ABSTRACT

Title of Document: FACTORS ASSOCIATED WITH OBESITY AND PERCEIVED BARRIERS TO WEIGHT MAINTENANCE AMONG SAUDI WOMEN OF REPRODUCTIVE AGE IN JEDDAH CITY.

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The prevalence of obesity is significantly higher in Saudi women (33.5%) than men (24.1%), however, the information surrounding the risk factors of obesity and barriers to maintaining a healthy weight among Saudi women of reproductive age is deficient due to the limited number of studies that assessed obesity among them. Using a representative sample of 15-49 years old Saudi women attending Jeddah Public Health Care Centers (JPHCCs), this study aims to (1) identify obesity risk factors, (2) explore the barriers to maintaining a healthy weight, and (3) explore the obesity rates and physical activity (PA) levels. A cross-sectional study was conducted in 2014 using a stratified two-stage cluster sampling design comprising 408 Saudi women attending 12 JPHCCs. Body mass index (BMI) and waist circumference (WC) data also were obtained. Data were collected using a structured questionnaire consisting of socio-demographic factors, eating habits (EHs), PA, and perceived barriers to weight maintenance. Of the 408 women evaluated, 33.8% were obese (BMI ≥ 30 kg/m2), 25.1% were abdominally obese (WC ≥ 88 cm), and 31.2% were physically inactive. Age, family history of obesity, and EHs were significant risk factors for both general and abdominal obesity. A high proportion of women faced great barriers in maintaining their weight related to healthy eating (HE) or PA (49.2% versus 50.7%). The most common barriers to HE and PA in the study group were a lack of willpower, skills, knowledge, enjoyment, time, resources, and social influence. Social norms and hot weather had a great impact on the women's PA level. There was a positive significant association between EHs and PA level and between HE and PA barriers, but no significant associations were found between barriers to maintaining weight and either type of obesity. An intervention program to combat obesity is thus greatly needed, especially one that focuses on eliminating the identified obesity risk factors, and barriers to maintaining a healthy weight.

FACTORS ASSOCIATED WITH OBESITY AND PERCEIVED BARRIERS TO WEIGHT MAINTENANCE AMONG SAUDI WOMEN OF REPRODUCTIVE AGE IN JEDDAH CITY.

By

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Dedication

To my spiritual father whose words and deeds have always driven my life.

To my family and friends for their prayers and encouragement.

To my devoted sister Noura, who inspired me to attempt and follow my dreams.

To my dearest sisters Rwida and Rehab, who have never left my side and prayed for my successes.

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Chapter 1: **Introduction**

Obesity, an increasing worldwide trend, constitutes a major health problem (1). The prevalence of obesity is generally higher among women than among men (2). Similarly, the prevalence of obesity in Saudi Arabia has increased, and it is significantly higher in women than men. Based on the latest Saudi National Health Survey (2013), the prevalence of obesity in Saudi Arabia for those 15 years of age and older was significantly higher among women (33.5%) when compared to men (24.1%) (3). Another Saudi National Nutrition Survey found a higher rate of obesity among 18-60 years old women (23.4%) than men (14.2%) (4). An earlier study conducted in Jeddah City (1994), the most urbanized city in the western part of Saudi Arabia, indicated high rates of overweight/obesity (64.3%, BMI ≥ 25) among 11- 70 years old Saudi women, attending primary health care centers (PHCCs) in Jeddah City (5). The prevalence of overweight and obesity (52.6%) among 16-45 years old Saudi women of reproductive age in Riyadh City, Saudi Arabia (6) was similar to 15-49 years old women in the United States (51%) (7).

Obesity is a serious, chronic disease that can have a negative impact on women's health. A recent Saudi health survey revealed that Saudi women (15 years of age and older) have high rates of non-communicable diseases (NCDs) such as diabetes, hypertension and hypercholesterolemia (40% of the study sample between aged 15-24 years old). It found 11.7% of women had diabetes, 12.5% hypertension, and 7.3% hypercholesterolemia (8). It is important to monitor and address adverse weight transitions among women in the reproductive age stage, as these transitions will have adverse effects not only on women's short- and long-term health but also on the health of their children (9). The adverse effects that may be experienced by obese women during pregnancy and delivery are: pregnancy-induced hypertension and preeclampsia, gestational diabetes, urinary tract infections, venous thromboembolism, as well as the necessity for induced labor and cesarean delivery. Additionally, maternal overweight and obesity are significantly associated with a greater risk of pre-term delivery, stillbirth, perinatal death, fetal macrosomia, and fetal birth defects (10). Though, as most studies in Saudi Arabia have focused on the male population, children, adolescents, and women in their college years (under the age of 24 years), existing literature in Saudi Arabia focusing on the prevalence of obesity and related risk factors among Saudi women of reproductive age is lacking.

Obesity has become a common issue among Saudi women due to different factors, such as socio-demographic and lifestyle factors (e.g., age, socioeconomic status, marital status, parity, eating habits (EHs), and physical activity (PA) (3- 5, 11-13). Among Saudi women (16 years of age and older), the latest Saudi National health survey found the risk of obesity increased with age, marital status, history of chronic conditions (3). In Jeddah City, Western Province of Saudi Arabia, Khashoggi (1994) found five variables were significant predictors for women's obesity (11-70 years): age, marital status, number of servants, childbearing, and parity (5). Among women of reproductive age (15-45 years), Al-Malki (2003) indicated a positive correlation between age and weight, and age and BMI (6). A significant difference was observed in the results of single (never married) and married women, particularly those who were students; among the single women only 20.5% were overweight, 9.12% were obese, while in married women the frequency increased to 43.0%, and 29%. A number of studies in Eastern Mediterranean

Region (EMR) countries have shown that the employment status of women is significantly associated with weight gain (6). These studies showed that working women were less likely to be overweight than non-working women. Furthermore, the rate of obesity in unemployed Saudi women was 79%, compared to 53% in employed women (14).

Family history of chronic disease offers valuable genomic information and environmental risk factors. Biologically related individuals not only share their genomic information, but often share behaviors, beliefs, lifestyle, culture, and physical environments (15). The increasing risk of obesity has been observed among individuals who have a positive family history of chronic diseases (13, 17-21), and they are more likely to develop these health problems if they are obese (22, 23). Therefore, identifying individuals with a positive family history of chronic diseases and monitoring of obesity and other health condition risks, would be desirable to implement interventions to lower risks of developing common chronic diseases in the future (20, 22).

During the past four decades, EHs in Saudi Arabia have changed markedly, with the changes in lifestyle and reduced PA behaviors. In fact, Western fast food, which has high levels of fat, sugars, sodium, and cholesterol, is now being consumed in large amounts (14, 24) Moreover, the Saudi National Nutrition Survey disclosed that eating unhealthy foods (e.g., fried foods, fewer fruits and vegetables) and high-calorie snacks (e.g., cake, donuts, or chips) is becoming a common practice among Saudi people (4).

Sedentary lifestyles and patterns of PA are risk factors associated with obesity. Saudis with increased urbanization, availability of cars, traffic, involvement in office work, and extreme weather, all make PA a difficult choice for Saudis (25, 26). According to data from the Saudi National Health Survey (2013) (3), the prevalence of physical inactivity was high among the Saudi population (15 years of age and older), revealing significantly higher levels of inactivity in women (75.1%) than men (47.0%). Such levels of inactivity could be caused by the numerous challenges Saudi women face to being physically active, such as being prohibited from driving, requiring a guardian for commuting, wearing an Abaya (an outer garment worn by Muslim women), or needing the family's permission to practice PA outside the home (such as walking in a public area or attending a fitness gym) (27). However, information on the levels of PA and other lifestyle practices in Saudi adult women is lacking, especially among women particularly at risk of weight gain, such as those of reproductive age.

Maintaining a healthy body weight is important for overall health and can help prevent and control obesity and many diseases and health conditions (28). Healthy eating (HE) and PA are vital strategies for losing and maintaining weight. The perceived barriers to increasing PA and improving HE that women face may vary according to their social and personal circumstances (29). Barriers are defined as factors that impede health-promoting behavior and include perceptions about the potentially negative aspects of changing. Health-promotion and disease-prevention literature have established barriers as important predictors of behavior change (30). Generally, weight management results from many impediments to PA and HE, including those related to personal (e.g., lack of willpower, knowledge, motivation, cooking skills, and exercise), social environmental (e.g., social influence, family support, and commitment), and physical environmental (e.g., lack of money, limited access to exercise facilities, and a hot climate) (31). Moreover, young women are more likely than older women to experience particular life events, such as leaving the family home, starting work, entering marriage, and becoming mothers, that may influence their PA and EHs (29). However, information on the levels of PA, EHs and related barriers in Saudi adult women is lacking, especially among women particularly at risk of weight gain, such as those of reproductive age.

In Jeddah City, only one study was found that was conducted in 1994, which investigated adolescent and adult Saudi women between the ages, 11 through 70, attending primary health centers in Jeddah City (5). This study is outdated and it is important to update the obesity statistics and to clarify the risk factors, especially among Saudi women of reproductive age living in Jeddah city. The other reasons for choosing Jeddah City for this study include the following:

a. The increasing population, location, urbanization, diversity, and influence of city life all make Jeddah City an important city in which to conduct research on obesity. Jeddah City is the largest city in the Makkah Province and with a population exceeding three million, and it is the second largest city in Saudi Arabia after the capital, Riyadh. Jeddah City is an important commercial center, and cosmopolitan of Saudi cities due to its historic role as port and gateway to the holy city of Mecca. Over more than a millennium, Jeddah City has received millions of pilgrims of different ethnicities and backgrounds, from Africa, Asia, Russia, Southeast Asia, Europe and the Middle East, some of whom remained and became residents of the city.

b. Jeddah City is much more ethnically diverse than most Saudi cities and its culture is more eclectic. This mixture of races has had a major impact on Jeddah's traditional food habits.

c. It is considered an important city in which to establish obesity prevention that other cities in Saudi Arabia can adopt, since their residents are more liberal than other residents in Saudi Arabia, and the women have greater freedom of movement, as the religious police are less active (32), and have the ability to change and adapt to new skills and behaviors.

Most of the existing studies in Saudi Arabia used BMI to measure the obesity levels and failed to incorporate WC measurements (3-6, 12). BMI remains one of the most widely used to assess total body fatness, and strongly correlated with the gold-standard methods {Dual energy X-ray absorptiometry (DEXA), and hydrostatic weighing} for measuring body fat (33-35). On account of its simplicity as a measure, it has been used in epidemiological studies and is recommended as a screening tool in the clinical practice assessment of obesity. Although BMI has been found to be a reliable indicator of total body fat, there are limitations to the use of BMI alone to assess for adiposity in clinical practice, particularly among adults with BMI ≥30 kg/m2 (36, 37). Because of these limitations of BMI, the WHO and several organizations suggest combining the measurements of BMI and waist circumference (WC) to assess obesity-related health risks. WC, which is highly correlated with cardiovascular disease (CVD) risk factors, has been shown to be a strong predictor of total body fat, adipose tissue (38-40), and obesity-related health risk (39). Therefore, the current study described the prevalence of obesity among women of reproductive age in Jeddah City, measuring by BMI and WC.

Rationale

This quantitative study is important and needed for several reasons. First, a lacking exists in the food and nutrition literature about the prevalence of obesity in Jeddah City (Saudi Arabia) women of reproductive age and the risk factors associated with this obesity. Second, obesity is a common phenomenon in Saudi women. Recent noted health issues associated with obesity highlight the increased need to address the problems associated with obesity. Third, this study will not only add new knowledge to this area of food and nutrition, but also provide information to social scientists, health care providers, educators, and policymakers for better understanding the needs of Saudi women, more specifically. Jeddah women. Fourth, prior obesity studies conducted in Saudi Arabia have used samples of women of college age in Riyadh and Abha cities, and mainly focused on the obesity risk factors in Saudi women of college age (under the age of 24 years), Saudi males, children and adolescents. This study was conducted in a large Saudi Arabian city, Jeddah City, the most liberal, urban, and diverse city in Saudi Arabia, where the prevalence of obesity is high, and Jeddah residents have the ability to change and adopt new behaviors. Moreover, this study was conducted at PHCCs, where the population women are more diverse than women in schools or in colleges. The sampling procedure aimed to select a representative sample of women who seeking services at PHCCs in Jeddah City. Finally, this study provides information for future researchers who wish to study obesity in Saudi women of reproductive age and the factors, and barriers associated with obesity in these women.

Study objectives

Using a representative sample of 15-49 years old Saudi women attending JPHCCs, the objectives of the current study are:

1. To identify how socio-demographic, parity, family history of obesity, EHs, and PA factors correlate with obesity assessed by BMI and WC in a representative sample of Saudi women attending JPHCCs.

2. To explore personal, social, and physical environmental factors that act as barriers to maintaining a healthy weight and how these barriers vary by socio-demographic status and weight status among study group.

3. To explore the obesity rates (assessed by BMI and WC) and PA levels, as well to evaluate the relationship between obesity measurements, family history of chronic disease (blood relatives), and practice of the PA using exercise equipment at home among study group.

Research Questions

The research questions for this study are:

1a. Are the socio-demographic, family history of obesity, parity, EHs, and PA significant predictors of obesity (obese or not obese) as measured by the BMI?

1b. Are the socio-demographic, parity, family history of obesity, EHs, and PA significant predictors of obesity (obese or not obese) as measured by the WC?

2a. Are there significant relationships among EHs and the perceived barriers for adopting healthy eating among Saudi women?

2b. Are there significant relationships among the level of PA and the perceived barriers to PA?

3a. Are the perceived barriers of healthy eating and the perceived barriers to PA significant predictors of obesity (obese or not obese) as measured by the BMI?

3b. Are the perceived barriers of healthy eating and the perceived barriers to PA significant predictors of obesity (obese or not obese) as measured by the WC?

4. Are there significant association between socio-demographic factors and the perceived barriers of healthy eating and the perceived barriers to PA?

5. What is the prevalence of overweight and obesity (measured by BMI) in the Saudi women attending JPHCCs?

6. What is the level of PA among the study group?

7. What is the prevalence of abdominal obesity using the WHO and Harmonizing WC cut-points in the Saudi women attending JPHCCs?

8a. Is there a significant difference between those who have a family history of chronic disease and those who do not (yes or no) according to the BMI (obese or not obese) among the study group?

8b. Is there a significant difference between those who have a family history of chronic disease and those who do not (yes or no) on waist circumference (WC) among the study group?

9a. Is there a significant relationship between ownership and use of physical activity equipment and BMI among the study group?

9b. Is there a significant relationship between ownership and use of physical activity equipment and WC among the study group?

Definition of Terms

The following definitions are provided to ensure uniformity and understanding of these terms throughout the study. The researcher developed all definitions not accompanied by a citation.

Reproductive age group – refers to the active reproductive years in women starting with menarche around 12-14 years and ending with menopause around 45-49 years. WHO identifies women of reproductive age between the ages of 15 to 49 years.

Adolescence age group – refers to the period in human growth and development that occurs after childhood and before adulthood. WHO identifies adolescence age from ages 10 to 19.

JPHCCs – Jeddah Public Health Care Centers.

BMI – is an anthropometric measurement to assess excess weight or obesity by dividing weight in kilograms by height in meters squared.

WC – Waist Circumference – is an anthropometric measurement to assess body fat that is placed around the waist.

Obesity – is an excess of body fat that may impair health.

Overweight – is excess in body weight.

Normal Weight – defined as subjects with a normal BMI (18.5–24.9 kg/m^2)

Healthy weight – for adults, is defined as the appropriate body weight in relation to height.

Socio-Demographic characteristic – is a word used to describe an element of a group within a society, such as age, sex, education level, income level, marital status, and occupation.

Parity – refers to the number of pregnancies of 24 weeks' gestation or more.

PA – physical activity – is defined as a bodily movement produced by the contraction of skeletal muscle that increases the energy expenditure above the basal level.

EHs – eating habits – is refer to the behavior of a person or a group of people in satisfying the need for food, which involves attitude, beliefs, and choice of food.

HE – healthy eating – is refer to a well-balanced diet which contains a lot of fruit, vegetables and dairy products, a good portion of starchy foods like bread, potatoes and pasta, a moderate portion of meat or fish, and not too much fat and sugar.

Barriers – are defined as factors that impede health-promoting behaviors and include perceptions about the potentially negative effects of changing.

Social influence – is defined as change in an individual's thoughts, feelings, attitudes, or behaviors that result from interaction with another individual or a group.

Social norms – are the rules for how people should act in a given group or society. Any behavior that is outside these norms is considered abnormal.

Chapter 2: Literature Review

1. Definition of Obesity

According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (1). Obesity has become a major public health problem and linked to several serious medical conditions worldwide, especially in developed countries, but the prevalence of obesity is also increasing in developing countries. In fact, one of the key factors accounting for this may be increased urbanization. The movement of populations from rural to urban ranges is associated with major changes in lifestyle, mainly the increased availability of calorie-dense foods and drinks. Obesity occurs when energy intake is greater than energy expenditure. Consequently, the surplus energy will be stored as fat in the adipose tissue (41). Overall, overweight and obesity are major factors that can impair health.

2. Classification of Overweight and Obesity

Overweight and obesity can be classified by the body mass index (BMI), and waist circumference (WC). These classifications help to further detail the problems of being overweight and obesity among women.

<u>2-1. Body Mass Index (BMI)</u>

BMI provides an approximation for an assessment of total body fat that is based on height and weight, regardless of gender. It is calculated as weight (kg)/height squared(m^2). Moreover, BMI is recommended and provides an acceptable approximation for assessment of total body fat for the majority of people, and monitoring changes in body weight. BMI is a widely used tool to screen obesity risk in several target populations as it is simple, inexpensive, and it is strongly correlated with the gold-standard methods (Dual energy X-ray absorptiometry (DEXA), and hydrostatic weighing) for measuring body fat (33-35).

For an adult (≥ 20 years), WHO (2008) defined overweight as a BMI of 25-29.9 kg/m^2, obesity as a BMI of 30 kg/m^2 or higher (**see Table 1.1**) (42). In contrast, overweight and obesity are defined in adolescents (15 to 19 years), based on an age- and sex-specific percentile for BMI. Consequently, overweight among adolescents is defined as BMI>85th and <95th age-specific percentile, and obesity as BMI >95th age-specific percentile value of WHO as the international anthropometrical reference. (43). Overall, BMI has proven to be an accurate measure of obesity and overweight in adolescents and adults.

Table 1.1. Classification of Overweight and Obesity by BMI and Waist Circumference, according to the World Health Organization for Adults (≥20 years), Obesity is Classified Associated Disease Risks.

			Disease Risk[a] Relative to Normal Weight and Waist Circumference	
	BMI (kg/m^2)	**Obesity Class**	**Men≤102 cm (≤40 in.) Women≤88 cm (≤35 in.)**	**Men>102 cm (>40 in.) Women≥88 cm (≥35 in.)**
Underweight	18.5		-------	-------
Normal[b]	18.5 – 24.9		-------	-------
Overweight	25.0 – 29.9		Increased[b]	Increased[b]
Obesity	30.0 – 34.9	I	High	High
Obesity	35.0 – 39.9	II	Very High	Very High
Extreme Obesity	≥40	III	Extremely High	Extremely High

[a] Disease risk for type 2 diabetes, hypertension, and CVD
[b] Increased waist circumference also can be a marker for increased risk, even in persons of normal weight.
Note: Adapted from Preventing and Managing the Global Epidemic of Obesity. Report of the World Health Organization Consultation of Obesity. WHO, Geneva, June 1997.

