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Prevalence and risk factors of obesity among school-age female children in Ha'il, Saudi Arabia

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ABSTRACT

Objectives: To assess the prevalence and associated risk factors of obesity among school-aged female children in the Ha'il region, Saudi Arabia. *Methods*: A total of 549 female students (age 8.9 ± 1.9) participated in this study. The sample was recruited from different primary schools. Students were required to answer questions about their feeding habits and activity level. Anthropometric measures of obesity were measured using a stadiometer, plastic measuring tape, and plastic skinfold caliper. *Results*: 155 out of the 549 female students aged 7-12 years were classified as obese based on their BMI values with an overall prevalence of obesity was 27%. Using the BMI as an indicator, the results revealed a significant (p=0.03) correlation (φ_c=0.1) between the consumption of chocolate and sweets and obesity. Consuming fast food and soft drinks exhibited high odds ratio despite having an insignificant correlation (OR= 1.53, 1.04) respectively. There was a significant correlation between watching TV while eating, fast-food consumption (r_{pb} = .11, .20, p <.05), and waist girth. There was a significant negative correlations between soft drink consumption and waist-hip ratio (r_{pb} = -.10, p = .03); both sweets consumption and activity level were correlated (r_{pb} = -.12, -.16 & p <.00) with the thickness of the abdominal skinfold. *Conclusion*: One out of each three female children attending primary school was obese. Unhealthy dietary habits were associated with obesity among school-age female students.

Keywords: Childhood obesity, Ha'il, risk factors, school-age girls

1. INTRODUCTION

Obesity has been described as the accumulation of excess body fat within the body. According to the World Health Organization (WHO), the body mass index (BMI) values, calculated as weight in kilograms divided by square of height in meters, is the gold standard measure that determines the cutoff point between normal and obese individuals (Kim, 2016). Obesity can be classified as central or peripheral; the central type is characterized by excess fat in the trunk area while the fat deposition is higher in the extremities in the peripheral type (Aras et al., 2015; Elerian et al., 2020). Both types of obesity have been shown to adversely affect different body systems and functions (Elerian et al., 2016) leading to a variety of adverse health conditions and diseases (Hussein et al., 2019). Specifically, diabetes (Abdullah et al., 2010), cardiovascular (Zhang & Wang, 2015), respiratory problems (Forno et al., 2018) have been associated with the central type of obesity. While peripheral obesity can affect the level of flexibility and normal joint movements (Erdoğan et al., 2016). The management of obesity and its related adverse effects places a huge burden on the person, society, and health care system (Tremmel et al., 2017). Yusefzadeh et al. suggested that 10% of health-care costs belong to the direct and indirect effects of obesity (Yusefzadeh et al., 2019).

Childhood obesity has been considered an epidemic problem worldwide. In the United States, a recent study suggested that severe obesity increases among children aged between 2 and 5 years (Skinner et al., 2018). A similar increase in the rate of obesity has been reported in European countries during the last decade (Blundell et al., 2017). The alarming increase in the rates of obesity also has been reported in developing countries as well (Ranjani et al., 2016; Roshdy et al., 2020). For example, Brazil showed an increase from 4.1% in 1975 to 13.9% in 1997; China from 6.4% in 1991 to 7.7% in 1997; and India from 16% in 2002 to 24% in 2007 (Al Shehri et al., 2013; Wang & Lobstein, 2006). In Saudi Arabia, the prevalence of obesity and its related adverse effects have been reported in several previous studies (Al-Kadi et al., 2018; Aljabri & Bokhari, 2014). During the last decades, Saudi Arabia has been subjected to tremendous cultural and economical changes, which lead to paralleled changes in lifestyle and daily routine (Ghaith & Ibrahim, 2020). These factors along with the variations in the growth between different regions in Saudi Arabi (El Mouzan et al., 2009) have potentially led to regional differences in prevalence estimates of obesity.

