid weight gain during the first year of life noted here (Al-Agha et al., 2020b) was previously reported in 1,899 infants from the USA (Li et al., 2012). In the latter study, with respect to bottle feeding, it was concluded that infant weight gain in the first year of life can be related to both the type of milk consumed and the mode of milk delivery, i.e., the proportion of bottle-feedings to breast-feeding (Li et al., 2012).

The most common micronutrient deficiencies among school-age children are calcium, fiber, folate, iron, magnesium, potassium and vitamin E with the most common deficiencies are being in iron and vitamin D (Suskind, 2009). This low intake of or deficiency in critical micronutrients important for growth was similarly reported in the present study region (Al-Taiar et al., 2018; Alshammari et al., 2017). Based on available evidence, the positive association between hypovitaminosis D and obesity seem to be primarily related to its action on glycemic control (Peterson & Belenchia, 2014). Indeed, abnormal blood glucose level was identified as a factor linked to childhood obesity in a population that also experience vitamin D deficiency (Al Amiri et al., 2015). It was reported that approximately 90% of the populations in the Arab Gulf States have below optimal vitamin D levels (Badawi et al.,

2012). This high prevalence of hypovitaminosis D has been reported both in adolescent and adult populations in many countries of the region (Badawi et al., 2012; Fahed et al., 2012; Fields et al., 2011; Lips, 2007; El Sonbaty & Nu, 1996). Several reports have implicated vitamin D deficiency to be associated with to insulin resistance, Impaired glucose tolerance and type 2 diabetes (for review see Badawi et al., 2010). Vitamin D deficiency has been linked to all of these diseases and also plays a role in other risk factors directly implicated in obesity such as physical inactivity (Peterson & Belenchia, 2014). Since excess adiposity is linked with vitamin D deficiency and that this status of hypovitaminosis D during obesity is related to its action on glycemic control, it may be critical to routinely monitor vitamin D status in obese children and adolescents. Dietary supplementation with vitamin D may, therefore, be an effective adjunct to the standard practices combating obesity (Peterson & Belenchia, 2014).

Sleep patterns has been extensively studied for its effect on obesity in childhood (Miller et al., 2015; Morrissey et al., 2020) and adulthood (Patel et al., 2014). Poor sleep is common in children and an association between short sleep duration in early childhood and obesity was consistently observed (Miller et al., 2015; Morrissey et al., 2020; Randler et al., 2017). However, studies from the Arab Gulf States have demonstrated that increased time spent sleeping at night (Al Yazeedi et al., 2020) and long afternoon naps (Amine & Samy, 1996) are positively associated with childhood obesity. This is in agreement with observations substantiating sleep timings and patterns as being more influential than sleep duration in child weight gain (Miller et al., 2015; Morrissey et al., 2020). Several mechanisms were proposed for sleep–obesity associations including the timing and behavior of eating in relation to sleep (Miller et al., 2015; Morrissey et al., 2020; Larson & Story, 2013), dietary intake and quality of diet (Fisher et al., 2014), obesogenic eating behaviors (Dweck et al., 2014) and changes in appetite-regulating hormones, e.g., ghrelin and leptin levels (Chaput et al., 2014). A better understanding for the effect of these factors on the relationship between sleep timings and patterns and obesity will provide promising avenues of approach for curbing the increased prevalence of childhood overweight and obesity.