2-2. Waist circumference (WC)

The presence of excess fat in the abdomen is an independent predictor of risk factors and morbidity. “Abdominal fat can be divided into two major components: subcutaneous fat and intra-abdominal fat. Subcutaneous fat lies just below the skin and is outside the abdominal muscle wall, while intra-abdominal (visceral) fat is located inside the abdominal muscular wall and lies in between the organs or viscera" (44). A number of studies suggest that the visceral fat component of abdominal fat is most strongly correlated with health risk factors such as diabetes, hypertension, dyslipidemia (raised triglycerides and lowered high-density lipoprotein cholesterol), and coronary vascular disease (CVD). However, other studies indicate that the subcutaneous component is most highly correlated with insulin resistance.

The most accurate measurement techniques of abdominal fat content, magnetic resonance imaging and computed tomography, are expensive and not readily available for clinical practice. Research with these techniques, however, has shown that the WC correlates with the amount of fat in the abdomen, and thus is an indicator of the severity of abdominal obesity. Moreover, a high WC is associated with an increased risk for dyslipidemia, hypertension, type-2 diabetes, and CVD in patients with a BMI in the range between 25 and 34.9 kg/m^2.

WC cutoff points have been measured differently by various organizations. For instance, the National Heart, Lung and Blood Institute (NHLBI) and WHO categorize the risk of obesity-related diseases in adult (≥ 20 years old) as high if men have a WC greater than 102 cm (40 in), and women have a WC greater than 88 cm (35 in) (45). Whereas Harmonizing Criteria recommended that the WC cutoff points used to define abdominal obesity, should be different among different ethnic groups, and that these criteria can be used for the Middle East, the Mediterranean, which is similar to IDF criteria, until national data become available (46-48). Thus, this dissertation research compared waist circumference (WC) measured using WHO (WC>88cm) and Harmonized criteria

(WC>80cm), to determine if the results differed significantly, and provided an indicator of which standard of reference used in Saudi Arabia to determine the abdominal obesity prevalence among adult women.

3. History of Obesity Prevalence Among Saudi Women

In the past three decades, Saudi Arabia has undergone tremendous changes in lifestyle, including patterns of PA and eating habits. Such dramatic lifestyle changes are thought to have contributed enormously to the increase in obesity among the Saudi population. In fact, the rates of obesity show a corresponding gender difference in Saudi Arabia.

Based on the WHO classifications, the latest Saudi National Health Survey (2013) (15 years of age and older) found that women had a significantly higher rate of obesity (33.5%) when compared to men (24.1%) (3). Another Saudi National Nutrition Survey (18-60 years old) found a higher rate of obesity among women (23.4%) than men (14.2%) (4). The numbers reported from earlier studies in Saudi on obesity were significantly lower than the current records. Therefore, the Saudi population must change their lifestyles in order to reduce the prevalence of obesity.

A previous study was conducted to determine the prevalence of abdominal obesity and its associated risk factors, in currently married, non-pregnant women (438 women) aged 18-60 years, born and permanent residents in and around Abha, southwestern heights, the Kingdom of Saudi Arabia. This study showed that the prevalence of abdominal obesity was 41.1%, and the prevalence of obesity increased significantly with an increase in age of women and parity and decreased significantly with an increase in educational level, and insignificantly with an increase in vigorous PA

(11). To reduce the risk factors for chronic diseases as related to abdominal obesity, this research study investigated additional factors (socio-demographic, parity, eating habits, and physical activity) correlated with abdominal obesity in a cohort of Saudi women (15-45 years old).

In Jeddah City, only one study was conducted that studied adolescent and adult Saudi women which investigated women between the ages of 11 to 70 years and found that the prevalence of obesity was 64.3% (5). However, this study is outdated and only focused on studying how socioeconomic factors affected the prevalence of obesity among female patients, attending primary health centers in Jeddah. Hence, it is important to update the obesity statistics and to clarify the other risk factors that may relate to obesity among these women such as, eating habits, PA, and parity.

Another study that focused on adolescent girls was conducted to quantify the problem of overweight and obesity in adolescent girls (13-18 years old) in Jeddah City and to explore the determinants, with a view to informing policy. This study found that more girls tended to be significantly overweight than did boys (28.4% vs 24.8%; $P<.001$). However, there was no significant difference between boys and girls in the prevalence of obesity (11.2% versus 10.0%; $P<101$) and severe obesity (2.6% versus 2.1%; $P<.100$) (49). As important, this dissertation study investigated specific risk factors and barriers related to women of reproductive age (15-49 years old).

In women of reproductive age (15-45 years old), only one study has been conducted in Riyadh City to determine the prevalence of obesity and its risk factor in Saudi women of reproductive age (students and faculty's college) (6). In a group of 600 women the prevalence of overweight was 31.5% and obesity 20.86%. Overweight prevalence in each age group was greater among married females compared to single females. The obesity prevalence was significantly higher in the married females in the 16-20 years and 26-30 years age groups, while in the other age groups the prevalence of obesity was either the same or greater in the single females. Additionally, morbid obesity was more prevalent among the married females (>31-years old). The main limitation of this study was that it only examined the association between the overweight and obesity and two risk factors (age and marital status). Also, this study used one BMI cutoff (BMI≥ 30) to determine the prevalence of obesity among all age groups; adolescent and adult women. To address this limitation, this dissertation research used a different BMI cutoff for different age groups (adolescent and adult women) and study a number of obesity risk factors.

4. Health implications of obesity in women

Obesity is a serious, chronic disease that can have a negative impact on health, including diabetes, stroke, heart disease, hypertension, gallbladder disease, and certain cancers (50). There is also considerable evidence that obesity plays a significant role in the development of women-specific reproductive health issues, which have a significant impact on public health (51). Nearly 33% of reproductive-aged women in the United States are currently overweight or obese, placing them at elevated risk for adverse health outcomes. It is important to monitor and address adverse weight transitions among women in the reproductive age stage, as these transitions will have adverse effects not only on women's short- and long-term health but also on the health of their children (9). The adverse effects that may be experienced by obese women during pregnancy and delivery are: pregnancy-induced hypertension and preeclampsia, gestational diabetes, urinary tract infections, venous thromboembolism, as well as the necessity for induced labor and cesarean delivery. Additionally, maternal overweight and obesity are significantly associated with a greater risk of pre-term delivery, stillbirth, perinatal death, fetal macrosomia, and fetal birth defects (10, 51, 52).

A recent Saudi health survey revealed that Saudi women (16 years of age and older) have a higher prevalence of risk factors than most developing and some developed countries. Moreover, this survey indicated high rates of non-communicable diseases (NCDs) among Saudi women such as diabetes, hypertension, and hypercholesterolemia. It found 11.7% of women had diabetes, 12.5% hypertension, and 7.3% hypercholesterolemia (40% of the study sample between aged 15-24 years old) (8). El-Gilany (2010) found that obese Saudi women (pregnant women) were at increased risk of pregnancy-induced hypertension, gestational diabetes mellitus, preeclampsia, urinary tract infection, cesarean delivery, postdate pregnancy, and macrosomia. Moreover, babies born to obese women had an increased risk for a low Apgar score at birth and admission to NICU. Also in this study, the relative risk of pregnancy-induced hypertension was found to be 4.9 times greater among overweight and 6.1 times greater among obese women. The relative risk of gestational diabetes was 4.4 and 6.1 among overweight and obese women, respectively. The relative risk for preeclampsia among the study population was 3.8 for overweight women and 5.9 for obese women, and the relative risk for urinary tract infection was 1.4 and 3.7 in overweight and obese women, respectively. Also, this study found that the risk for cesarean delivery was doubled in obese women as compared to normal weight women (10).

A study conducted by Meher et al. (2009) showed similar findings when the researchers determined the frequency of obesity and its adverse effects on the reproductive outcome in pregnant Saudi females. Compared with normal weight mothers, both overweight and obese mothers had a significantly increased risk (p-value-<0.05) for gestational diabetes, preeclampsia, delivery of a macrocosmic infant, and caesarean delivery. The results showed much higher rates of cesarean sections in obese women as compared to those with normal weight (15–25% versus 4.8%). The rate of macrosomia remained significantly high in obese (7%) and morbidly obese (12%) as compared to the normal-weight female infants (0.96%) (52). Although there is a consensus that promotion of healthy weight status among reproductive-aged women is necessary and important, little is known about the factors that influence the progression from normal weight status to overweight and obesity. Accordingly, these factors were determined to assist with mitigating overweight and obesity in this population.

5. Factors associated with Obesity in Saudi Women

5-1. Socio-demographic factors

Obesity in Saudi Arabia is more prevalent in women living in urban areas and among those of higher socioeconomic status. For instance, Khashoggi et al. (1994) conducted a study that considered the socio-demographic factors affecting the rate of obesity among women whose ages ranged between 11 and 70 years in the Western Province of the Kingdom (Jeddah city). This study found that the prevalence of obesity was 64.3% and that five variables were significant predictors of obesity: age, marital status, the number of servants, childbearing, and parity (5).

Another study was conducted that researched the socioeconomic factors related to obesity. In a study conducted by Al-Malki et al. (2003), the researchers reported that there was a positive correlation between age and weight, and age and BMI among Saudi females of childbearing age (from 16-45 years old), who were students or on the faculty in college. A significant difference was observed in the results of single (never married) and married females, particularly those who were students. Moreover, among the single females only 20.5% were overweight, 9.12% were obese, while in married females the frequency increased to 43.0%, and 29%, respectively (6). As important, in this study, single women were younger than the married women, but the difference in the prevalence of overweight and obesity continued to be highly significant.

In another study conducted to evaluate the socio-demographic factors affecting the prevalence of obesity among female Saudi college students showed that obesity was present among 20.9% of the students, and a significant relationship between age, and social status (53). Moreover, Khalid (2007) reported that the prevalence of abdominal obesity increased significantly from 31.8% in Saudi women age < 40 years to 62.4% in those age ≥ 40 years (11).

A number of studies in the Eastern Mediterranean Region (EMR) countries have shown that the employment status of women is significantly associated with weight gain. These studies showed that working women were less likely to be overweight than non-working women. Furthermore, these studies also showed that the rate of obesity in unemployed Saudi women was 79% compared to 53% of employed women (14). Moreover, 55.9% of non-working women were obese, and the rest (44.1%) were non-obese. Consequently, these results may relate to the fact that working women are generally young and unmarried, and the community at work may possibly put pressure on them to take more care of their weight (54).

The socio-demographic factor of education can contribute to the prevalence of obesity. One study found that the educated women tend to overestimate their actual body weight (28.6%), while women with who less educated tend to underestimated (28.9%) their actual body weight. Additionally, a change in the concept of an ideal body image from the overweight female to that of the slim body was observed with advancing education (55).

In order to reduce the obesity epidemic among Saudi women of reproductive age in Jeddah City, effective interventions must address socio-demographic factors. However, the main limitation of these previous studies was that the researchers did not study all these socio-demographic factors together as predictors for obesity. Moreover, most of these studies assessed the correlation rather than indicating which factors were associated with or contributed to the obesity, among the various Saudi populations. Consequently, this dissertation study was conducted research to mitigate the limitations shown in the previous studies.

5-2. Family history of chronic diseases

Obese family members create an obesogenic household environment. Family history of obesity on one hand, may lead to a genetic predisposition for obesity, but on the other hand, may reflect behaviors in the family that may lead to a sedentary lifestyle (56). Al-Qauhiz (2010) found that the family history of obesity was one of the most significant contributors to obesity, and the presence of at least one obese family member had an odds ratio of 1.88 for obesity. Conversely, obesity risk decreased among female students on a regime and those with a large family size. As important, the presence of obesity among family members increased the risk of obesity by 2 to 4 times (13). This dissertation assessed the relationship between family history and different types of obesity including overall obesity and abdominal obesity in Saudi women of reproductive age in Jeddah City.

5-3. Obstetric factors

Pregnancy and multi-parity have been broadly reported as obstetric factors contributing to obesity among women. The fertility rate of Saudi women is very high and the spacing between pregnancies is short, resulting in an accumulation of fat in the body. Furthermore, some studies conducted showed that obesity was high among women with multiple pregnancies and parity (the births of five or more viable infants). These studies also showed that the mean BMI increased significantly with parity in Saudi women: 25.1 in nulliparous women, increasing to 27.1, 29.8 and 31.7 in women with parity 1–2, 3–4 and >4, respectively (11). This research investigated whether the parity remained significantly associated with the BMI and WC, when it was studied with other factors, such as socio-demographic factors, eating habits, and physical activities.

5-4. Changes in eating habits and behaviors

During the past four decades, eating habits in Saudi Arabia have changed, markedly, with the changes in lifestyle and reduced PA behaviours. In fact, Western fast-food, which has high levels of fat, sugars, sodium, and cholesterol, is now being consumed in large amounts. These fast-foods are increasingly replacing the traditional Saudi diet, which is normally high in fiber, low in fat, and low in cholesterol and includes such foods as dates, milk, fresh vegetables and fruits, and whole wheat bread (14, 24).

Moreover, the National Nutrition Survey, a cross-sectional study to establish the nutritional status of the Saudi population, disclosed that eating unhealthy foods (e.g., fried foods, less fruits and vegetables) and high-calorie snacks (e.g., cake, donuts, or chips) is becoming common practice among Saudi people (4).

The trend in the energy and protein availability of the national food supply from 1961 to 2007 was compared to the national average per capita requirement (2100 kcal per day; 53 g protein per day) as estimated before. Since then, though, there emerges an increased surplus of calories available per capita per day, from 7% in (1976-1978) to 69 % in 2005-2007, while a surplus of protein supply per capita per day increased from 18% in 1976-978 to 80% in (2005-2007). In 2007, the average consumption per person per day of calories and protein was 3144 kcal and 88.1 g, respectively (57). Also, fat consumption has increased; fast-food restaurants are widespread and processed food has become a major ingredient in every meal. Over the same period, daily per capital fat intake showed a remarkable increase of 143%. It is possible that changing food habits, the high consumption of foods rich in calories and fats as well the prevalence of sedentary lifestyle among Saudi people played an important role in the rise of overweight and obesity (14).

Eating behaviors can contribute to the prevalence of obesity. Al-Qauhiz (2010) conducted a study in Riyadh city to explore the BMI distribution among university female students and to assess food consumption patterns and health-related behaviors. In this study, 48.2% of female students reported eating three meals/day, while 41.2% of students skipped breakfast. Moreover, snacking was reported by 98.9%, and fast-foods were the main items in snacking; soft drinks (e.g., Coke, Pepsi, or Seven Up), coffee, chocolate, potato chips, and pastry were all consumed in abundance. The daily consumption of coffee and tea were 75%, while the daily consumption of soft drinks and chocolate were 43.4%, and 39.9%, respectively. In addition, more than a fifth of the students reported daily eating of potato chips (24.5%) and pastry (22.1%). Only some of the participants reported not eating outside their houses (3.8%), whereas the frequency of eating out three meals or more/week was reported by 37.3% and 58.9% reported eating out 1 to 2 times/week. This study also demonstrated high consumption of meat, rice and bread 49.4%, 47.3%, and 30.4%, respectively. Only 29.5% of the students were drinking a cup of milk/day. The consumption of fruits and vegetables were 2 to 3 times/day being 7.4% and 9.8%, respectively. In total, 12.8% of students reported eating eggs once daily (13).

Eating and exercise behaviors can be associated with obesity and overweight. A case-control study was conducted to examine the differences in eating and exercise behavior among obese and non-obese females from an urban health center in Saudi Arabia. This study indicated that the obese women were significantly more likely to eat under emotional conditions of anger and stress, in secrecy, and pampered themselves in binge eating ($p<.05$). In addition, frequent snacking and drinking of sodas was more common as well in the obese group compared to the control group ($p<.05$). A poor association was detected about nibbling at food without being aware, and favoring sweet foods compared to savory ones by the obese ($p<.1$). Other eating antecedents in common demonstrated that the obese were less likely to eat at selected times and more often indulged in eating while watching TV. There was a difference in eating behavior patterns with obvious variations within the obese group. The severely obese groups chose to skip main meals more frequently ($p=.08$), mainly the breakfast meal (62.5%). On the other hand, as a result of fewer main meals, the severely obese group indiscriminately snacked more and ate in secrecy (58).

Though most of these studies investigated daily eating habits, nutritional status, and food consumption on a high level, it may be useful to perform a more detailed investigation of specific eating habits and eating behaviors. To mitigate the limitation of prior studies, this dissertation research study investigated and provided extensive information about specific eating and behavior habits, and food consumption. For example, this dissertation research study provided additional information about healthy and unhealthy eating habit practices among women of reproductive age, responses to eating (hunger or emotional conditions), who usually cook meals at home and purchase the family foods, what types of foods are usually consumed (traditional food, American fast-food, local fast-food, etc.), whether study participants eat alone, and if meals are consumed late at night. Overall, performing research in these areas will add to the body of literature on eating habits contributing to obesity in Saudi women and assist with developing programs to mitigate some problems of obesity.

5-5. Sedentary lifestyle and patterns of physical activity factors

Urbanization and modernization have mainly contributed to the epidemic of obesity through a reduced level of physical activity (56). It is believed that reducing the burden of chronic diseases depends on controlling several modifiable risk factors, including physical inactivity. Truly, physical inactivity is considered a major risk factor for a number of chronic diseases, including cardiovascular diseases, diabetes mellitus, obesity, osteoporosis and certain types of cancer (59). On the other hand, the benefits of regular PA have been clearly set out across the lifespan and reduce the risk of both cardiovascular disease and all-cause mortality (60, 61).

The CDC defines physical activity "as bodily movement produced by the contraction of skeletal muscle that increases the energy expenditure above the basal level" (62). The most recent recommendations for PA from the CDC are that people of all ages should perform a minimum of 30 minutes of PA of moderate intensity all or most days of the week. Even with the well-known benefits of regular physical activity, it is estimated that over 60% of the world's population is not physically active enough to gain health benefits (56). Quantitative estimates at a global level indicate that sedentary living causes about 22% of ischaemic heart disease cases and about 10–16% of cases, each of diabetes mellitus and breast, colon, and rectal cancers (60). Furthermore, PA is the fourth-leading risk factor for global mortality, accounting for 6% of deaths globally and ranking before overweight and obesity (5%) and after high blood pressure (13%), tobacco use (9%), and high blood glucose (6%) (61).