The prevalence of obesity in Saudi Arabia has been extensively documented for adults (Al-Kadi et al., 2018; Al-Nozha et al., 2005; Al-Quwaidhi et al., 2014; Aljamani et al. 2020) with less emphasis given to epidemiological studies among children especially in the Ha'il region (Ahmed et al., 2014). Farsi et al. reported a prevalence rate between 25 and 32% of obesity among school-age children and preadolescents in Jeddah (Farsi & Elkhodary, 2017; Farsi et al., 2016). Similar rates were observed among college-age females in Dammam city, Eastern province (Sabra, 2014). Although these studies reported a similar trend toward increasing the prevalence of obesity, the prevalence estimates were quite different among these studies. This was reported by a recent review conducted by (Alqarni, 2016). The prevalence of obesity among adults in Ha'il is considerably high. Ahmed et al. (2014) reported that the overall prevalence of obesity in Ha'il was 63.6%; being higher in females (71%) than that of males (56.2%). For individuals <25 years of age, the prevalence of those classified as having obesity and morbid obesity was 28.8%. Al-Nozha et al. (2005) reported a prevalence of 37% among individuals 30-70 years of age in the Northern region of Saudi Arabia. Furthermore, a study conducted by Alazzeh et al. (2018) showed that 21.3% of male students in Ha'il City were overweight and 27% were obese. The prevalence of overweight and obesity among children has been reported in other regions of Saudi Arabia including the Northern Province where Ha'il is located but no study particularly investigated the prevalence of obesity among female children in Ha'il.

Risk factors for obesity during early childhood have been well documented in the literature. These risk factors are diverse and include family history (Alqarni, 2016), lack of physical activity (Mahfouz et al., 2011), eating habits (Della Torre et al., 2016), or using electronic devices (Al-Agha et al., 2016). It is worth to mention that these risk factors are not applicable in all circumstances and among various demographic regions. The majority of the previously published studies used BMI as a single measure of obesity (Al-Kadi et al., 2018; Deema J. Farsi et al., 2016; Sabra, 2014). BMI alone does not accurately represent the status of body fat and it could be easily affected by different factors such as muscle mass. Moreover, BMI cannot report regional body fat (Gurunathan & Myles, 2016). The use of additional (Al Shehri et al., 2013) measures such as waist girth, waist-hip ratio, and skinfold thickness has been recommended to capture more details to the data obtained using BMI (Abdel-Aal et al., 2020; Akpinar et al., 2007).

Well-designed studies that take into consideration the limitations demonstrated in the previous studies and targeting the female children in Ha'il are needed to provide more objective and reliable information about the prevalence and risk factors of obesity among this particular population. This study aimed at investigating the prevalence of obesity among school-age females in Ha'il, and explores obesity-associated risk factors.

2. METHODS

Participants

This cross-sectional study was conducted between January and March 2020. Four preparatory schools were randomly selected from a list containing all preparatory schools in Ha'il Region, Saudi Arabia. 549 female students between 7 and 12 years of age participated in this study. Of these, 98 % were Saudi Citizens and 2% had other nationalities. This narrow age group was selected to avoid the heterogeneity associated with growth and puberty while children below 6 years could not answer the questionnaire accurately. This study was reviewed and approved by the local institutional review board (Protocol #: H-2020-160). All participants, their parents, or legal guardians, provided informed written consent before their enrollment into the study.

Instruments and procedures

To recruit participants into the study, the authors contacted local schools in the Ha'il region, Saudi Arabia. An email consisting of information about the study and an invitation for participation was sent to 12 schools. Seven out of the 12 schools agreed to participate in the study. Using a simple random method (closed envelope), four out of the seven schools were randomly selected. One week prior to the commencement of the study, the authors conducted a visit to the selected schools to provide flayers explaining the objectives and importance of the study and to provide informed consent to be signed by the students' parents. Students who provided signed consent form, students with age in the range 7-12 years, and students without spinal or other deformities that may hinder the anthropometric measures were allowed to join the study.