Mother's eating habits, the extent of their physical activity, their sedentary lifestyle practices (e.g., computer/video game use and TV screen time) and their habits of eating out for fast food, together with their participation in children's activity were all considered as risk factors influencing the increased prevalence of childhood and adolescent overweight and obesity in the Arab Gulf States (Al-Muhaimeed et al., 2015; Al-Agha et al., 2020a, 2020b; Al-Hazzaa & Albawardi, 2019; Amine & Samy; 1996; Fernandez-Luque et al., 2017). This effect of mother's behavior on child's obesity was also noted in both developing (Oli et al., 2015; Arunachalam & Kandasami, 2019) and developed (Musher-Eizenman et al., 2009) countries of the world. As primary caregivers and role models, the perception of mothers to their child's health highly influences children's nutritional pattern and physical activity. Parents in general and mothers in particular play a vital role in shaping their children's knowledge, behavior and attitudes at early ages (Mabiala et al., 2016) and help them developing their eating habits, food preferences and energy expenditure practices (Birch et al., 2001). Children not only model the behavior of their parents in their eating habits (Brown & Ogden, 2004) but are also influenced by their mother's feeding practices (Rodgers et al., 2004). Mothers who encourage their children to over-consume food contribute for their child's weight gain early in life and the child's eating habits later in life (Rodgers et al., 2004). Investigations of mother-child dietary trends among Muslims, has shown a major influence of the mother's religious values (e.g., not eating pork or drinking alcohol) and culture of origin (e.g., preference to traditional Arabic dishes) (Shaban et al., 2018). This modelling behavior clearly indicates the alignment of children's eating habits and behavior with that of their mothers' and that their consumption of and preference for given foods are generally comparable the foods being consumed at home (Savage et al., 2007). Similar to the mother-child dietary habits resemblance, children of active mothers were twice as likely to be active than their counterparts of non-active mothers (Moore et al., 1991). Mothers' perception on healthy diet and physical practices is another major factor that influences childhood obesity. It was shown that nearly 60% of the mothers of overweight children are not aware of childhood obesity as a health problem (Etelson et al., 2003) and was even perceived as manifestation of good health (Berge & Everts; 2011).[77] This lack of knowledge on childhood obesity presents a challenge to many community-based intervention programs. Mothers who receive education about healthy nutrition and physical activity were found to be more likely to offer healthier dietary practices to their children (Bender et al., 2013).

The present study has several limitations. The identified reports have shown a wide among-studies variation in the number of studied populations. This factor may levy some limitations on the observation, particularly in the small-sample size studies, leading to subjective evaluation of the reported observations. Moreover, the large between-studies difference in the sample size render the comparison challenging among the different countries and/or examined populations. Furthermore, the small number of studies identified for some countries, e.g., UAE, Kuwait, Oman and Qatar did not allow us to comprehensively evaluate factors related to obesity in these countries and in wider age groups. Additionally, little information was provided in the original articles on the chronic

comorbidities, if any, that might contribute to obesity in children, e.g., diabetes which may have an interrelationship with obesity in the studied age group(s). Also, the study did not address the effect of prevention programs or weight management practices on childhood obesity as we are simply reporting the causative factors of the studies condition. Other limitation is that we excluded non-English language articles which may have influenced our overall evaluation and led to missing factors relative to the effect on BMI in the studied region.

In conclusion, several factors were identified to influence the elevated prevalence of overweight and obesity in children and adolescents in the Arab Gulf States. These factors are both universal (e.g., unhealthy dietary practices and lack of physical activity) and regional (e.g., mother's dietary behavior and family-related activities). This accelerated rise and high rates of childhood and adolescent overweight and obesity in the Arab Gulf States necessitates the developing effective policies and practices that address this public health concern to curb and reverse the rise in its prevalence. Similar trends were observed in east, south, and southeast Asia (NCD Risk Factor Collaboration, 2017). Specific initiatives are needed by governments, community groups, schools, and individuals to increase the public awareness about overweight and obesity in children. This may be principally relevant to parents in general and mothers in particular. Such initiatives will clearly lead to changes in dietary habits and physical activity in a manner sufficient to curb the rise in mean BMI. Furthermore, policies using taxes and industry regulations to change eating and drinking behaviors (Kraak et al., 2016; Popkin, 2017; Hawkes & Harris, 2011) are being widely adopted to combat overweight and obesity in children and adolescents. The use of tax regulations to diminish the consumption of high-energy foods together with policies and programs encouraging the affordability of healthy foods (e.g., fresh fruits and vegetables and whole) through price subsidization or healthy school meals and also implementing compulsory restrictions for fast-food advertisement that target children have all shown to promote population health and reduce the rates of childhood obesity (NCD Risk Factor Collaboration, 2017; Bleich et al., 2017; Parker et al., 2009). Given the highlighted factors influencing the increased prevalence of childhood obesity in the Arab Gulf States, efforts undertaken in a population-based approach to combat this condition should be accompanied by educational programs for behavioral changes towards both diet and exercise as well as recommendations of micronutrients supplementation and screening for metabolic syndrome consequences of obesity.