Saudis with increased urbanization, availability of cars, traffic, involvement in office work, crowding and poor air quality in major cities, extreme weather, socio-culture barriers, (such as wearing the Abaya, or asking for a family's permission) and lack of resources (such as lack of money, limited access to exercise facilities, and safe neighborhood areas), lack of social support (such as lack of family and friend support, or social gatherings and obligations), and the lack of energy (such as fatigue and feeling tired), all make PA a difficult choice for Saudis (25, 26). According to data from the Saudi National Health Survey (2013) (3), the prevalence of physical inactivity was high among the Saudi population (15 years of age and older), revealing significantly higher levels of inactivity in women (75.1%) than men (47.0%). Moreover, a large population-based cross-sectional study on PA status of Saudis between the ages of 30 to 70 years showed that the prevalence of physical inactivity was very high (96.1%) among both sexes, based on 30 minutes or more of moderately intense PA for at least three times per week. There were significantly ($p < 0.001$) more inactive females (98.1%) than males (93.9%). Only 3.9% of Saudi males and 1.5% of females met CDC and American College of Sports Medicine (ACSM) recommendations for daily PA. Inactivity prevalence increases with increasing age categories, particularly in males, and decreases with increasing education levels (25). This is consistent with another study that found females were more physically inactive (87.6%), compared to the males (71.5%) (26). However, one study found that Saudi women were moderately more active than men (59). The data suggests that the high prevalence of inactivity, seen among Saudi population, represents a major public health concern.

Limitations in the previous studies about sedentary lifestyles and patterns of PA included the lack of information on how to perform the occupational and leisure activities, household domains, and how these activities affect body weight. Therefore, this dissertation study also provided more information about Saudi women PA in occupational and leisure activities, household domains, and lifestyles, and how these activities and behaviors affect their body weight. For example, this information included: (a) occupational, leisure and household activities; (b) where and when women prefer to usually perform PA; (c) the main reasons to do exercise; (d) the number of sleeping hours; (e) siesta habits; (f) media effects and celebrity stars appearance on women body image; and (g) the availability and use of exercise equipment at home.

6. Barriers to Weight Maintenance

Barriers are defined as factors that impede health-promoting behavior and include perceptions about the potentially negative aspects of changing. Health-promotion and disease-prevention literature have established barriers as important predictors of behavior change (30). The perceived barriers women face to increasing PA and improving diets may vary according to their social and personal circumstances. As well, young women are more likely than older women to experience particular life events (e.g., leaving the family home, starting work, entering a marriage, and becoming a mother) that may influence their PA and dietary habits (29).

Weight management is influenced by many barriers, including personal, social and physical environmental barriers (31). Personal barriers encompass a variety of internal thoughts and emotions that individuals identify as reasons why making behavioral changes are difficult, such as lack of willpower, lack of knowledge, lack of enjoyment, and lack of skills. Also, social relationships are barriers to weight management that occur when these relationships encourage unhealthy behaviors or discourage behavior change, such as lack of social support from families interfered with weight management. On the other hand, the physical environment in which Saudi women live has a great influence on their level of PA and their healthy food choices, such as limited access to exercise facilities, lack of money, or food availability (26, 30, 31). Thus, Saudi women face quite a few barriers to weight management.

6-1. Barriers to healthy eating (HE)

HE diet is important for controlling weight and for preventing or managing many chronic conditions. However, a HE pattern is not a rigid prescription, but rather an array of options that can accommodate cultural, ethnic, traditional, personal preferences, food cost and availability (63). A healthy diet is defined as “a well-balanced diet which contains a lot of fruit, vegetables and dairy products, a good portion of starchy foods like bread, potatoes and pasta, a moderate portion of meat or fish, and not too much fat and sugar. Moreover, the intake of a large amount of fluid is very important in a healthy diet” (64).

HE may be attempted by many people after receiving information or advice from different sources. Moreover, after experiencing health problems many people make or at least plan changes in their eating habits. On the other hand, many may revert to their previous eating habits because of the difficulties faced, and many others may not even try to change their eating habits because of anticipated difficulties or barriers (65). HE reflects a complex decision-making process influenced by numerous factors or barriers, including demographic, social, personal and emotional (66).

Studies have been conducted to research factors associated with barriers to HE. For instance, a cross-sectional study was conducted to determine the factors that were perceived to be important to HE among the European Union (EU) adults in which quote-controlled, nationally-representative samples of approximately 1,000 adults (aged 15 years old and up) from each country completed a face-to-face interview-assisted questionnaire. Findings demonstrated a great variability in perceived barriers to HE among EU countries. Lack of time was the most frequently mentioned difficulty among European Union subjects for not following nutritional advice (24% of EU sample). This barrier was frequently reported by the younger people and people of higher education. Other frequently reported barriers were giving up favorite food (23%) and willpower

(18%). Therefore, healthy diets did not appear to be viewed as an easy or attractive alternative to current diets. There was geographical variation in the number of subjects mentioning price as an important barrier to healthy eating (15% in overall EU sample) (65).

Studies have been conducted to research factors associated with barriers to adapting HE. For instance, Andajani-Sutjahjo et al. (2004) examined a range of perceived personal, social and environmental barriers to physical activity and HE for weight maintenance, among Australian young women (aged 18–32 years), and how these varied by socioeconomic status, overweight status, and domestic situation. This study suggested that a lack of motivation, time constraints due to work, and cost issues are the key perceived barriers to maintaining weight, faced by young women. Generally, these findings are consistent with other research that examined barriers to PA and HE. Findings also showed that young women tended to rate personal factors as key perceived barriers to PA and HE, followed by environmental factors, with social factors rated as less important. On the other hand, the physical environmental barriers (e.g., money, lack of recreation and sports facilities, and weather) were likely to be an important source of influence on obesity-related behaviors (29). Compared to other women, those living with children were the most likely to report a lack of social support for PA, and lack of support and time for HE, as key perceived barriers to maintaining their weight. Furthermore, young women who lived with their parents were the least likely to perceive these to be barriers to weight maintenance. The findings of this study are consistent with those of previous studies showing that getting married and having children are associated with decreased PA and greater weight gain (31).

Another quantitative study was conducted to explore how contextual factors such as social, cultural and economic factors influence Qatari women's participation in physical activities, dietary practices, and smoking, using a semi-structured questionnaire consisting of open-ended questions. Study participants included 50 Qatari women (aged 30 years and over) who were having a confirmed diagnosis of coronary vascular disease (CVD) (67). Findings showed that consumption of fatty and salty foods is one of the risk factors for CVD. Interviews revealed that the consumption of sugar, salt, and fat foods among the participants was high. Current studies also showed that the participants' dietary habits were highly influenced by the traditional cultural beliefs and values. Taste, color and appearance of foods were of great importance among Qatari and Arabic women. The participants identified that salt and oil play an imperative role in creating taste, color, and the appearance of their foods. Participants believed that the food would not taste as good if it has less salt and oil.

In Qatari culture, which is similar to Saudi culture, hospitality and the showing of generosity are principal to women's beliefs and values. It is a common practice for women to invite each other out to lunch or to gather daily in each other's homes to communicate, celebrate and share ideas. During these regular gatherings, social courtesy is extended by serving various kinds of foods and drinks such as fresh dates, sweets, and coffee. In these events, women often feel pressured to eat because the visitor's refusal to accept food and drinks may offend the hosts. These social activities can lead to unhealthy food choices for some women. In addition, eating out has become popular aspects of life in Qatar. It seems to have a significant impact on healthy dietary choices of Qatari women. Obviously, the participants' comments that people, especially the younger generation, usually eat outside their homes every Friday and Saturday. Participants indicated that social networks and activities have an important effect on the kind of diet and foods that are chosen.

Some Qatari women emphasized individual responsibility, believing that the individual is responsible for making her own healthy food choices. Another barrier that is associated with the Qatari women's inability to eating healthy foods, was a lack of motivation because eating healthy foods requires commitment. In spite of some culturally and socially negative influences on diet, participants also believed that women can encourage each other to adopt a healthier diet, by cooking healthier foods and inviting each other to taste foods (67).

A recent study was conducted by Al-Jaaly (2011) to quantify the problem of overweight and obesity in adolescent girls (13-18 years old) in Jeddah city and to explore the determinants, with a view to informing policy. This study indicated a strong association between a number of factors and weight status of Jeddah adolescent girls. These factors involved individual actors such as biological factors (e.g., age of menarche), EHs and lifestyle and environmental factors such as family influence, access to food and societal influence. Steps are needed to ensure compliance by parents, schools, dieticians and other health professionals and policymakers to make healthful food choices available, for Saudi adolescent girls (49).

Barriers to adopting HE and engaging in regular exercise can contribute to the prevalence of obesity. Al-Quaiz et al. (2009) conducted a study to identify barriers to PA and HE among Saudi patients attending primary health care clinics in Riyadh city, using a self-administered questionnaire “Barriers to Being Physically Active Quiz” that available on the CDC website. The ages of the 450 participants (144 males, 306 females) ranged from 15 to 80 years. In the current study, the main barriers to adherence to a healthy diet were the lack of willpower (80.3%) followed by the lack of social support (72.4%) and the lack of time (67.6%) and resources (60.2%). The lack of willpower was significantly higher among the middle-aged group (30-45 years) ($p=.029$) and among those ever married ($p=.013$). It seems that it is difficult to give up favorite foods and substitute with healthy foods, particularly if the individual is living with a family. Further, the social support was significantly higher among the middle-aged group ($p=.034$) and in those with less than a university level of education ($p=.010$). Large numbers of social gatherings with extended families interfered with adherence to a healthy diet. Moreover, lack of time and resources were barriers for healthy diet among the younger age group and those never married ($p<.001$). Busy lifestyles and a paucity of restaurants with healthy food choices have led the young women to consume fast-food (26).

The limitation of this study was that the "Barriers to Being Physically Active Quiz" questionnaire was designed to identify barriers to healthy habits among the American people, but not for Saudi people. Therefore, this dissertation research was conducted by identifying how conservative societies, Saudi cultures and politics, affect eating habits and PA of Saudi women (reproductive ages 15-49 years old) in Jeddah City.

In Jeddah City, society's values include family support and obligations, guarding permutations, prohibited from driving, customary foods, traditional clothes, accessibility to food shops and exercise places, and neighborhood safety. On the other hand, this dissertation study investigated the impact of lifestyle changes in these women's practices, such as eating and gathering out, ordering food for a special event or for dinner meals, and having housemaids cook foods. Additionally, this dissertation research also investigated the personal barriers to healthy lifestyles, such as hunger, appetite, taste, motivation, self-confidence, skill, beliefs and knowledge.

6-2. Barriers to physical activity

In the Arab countries, women are facing more barriers to engaging in regular physical activity than men because, in general, men have more freedom and access to places to play sports and partake in other recreational activities. In Bahrain, for instance, the main sociocultural barriers to practicing physical activities perceived by women were home commitments (49%), care of children (36%), and negative attitudes by family members towards women practicing exercise/sport (24%) (68). Similar to Bahrain women, Saudi women do not generally enjoy freedom and access to places to play sports and partake in other recreational activities.

There are many factors that prevent Saudi women from engaging in physical activity. For instance, Saudi women are prohibited from driving and require a guardian for commuting, which affects their activity/mobility for getting to and from exercise places and grocery stores. Also, some Saudi women are widely dependent on housemaids and this contributed to decreasing their house activities, such as cleaning and cooking healthy food (27). Exercise as a routine activity in life is not common because there are many social and culture barriers. Unfortunately, the physical exercise of any kind is forbidden in public girl schools. It is not acceptable for men and women to mix and only rich women can afford to go to women's exercise clubs. Moreover, the opportunities to attend children and adult health clubs for this purpose are also limited. Some fathers and husbands refuse to allow wives or daughters to go outside for jogging or walking. In addition, another barrier is that Saudi women have to wear the traditional cloth "Abaya," when walking or jogging in a public park because it is not culturally acceptable to remove it (58, 69).

Al-Quaiz (2009) conducted a study to identify barriers to PA and HE among patients attending primary health care clinics in Riyadh City. The main barriers to adherence to PA demonstrated in this study were the lack of resources (80.5%), the lack of willpower (76.8%), the lack of social support (76.8%) and the lack of energy (73.2%). The lack of resources was significantly higher in females than males (p=.05) and in the lower versus higher income group (p=.007). The participants with income less than 10,000 SAR/ month believed that lack of resources is a barrier because it is expensive for them to have a class or join a club or buy the right equipment. In addition, the lack of willpower and social support were ranked second as barriers to exercise. More than three-quarters of the study group (76.8%) had been thinking about getting more exercise and about the lack of social support. The lack of social support was significantly higher among females than males (p<.001). The lack of willpower was a result of the lack of self-motivation. The main motivators reported for exercising in the younger age group were fitness and fun, while in the older age group it was good health (26).

Ali et al. (2010) conducted a study to explore barriers and enablers to weight management of Emirati women at risk for type-2 diabetes. Data from focus group interviews in this study identified a number of personal, social and physical environmental barriers, including low social support from families, social norms (social gatherings involving eating and outdoor exercise restrictions), limited access to dietitians in the health care centers, lack of culturally acceptable exercise facilities, and hot weather. Lack of social support, low motivation, competing demands, lack of culturallysensitive exercise facilities and sociocultural norms that restrict outdoor PAs were the main barriers cited by the participants. Additionally, social support, such as having other women to walk with, helped them stay physically active. On the other hand, women in the study were generally aware of the health complications of excess body weight, such as numerous obesity-related chronic diseases, as well as its effect on normal daily activity, for instance, difficulties in movements when praying. Even with this awareness, most of the women were not engaged in regular PA or were not following eating patterns consistent with a healthy diet (31).

According to a study conducted by Donnelly et al. (2011) that explored how contextual factors such as social, cultural and economic factors influenced Qatari women's participation in PAs, dietary practices, and smoking, the majority of women believed that exercise was important to maintaining health, reducing weight and preventing cardiovascular diseases. Several women noted that the Qatar government has created various sports clubs throughout all regions of Qatar, in order to meet the needs of Qatari women. However, even though various recreational facilities are available and accessible, several women reported that some women remain physically inactive. These women related their inactivity to health problems that act as barriers to engaging in a more active lifestyle or other social support networks. Many women mentioned the importance of having family support and encouragement that influenced their decision to stay physically active. Moreover, other participants attributed the reason for their inability to engage in regular exercise to their busy schedules and home responsibilities, such as taking care of their family members. Other participant’s reasons put emphasis on individual responsibility in making the decision of whether or not to participate in PA.

These participants considered it a personal decision based on the individual's awareness of their health status (67).

Overall, performing research in these areas will add to the body of literature on barriers contributing to obesity in Saudi women, and the relationships among their eating habits and the perceived barriers to adopting healthy eating habits, as well as the relationships among their PA levels and the perceived barriers to engaging in regular PA.

7. Summary

The literature review of the health implications of obesity in Saudi women revealed the association of obesity and multiple adverse health outcomes for the mother and fetus, once a woman becomes pregnant. Consequently, there is a consensus that the promotion of healthy weight status among reproductive-aged women is necessary and important. Little is known about the factors that influence the progression from normal weight status to overweight and obesity. Thus, these factors needed to be determined to assist with mitigating overweight and obesity in this population. To eliminate the limitation of prior studies, this dissertation research investigated and provided extensive information about factors and barriers contributing to obesity in Saudi women. Consequently, this research assisted with the development of programs to relieve some problems of obesity and maintaining a healthy weight, particularly among women of reproductive age.

Chapter 3: Methodology

The main purposes of this study were: (a) To identify how socio-demographic, parity, eating habits, and PA factors correlate with obesity in a cohort of Saudi women 15-49 years old (reproductive age) attending Jeddah Primary Health Care Centers (JPHCCs); (b) To examine perceived personal, social and physical environmental barriers to maintaining healthy body weight in this cohort, as well as differences in these barriers related to socio-demographic factors and body weight status; and (c) To determine the prevalence of overall obesity (measured by BMI) and abdominal obesity (estimated by WC) among Saudi women of reproductive age attending JPHCCs. This chapter was focused on the methodology used in achieving the purpose of this study.

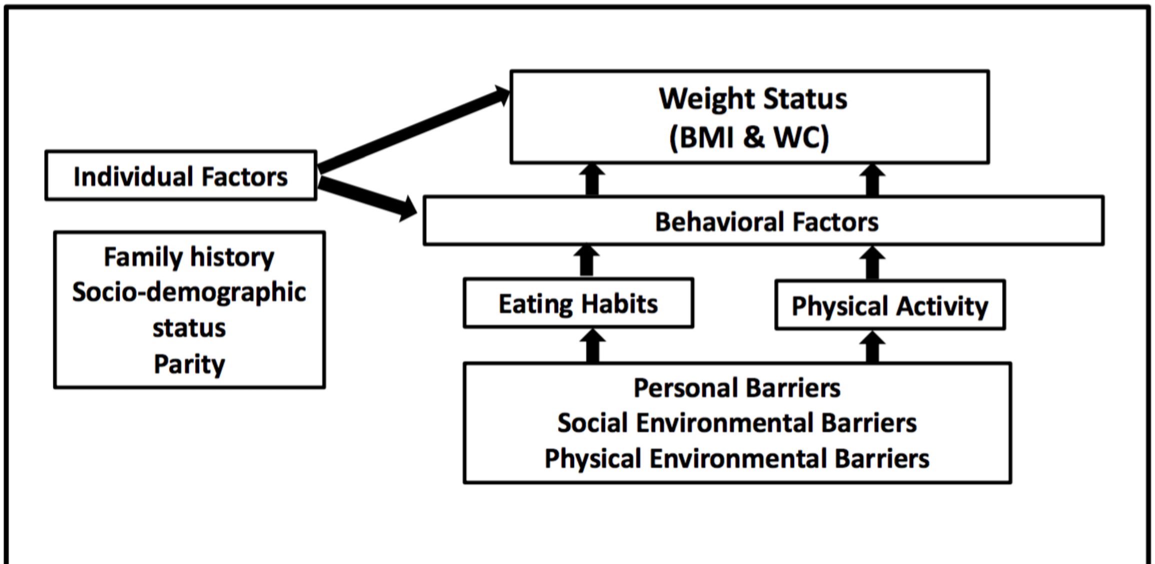
1. Research Design

A quantitative comparative and associational research design was utilized for this study (50). The study design was a cross-sectional study using a questionnaire developed by the researcher. There are many advantages and disadvantages of this observational study design. First, the design is useful for assessing theoretical differences and relationships to guide and build theory and practice. An often-overlooked benefit to any observational study design is it offers researchers the opportunity to investigate processes that would be unethical or impossible with a more sophisticated experimental approach. This is of particular concern for researchers in the social and behavioral sciences. The main disadvantage to any observational study design is that the researcher cannot imply cause-and-effect relationships.

2. Research Framework

The study theoretical framework to accomplish the research objectives was adapted from Robert Wood Johnson Foundation's Bridging the Gap program (RWJF) (**see Figure 1.1**). RWJF began studying the effect of environmental factors and their interaction with individual and social factors in affecting diet, PA, and weight status.

Figure 1.1- Study Theoretical framework



Note: Conceptual model for Robert Wood Johnson Foundation's Bridging the Gap Program. Reported of Centers for Disease Control and Prevention(www.cdc.gov/pcd/issues/2009/jul/08_0261.htm).

3. Research Setting

This research study was conducted in the city of Jeddah, which is located on the coast of the Red Sea and is the major urban center of western Saudi Arabia (71). Jeddah is the largest city in Makkah Province, the largest seaport on the Red Sea, and the second largest city in Saudi Arabia after the capital city, Riyadh, with a population exceeding three million.