To ensure consistency in data collection, a standard protocol was adopted consisting of three successive stations; in which each student was required to go through a set of standard procedures designated to each station. In the first station, a research assistant was responsible for recording the name of the students and assigning a code number for her data collection sheet. In the second station, another research assistant was responsible for collecting personal data (age, address, nationality, school achievements) in addition to data regarding physical activity, eating habits, eating while watching TV. The third station was conducted by a third research assistant. In this station, measures such as weight, stretching height, waist, hip girth, and skinfold thickness were measured. These separate stations were adopted to allow blinding of each research assistant regarding the data measured in the other stations. All research assistants attended a one-week training program to improve their skills regarding anthropometric measures of body fat. All measurements were performed inside the selected schools using light-weight easily movable devices and tools. A digital weight measuring device was used to assess weight, while a large paper ruler was used to assess height (after being fixed to a wall). The participant was asked to remove shoes and stand on the weight measuring scale. After recording the weight, the participant was asked to stand with back against the paper ruler attached to the wall for detecting the height. Stretching standing height (measured to the nearest cm) was recorded by asking the participant to stand erect as much as possible (Al-Agha et al., 2016). This type of height measure has the advantage of being consistent through different times of the day (Riolo et al., 2005).

A flexible rubber measuring tape was used to assess waist and hip girth in cm. From the standing position, waist circumference was measured at the level of the midway between the last rib and iliac crest (measured during relaxed expiration). The hip girth was measured at the level of the widest area of the hip region (Marfell-Jones et al., 2012). Abdominal skinfold thickness was measured at a point located 5 cm to the right of the umbilicus. The detailed description of the anatomical landmarks and methods of measuring skinfold thickness were reported previously in the international standards for anthropometric assessment (Marfell-Jones et al., 2012). A plastic-made 6-cm skinfold caliper was used to assess the abdominal fold and the results were recorded in mm. Waist hip ratio (WHR) was determined by subdividing the value of the waist girth by that of the hip. This measure accurately determines the central obesity (Marfell-Jones et al., 2012). BMI was calculated by subdividing the weight in kg by the squared height in m (Hussien et al., 2017).

Statistical analysis

Data were analyzed using the Statistical Package for Social Science (SPSS Inc., Chicago, IL, USA) version 20. Shapiro-wilk test was used to test the normal distribution of data. Means, standard deviations (SDs), and percentages were used to express the results. Chi squared analysis using Cramer's V test was used to assess the significance of the association between categorical variables. Odds ratio was calculated to determine the magnitude of risk associated with each factor. Point-biserial correlation was used when one variable was continuous and the other was dichotomous. The differences were considered significant at $p < 0.05$.

3. RESULTS

This study was conducted on a sample consisted of 549 female students between 7 and 12 years of age. Based on measurements of BMI, the entire sample was classified into two groups: non-obese (BMI<25 kg/m^2) or obese (BMI ≥25 kg/m^2), (Aljabri & Bokhari, 2014). 399 participants (83%) fall into the non-obese category while 155 participants were categorized as being obese giving an overall prevalence of obesity 27% of the female students in this study (Table 1). Overall, there was a trend toward increasing prevalence of obesity among older children as shown in Figure 1. The average weight (in kg), height (in m), and waist girth (in cm), waist-hip ratio, and abdominal SFT (mm) measures were higher in the obese compared to the non-obese group (Table 1). The mean age of the study population was 9.04±2.03 years with 8.69 ± 1.99 for the non-obese group and 10.02 ± 1.7 for the obese group.