Ethical Approval

Not applicable.

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Author Contribution

AB conceived the study idea and design, data acquisition, analysis and interpretation and wrote the manuscript. HMA and RAA assisted in abstract screening and data extraction. FMH critically revised the manuscript. All authors critically reviewed the manuscript, approved the final draft, and agreed to be accountable for all aspects of the work.

Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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Appendix A

Supplementary Materials

Table A1. PRISMA Checklist[1]

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Systematic review
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	All included in the abstract of the article. Some details in the results section. The study has not been registered
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	The protocol has not been registered
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g. piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6

Data items	11	List and define all variables for which data were sought (e.g. PICOS, funding sources) and any assumptions and simplifications made.	5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in data synthesis.	n/a[2]
Summary measures	13	State the principal summary measures (e.g. risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g. I^2) for each meta-analysis.	6
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g. publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analysis, meta-regression), if done, indicating which were pre-specified	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assess for eligibility, and included in the review, with reasons for exclusion at each stage, ideally with a flow diagram.	7-9
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7-9
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	n/a
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with forest plot.	7-9
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15)	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g. sensitivity or subgroup analyses, meta-regression [see item 16]).	7-9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10-16
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	15
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	15-16
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	See funding statement

Note. [1]Liberati A et al., 2009. [2]n/a: not applicable.

Table A2. PICOST Table

Component	Criteria
Population	Children (<18 years old) from the Arab Gulf States
Intervention	No intervention criteria.
Comparison	Factors related to weight (overweight, and obesity) in healthy subjects.
Outcome	Overweight and obesity
Study Design	- Observational studies (including retrospective chart review). - Case-control studies. - Randomized Control Trial (untreated arm). - Cross-sectional studies. - Case reports of more than 3 cases.
Time	From inception of Ovid MEDLINE (Epub Ahead of Print, In-Process and Other Non-Indexed Citations); Ovid MEDLINE(R) (Daily and Ovid MEDLINE(R)) and Embase (Embase and Embase Classic) to February 18, 2021.
Selection criteria for full-text screening	*Inclusions*: Human studies, children, studies reporting effects on different weight categories, studies from the Arab Gulf States *Exclusions*: Conference reports, reviews, letters, animal studies, non-human studies, editorials, questionnaires, case reports, notes to the editor, book chapters, no abstract, weight not reported, duplicate studies, non-English literature.

Table A3. Ovid Medline, Embase, Embase classic and PubMed databases (from inception to February 18, 2021)

Terms	Search term	Results
1	Diet	1,249,444
2	Emirates	7,439
3	Oman	6,230
4	Kuwait	10,417
5	Bahrain	2,978
6	Qatar	5,571
7	Saudi	49,087
8	Childhood obesity	32,132
9	Children obesity	565
10	Child obesity	2,012
11 Combination	8 or 9 or 10	33,651
Combinations	1 and 2 and 11	6
	1 and 3 and 11	1
	1 and 4 and 11	8
	1 and 5 and 11	0
	1 and 6 and 11	3
	1 and 7 and 11	27
	12 or 13 or 14 or 15 or 16 or 17	45

Elimination	De-duplicate	38
Language	Limit to English	36
Limitations	Human	36