There are 37 primary health care centers (JPHCCs) distributed in four health sectors according to its geographic location. These health sectors are in the northeast (Bryman), northwest (Al-salamah) health, southeast (Prince Abdulmajeed), and southwest (Al-balad) health sectors. Each PHCC services a catchment area with a defined population. The PHCCs cover a population of about 469,139 Saudi women, 49.6% of them are Saudi women of reproductive age (15-49 years old) (72). The PHCCs form a network that provides various components of primary health care such as promotional (the process of enabling people to increase control over, and to improve, their health), preventive, curative and rehabilitative services, including maternal and child health, immunization, management of chronic diseases (e.g., hypertension and diabetes), dental health, and pharmaceutical services, food hygiene, environmental health, health education, and disease control. Moreover, these PHCCs carry out population and family censuses within their catchment areas, maintain patient health files, survey schools in their areas and conduct routine home visits. The health centers are closely linked to the general hospitals, which in turn are linked to tertiary care services by a referral and feedback system (73,74). The average number of the Saudi women who attended the general clinic in each center was about 684women/month in 2011 (75).

4. Sample Selection and Size

4-1. Sample Size Justification

There are several ways to determine the sample size for a quantitative study. A common strategy is to determine the number of participants required to reach a specified level of statistical power for given fixed parameters (76,77). An a-priori power analysis was conducted to determine the number of participants required to detect a small effect of design ($f^2 = 0.1$) with power = .80 for a multiple regression with 15 predictors and hypothesis tests conducted at $\alpha = .05$. The analysis indicated a sample size of 201 would be sufficient. The power analysis was conducted with G*Power 3.1.4.

Design effect

Since this study's proposed sampling procedure was a cluster sample design that required more participants to obtain equivalent statistical power for a random sampling design, complex cluster samples such as the stratified two-stage cluster sampling design used here typically have sampling errors much larger than a simple random sample of the same size. In brief, observations on individuals within cluster samples tend to be correlated (non-independent), making the effective sample size less than the total number of individual participants. The loss of effectiveness by the use of cluster sampling, instead of simple random sampling, is measured by the Design Effect (DEFF), the sampling variance of an estimate accounting for the complex sampling design divided by the sampling variance of the same estimate assuming a sample of equal size had been selected as a simple random sample (78). DEFFs differ for different subgroups and different statistics; no single design effect is universally applicable to any given survey or analysis. Moreover, DEFFs have been examined for cluster sampling designs using simple estimators such as means, proportions, as well as for regression coefficient estimators. The reduction in effective sample size depends on average cluster size and the degree of correlation within clusters, known as the intra-class correlation coefficient (ICC). The ICC is the proportion of the total variance of the outcome that can be explained by the variation between clusters. To retain power, the simple random sample (SRS) should be multiplied by DEFF = (1+(m − 1) ICC), where m is the average cluster size, and ICC is typically in the range of 0.05 to 0.15 (79). A DEFF of one indicates that the sampling design is equivalent to simple random sampling. A DEFF greater than one indicates that the sampling design reduces the precision of estimates (increased the variance) compared to simple random sampling, and a DEFF less than one indicates that the sampling design increases precision compared (decreased variance) to simple random sampling.

The adjustment for clustering by multiplying the sample size (SRS) by the design effect stat is an adjustment for the mean. In this research, the interest is in regression coefficients, not mean measurements. In general, the design effect for mean tends to be larger than design effect for regression coefficients, though the design effect for regression coefficients remains larger than 1.0 (80). For this case, a conservative design effect for regression coefficients of 2.0 was applied to an SRS sample size (201), which indicated that a minimum of 402 women would be sufficient to accurately estimate results for the final sample. However, to select an equal number of the women from the selected health centers (12 centers), we increased the sample size to 408 (402 women/12 centers = 33.5 women≈ 34).

Clusters within each stratum (health sector) were selected with probability proportional to size (PPS) of women selected in fixed size samples (34 women) in each selected cluster. Through the two stages of selection, women within each sample (PHCCs) were selected with approximately equal probability. However, adjustments for differential nonresponse across groups of women were considered in the study. The sampling variances of regression coefficients accounting for the complex sample design were estimated using the Taylor series linearization method.

4-2. Sample Criteria

1. Inclusion criteria:
    a. Saudi women (who identified by national ID card) attending PHCCs in Jeddah City.

b. Age 15-49 years (reproductive ages).

c. Not currently pregnant or lactating (medical file, or asking a subject).

2. Exclusion criteria

a. Having serious diseases (e.g. organ failure, transplant, ascites, and cancer).

b. Having impaired-decision capacity or mental illness.

4-3. Sample Design and Procedures

The study sample was selected from four health sectors (strata) in Jeddah City, Saudi Arabia, that include 37 PHCCs (clusters). Decisions about appropriate sample sizes across strata were developed after a range of considerations, including the study's aims, the level of disaggregation, and the accuracy of the survey estimates. The representative sampling frame was based on data from the PHCC listing of the Department of Statistics in Jeddah Primary Health Care, Ministry of Health (Saudi Arabia) in 2011.

The study sample was selected using a stratified two-stage cluster sampling design with proportional allocation across strata. The sampling procedure aimed to select a representative sample of women who only seeking services at PHCCs in Jeddah City. PHCCs are the primary sampling units (PSUs).

Stage 1, clusters selection (PHCCs)

For the first sampling stage, the PHCCs were selected with probabilities proportional to their size (PPS) from the list of PHCCs in the survey area. This means that a cluster (PHCC) with more women attending had have a greater chance of being picked for the sample than a cluster (PHCC) with fewer women (81). The clusters were sampled without replacement, such that no cluster can be selected more than once in the same sample, unless the cluster was extremely large (**see Table 1.2**). The number of PHCCs in each health sector ranged from 6 to 13. This stage involved the selection of 12 out of 37 clusters. The cost model in this survey was unknown, which was required to calculate the optimal number of clusters that cost consideration. This led to the conclusion that the feasible sample size of 12 clusters. Selecting many clusters with fewer participants was better than selecting fewer clusters with more participants, keeping the design effect as low as possible and to minimize the sampling error for maintaining precision. In order to avoid overestimation of women selection, the number of clusters that represent each health sector was determined according to the proportion of women attendance in each health sector (stratum) (**see Table 1.3**).

To select PHCCs from the fourth health sector (strata), all clusters were listed across health sectors with their population sizes of women attending and ordered according to their geographic locations in each health sector. Then, a cumulative sum of the PHCCs sizes in all health sectors was calculated. A sampling interval (SI) was calculated as the cumulated total population (232, 568 women) divided by the number of clusters required (12 PHCCs) (SI=19,380.66667). To select the clusters, a random number was generated between zero and the sampling interval. Here, this random number (RN)=10374.46363, was chosen using the Excel RANDBETWEEN(0, 19,380.66667) function. The first cluster selected corresponded to the cumulative number that first exceed the RN. To select the second cluster, the sampling interval (19,380.66667) was added to the selected RN, and the PHCC whose cumulative population, which exceeds this number, was selected. To identify each subsequent cluster, the SI was added to the number for the previous cluster, until all 12 PHCCs were selected. (see Table 1.3). Since Alamir Abdulmajed health center, located in health sector 3 had the highest number of women attendance (23,751 women), it was selected twice and represented two health centers (clusters).

Stage 2, participants' allocation

The second sampling stage involved recruitment of women from the selected PHCCs (12 centers) to achieve the proposed estimated sample size (n=408). In this stage, the probability of any woman being selected was inversely proportional to the size of the cluster. Therefore, the probability of any woman being included in the sample across all clusters was equal for all women, because the unequal first-stage probabilities were balanced by the second-stage probabilities. That is the total sample size of 408 divided by 12 selected centers, giving (34) women from each center (**see Table 1.2**).

Within each PHCC, participants were selected by a systematic sampling procedure from the eligible women attending on days the sampling PHCCs (General Clinics) were visited. The sampling interval was determined by dividing the daily average number of women (n=90) who were attending the primary care clinic by the number of sample women (90/34=2.6 ≈3). The first woman participant who fulfilled the inclusion criteria was invited to enroll in the study. Then, every third attending woman who fulfilled the criteria was selected and soon until completion of the required sample from the PHCC was achieved. However, if a selected woman did not fulfill the inclusion criteria (exclusion criteria) or refused to participate in this study, then selection proceeded to the next sample woman attending the PHCC. The process was continued including women meeting the inclusion criteria. Some socio-demographic data (age, level of education, marital status, occupation, and economic status) were obtained from medical records for nonresponse-eligible women, who refused to participate in this study. These data was used for nonresponse analysis to determine the differences between those who chose to participate in the survey and those who did not.

Table 1.2. The number & the proportion of Saudi women attending the 4th health sectors in Jeddah City.

Health sectors	Total number of PHCCs in each health sector	Total number of the women attending the general clinics in each sector/year	Women proportion Sample size	Number of selected clusters
Health sector 1	10	68,332	29.4%	4
Health sector 2	6	26,948	11.6%	1
Health sector 3	12	116,914	50.3%	6
Health sector 4	9	20,374	8.8%	1
Total	37	232,568	100%	12

Table 1.3. The list of PHCCs and the Number of women per PHCC (cluster).

Health sectors	No.	PHCC names	Sector size	Cluster sizes
Health sector 1	1	Al-marwah	136	34
	2	Sharq Alkhat Alsaree’		34
	3	Al-rabwah		34
	4	Mishrifa		34
Health sector 2	5	Alsalamah	34	34
Health sector 3	6	Al-salaymaniah	204	34
	7	Al-jamiah		34
	8	Madain alfahd		34
	9	Al-mutanazahat		34
	10	Alamir Abdulmajed		34
	11	Alamir Abdulmajed		34
Health sector 4	12	Al-quraiyat	34	34
Total	12		408	408

5. Data Collection Tools

As study participants visited the general clinic, participants were asked to participate in answering the survey questions as volunteers. Upon agreement from study participants, informed consent information was distributed to participants before participating in the study. Then, a survey was administered, using a structured questionnaire that covered socio-demographic characteristics, medical and history of chronic diseases, obstetric history, EHs, PA and lifestyle information, barriers to weight maintenance, and anthropometrics measurements. This involved the researcher conducting face-to-face interviews with each study participant to complete this questionnaire.

Development of a valid and reliable questionnaire

A structured questionnaire form was developed by the researcher, based on the review of associated literature, consultation with experts in the field, and proposed respondents (**see Appendix A.1**). To assure the validity and reliability of the research questionnaire, the following procedures were conducted:

Step 1, item generation, wording, and order:

To assure face and content validity, items were generated from a number of sources, including consultation with experts in the field, proposed respondents, and review of associated literature. A key strategy in item generation was to revisit the research questions frequently to ensure that items were reflecting these questions and remaining relevant. During this step, the proposed subscales of a questionnaire were identified to ensure that items were representative of these research questions (82).

Step 2, pilot study

The study questionnaire was piloted with 20 women who attend PHCCs in Jeddah City. Those women purposely chose to participant in the pilot study and were excluded from the study sample. The responses of these women were entered in the Statistical

Package for the Social Science (the SPSS Complex Samples Software) to calculate the Cronbach's alpha coefficient of the pilot instrument in order to determine the reliability of the study questionnaire, and the relationship among all questionnaire items (82). Three sections of the research questionnaire were subjected to the reliability test to check for internal consistencies including sections 4, 6, and 7. A value of Cronbach's alpha 0.60 or higher is suggested for a robust scale (consistency (83,84). Modifications to the questions were changed as necessary, based on the results of pretesting and suggestions from the pilot study sample.

5-1. Socio-demographic Data

A number of socio-demographic variables were collected including age (date of birth), the level of education, marital status, occupation, and economic status. Education levels were determined from the question, "How many years of academic education has you completed?" Marital status was divided into two categories as married including living as married, and unmarried including being widowed, divorced, separated, and never married. The occupation was categorized as (housewife, student, employed, and other). Additionally, monthly income was categorized as: low (less than 8,000 SR), middle (8,000 SR to 18,000 SR), and high (more than 18,000 SR) levels (85).

5-2. Medical and History of Chronic Diseases

In this study, the medical history for the participants (hypertension, diabetes, cardiovascular diseases, and dyslipidemia) and family history of chronic disease was included in the analysis categorized as clinical variables. This information regarding woman's medical and family history was obtained by women's self-reports or medical records at the time of the clinical visit, and then, the clinical variables was categorized as (yes or no) as to whether the participant or her family has had a history of chronic disease.

5-3. Obstetric History

Gravidity, parity, abortions, number of children breastfeeding and its duration were included in the analysis and categorized as obstetric variables. Gravidity is defined as the number of times that a woman has been pregnant (the sum of her parity and number of abortions), regardless of whether the pregnancies were interrupted (by abortion, or fetal death) or resulted in a live birth. Parity refers to the number of pregnancies of 24 weeks' gestation or more, while abortion is the termination of pregnancy by the removal or expulsion from the uterus of a fetus or embryo prior to viability (about 31 days after the mother's last menstrual period). (86). Moreover, a grand-multi-parity refers to the birth of 5 or more infants.

5-4. Eating Habits

EHs were assessed in the questionnaire by taking a selection of items from the reliable (Cronbach's alpha = .75) EHs questionnaires for adolescents (87,88), while others were generated from the literature (4,13,14,24,58,89,90) with expert advice from nutritionists, as well from the information obtained from the pilot study. The EHs section of the survey (section 4) consisted of 24 questions (items) that were designed to investigate the actual eating behaviors of the study population. The items referred to both healthy and unhealthy EHs as well as to other behaviors. Overall EHS were assessed with a mean composite score for the 13 items, which had the following response categories: always, often, sometimes, never. The 6 items of the response categories ranged from always (highest score = 4) to never (lowest score =1), while the scores of other 7 items were reversed (always = 1 and never = 4). Non-scored items in this questionnaire (11 items) were used to obtain further information on Saudi women's dietary practices and behaviors. The total score (52) was divided into tertiles (88), where the lowest tertile (score ≤33) referred to "inadequate eating habits," the medium tertile (score ≥ 34 to 37) referred to "partially satisfactory eating habits" and the highest tertile (score ≥ 38) referred to "satisfactory eating habits."

The eating habits questionnaire (13items) that were used to determine the overall eating habits score) was piloted with 20 women (from PHCCs in Jeddah City) to test the reliability using Cronbach's alpha coefficient. The value of Cronbach's alpha coefficient for eating habits items was 0.648, indicating an acceptable level of internal consistency (84).

5-5. Physical Activity and Lifestyle

This section consisted of two parts:

a. Physical Activity

PA was assessed using the official Arabic short version of the International Physical Activity Questionnaire (IPAQ) (91). IPAQ was subjected to a reliability and validity study carried out in 14 centers in 12 countries during the year 2000 (e.g., Australia, the United States, the United Kingdom, Japan, and South Africa) and demonstrated reasonable test-retest reliability (intra-class correlations range 0.7–0.8) and inter-method validity (median r_s = .67), with criterion validity around rho = 0.3 based on comparisons with accelerometer data (92). The findings suggest that IPAQ has acceptable properties for use in many settings and in different languages, and is suitable for national population-based prevalence studies of participation in PA. The short form of IPAQ (Arabic version) has been validated and used by numerous studies among the Saudi Arabia adult population (3, 27, 59, 60, 93). The IPAQ has seven items (5.1a to 5.4 in study survey) relating to PA, which provided information on the time (i.e., number of days and average time per day) spent in PA performed across leisure time, work, domestic activities, and transport at each of three intensities: 1) walking; 2) moderate; and 3) vigorous in the preceding seven consecutive day periods. The outcome measures used in the present study were: 1) minutes reported in vigorous, moderate, walking and sedentary activities per week (Min week-1); and 2) MET-Min/week (Metabolic Equivalent Task minutes per week). Time spent in each activity category was derived by multiplying the number of days per week with the minutes spent performing the activity per day. The total weekly physical activity (MET-Min/week) was calculated by multiplying the number of minutes spent in each activity category with the specific MET score for each activity. The MET intensity values that were used to score IPAQ questions were: vigorous (8 METs), moderate (4 METs) and low (3.3 METs). With the regression model, the total PA scoring was used as a continuous measure, which was expressed as metabolic equivalent (MET) min/week (94). For descriptive analysis, the PA scoring was categorized as: Category (1):

- Low activity (insufficient activity), those individual who not meet criteria for Categories 2 or 3 are considered to have a 'low' physical activity level (below 600 MET-min./week).

Category (2): moderate activity (sufficient activity), meeting either of the following criteria:

- 3 or more days with vigorous activity, at least 20 min. each day,
- 5 or more days with moderate activity or walking, at least 30 min. each day,
- 5 or more days with any combination of the above, total activity exceeding 600 MET-min./week.

Category (3) High activity, meeting either of the following criteria:

- 3 or more days with vigorous activities, totaling at least 1500 MET-min./week,
- 7 or more days with any combination of vigorous, moderate or walking activities, totaling at least 3000 MET-min./week.

b. Lifestyle

This part was attempted to provide additional information about Saudi women's lifestyles, and how these activities and behaviors affect their body weights. This information included: (a) where and when women prefer to usually perform PA; (b) the main reasons for doing exercise; (c) the number of sleeping hours; (d) siesta habits; (e) media effects and appearance on women body image; and (f) the availability and use of exercise equipment at home.

5-6. Perceived barriers to weight maintenance

The barriers questionnaire was designed to provide extensive data about the perceived barriers that Saudi women face in healthy eating (HE) and being physically active. Study participants were presented with a list of 91 possible barriers (items), 41 items to identify the EHs barriers set, and 50 items to identify PA barriers set (See Appendix A.2). The participants were inquired to select those that would be perceived as presenting major difficulties when trying to maintain their body weight. Participants were asked', 'How important are the following as barriers to maintaining a healthy body weight?' Most of the items included in the questionnaire were adopted from previous research (26, 29, 56, 65, 95-99).

The perceived barrier items formed different groupings around the major barrier themes in the literature, including those related to HE (41 items) and those related to PA

(50 items). Each set of perceived barriers had three main categories, namely, personal, social environmental, and physical environmental barriers. The personal barriers for PA were grouped into 8 subsets: lack of willpower, of self-confidence, of skills, of knowledge, of energy, of enjoyment, fear of injury, and health problems, while the personal barriers for HE were grouped into 4 subsets: lack of willpower, of knowledge, of skill, of enjoyment (e.g., does not enjoy eating healthy foods such as low salt, low sugar and fat diet, and following a meal plan would take the pleasure out of eating). The social environmental barriers for PA were grouped into 4 subsets: lack of support, lack of time, social influence, and social norms. Social influence is defined as "change in an individual's thoughts, feelings, attitudes, or behaviors that result from interaction with another individual or a group," while social norms are the rules for how people should act in a given group or society. Any behavior that is outside these norms is considered abnormal (100). The social environmental barriers to HE were grouped into 4 categories: lack of social support, lack of time, social influence, and lifestyle changes. The physical environmental barriers for PA were grouped into 3 subsets: lack of resources (e.g., lack of money, limited access to exercise facilities, and safe neighborhood areas), lack of transportation, and hot weather. The physical environmental barriers to HE had one subset: lack of resources (e.g., lack of money, food availability, and cooking facilities). Each category consists of two or more items and rates of questions were summed up to find the score of the category.