Table 1 Mean ± SD for personal characteristics and continuous outcome measures

	Non-obese (n=399) 83% Mean ± SD	Obese (n=155) 27% Mean ± SD
Age (year)	8.69 ± 1.99	10.02 ± 1.7
Weight (kg)	26.9 ± 6.58	46.03 ± 12.3
Height (m)	1.26 ± 0.11	1.36 ± 0.12
BMI Z score (w/m^2)	19.59 ± 2.52	29.14 ± 4.57
Waist girth (cm)	63.64 ± 8.22	78.47 ± 8.57
Waist-hip ratio	0.93± 0.155	0.945 ± 0.32
Abdominal SFT (mm)	6.01 ± 3.34	9.31 ± 3.27

n, number; %, percentage within the total sample; SD, standard deviation; kg, kilogram; m, meter; w, weight; cm, centimeter; SFT, skinfold thickness; mm, millimeter

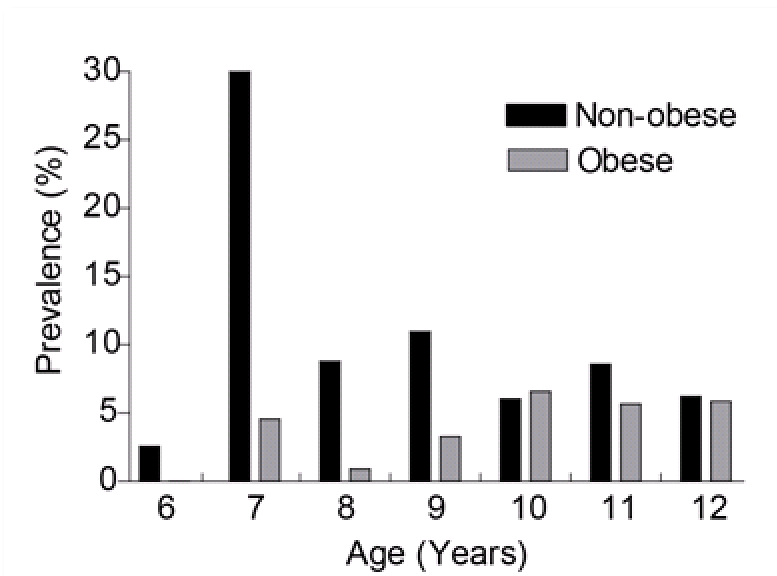

Figure 1 Distribution of obesity based on body mass index (BMI) per student's age.

Using the BMI as an indicator of obesity, the findings revealed that there was a weak significant (p=0.03) positive correlation (φ_c=0.1) between the consumption of chocolate and sweets and the prevalence of obesity. Incorporating chocolate and sweets in the diet regime increases the likelihood of developing obesity by 1.8 times, while the consumption of fast food and soft drinks increases the risk of obesity by 1.5 and 1.04 times, respectively (Table 2).

Table 2 Results of Chi-Square (Cramer's V test) and Odds ratio for the correlation between obesity and different factors

Risk factors	BMI category non-obese/obese				
	φ_c	P	OR	95% CI for OR	
WTV	0.04	0.35	0.83	0.57	1.22
FFC	0.06	0.16	1.53	0.83	2.79
SDC	0.01	0.81	1.04	0.69	1.57
GVC	0.04	0.28	0.78	0.49	1.22

CSC	0.10	0.032	1.84	1.04	3.23
AL	0.04	0.29	0.79	0.52	1.21

WTV, watching TV while eating; FFC, fast food consumption; SDC, soft food consumption; GVC, green vegetable consumption; CSC, chocolate and sweets consumption; AL, activity level; BMI, body mass index; $\varphi_{c,}$ cramers association; p, significant value, OR, odds ratio; CI, confidence interval

There was a weak but significant correlation between watching TV while eating and the girth of the waist (r_{pb} = .20, p < .00). Another significant weak correlation was also observed between fast food consumption and waist girth (r_{pb} = .11 p = .04). On the other hand, weak significant negative correlations were observed between soft drink consumption and WHR (r_{pb} = -.10, p = .03), chocolate and sweets consumption and thickness of the abdominal skin fold (r_{pb} = -.12, p <.00), and the activity level and the thickness of the abdominal skinfold (Table 3).