All barriers on the questionnaire were scored on a 4-point Likert scale that ranged from "very likely" (3) to "very unlikely" (0) (62). All barriers items were positive statements, which meant that the higher the score, the higher the likelihood that the item was a barrier. Then, the sum-scores of the categories' barriers and subgroups were computed to define the overall barriers sets, from adding the sum-scores of personal, social environment, and physical environment barriers together. The median score for the scale was then used to divide respondents into high-scoring and low-scoring groups (important and not important barriers) (101).

The barriers questionnaire was piloted with 20 women (from PHCCs in Jeddah City) to test the reliability Likert-Type Scales using Cronbach's alpha coefficient. Cronbach's alpha coefficient was calculated for overall perceived barriers to maintaining body weight, as well for individual barriers set, HE and PA barriers. The values of Cronbach's alpha coefficient for overall perceived barriers to maintaining body weight (91 items) were 0.913, for HE barriers (41 items) was 0.884, and for PA barriers (50 items) was 0.837, indicating a high level of internal consistency (83,84).

5-7. Anthropometrics Measurements

The following anthropometric measurement variables were included in the analysis: height (ht), weight (wt), BMI, and WC. The anthropometric measurements were conducted according to the Anthropometry Procedures Manual proposed by the National Health and Nutrition Examination Survey 2002 (102). Weight and height measurements were taken by health care nurses who trained to use the same technique of weight and height measurements for all subjects of the study sample. Initially, the weighing scale was zeroed out before and after every measurement by a health care nurse and standardized with a certified weight (2-kg weight for calibrating the scale) every day before data collection. The participant's weight were measured on a Seca 703 medical scale with subjects wearing light clothing; coats, hejab or abaya (covering), and shoes removed. The health care nurses instructed the subject to remove excess clothing, overcoats, hejab, abaya, and shoes. Pockets containing keys or money should be emptied and any heavy jewelry or accessories (such as watches and necklaces) should be removed. The subject must stand in the center of the scale platform facing the recorder, hands at side, looking straight ahead. The recorder took the measurements to the nearest 0.1 kilogram. Height (m) was measured without shoes using a stadiometer. For the measurement of standing height, the subject was asked to remove any accessories such as hair ornaments, and hejab or abaya (covering) from the top of the head in order to properly measure stature. Then, the recorder, at eye level of the headboard, took the height to the nearest 0.1 centimeter and this value was converted to meters. Subjects stood up straight with head pointed straight forward, feet together and the toes pointed slightly outward, at approximately a 60^{o} angle. The body weight of the subject was evenly distributed and both feet were positioned flat on the floor, with proper heel position, and the buttocks, shoulder blades, and back of the head in contact with the vertical backboard.

BMI is a measure of body fat based on height and weight (weight (kg)/height^2 (m^2)). BMI remains one of the most widely used tools to screen obesity risk in several target populations as it is simple, inexpensive, and strongly correlated with the gold-standard methods (Dual energy X-ray absorptiometry (DEXA), and hydrostatic weighing) for measuring body fat (33-35). WC was measured in order to identify abdominal obesity at the midpoint between the iliac crest and lowest rib, by a flexible non-elastic tape and recorded to the nearest 0.1 cm (103). WC, which is highly correlated with cardiovascular disease (CVD) risk factors, has been shown to be a strong predictor of total body fat, adipose tissue (38,40,104), and obesity-related health risk (39).

For adult women ≥ 20 years old, BMI was classified based on (WHO, 2012) into four categories: underweight (BMI<18.5kg/m^2), normal weight (BMI=18.5-24.9kgm^2), overweight (BMI= 25-29.9 kgm^2), and obese (MBI=> 30 kgm^2) (42,105). Other measurements were defined as: adolescent group (≤19 years old), underweight with BMI <5th age-specific percentile, normal weight as BMI 5th–< 85th age-specific percentile, overweight as BMI 85th–< 95th age-specific percentile, and obesity as BMI ≥95th age-specific percentile. Online software was used to calculate BMI percentile from height, weight, age, and sex data, based on WHO reference populations (105,106). While the abdominal obesity was defined using two cut-offs; WC>88cm according to WHO criteria (103), WC>80cm according to IDF criteria among the study participants (47,48).

6. Data Analysis

A complex sample design was used to select the sample. Consequently, analysis methods take into account the sample design in estimation. In the design, the anticipated effects of the complex sample design were accounted for as well through a "design effect" adjustment to the sample size. The sample design was a stratified two-stage cluster sampling design.

The sample was designed to provide a representative sample of women who were seeking services at PHCCs in Jeddah City. Clinics served as Primary Sampling Units (PSU's) and were grouped into four health sector strata. Clinics were selected from within strata either with certainty (for self-representing PSU's) or with a probability equal to the number of clinics selected divided by the number of clinics in the stratum. Women were selected within clinics at random using a sampling rate chosen to facilitate systematic selection as they entered the clinic.

Health sector 1 had only one clinic, which was selected with certainty, but when there is only one PSU selected within a stratum, there is insufficient data to compute an estimate of that stratum's variance. For analysis purposes, stratum one and two were collapsed. Similarly, for purposes of variance estimation, the selections in strata three and four were also collapsed, resulting in two final strata.

All analyses were based on the complex sampling design using the SPSS Complex Samples Software (Version 23.0). The Taylor Series Linearization (TLS) method was used for variance estimation of non-linear statistics such as means, proportions, and regression coefficients. Design variables for variance estimation included a sampling error stratum (SEST) and sampling error computing unit (SECU), as well as a sample weight. SEST variable equal to the 'health sector' collapsed into two strata, with all cases in stratum one coded as 1, and all cases in stratum two coded as 2. SECU variable corresponded to the clinics in each stratum. For example, stratum one had 5 clinics, and all cases in each clinic were coded from 1 to 5 as corresponded to their clinic number. Similarly, stratum two had 7 clinics. All completed interviews in each clinic were coded as 1 to 7, corresponding to the clinic from which the woman was selected.

Data were weighted to account for the probability of selection (PS) as follows. PS were computed for each clinic, equal to the number of selected clinics in each health sector divided by the total number of clinics in the heath sector. The PSs were also computed for each selected woman within the clinic as the number of selected women in each clinic (34 women) divided by the number of women attending the clinic during data collection. The clinic and woman probabilities were multiplied together to produce an overall PS for each woman in the sample. The inverse of the overall PS was used as a base weight (that is, $w_i = 1/PS_i$). The base weights were rescaled to sum to the sample size by dividing each base weight for each woman by the mean base weight across all women with completed interviews in the 12 sample clinics. There were thus identical weights for all women in the same clinic, but different weight values across clinics. In order to avoid potential problems in how Complex Samples SPSS handles sums of weights in calculations of standard errors, the rescaled weights were used throughout the analysis (108).

Descriptive statistics (using the SPSS subprogram CSDESCRIPTIVES) were used to describe the characteristics of the study population and its mean, standard error, median, frequency, and percentage. Frequencies and percentages were calculated on the proportion of participants according to different variables. A p-value < 0.05 was considered statistically significant. Chi-square tests (using the SPSS subprogram CSTABULATE) were used to examine the statistical significance and extent of associations between the two categorical variables, while General Linear Model (using the SPSS subprogram CSGLM) was used to conduct the Independent Samples t-test to examine the statistical significance and extent of associations between those continuous variables.

Multiple regression (using the SPSS subprogram CSGLM) and a binary logistic regression (using the SPSS subprogram CSLOGISTIC) were conducted to determine if the socio-demographic, parity, family history of chronic disease, EHs and PA were significant predictors of participants' obesity as measured by BMI and WC, respectively. Age, years of education, parity, number of meals, EHs and PA were all continuous variables; occupation, marital status, income, family history of chronic disease, eating fast-food, and consumed saturated fatty food were categorical variables. For categorical variables that have more than two levels, reference groups were assigned and dummy variables were created for the analyses. In the logistic regression and Chi-square analysis, the BMI levels (dependent variable) were divided into two groups: obese (BMI≥ 25kg/m^2) and non-obese (BMI< 25kg/m^2).

Additionally, the multiple regression (using the SPSS subprogram CSGLM) and a binary logistic regression (using the SPSS subprogram CSLOGISTIC) were conducted to assess the associations between perceived barriers to maintaining body weight (HE and PA barriers), general obesity (BMI) and abdominal obesity (WC), respectively. The General Linear Model (using the SPSS subprogram CSGLM) was used to assess the correlation between the perceived barriers to maintaining a healthy body weight, and EHs and PA level, as well to assess the correlation between EHs, and PA level.

7. Ethical approval

Ethical approval for the study (IRB approval) was obtained from the University of Maryland, College Park, and the Ministry of Health - Jeddah Health Affairs Directorate in Saudi Arabia. Prior to the interview, each woman was asked to read and sign a consent form, which stated the purpose of the study, that participation was voluntary, and that women's responses were to be kept confidential.

Chapter 4: Results

I. Factors associated with obesity among Saudi women of reproductive age in Jeddah City

ABSTRACT

Background: Previous studies have shown that women who are overweight or obese are at risk for adverse reproductive outcomes, including infertility, gestational diabetes, and hypertensive disorders of pregnancy. However, information surrounding the risk factors for obesity among Saudi women of reproductive age is deficient due to the limited number of studies that assessed obesity prevalence among them.

Objective: To identify how socio-demographic, parity, EHs (EHs), family history, and physical activity (PA) factors correlate with obesity assessed by BMI[1] and WC[2] in a representative sample of Saudi women attending Jeddah Primary Health Centers (JPHCCs).

Methods: A cross-sectional study was conducted in 2014 using a stratified two-stage cluster sampling design that consisted of 408 Saudi women (15-49 years) attending 12 JPHCCs. Sampling weight and design effect were incorporated into the analysis. BMI and WC data were collected through previously validated interviews. Additionally, the anthropometric measurements (BMI and WC) were defined according to the WHO criteria.

Results: The prevalence of general and abdominal obesity among the study population was 33.5% and 25.1% respectively. Age, family history of obesity, and EHs were significant positive predictors for both general and abdominal obesity, while a fast food

[1] BMI – Body Mass Index
[2] WC – Waist Circumference

habit was a significant positive predictor for general obesity only. Being a student, being in a higher-income level, and eating three main meals/day were the three predictors with significant negative associations with abdominal obesity, while hours of sitting had significant positive associations.

Conclusion: The prevalence of general and abdominal obesity were remarkably high in Saudi women of reproductive age attending Jeddah PHCCs. Our results suggest that age and family history of obesity are crucial factors that positively associated with elevated risks of developing both types of obesity.

KEY WORDS: Body mass index (BMI), waist circumference (WC), obesity, abdominal obesity, risk factors, Saudi, reproductive-aged women

INTRODUCTION

Obesity, an increasing worldwide trend, constitutes a major health problem (1). The prevalence of obesity has generally found to be higher among women than among men (2). Similarly, the prevalence of obesity in Saudi Arabia has increased, and it is significantly higher in women than men. Based on the latest Saudi National Health Survey (2013), the prevalence of obesity in Saudi Arabia for those 15 years of age and older was significantly higher among women (33.5%) when compared to men (24.1%) (3). Another Saudi National Nutrition Survey (18-60 years old) found a higher rate of obesity among women (23.4%) than men (14.2%) (4). An earlier study done in Jeddah City (1994), the most urbanized city in the western part of Saudi Arabia, indicated high rates of overweight and obesity (64.3%, BMI ≥ 25) among adolescent and adult Saudi women between the ages 11 through 70, attending primary health centers in Jeddah City (5). The prevalence of overweight and obesity (52.6%) among Saudi women of reproductive age (16-45 years old) in Riyadh City, Saudi Arabia (6) was similar to results (51%) obtained from national representative data collected over 10 years among all U.S women of reproductive age (15-49years old) (7).

Obesity is a serious, chronic disease that can have a negative impact on women's health. A recent Saudi health survey revealed that Saudi women have high rates of non-communicable diseases (NCDs) such as diabetes, hypertension and hypercholesterolemia. It found 11.7% of women had diabetes, 12.5% hypertension, and 7.3% hypercholesterolemia (8). Women who are overweight or obese are also at risk for adverse reproductive outcomes, including infertility, gestational diabetes, hypertensive disorders of pregnancy, increased risk of delivery by Cesarean section (9). And finally, it is imperatives that evidence-based strategies be developed to address obesity in women of child bearing age."

Obesity has become a common issue among Saudi women due to different factors, such as socio-demographic and lifestyle factors (e.g. age, socioeconomic status, marital status, parity, EHs, and PA (3-6,10-12). Among Saudi women (aged 15 years or older), the latest Saudi National Health Survey found the risk of obesity increased with age, marital status, history of chronic conditions and hypertension (3). In Jeddah City, Western Province of Saudi Arabia, Khashoggi (1994) found five variables were significant predictors for women's obesity (11-70 years): age, marital status, number of servants, childbearing, and parity (5). Among women of reproductive age (15-45 years), Al-Malki (2003) indicated a positive correlation between age and weight, and age and BMI. A significant difference was observed in the results of single (never married) and married women, particularly those who were students; among the single women only 20.5% were overweight, 9.12% were obese, while in married women the frequency increased to 43.0%, and 29% (6). A number of studies in Eastern Mediterranean Region (EMR) countries have shown that the employment status of women is significantly associated with weight gain. These studies showed that working women were less likely to be overweight than non-working women. Furthermore, the rate of obesity in unemployed Saudi women was 79%, compared to 53% in employed women (13).

Obese family members create an obesogenic household environment. A family history of obesity may indicate a genetic predisposition for obesity, but on the other hand, may reflect behaviors in the family that may lead to a sedentary lifestyle (14). Al-Qauhiz (2010) found that the family history of obesity was one of the most significant associates of obesity among university female students at Princess Nora University, Riyadh, Saudi

Arabia, and the risk of obesity increased among those with at least one obese family member (odds ratio (OR) = 1.88) (12).

During the past four decades, EHs in Saudi Arabia have changed markedly, with the changes in lifestyle and reduced PA behaviours. In fact, Western fast food, which has high levels of fat, sugars, sodium, and cholesterol, is now being consumed in large amounts (13,15). Moreover, the Saudi National Nutrition Survey disclosed that eating unhealthy foods (e.g., fried foods, fewer fruits and vegetables) and high-calorie snacks (e.g., cake, donuts, or chips) is becoming a common practice among Saudi people (4). Other eating antecedents in common demonstrated that the obese were less likely to eat at selected times and more often indulged in eating while watching TV. The severely obese groups chose to skip main meals more frequently (P= 0.08), mainly the breakfast meal (62.5%). On the other hand, as a result of fewer main meals, the severely obese group indiscriminately snacked more and ate in secret (16).

Sedentary lifestyles and PA patterns are risk factors associated with obesity. Saudis with increased urbanization, availability of cars, traffic, involvement in office work, and extreme weather, all make PA a difficult choice for Saudis (17,18). A large population-based cross-sectional study on PA status of Saudis between the ages of 30 to 70 years showed that the prevalence of PA was very high (96.1%) for both sexes (based on definition of PA for 30 minutes or more of moderately intense PA at least three times per week). There were significantly ($p < .001$) more inactive females (98.1%) than males (93.9%). Only 3.9% of Saudi males and 1.5% of females met CDC and American College of Sports Medicine (ACSM) recommendations for daily PA (17).

BMI is the anthropometric measurement most widely used to assess total body fatness. In addition, it has long been recognized that BMI is a predictor of morbidity and mortality. On account of its simplicity as a measure, it has been used in epidemiological studies and is recommended as a screening tool in the clinical assessment of obesity. Although BMI has been found to be a reliable indicator of total body fat, there are limitations to the use of BMI alone to assess for adiposity in clinical practice, particularly among adults with BMI ≥30 kg/m^2 (19,20). Because of these limitations of BMI, the WHO and several organizations suggest combining the measurements of BMI and waist circumference (WC) to assess obesity-related health risks (21). WC, which is highly correlated with cardiovascular disease (CVD) risk factors, has been shown to be a strong predictor of total body fat, adipose tissue (22-24), and obesity-related health risk (21).

The reproductive age is an important feature of monitoring and addressing adverse weight transitions among women, as these transitions will have adverse effects on women's short and long-term health and their children's health (25). However, the literature in Saudi Arabia suggests that current information about risk factors for obesity among Saudi women of reproductive age is not sufficient due to the lack of studies performed to determine obesity risk factors. Most studies focused on the male population, children and adolescents, or on women in the adolescent and college years (under the age of 24 years). Also, most of these studies used BMI rather than WC to determine obesity and its associated factors. Moreover, there has been no study to date explore the risk factors of obesity among Saudi women of reproductive age in Jeddah City, the most liberal, urban, and diverse city in Saudi Arabia, where the prevalence of obesity is high (5). Therefore, the present study was planned and conducted in Jeddah City using a representative sample of Saudi women (15-49 years) who attended services at JPHCCs, to determine how socio-demographic, parity, family history of obesity, EHs, and PA factors are associated with two types of obesity – general (BMI) and abdominal (WC) obesity. Meeting this need can assist in the development of programs and policies that support national health objectives.

METHODS AND PROCEDURES

Setting, population, and sampling

The study was conducted using a cross-sectional stratified two-stage cluster sampling design survey of 408 Saudi women, aged 15-49 years, who attended general clinics at JPHCCs. The sampling procedure aimed to select a representative sample of women who were only seeking services at PHCCs in Jeddah City. As a note, PHCCs are the primary sampling units (PSUs). An a-priori power analysis was conducted to determine the number of participants required to detect a small effect of design ($f^2 = 0.1$) with power = .80 for a multiple regression with 15 predictors and hypothesis tests conducted at $\alpha = .05$(the power analysis was conducted with G*Power 3.1.4.). The analysis indicated a sample size of 201 would be sufficient. Then, this was adjusted for clustering by multiplying this simple random sample size by a convenient design effect of 2.0, which indicated that a minimum of 402 women would be sufficient to accurately estimate results for the final sample. However, to selected equal number of the women from the selected health centers (12 centers) we increased the sample size to 408 (34women /12 centers).

In the first stage, the PHCCs (clusters) were sampled without replacement and selected with Probabilities Proportional to their Size (PPS), from the list of PHCCs in survey area. This stage involved the selection of 12 out of 37 clusters, from four health sectors (strata). The second sampling stage involved recruitment of women from the selected PHCCs (12 centers) in order to achieve the proposed estimated sample size (n=408). The total sample size of 408 was divided by 12 selected centers, giving (34) women from each center. Within each PHCC, participants were selected by a systematic sampling from the eligible women attending on days the sampling PHCCs (General Clinics) were visited. The first woman participant who fulfilled the inclusion criteria was invited to enroll in the study. Then, every third attending woman who fulfilled the criteria was selected and soon until completion of the required sample from the PHCC was achieved. However, if a selected woman did not fulfill the inclusion criteria (exclusion criteria) or refused to participate in this study, then selection proceeded to the next sample woman attending the PHCC. The process was continued until all women meeting the inclusion criteria, were surveyed.

Inclusion/exclusion criteria

Inclusion criteria for the study included: Saudi women (who identified by national ID card) attending PHCCs in Jeddah City were: being age 15-49 years (reproductive ages), and not currently pregnant or lactating. Exclusion criteria for the study included: having serious diseases (e.g., organ failure, transplant, ascites, and cancer), and having impaired-decision capacity or mental illness.

Instruments and procedures

Survey

Participants who visited the general clinic were asked to participate in answering the survey questions as volunteers. Upon agreement from study participants, informed consent information was distributed to participants and eventually collected by the researcher. Then, a survey was administered, using a structured pretested questionnaire that covered socio-demographic characteristics, medical and history of chronic diseases, obstetric history, EHs, PA and lifestyle information. Monthly income was categorized as: low (less than 8,000 SR), middle (8,000 SR to 18,000 SR), and high (more than 18,000 SR) levels (26). This involved the researcher conducting face-to-face interviews with each study participant to complete this questionnaire. Additionally, the researcher collected anthropometric measurements for each study participant and entered this data in the questionnaire. Moreover, the study's protocol was approved by the Institutional Review Board of University of Maryland, College Park, and by the Research and Ethics Committee of the Research Center Jeddah, Ministry of Health - Jeddah Health Affairs Directorate in Saudi Arabia.

Anthropometric measurements

Researchers argue that ethnic variation among populations from different countries might necessitate different anthropometric measurement cut-off points for diagnosing obesity (27). However, in Saudi Arabia or Arab countries, the best indicators for general and abdominal obesity and locally appropriate cut-off points for the prediction and diagnosis of obesity among Arab populations had not been investigated prior to this study. Furthermore, most of the current studies in Saudi Arabia and in Middle East countries have used the World Health Organization (WHO) standards for determining general (BMI) and abdominal (WC) obesity. Therefore, in order to compare and interpret our results with the previous studies, we decided to use WHO criteria to measure general and abdominal obesity.

Anthropometric measurements were gathered for each study participant. Body weight and height were determined following standardized techniques, using a digital scale with stadiometer (Seca 703 medical scale) (Hamburg, Germany). Weight was recorded to the nearest 100gm and height to the nearest 0.1cm. BMI was calculated as weight divided by height squared (kg/m^2), and was stratified for the purpose of analysis into two categories: non-obese and obese. For adult women ≥ 20 years old, BMI was classified based on (WHO, 2012) into four categories: underweight (BMI<18.5kg/m^2), normal weight (BMI=18.5-24.9kgm^2), overweight (BMI= 25-29.9 kgm^2), and obese (MBI=> 30 kgm^2) (28). While in adolescent women ≤19 years old, underweight was defined as BMI <5th age-specific percentile, normal weight as BMI 5th–< 85th age-specific percentile, overweight as BMI 85th–< 95th age-specific percentile, and obesity as BMI ≥95th age-specific percentile. Online software was used to calculate BMI percentile from height, weight, age, and sex data, based on WHO reference populations (29,30). Waist circumference was measured in order to identify abdominal obesity at the mid-point between the lowest of the rib margin cage and above iliac crest, by a flexible non-elastic tape and recorded to the nearest 0.1 cm. Then, abdominal obesity was defined as WC>88cm among the study participants (27,31).

Eating habits (EHs) Assessment

EHs were assessed in the questionnaire by taking a selection of items from the reliable EHs questionnaire (32,33) while others were generated from the literature (4,12,13,16,34,35) with expert advice from nutritionists, as well from the information obtained from the pilot study.The EHs section of the survey consisted of 24 questions (items), which were designed to investigate the actual eating behaviors of the participants in the study. The items referred to both healthy and unhealthy EHs as well as to behaviors. EHs were operationalized with four variables from survey section four (EHs section) including: the number of regular meals eaten each day, eating fast food, consuming saturated fat, and overall EHs score. Overall EHs were assessed with a mean composite score of 13 items, which had the following response categories: always, often, sometimes, never. The total score (52) was divided into tertiles, where the lowest tertile (score ≤33) referred to "inadequate EHs," the medium tertile (score ≥ 34 to 37) referred to "partially satisfactory EHs" and the highest tertile (score ≥ 38) referred to "satisfactory EHs."

Physical activity Assessment

PA was assessed using the official Arabic short version of the International PA Questionnaire (IPAQ) (36). A reliability and validity study of IPAQ was conducted in 12 countries (e.g., Australia, United States, United Kingdom, Japan, and South Africa) and demonstrated reasonable test-retest reliability (intra-class correlations range 0.7–0.8) and inter-method validity (median r_s = .67), with criterion validity around rho = 0.3 based on comparisons with accelerometer data. The short IPAQ (Arabic version) has seven items (5.1a to 5.4 in study survey) relating to PA, which provided information on the time (i.e., number of days and average time per day) spent in PA performed across leisure time, work, domestic activities, and transport at each of three intensities: 1) walking, 2) moderate, and 3) vigorous in the preceding seven consecutive day periods. The outcomes measures used in the present study were: 1) minutes reported in vigorous, moderate, walking and sedentary activities per week (Min week-1), and 2) MET-Min/week (Metabolic Equivalent Task minutes per week). Time spent in each activity category, was derived by multiplying the number of days per week with the minutes spent performing the activity per day. The total weekly PA (MET-Min/week) was calculated by multiplying the number of minutes spent in each activity category with the specific MET score for each activity. The MET intensity values that were used to score IPAQ questions were: vigorous (8 METs), moderate (4 METs) and walking (3.3 METs). With the regression model, the total PA scoring was used as continuous measure, which was expressed as metabolic equivalent (MET) min/week (37). For descriptive analysis, the PA scoring was categorized as: low activity (insufficient activity <600 MET-min./week), moderate activity (sufficient activity ≥600 to 1500 MET-min./week), and high activity (vigorous activity≥ 1500 MET-min./week).

Statistical Analysis

A complex sample design was used to select the sample. Consequently, analysis methods take into account the sample design in estimation. In the design, the anticipated effects of the complex sample design were accounted for as well through a “design effect” adjustment to the sample size The sample design was a stratified two-stage cluster sampling design.

The sample was designed to provide a representative sample of women who were seeking services at PHCCs in Jeddah City. Clinics served as Primary Sampling Units (PSU’s) and were grouped into four health sector strata. Clinics were selected from within strata either with certainty (for self-representing PSU’s) or with a probability equal to the number of clinics selected divided by the number of clinics in the stratum. Women were selected within clinics at random using a sampling rate chosen to facilitate systematic selection as they entered the clinic.

Health sector 1 had only one clinic, which was selected with certainty. But when there is only one PSU selected within a stratum, there is insufficient data to compute an estimate of that stratum's variance. For analysis purposes, stratum one and two were collapsed. Similarly, for purposes of variance estimation, the selections in strata three and four were also collapsed, resulting in two final strata.

All analyses were based on the complex sampling design using the SPSS Complex Samples Software (Version 23.0). The Taylor Series Linearization (TLS) method was used for variance estimation of non-linear statistics such as means, proportions, and regression coefficients. Design variables for variance estimation included a sampling error stratum (SEST) and sampling error computing unit (SECU), as well as a sample weight. SEST variable was equal to the 'health sector' collapsed into two strata, with all cases in stratum one coded as 1, and all cases in stratum two coded as 2. SECU variable corresponded to the clinics in each stratum. For example, stratum one had 5 clinics, and all cases in each clinic were coded from 1 to 5 as corresponded to their clinic number. Similarly, stratum two had 7 clinics. All completed interviews in each clinic were coded as 1 to 7, corresponding to the clinic from which the woman was selected.

Data were weighted to account for the probability of selection (PS) as follows. PS were computed for each clinic, equal to the number of selected clinics in each health sector divided by the total number of clinics in the heath sector. The PSs were also computed for each selected woman within the clinic as the number of selected women in each clinic (34 women) divided by the number of women attending the clinic during data collection. The clinic and woman probabilities were multiplied together to produce an overall PS for each woman in the sample. The inverse of the overall PS was used as a base weight (that is, $w_i = 1/PS_i$). The base weights were rescaled to sum to the sample size by dividing each base weight for each woman by the mean base weight across all women with completed interviews in the 12 sample clinics. There were thus identical weights for all women in the same clinic, but different weight values across clinics. In order to avoid potential problems in how Complex Samples SPSS handles sums of weights in calculations of standard errors, the rescaled weights were used throughout the analysis (39).

Multiple regression (using the SPSS subprogram CSGLM) and a binary logistic regression (using the SPSS subprogram CSLOGISTIC) were conducted to determine if the socio-demographic, parity, family history of chronic disease, EHs and PA were significant predictors of participants' obesity as measured by BMI and Waist Circumference, respectively (**see Table 2.1**). A p-value < .05 was considered statistically significant. Age, years of education, parity, number of meals, EHs and PA were all continuous variables; occupation, marital status, income, family history of chronic disease, eating fast food, and consumed saturated fatty food were categorical. For categorical variables that have more than two levels, reference groups were assigned and dummy variables were created for the analyses. Moreover, descriptive statistics (using the SPSS subprogram CSDESCRIPTIVES) were used to describe the characteristics of the study population including mean, standard error, frequency, and percentage. Chi square tests (using the SPSS subprogram CSTABULATE) or t tests (using the SPSS subprogram CSGLM) were used to examine the associations between participant's characteristics and obesity status. In the logistic regression and Chi square analysis, the

BMI levels (dependent variable) were divided into two groups: obese (BMI≥ 25kg/m^2) and non-obese (BMI< 25kg/m^2).

Multivariate outliers were assessed in initial models by examining standardized residuals. An observation of a particular variable was considered an outlier if the absolute value of standardized residual was greater than 3. There were two cases that had absolute values of standardized residuals greater than 3 based on the logistic regression analysis and one case based on the multiple linear regression analysis. The regression analyses were run twice with and without the outlying cases with no changes in the significance of parameter estimates. Therefore, the outlying cases were retained in the final analyses.

Next, variance inflation factors (VIF) and tolerance level were calculated to assess the potential of multicollinearity in the models. No variables had VIFs greater than 10 (or tolerance less than .10) indicating no multicollinearity. Plotting the standardized residuals against standardized fitted values revealed no violations of the assumption of homoscedasticity. Furthermore, the residual values appeared to be centered at approximately 0 for each standardized fitted value. Finally, a histogram of the residuals also indicated that the residuals were approximately normally distributed with a mean of 0. Taken together, these plots suggested that the data were appropriate for use in a multiple linear regression model.

RESULTS

In 2014, we contacted a total of 408 Saudi women, 15-49 years old (reproductive age), who attended Jeddah Primary Health Care Centers (JPHCCs). Out of 424 eligible women, 408 agreed to participate in this study, giving a high response rate of 96.2%.

Anthropometric characteristics and prevalence of women with overweight and obesity

Table 2.2 shows the anthropometric characteristics of the study participants. Throughout the results section, descriptive statistics for continuous variables are presented as mean± SE. Mean height and weight of participants were 156.5±0.41 cm and 67.7±1.3kg, respectively. Based on the WHO BMI classifications, 33.8% (n= 138) of the participants in our study were obese, 29.5% (n=121) were overweight, 26.6% (n=108) had normal body weight, and 10.1% (n=41) were underweight. Mean WC of the entire study population was 80.4±1.12 cm. Using the WC as an indicator for abdominal obesity, 25.1% (n=102) of women were abdominally obese based on WHO criteria.

Socio-demographic characteristics and lifestyle factors of study participants

Table 2.3 shows the socio-demographic characteristics and lifestyle factors of the study participants. The mean age' (mean ± SE) of study participants was 30.27± 0.74, and the majority of the women were in the age group of 20–35 years (51.4%), married (64%), housewives (53.4%), had more than a high school diploma (54.2%), and belonged to low (39.1%) or middle (52.8%) income levels. One-third of married women had 4 children or more, and 94% of them had breastfed their children for seven months. Two-thirds (67%) of the women reported not having health problems, while 19.6% reported being obese, 8.8% had diabetes, 8.2% had hypertension, and 8% had high cholesterol levels. Moreover, 84.7% of women reported a family health history for chronic diseases, 68% of them had family history of diabetes, 49.7% hypertension, and 14.7% obesity. Thirty-two percent of the women showed "satisfactory EHs," and 65% of them engaged in moderate PA.

Association of socio-demographic and lifestyle factors with general and abdominal obesity among study participants

Using Chi square tests, we examined the associations between participant's characteristics with general and abdominal obesity (**see Table 2.4**). We found that both general and abdominal obesity were significantly related to age, parity, family history of obesity, and participant's medical health problems. Marital status had a significant association with general obesity ($p<.01$), but not with abdominal obesity ($p<.183$). However, there were no significant associations between general and abdominal obesity and education level, occupation status, income level, having maids, fast food habits, using saturated fats, eating while watching TV, nap habits, EHs, and PA level.

Overall, the analyses revealed that being obese was related to the age grouping. Women in the middle-age group (36-49 years) were 10.2 (95% CI: 4.62-22.60) and 6.1 (95% CI: 1.52-24.13) times more likely to develop general and abdominal obesity as compared to adolescent women, respectively, whereas women in the young age group (20-35 years) were 2.63 times more likely to develop general obesity only, as compared to adolescent women (15-19years) (95% CI: 1.14-22.6). In addition, the data demonstrated that women who had 4 or more children were 7.0 (95% CI: 3.03-16.00) and 3.3 (95% CI: 1.51-7.1) times more likely to develop general and abdominal obesity as compared to adolescent women, respectively. Furthermore, our results show a significant difference between the prevalence of general obesity among nulliparous women, women with 1-2 children, 3 children, and 4 and more children ($p<.001$); however, the prevalence of abdominal obesity was only significant between nulliparous women and women with 4 and more children ($p<.015$). Married women were 3.01 times more likely to be at risk of develop general obesity as compared to unmarried women (95% CI: 1.41-6.6).

Overall, 84.8% (n= 50) of the women who have family history of obesity had general obesity, and 3.79 were more likely to be at risk of developing general obesity as compared to women without family histories of obesity (95% CI: 1.66-8.67). Although, 50.7% (n=30) of the women who have family histories of obesity had abdominal obesity, and 3.94 were more likely to be at risk of developing abdominal obesity as compared to women without family histories of obesity (95% CI: 1.93-8.04). Moreover, 90.7% (n=122) of the women who have medical health problems had general obesity, and were 9.8 times more likely to be obese (BMI) as compared to participants without medical health problems (95% CI: 5.10-18.74.) Furthermore, 55.2% (n=74) of the women who have medical health problems had abdominal obesity, and were 10.85 times more likely to be abdominally obese as compared to women without medical health history problems (95% CI: 5.78-20.40).

Logistic regression analysis and overweight and obesity (BMI) risk factors

A binary logistic regression was run to determine the effect of socio-demographic and lifestyle factors on risk of developing overweight and obesity (BMI) (**see Table 2.5**). Overall, the analysis produced a significant model, Wald F (15) = 116.70, $p < .001$, that correctly classified 74.7% of the cases, performing better in predicting obesity (82.6% correctly predicted) than non-obesity (61.2%). The model accounted for between 24.4% (Cox and Snell) and 33.3% (Nagelkerke) of the variance in obesity.

The analysis showed that only four risk factors (predictors), were significantly associated with obesity as measured by BMI: age (years), family history of obesity, eating fast food, and eating habit score: odds ratios (ORs) of 1.10 (95% CI 1.05–1.14; $P < .001$), 4.6 (95% CI 1.60–13.4; $p = .002$), 3.3 (95% CI 1.40–7.86; $p = .002$), and

1.08 (95% CI 1.01–1.16; p = .015), respectively. Women with family histories of obesity were 4.6 times more likely to be obese than those without family histories of obesity. Women with fast food habits were 3.3 times more likely to be obese than those without fast food habits. Each year increase in age is associated with a 10 % increase in the likelihood of being obese. Each point increase on the eating habit scores is associated with an 8% increase in the likelihood of being obese.

Multiple linear regression analysis and abdominal obesity (WC) risk factors

A multiple linear regression was conducted to determine the association between the risk factors and the risk to developing abdominal obesity (WC). The analysis produced a significant model, Wald x^2 (15) = 304.0, p <.001 and accounted for 39.7 % of the variance in women's WC (R^2 = 0.397). The analysis showed that seven risk factors (predictors), were significantly associated with abdominal obesity (WC) (**see Table 2.6**).

This model indicates positive associations between age (years), EHs, hours sitting, and abdominal obesity (WC). In contrast, the analysis showed that there were negative association between income status, occupation status, number of meals, and having a family history of obesity, and abdominal obesity (WC). Each additional year of age was associated with an increase of 0.63 cm in WC [95% CI= 0.37 to 0.89], and each additional point on the EHs scale was associated with an increase of 0.41cm in WC [95% CI= 0.14 to 0.68]. Each additional one-hour sitting was associated with an increase of 1.04 cm in WC [95% CI= 0.18 to 1.9]. Women Students have lower WC compared to housewives & employed women (B= -3.66 [95% CI= -6.62 to -0.69]), as well as women in higher-income levels have lower WC compared to women in low- and middle-income level women (B= -4.74 [95% CI= -9.53 to 0.53]). Each additional meal was associated with a decrease of 2.9 cm in WC [95% CI= -4.84 to - 0.95]. Women without family histories of obesity have lower WC compared to women with family histories of obesity (B= -9.32 [95% CI= -13.40 to -5.24]).

DISCUSSION

To our knowledge, this is the first study based on a representative data set to identify factors associated with two types of obesity (BMI and WC) in non-pregnant Saudi women of reproductive age (15-49 years) obtaining services at PHCCs in Jeddah City.

Prevalence of general and abdominal obesity

Based on the WHO classifications, our findings on general obesity (BMI≥30) among women of reproductive age are higher than those of the WHO publication for the Eastern Mediterranean Region (40), which reports a prevalence of obesity of 24%, compared with 33.5% in our sample. Our study rates (29.5% and 33.8%, respectively) are comparable to those reported by the latest National Saudi Health Information Survey (SHIS)(aged ≥16 years) (28% and 33.5%, respectively) (3), lower than those reported by Al-Nozha et al. (2005) (31.8% and 44%, respectively), and higher than those estimated by Al-Othaimeen et al., (2007) (28.4 % and 23.4%, respectively) in women 30-70 years old (11,4).

In terms of abdominal obesity (WC), there were a limited number of studies that examined the prevalence of abdominal obesity among Saudi women, specifically in reproductive age women. Comparing our rate of abdominal obesity (25.1%) to two previous national surveys by Al-Saif et al. (2002) and Al-Nozha et al., (2005) among women in aged 30-70 years using WC cut-off point (>88cm), indicated that their rates in women (66.1%, and 55.2% respectively) were much higher than our rates (41,11). Also, our rate of abdominal obesity was lower than that of some other Middle East countries (≥20 years of age), such as, Kuwait (≥20 years of age), and Iran (≥15-65 years of age) (59.7% & 53.2% respectively) (42,43).

Association of socio-demographic and lifestyle factors with general and abdominal obesity

Studies have shown a wide variability in factors that are associated with general and abdominal obesity among women. The findings provide strong evidence of a positive association between age, parity, medical health problems, and family history of obesity and both types of obesity in Saudi women of reproductive age residing in Jeddah city, Saudi Arabia (**see Table 2.4**).