Table 3 Point-biserial test results for the correlations between anthropometric measures and different factors

	WTV	FFC	SDC	GVC	CSC	AL
Waist	r_{pb} = .20 p < .00	r_{pb} =.11 p = .04	r_{pb} = .059 p = .17	r_{pb} = - .017 p = .68	r_{pb} =-.005 p =.89	r_{pb}= -.018 p = .68
WHR	r_{pb} = 0.084 p =.05	r_{pb} = 0.052 p=.22	r_{pb} = .10 p = .03	r_{pb} =.023 p = .59	r_{pb} = .012 p=0.77	r_{pb} =-.044 p=.30
Abdoinal SFT	r_{pb} = .056 p=.18	r_{pb} = - .047 p= .27	r_{pb} = .059 p= .17	r_{pb} = -.060 p= .16	r_{pb} = -.12 p< .00	r_{pb} = -.16 p < .00

WTV, watching TV while eating; FF, fast food consumption; SD, soft food consumption; GVC, green vegetable consumption; chocolate and sweets consumption; AL, activity level; WHR, waist-hip ratio; r_{pb}, point-biserial correlation.

4. DISCUSSION

The current study aimed at exploring the prevalence of obesity among school-age girls in Ha'il, Saudi Arabia, and to determine the risk factors that may lead to obesity in this age range. Anthropometry measures, specifically BMI, have long been used as an indirect indicator of obesity due to the non-invasiveness nature of the measure as well as being financially convenient. The current study used BMI as an indicator of obesity, However; BMI when used alone as an indicator for obesity poses certain limitations and therefore we sought to include other measures such as waist and hip girth, waist-to-hip ratio, and skinfold thickness. The findings of the current study reveal that 27% of the female children aged 7-12 years old demonstrated above normal BMI values, while 85% demonstrated above normal WHR.

Comparing the prevalence estimates reported in the current study with those of other previous studies from Saudi Arabia and particularly Ha'il city is difficult due to differences in the age range studied and the standard reference and cutoffs used to classify obesity (WHO or CDC). An extensive review of the literature showed that the prevalence of obesity among children in Saudi Arabia ranges from 6 to 23.3% across different regions of the country (Al-Dossary et al., 2010; Al-Hussaini et al., 2019; Al-Shammari et al., 2001; El Mouzan et al., 2012; El Mouzan et al., 2010). Moreover, Al Shehri et al (2013) reviewed existing literature concerning the prevalence of obesity among Saudi children. Obesity was found to affect 9.3% and 6% of school-age and preschool Saudi children, respectively. However, this review demonstrates a lack of studies assessing the prevalence of obesity and associated dietary habits and risk factors among children in the Ha'il region. In the Northern province, where Ha'il is located, El Mouzan et al. (2012) demonstrated that the prevalence of obesity among children aged 2 to <13 years of age was significantly lower (7.8%) than our prevalence value (27%).

The findings of the current study showed a higher prevalence rate of obesity compared to a previous survey conducted in 2015 among female students aged 10-18 years in Ha'il region, which found that 35% demonstrated above normal BMI values (Farshori et al., 2015). The findings of the current study and those of Fashori et al. (2015) together demonstrates an increasing trend of obesity among children in Ha'il when compared to values (7.3%) reported by El Mouzan et al. (2012) which included children from the Northern province. Comparing the findings of the current study with those from different regions of Saudi Arabia also confirmed the rising trend of obesity in Saudi Arabia. Specifically, the rate of obesity among Saudi Arabian children has increased by 5.5 percentage points in the period from 2006 to 2015 (Al-Hussaini et al., 2019). Children between the ages of 2 and 18 years old in Jeddah city in Western province of Saudi Arabia showed a higher prevalence rate of obesity (85% demonstrated either obesity or severe obesity values) compared to the current study (Al-Agha et al., 2016). In a multi-center school-based study that included 2908 participants between 14-19 years of age in three different cities Al-Khobar, Jeddah, and Riyadh, Al-Hazzaa et al. (2014) reported that more than 34% of female participants were obese. Al Shehri et al. (2013) reported prevalence rates of obesity in different regions of Saudi Arabia. The highest prevalence rates were reported in the eastern and middle regions, while the lowest rate was reported in the southern region.