The positive association of obesity with increasing age found in this study has been reported by several other studies in Saudi Arabia (5,6,10,12,44-46), in Arabic-Speaking Countries such as Kuwait, UAE, and Jordan (47,48), and in around the world (49,50). Women aged 36 years and older were more likely to develop general and abdominal obesity. The association between obesity and age may be explained by the hormonal changes and pregnancy, and a decrease in metabolism with age (51,52). In addition, inactivity increases with age and is more common among women than men (17,53). In the present study, we found 34.1% of the women above age 36 years had low PA level, and 87.8% of them had spent their time in leisure activities (e.g. watching TV, listening to music, using computer, chatting or talking in phone, and reading a book), and 73% of them had more children (Mean=4 children).

A number of studies had reported that parity-related weight gain or retention has the greatest impact on weight gain in women (10,52,54-59). Our results are in agreement with these previous studies, showing a positive association between high parity and general and abdominal obesity among women of reproductive age. Women of higher parity had a higher mean BMI and WC than women of lower parity. The mean BMI and WC for women who had 4 children or more were 30.4 ± 0.4 kg/m^2, and 87.44 ± 0.9 cm, respectively. These values were lower than those reported by Mansour et al., (2009) in Iraqi women (at 18 years of age and older) attending two primary health care centers (55). Several factors may contribute to sustained postpartum weight gain, including retention of gestational weight gain, dietary and lifestyle alterations related to pregnancy and childrearing, behavioral and genetic factors influencing fat metabolism regulation, and hormonal changes (54). Furthermore, new evidence suggests that high maternal glucose, free fatty acid and amino acid concentrations may also play a role in gestational weight gain and postpartum weight retention (56). However, Wolfe et al., (1997) reported that parity-associated with obesity was modified by some socio-demographic and behavioral factors (60). Our results support this finding; when controlling for other lifestyle and socioeconomic factors in regression models, the association between parity and the two type of obesity became non-significant.

Married women were found to be at higher risk of obesity than those who were unmarried. The positive association of obesity and marital status found in this study has been reported by several other studies in Saudi Arabia (3,5,6), in Arabic speaking countries such as Kuwait, UAE, and Jordan (47), and in around the world (6-63). This positive relationship between marital status and general obesity in our study could be related to married women being engaged in less PA, placing less emphasis on being attractive, and tending to eat with their family, likely facilitating increased food intake. About 67% (n=88) of the women who engaged in low PA were married women, and 71.7% (n= 259) of married women ate with their families. Also, our results revealed that married women placed less emphasis on being attractive, since 75.8% (n=88) of the women who did not report an influence of TV on their body appearance were married women, and 74.4% (n=131) of the women who did not wish to look like celebrities were married women. These results are similar to those found previously in Saudi Arabia (8) and Syria (47,64).

Consistent with other studies, our study found that the prevalence of general and abdominal obesity was significantly difference among women according to family history of obesity (12, 45,48). Overall, 14.7% (n=60) of the women had family history of obesity; 84.8% (n= 50) of them had general obesity, 50.7% (n=30) had abdominal obesity. This result is much lower than that observed in female university students in Taif City, Saudi Arabia, where 29.1% (n=66) of female students had family history of obesity (45). Al-Qauhiz (2010) found that the family history of obesity was one of the most significant associates of obesity among university female students at Princess Nora University, Riyadh, Saudi Arabia, and the risk of obesity increased among those women with at least one obese family member (OR = 1.88) (12). Similar results were found among Jordan university students; there was a significantly higher mean BMI and WC for students with family history of obesity ($p < 0.001$ and $p < 0.01$, respectively) (48). It is worth mentioning that obese family members create an obesogenic household environment. Family history of obesity on the one hand may indicate a genetic predisposition for obesity, but on the other hand may also reflect behaviors in the family that lead to a sedentary lifestyle (14).

The study shows a strong relation between the two types of obesity (general and abdominal obesity) and having medical health problems (NCDs) such as hypertension, diabetes mellitus, cardiovascular disease, hypercholesterolemia, and hypertriglyceridemia. In the present study, women with NCDs were 10.85 and 9.8 times more likely to develop abdominal and general obesity, respectively, compared to women without medical health problems. The prevalence of chronic diseases was directly related to obesity and has been confirmed by many studies in both developed and developing countries (65). Our study revealed 27.6% (n=113) of the women in reproductive age attending JPHCCs had reported at least one NCD. The overall prevalence of diabetes and hypertension (8.8% and 8.2%, respectively) in this study were lower than those reported by the latest Saudi National health survey (11.7% and 12.5%, respectively), but our prevalence of hypercholesterolemia (8.1 %) was higher than those reported (7.3%) (3).

Predictors of general and abdominal obesity

Overall, multivariate regression analyses revealed that more predictors were associated with abdominal obesity than general obesity. One factor that could lead to detection of more significant predictors was the choice to model WC continuously. Despite the high number of predictors, we found significant association with abdominal obesity; the two models had approximately equal explanatory or predictive power. The predictors in the linear regression model explained 39.7% of the variation in abdominal obesity, while in logistic regression explained between 24.4% (Cox & Snell) and 33.3% (Nagelkerke) of the variation in general obesity.

The present study found age, family history of obesity, and EHs were significant predictors for both general and abdominal obesity, while fast food habit was a predictor for general obesity only. In terms of abdominal obesity alone, not having a family history of obesity, being a student, being in higher-income level, and eating three main meals had significant negative associations with abdominal obesity, while age, EHs, and hours sitting had significant positive associations with abdominal obesity. Education, marital status, parity, and consuming saturated fat were not significant predictors of either type of obesity.

Results from chi-square and the multivariate regression analyses confirmed the association between age, family history of obesity, and both types of obesity (dependent variables) in the study population. This finding has been found by other studies as well. Not surprisingly, age, which is related to marital status and parity, was a significant predictor of obesity in the study population. Among adult women (25-54years old) in Nairobi Province, Kenya, age was the most significant predictor of general and abdominal obesity (66). A similar finding has been observed among both Jordanian women (aged 15–49 years) (67) and Iranian women (aged 35-57 years) (68). Furthermore, in accordance with our results, family history of obesity has been recognized as an important predictor of obesity in several studies in Saudi Arabia (12,45), Jordon (48), and Iran (69). A family history of obesity reflects the effects of shared genetics and environment among close relatives. Families cannot change their genes; however, they can change their family environment to encourage healthy EHs and PA behaviors. Such changes can improve the health of family members and improve the family health history of the future generation (70,71).

Among the four eating habit indicators, EHs score was a significant positive predictor for both types of obesity, eating fast foods was a significant positive predictor of general obesity, eating three meals per day was a significant positive predictor of abdominal obesity, while no significant association was found between consuming saturated fats and either type of obesity. Surprisingly, the significant positive associations between the EHs score and both types of obesity indicate that obese women have more good EHs than non-obese women. This finding differs from those of many other studies conducted in Saudi Arabia (12,45,72) and in Gulf countries (13). However, the present paper found that women with high eating habit scores were more likely to be old, have medical health problems, and be less active than women with lower and medal scores. More than half of the women in the age group above 35 years reported medical health problems. Nearly, 91.6% of women who had diabetes, 92% of the women who had hypertension, and 87% of the women who had high cholesterol levels were obese. These women may be concerned about their EHs in order to reduce their weight and achieve related health goals, and therefore have higher eating habit scores. Also, women suffering from chronic health problems are more likely to receive health education from the health centers, which may improve their healthy eating knowledge, but does not seem to have the desired impact on PA. We found 31.2% (n=59) of the women with satisfactory EHs had low PA. This finding was consistent with a previous study that examined the inter-relationship between dietary habits, PA and health education provided at the PHCCs in the Qassim region of Saudi Arabia (73). That study demonstrated that health education provided at the PHCC had a positive impact on dietary practices, but was not associated with increased PA. To be most effective in the long run, PHCC education programs should focus on promoting healthy eating as well as encouraging sustainable PA.

Most of the cross-sectional studies in free-living adults show an inverse relationship between eating frequency and adiposity (74). The results of this study support these findings. We found a significant decrease in the risk of abdominal obesity with increasing number of meals in study population. Women who ate three main meals had lower WC than the women ate one or two meals per day. In a cross-sectional study on 7,958 Iranian adults, irregular meal pattern was also associated with greater odds of obesity. After adjustment for potential confounders, individuals with irregular meal patterns were more likely to have general and abdominal obesity, compared with those who had a regular meal pattern (ate 3 main meals per day) (75). Numerous studies have established that low meal frequency is associated with higher 24-hour insulin concentrations when compared with high meal frequency. Eating multiple meals may suppress hunger and overall serum insulin concentrations. Furthermore, insulin inhibits lipolytic activity and increases fat deposition. As insulin is related to fatty acid storage, meal frequency may be one of the factors affecting body weight (76).

Scientific evidence indicates that fast food consumption is associated with higher total energy intake, as well as with weight gain and obesity (77). In this study, a positive and significant association between fast food consumption and general obesity was confirmed among study population. Women who consumed fast food at least one a week were three more times as likely to be obese than those who had not. A cross sectional study among Michigan adults in the USA found a strong association between fast-food consumption and obesity prevalence; regular consumers of fast food had odds of being obese that were 60% to 80% higher than those for people who ate fast food less than once per week (78). Overall, the prevalence of fast food among Michigan adults was lower than our rate, 28% and 84.7% respectively. Another study among 320 Kuwait college students found that regular consumption of fast food was the most significant predictor of obesity (OR 3.3, 95% CI:1.3–8.9) (9). A cross-sectional study conducted to examine the pattern of fast food consumption among university students (18 to 25 years old) in King Faisal University, Al-Hassa, Saudi Arabia, using a logistic regression model, indicated a significant association between obesity/overweight and consuming fast food two or more times per week (OR=3.072, 95% CI: 1.107-8.523) (79). The percentage of those who consume fast food more than twice a week (47.1%) was higher than in the present study (38.2%). Globalization and westernization have contributed to the spread of fast food outlets in Saudi Arabia and home delivery services provided by fast food restaurants have contributed to a rise in the consumption of fast foods (80).

The association between socioeconomic status (SES) and obesity varies depending on each country's level of development and the SES indicators that are used (81). In terms of indicators of socioeconomic status, such as income, occupational status, and years of education, we found associations between some of these indictors and abdominal obesity, but not with general obesity. Our study indicated a significant inverse association between abdominal obesity and income level. This finding was inconsistent with the findings of Al-Nozha et al. (2005) and Al-Saife et al. (2002) in Saudi women aged 30-70 years old; Al-Nozha indicated that income was a significant positive predictor of abdominal obesity and Al-Saife[41] found an association with general obesity. In our study, women at higher-income levels had lower mean WC compared to women at low-income levels, 76.7cm and 80.7cm respectively (11,41). These findings could be due to women at higher-income levels being more active and having higher EHs score (healthy EHs) than women at low-income levels (PA means: 1440 vs 920 MET-Min/week, respectively; EHs score means: 39 vs 36, respectively). According to occupation status, we found that housewives were more likely to have abdominal obesity than students. In fact, high proportions of those housewives were less active, married, and had more children compared to students. In terms of education, data from the latest Saudi National survey found that high education level was associated with deceased risk of general obesity (3). Khalid (2007) found a significant negative relationship between educational level and abdominal obesity among 438 currently married non-pregnant women (aged 18-60 years) in Abha City, Saudi Arabia (10). However, the present study did not indicate any association between education and the two types of obesity. This may due to the fact that the majority of women in our study were educated (69%), and had high school diploma or higher level of education, while the majority of the women in Khalid study were less educated; 81% of them had less than a high school diploma.

Lack of PA and sedentary behaviors are a major risk factor for obesity and many adverse health outcomes. A strong association between lack of PA and general and abdominal obesity has been observed in adolescents, males (n=1400) and females (n=1506) aged 14-19 years from three cities in Saudi Arabia (Al-Khobar, Jeddah and Riyadh) (72). Data from the latest Saudi National survey found an association between general obesity and PA in men but not in women (3). In the present study, we did not find any association between PA and the two types of obesity among the study population. However, we found positive significant association between times sitting and abdominal obesity. Women who sit more hours per day were at higher risk to have a large WC than women who sit fewer hours per day. The mean WC for women who sit 6 or more hours per day was much higher than for those who sit less than 6 hours (92.7 cm and 79.4 cm, respectively). Moreover, 87.6% of the women spent their time each day in sedentary behaviors (e.g. watching TV, phone, and computer use), and 99.2% of them used a car for transportation. Sedentary behaviors have also been shown to be independently associated with overweight and obesity. For example, in a population-based sample of Australian adults (n=11,247, aged≥ 25 years), a linear regression analysis showed that sitting time and TV viewing time were deleteriously associated with BMI, WC, and several biomarkers of cardio-metabolic risk in both women and men (82). The link between sedentary behaviors and obesity are reduced leisure-time PA and increased energy intake (83). In our study, women who spent more time sitting (≥ 6hours/day) tended to be less activity than those sitting fewer hours (Mean METs min/week: 467 vs 1050, respectively).

Study Strengths and Limitations

Notable strengths of the study include the study design, study population, and a representative sample with a high response rate (96.2%) to participate in the study. The study was selected from the most urbanized, liberal, diverse city in Saudi Arabia, Jeddah City. The sample was drawn from a large population to update the data on the prevalence of general (BMI) and abdominal (WC) obesity, and provide new data on (1) factors associated with these two types of obesity, (2) barriers to maintaining a healthy weight, (2) eating habits (EH), and (4) the level of PA and the practice of using exercise equipment at home. Moreover, taking a complex sample approach using specialized software resulted in unbiased parameter estimates, as well as robust standard errors that accurately reflect the variability in the population of interest.

An additional strength is that this is one of the first studies to examine risk factors associated with obesity among Saudi women of reproductive age in Jeddah City, as well as the first study that used combination measurements of WC and BMI categories to identify obesity risk factors among these women. It has been established that WC predicts obesity-related health risk, and the weighted evidence indicates that the addition of WC to BMI predicts a greater variance in health risk than does BMI alone (20). At the same time, we are also aware of major limitations: this survey is cross-sectional; therefore, cause-and-effect cannot be determined for the associations between BMI or WC and their risk factors. Many of our behavioral data, such as EHs and PA, are self- reported and subject to reporting and social desirability biases.

CONCLUSION

The findings of the present study provide evidence that the prevalence of overweight, obesity, and abdominal obesity were remarkably high in non-pregnant Saudi women of reproductive age attending Jeddah PHCs. The present study found age, family history of obesity, and EHs were significant positive predictors for both general and abdominal obesity, while fast food habit was a significant positive predictor for general obesity only. Being a student, being in a higher-income level, and eating three main meals were the three factors with significant negative associations with abdominal obesity, while hours of sitting had significant positive associations. Education level(years), marital status, parity, and consuming saturated fat were not significant predictors of either type of obesity. Moreover, we found a significant association when using chi-square test between both types of obesity and age, parity, medical health problems, and family history of obesity. Our results highlight the need for further attention to the health and wellbeing of women of reproductive age in order to prevent the epidemic of obesity and related health problems. Health service providers should adopt, implement, and monitor policies that support healthy weight before and weight gain during pregnancy, and postnatally through primary care physicians and obstetricians/gynecologists. An effective national obesity prevention strategy is needed and should start early, in the younger age groups, including health education regarding healthy EHs, avoiding high calorie fast-foods, encouraging PA, and reducing sedentary behaviors. Furthermore, healthcare practitioners should routinely collect family health histories to help to identify people at high risk of obesity-related diseases, and should therefore utilize every opportunity to include direct family members at risk in health education. An intervention that includes individuals at high-risk for developing obesity-related diseases and their families to promote lifestyle changes in their diet and PA is, therefore, a rational strategy that will contribute to the control and prevention of overweight and obesity-related health diseases in the reproductive age group.

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TABLES

Table 2.1. Potential predictors and dependent variables included in regression models[a] among non-pregnant Saudi women of reproductive age residing in Jeddah city, Saudi Arabia (n=408).

Variables	**n(%)[b]**	**Mean ± SE[c]**	**P value[d]**	**P value [e]**
BMI (dependent variables in logistic regression)				
Non-obese (BMI<25kh/m^2)	149(36.5%)			
Obese(BMI≥25kh/m^2)	259(63.5%)			
WC (dependent variables in multiple linear regression)		80.2(± 1.1)		
Occupation Status			.518	.006*
Housewife	218(53.4%)			
Employed	87(21.4)			
Student	103(25.2)			
Income Status			.792	>028*
Low Income (<8,000SAR)	159(39.1)			
Middle Income (8,000-18,000 SAR)	216(52.8%)			
High Income (>18,000 SAR)	33(8.1%)			
Marital Status			.137	.081
Never married	127(31.0%)			
Married	281(69.0%)			
Fast Food Habit	345(84.6%		.002*	.079
Consume saturated fat	194(47.5%)		.42	.144
Family history of obesity	60(14.7%)		.002*	<.001*
Age		30.3 (± 0.7)	<.001*	<.001*
Years of Education		12.1(± 0.3)	.652	.649
Parity		2.3(±0.2)	.234	.274
Number of meals		2.4(±0.04)	.211	.001*
EHs Scores		37.5(±0. 3)	.015*	.001*
PA Scores		953.1(±0.7)	.521	.388
Hours Sitting per day		2.9(±0.1)	.418	.007*

Abbreviations: BMI=Body mass index, WC=waist circumference. [a] Predictors used in logistic and multiple linear regression models, [b] Percentage may not total to 100% due to rounding, [c]mean ± standard error, [d] p value for logistic regression model, [e] p value for multiple linear regression model, *significant p=<.05.

Table 2.2. Anthropometric characteristics of non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

Anthropometric characteristics	Number	Percentage of total[a]	Mean± SE[b]
Height (cm) (mean± SE)			156.50±0.41
Weight (kg) (mean± SE)			67.7±1.30
BMI (kg/m^2) WHO cutoff			
Underweight (<18.5)	41	10.1	
Normal (18.5-24.9)	108	26.6	
Overweight (25–29.9)	121	29.5	
Obese (≥30)	138	33.8	
WC (cm) (mean± SE)			80.4±1.12
WC (cm) WHO cutoff			
Normal (<88)	306	75.0	
Health Risk (≥88)	102	25.1	

Abbreviations: BMI=Body mass index, WC =waist circumference, kg=kilogram, m^2 = meter square, cm= centimeter.
[a] Percentage may not total to 100% due to rounding, [b]Mean and ± standard error.