Due to the complex nature of obesity, many behavioral risk factors might contribute to its onset. The current study reported an increased risk of obesity among children who consume chocolate, sweets, fast food, and soft drinks. Watching TV while eating and fast-food consumption was associated with increased waist girth. Consumption of soft drinks was associated with high WHR. Moreover, chocolate and sweet consumption and the activity level were associated with increased thickness of abdominal subcutaneous fat (skinfold thickness). Alazzeh et al. (2018) reported a negative association between obesity and exercise, regardless of the exercise duration, in male children living in the Ha'il region, this is in contrast to the findings of the current study where the level of activity was not associated with the onset of obesity. Moreover, Alazzeh et al. (2018) study reported a significant association between obesity and family size, economic status, work of the mother. The gender-variations between the Alazzeh study and the current one might contribute to the differences between the two studies.

Previous study including male children in Tabuk city found that children who spent a long duration of TV-watching per day and consume fast food were considered at high risk of obesity (Elbadawi et al., 2015). This environment stimulates what is called unconscious eating, where the child eats large quantities of food while his concentration is on the TV (Al-Agha et al., 2016). Al-Agha et al. (2016) found a significant correlation between using electronic devices for more than 2 hours per day and obesity. This study used the BMI standard deviation as an indicator of obesity. In the current study, watching TV was correlated with the girth of the abdomen.

Surprisingly, the current study reported no correlation between chocolate consumptions and BMI, however, a negative correlation was reported between abdominal fat and the consumption of chocolate and sweets. In a recent study, dark chocolate has been found to fight the gaining of weight through different mechanisms (Farhat et al., 2014). This effect may be related to the type of chocolate and sweet gradients (Dorenkott et al., 2014). The response of each individual to the exposure to obesity-related risk factors might differ and could be influenced by multiple behaviors that are hard to consider in a single study. Psychological status (Rankin et al., 2016), duration of sleep (Kong et al., 2011), feeding before bedtime (Burt et al., 2014) are examples of these behaviors.

From the findings of the current study along with studies in the literature show widely scattered prevalence rates of obesity in different regions in Saudi Arabia as well as globally. These variations might be explained by the differences in measures that can reflect obesity such as BMI, various anthropometric measures (WG, WHR). Each of these measures cannot give, if used alone, a complete picture of the distribution of fat within the human body which may underestimate the prevalence of obesity.

Study limitations

The main limitation of the current study is the nature of its design, being a cross-sectional; this study cannot provide causal-effect results. Consequently, the results of the current study should be taken with caution. Other limitations include the limited number of participants as well as the small number of risk factors covered. In addition, many of the variables were based on self-reports, which may affect the reliability of the data. The major strength of our study was the sampling method and the targeting students inside schools where the sample could be representative.

5. CONCLUSION

The current study demonstrated that 27% of female school-aged children are classified to have obesity based on their BMI values. The adverse effect of obesity on health, psychological well-being, and economic burden is well established. The findings of the current study encourage the implementation of health education campaigns to increase the level of awareness regarding healthy food choices and physical exercises among children.

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Author's contribution

Hisham M. Hussein	Construction of the idea, scientific writing, collecting data, statistics, and revision of the final version
Ali A. Almishaal	Construction of the idea, scientific writing, editing of the final version
Saud M. Alrawaili	Construction of the idea, statistics, revision of final version
Ahmed A. Ahmed	Construction of the idea, scientific writing, collection of the data, revision of the final version

Ehab M. Kamel Construction of the idea, scientific writing, collecting data, and revision of the final version

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Conflict of interest
The authors declare that there are no conflicts of interests.

Informed consent
Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

Ethical approval
The study was approved by the Institutional Ethics Committee of University of Ha'il (ethical approval code: H-2020-160).

Data and materials availability
All data associated with this study are present in the paper.

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