Table 2.3. Socio-demographic characteristics and lifestyle factors in non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

Variables	Number	Percentage of total[a]	Mean± SE[b]
Age (mean± SE)			30.3±0.7
Adolescents (15-19yrs)	70	17.3	
Young women (20-35yrs)	210	51.4	
Middle aged (36-49yrs)	128	31.4	
Education (mean± SE)			12.1±0.3
Less than high school	125	30.7	
Completed high school	99	24.1	
More than high school	184	45.2	
Income level			
Low income (< 7,999SAR)	159	39.1	
Middle income (8000-17,999SAR)	216	52.8	
High income (> 18,000SAR)	33	8.1	
Marital status			
Never married	127	31.1	
Married	261	64.0	
Separated	3	0.8	
Divorced	11	2.7	
Widowed	6	1.4	
Occupation status			
Housewife	218	53.4	
Employed	87	21.4	
Student	103	25.2	
Breastfeed			
Yes	247	94.0	
No	15	6.0	
Duration of breastfeed (months) (mean± SE)			6.7±0.5
Times of parity (mean± SE)			2.29±0.2
Nulliparous	149	36.5	
1-2 children	97	23.8	
3 children	36	8.7	
4 and more children	126	31.0	
Family history of chronic diseases			
Yes	346	84.7	
No	62	15.3	
Women having health conditions			
Yes	134	32.9	
No	274	67.1	
EHs Scores (mean± SE)			37.5±0.27
Inadequate EHs	97	24.0	
Partially Satisfactory EHs	122	30.0	
Satisfactory EHs	189	46.1	
PA scores[c] (mean± SE)			953.11±62.9
Low activity	131	32.0	
Moderate activity	262	64.2	
Vigorous activity	15	3.80	
Sitting hours/day (mean± SE)			2.85±0.1

[a]Percentage may not total to 100% due to rounding, [b]mean ± standard error, [c]total Metabolic Equivalent-minutes/week.

Table 2.4. Association between socio-demographic, lifestyle factors and general and abdominal obesity in non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

	General obesity (BMI)				Abdominal obesity (WC)			
	Non-obese % (BMI≤ 24.9)	Obese % BMI (≥ 25)	P value[a]	OR [95CI][b]	Non-obese % (WC<88cm)	Obese % (WC≥88 cm)	P value[a]	OR [95CI][b]
Age								
Adolescent (15-19yrs)	46 (64.3%)	25(35.7)	<001*	1[Reference]	62 (88.3%)	8(11.7%)	<001*	1 [Reference]
Young women (20-35yrs)	85(40.7%)	124(59.3%)		2.6 [1.1,6.1]*	172 (82.3%)	37(17.7%)		1.6 [0.4,6.7]
Middle aged women (36-49yrs)	19(15%)	109(85.0%)		10.2 [4.6,22.6]*	71 (55.5%)	57(44.5%)		6.1 [1.5,24.1]*
Marital Status								
Never married	69 (54.7%)	58 (45.3%)	0.01*	3.0 [1.0,6.6]*	103(81%)	24(19%)	0.183	
Married	80 (28.6%)	201(71.4%)			203 (72.2%)	78(27.8%)		
Education level								
Less than high school	42(33.1%)	84(66.9%)	0.2		87(69%)	39(31%)	0.085	
Completed high school	33(33.7%)	65(66.3%)			67(68.4%)	31(31.6%)		
More than high school	75(40.8%)	109(59.2%)			152(82.5%)	32(17.5%)		
Occupation status								
Housewife	81 (37.2%)	137(62.8%)	0.934		155(71.1%)	63(28.9%)	0.184	
Employed	30(35.0%)	57 (65.0%)			68(77.7%)	191(22.3%)		
Student	38(37.2%)	65(62.8%)			83(80.5%)	20(19.5%)		
Income level								
Low income	61(38.4%)	98(61.6%)	0.815		28(72.5%)	5(27.5%)	0.394	
Middle income	78(36.3%)	137(63.7%)			163(75.3%)	53(24.7%)		
High income	11(13.6%)	23(68.4%)			115(84.1%)	44(15.9%)		
Parity (Live Births) groups								
Nulliparous	85(57.2%)	64(42.8%)	,<.001*	1[Reference]	125(83.9%)	24(16.1%)	0.015*	1 [Reference]
1-2 children	34(34.9%)	63(65.1%)		2.5 [1.3,5.0]*	79(81.0%)	18(19%)		1.2 [0.4,4. 0]
3 children	10(28.8%)	25(71.2%)		3.3 [1.1,10.4]*	25(69.3%)	11(30.7%)		2.3 [0.7,8.1]
4 and more children	21(16.2%)	106(83.8%)		7.0 [3.0,16.0]*	77(61.2%)	49(38.8%)		3.3 [1.5,7.1]*
Family history of obesity								
Yes	9(15.2%)	50(84.8%)	0.003*	3.8(1.7,8.7)	29(49.3%)	30(50.7%)	0.001*	3.9 [1.9,8.0]
No	140(40.4%)	207(59.6%)			276(79.3%)	72(20.7%)		
Participants with medical health problems								
Yes	13(9.3%)	122(90.7%)	<001*	9.8 [5.1,18.7]	60(44.7%)	74(55.3%)	<001*	10.9[5.8,20.4]
No	137(50.2%)	136(49.8%)			246(89.8%)	28(10.3%)		
Fast food habit								
Yes	127(36.9%)	218(63.1%)	0.932		260(75.3%)	85(24.7%)	0.761	
No	23(35.9%)	40(64.1%)			46(73.1%)	17(26.9%)		
EHs scores groups								
Inadequate EHs	47(48.1%)	50(51.9%)	0.736		72(73.6%)	26(26.4%)	0.862	
Partially Satisfactory EHs	47(38.4)	75(61.6%)			93(76.7%)	28(23.3%)		
Satisfactory EHs	56(29.8%)	132(70.2%)			141(74.5%)	48(25.5%)		
PA level								
Low activity	45(34.4%)	85(65.6%)	0.737		92(70.6%)	38(29.4%)	0.378	
Moderate activity	98(37.5%)	164(62.5%)			203(77.6%)	59(22.5 %)		
Vigorous activity	7(43.3%)	9(56.7%)			11(68.4%)	5(31.6%)		

Abbreviations: BMI=Body mass index, WC=waist circumference (according to WHO criteria), OR=odd ratio, CI=confidant interval. [a]Chi-square test was used for analysis, [b]OR & 95%CI for significant factors, *category is significant different than the reference group (p =< 0.05), percentage may not total to 100% due to rounding, *significant p=<.05.

Table 2.5. Logistic regression model of general obesity (BM) risk factors in non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

Factors [a]	**B**	**SE**	**Wald x^2**	**P value**	**Odds ratio**	**95%CI**
Fast Food Habit	1.19	0.40	9.40	.002	3.30	1.40-7.86
Family History of obesity	1.52	0.50	9.83	.002	4.60	1.60-13.41
Age (years)	0.09	0.02	25.1	<.001	1.10	1.05-1.14
Eating Habit Scores	0.08	0.03	6.00	.015	1.08	1.01-1.16
Constant	**-2.60**	**1.45**	**14.73**	**<.001**	**0.08**	**0.00-2.00**
Wald x^2		**116.70 (df=15)**				
Cox and Snell pseudo R^2		**0.244**				
Nagelkerke pseudo R^2		**0.333**				

Abbreviations: B Coefficient, SE stander error, CI confidence interval.
[a] Only significant factors are presented.

Table 2.6. Multiple-linear regression model of abdominal obesity (WC) risk factors in non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

Risk factors [a]	**B (95%CI)**	**SE**	**Wald x^2**	**P value**
Constant	51.74(30.94,67.68)	9.02	35.51	<.001
Age (years)	0.63(0.37,0.89)	0.12	28.98	<.001
Income Status	-4.74(-9.53, -0.05)	2.15	4.85	.028
Occupation Status	-3.66(-6.62, -0.69)	1.33	7.54	.006
Family History of Obesity	-9.32(-13.40,-5.24)	1.83	25.90	<.001
Eating Habit Scores	0.41(0.14,0.68)	0.12	11.60	.001
Number of meals	-2.90(-4.84,-0.95)	0.87	11.03	.001
Hours Sitting	1.04(0.18,1.90)	0.40	7.31	.007
Wald x^2	**304.90 (df=15)**			**<.001**
R^2	**0.397**			

Abbreviations: WC waist circumference B Coefficient, SE stander error, CI confidence interval.
[a] Only significant factors are presented.

II. Physical activity and prevalence of general and abdominal obesity among Saudi women of reproductive age in Jeddah City

ABSTRACT

Background: Obesity and physical inactivity are growing problems that are associated with major health problems. However, the current information on the association between obesity and physical activity (PA) in Saudi women of reproductive age is insufficient to design and develop intervention programs.

Objective: Using a representative sample of 15-49 years old Saudi women attending JPHCCs[3], this study aims to (1) explore the obesity rates and PA levels and (2) evaluate the relationship between obesity measurements, family history of chronic disease, and practice of the PA using exercise equipment at home.

Methods: A cross-sectional study was conducted in 2014 using a stratified two-stage cluster sampling design comprising 408 Saudi women attending 12 JPHCCs. Sampling weight and design effect were incorporated into the analysis. BMI[4] and WC[5] data were collected through previously validated interviews.

Results: Of the 408 women evaluated, 33.8% were obese (BMI≥30 kg/m^2), 25.1% were abdominally obese at WC ≥ 88 cm, 47.1% were abdominally obese at WC ≥ 80 cm, and 31.2% were physically inactive. There were significant associations between obesity measurements and family history of chronic diseases. No significant associations were found between PA levels and either type of obesity, and mean WC. Women who had and used the exercise equipment were significantly more physically active than those who

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[3] JPHCCS- Jeddah Primary Health Care Centers
[4] BMI- Body Mass Index
[5] WC- Waist Circumference

had it but did not use it; however, no significant differences were found between those women based on BMI and WC levels.

Conclusion: The prevalence of general obesity, abdominal obesity, and physical inactivity were remarkably high in Saudi women of reproductive age attending JPHCCs. An intervention program to combat obesity is thus greatly needed, especially one that focuses on PA and mitigates social norms.

KEY WORDS: Body mass index, waist circumference, prevalence, obesity, abdominal obesity, physical activity, Saudi, reproductive-aged women

INTRODUCTION

Obesity is one of the ten leading health indicators used to measure health status (1). Worldwide, the prevalence of obesity is generally higher among women than among men; nearly two thirds of reproductive-aged women in the United States are currently overweight or obese (2), placing them at elevated risk for adverse health outcomes. According to data from the latest Saudi National Health Survey (2013), the prevalence of obesity in Saudi Arabia among those 15 years of age and older was significantly higher among women (33.5%) than men (24.1%) (3). Daoud et al. (2015) study also reported a high prevalence of hypertension (12.5%), diabetes (11.7%), and hypercholesterolemia (7.3%) among Saudi women (4).

Family history of chronic disease offers valuable genomic information and environmental risk factors (5). Biologically related individuals not only share their genomic information, but often share behaviors, beliefs, lifestyle, culture, and physical environments (6). The increasing risk of obesity has been observed among individuals who have a positive family history of chronic diseases (7-12), and they are more likely to develop these health problems if they are obese (13,14). Therefore, identifying individuals with a positive family history of chronic diseases and monitoring of obesity and other health condition risks, would be desirable to implement interventions to lower risks of developing common chronic diseases in the future (11,13).

Physical activity (PA) is defined as, “Bodily movement produced by the contraction of skeletal muscle that increases the energy expenditure above the basal level” (15). As an important component of a healthy lifestyle, PA is essential for the management of many health conditions and for combating the obesity epidemic (16,17). An inverse association between PA and obesity has also been found (18-20).

Several studies have shown that performing PA on a regular basis (at least 30 minutes of moderate PA per day) enhances quality of life and health condition. Additionally, PA helps prevent and control obesity, diabetes, cardiovascular diseases, and hypertension (21). The findings of a recent study by Ladabaum et al. (2014), which analyzed National Health and Nutrition Examination Survey (NHANES) data from the last 20 years (1988 through 2010), do not support the popular notion that the increase in obesity in the United States can be attributed primarily to sustained increases in the average daily caloric intake of Americans over time. They discovered a significant sharp decrease in physical exercise and an increase in average BMI and waist circumference (WC), while caloric intake remained constant. The percentage of women reporting no participation in PA jumped from 19% to 52% between 1988 and 2010 (22).

In Saudi Arabia, low levels of PA and a sedentary lifestyle have become the norm among the Saudi population (23). According to data from the Saudi National Health Survey (2013) (3), the prevalence of physical inactivity was high among the Saudi population (15 years of age and older), revealing significantly higher levels of inactivity in women (75.1%) than men (47.0%). Such levels of inactivity could be caused by the numerous challenges Saudi women face to being physically active, such as being prohibited from driving, requiring a guardian for commuting, wearing an Abaya (an outer garment worn by Muslim women), or needing the family's permission to practice PA outside the home (such as walking in a public area or attending a fitness gym) (24). However, information on the levels of PA and other lifestyle practices in Saudi adult women is lacking, especially among women particularly at risk of weight gain, such as those of reproductive age.

BMI is the anthropometric measurement most widely used to assess total body fatness. In addition, it has long been recognized that BMI is a predictor of morbidity and mortality. On account of its simplicity as a measure, it has been used in epidemiological studies and is recommended as a screening tool in the clinical assessment of obesity. Although BMI has been found to be a reliable indicator of total body fat, there are limitations to the use of BMI alone to assess for adiposity in clinical practice, particularly among adults with BMI ≥30 kg/m^2 (25,26). Because of these limitations of BMI, the WHO and several organizations suggest combining the measurements of BMI and waist circumference (WC) to assess obesity-related health risks (27). WC, which is highly correlated with cardiovascular disease (CVD) risk factors, has been shown to be a strong predictor of total body fat, adipose tissue (28-30), and obesity-related health risk (27).

It is important to monitor and address adverse weight transitions among women in the reproductive age stage, as these transitions will have adverse effects not only on women's short- and long-term health but also on the health of their children (31). The adverse effects that may be experienced by obese women during pregnancy and delivery are: pregnancy-induced hypertension and preeclampsia, gestational diabetes, urinary tract infections, venous thromboembolism, as well as the necessity for induced labor and cesarean delivery. Additionally, maternal overweight and obesity are significantly associated with a greater risk of pre-term delivery, stillbirth, perinatal death, fetal macrosomia, and fetal birth defects. (32). However, as most studies in Saudi Arabia have focused on the male population, children, adolescents, and women in their college years (under the age of 24 years), existing literature in Saudi Arabia focusing on the prevalence of obesity and PA levels among Saudi women of reproductive age is lacking.

Additionally, most of the existing studies used BMI to measure the obesity levels and failed to incorporate WC measurements. Moreover, to the best of our knowledge, no study has explored the prevalence of obesity and PA among Saudi women of reproductive age in Jeddah City, the most liberal, urban, and diverse city in Saudi Arabia, where the prevalence of obesity is high (33). To fill the gap in the literature, we conducted this study in Jeddah City using a representative sample of Saudi women (15-49 years), who attended services at JPHCCs, to explore the rates of two types of obesity (general and abdominal obesity) and the levels of PA, and to evaluate the relationship between obesity, family history of chronic disease (blood relatives), and practice of PA using exercise equipment at home. This information may help design strategies and interventions that will help prevent and control obesity and increase PA among Saudi women who received services at JPHCCs.

METHODS AND PROCEDURES

Setting, population, and sampling

The study was conducted using a cross-sectional stratified two-stage cluster sampling design survey of 408 Saudi women, aged 15-49 years, who attended general clinics at JPHCCs. The sampling procedure aimed to select a representative sample of women who were only seeking services at PHCCs in Jeddah City. As a note, PHCCs are the primary sampling units (PSUs). An a-priori power analysis was conducted to determine the number of participants required to detect a small effect of design ($f^2 = 0.1$) with power = .80, and at $\alpha = .05$ (the power analysis was conducted with G*Power 3.1.4.). The analysis indicated a sample size of 201 would be sufficient. Then, this was adjusted for clustering by multiplying this sample size by a convenient design effect of

2.0, which indicated that a minimum of 402 women would be sufficient to accurately estimate results for the final sample. However, to select an equal number of the women from the selected health centers (12 centers), we increased the sample size to 408 (402 women/12 centers = 33.5 women≈ 34).

In the first stage, the PHCCs (clusters) were sampled without replacement and selected with Probabilities Proportional to their Size (PPS), from the list of PHCCs in survey area. This stage involved the selection of 12 out of 37 clusters, from four health sectors (strata). The second sampling stage involved recruitment of women from the selected PHCCs (12 centers) in order to achieve the proposed estimated sample size (n=408). The total sample size of 408 was divided by 12 selected centers, giving (34) women from each center. Within each PHCC, participants were selected by a systematic sampling procedure from the eligible women attending on days the sampling PHCCs (General Clinics) were visited. The sampling interval was determined by dividing the daily average number of women (n=90) who were attending the primary care clinic by the number of sample women (90/34=2.6 ≈3). The first woman participant who fulfilled the inclusion criteria was invited to enroll in the study. Then, every third attending woman who fulfilled the criteria was selected and soon until completion of the required sample from the PHCC was achieved. However, if a selected woman did not fulfill the inclusion criteria (exclusion criteria) or refused to participate in this study, then selection proceeded to the next sample woman attending the PHCC.

The process was continued until all women meeting the inclusion criteria were surveyed. Some socio-demographic data (age, level of education, marital status, occupation, and economic status) were obtained from medical-eligible women who refused to participate in this study. These data were used for non-response analysis in order to determine the differences between those who chose to participate in the survey and those who did not. There were no differences between these women according to socio-demographic characteristics.

Inclusion/exclusion criteria

Inclusion criteria for the study included: Saudi women (who identified by national ID card) attending PHCCs in Jeddah City were: being age 15-49 years (reproductive ages), and not currently pregnant or lactating. Exclusion criteria for the study included: having serious diseases (e.g., organ failure, transplant, ascites, and cancer), and having impaired-decision capacity or mental illness.

Instruments and procedures

Survey

Participants who visited the general clinic were asked to participate in answering the survey questions as volunteers. Upon agreement from study participants, informed consent information was distributed to participants before participating in the study. Then, a survey was administered, using a structured questionnaire that covered socio-demographic characteristics, medical and history of chronic diseases, obstetric history, physical activity, and lifestyle information. This involved the researcher conducting face-to-face interviews with each study participant to complete this questionnaire. Additionally, the researcher collected anthropometric measurements for each study participant and entered this data in the questionnaire. The study's protocol was approved by the Institutional Review Board of University of Maryland, College Park, and by the research and ethics Committee of the Research Center Jeddah, Ministry of Health - Jeddah Health Affairs Directorate in Saudi Arabia.

Anthropometric measurements

Researchers argue that ethnic variation among populations from different countries might necessitate different anthropometric measurement cut-off points for diagnosing obesity (34,35). However, in Saudi Arabia, the best indicators for general and abdominal obesity and related local appropriate cut-off points for the prediction and diagnosis of obesity among Saudi populations had not been investigated prior to this study. Furthermore, most of the current studies in Saudi Arabia and in Middle East countries have used the World Health Organization (WHO) standards for determining general (BMI $\geq$ 30) and abdominal (WC>88 cm) obesity. Therefore, in order to compare and interpret our results in relation to the previous studies, we decided to use WHO criteria to measure general and abdominal obesity. Also, to compare our results with worldwide literature, we determined the abdominal obesity using another WC cut-off point (WC>80cm), which is the International Diabetes Federation (IDF) criteria. Since, the new harmonized guidelines for the diagnosis of metabolic syndrome had recommended to use the European cut-off points (IDF) for the Eastern Mediterranean Region until more specific data are available (35).

Anthropometric measurements were gathered for each study participant. Body weight and height were determined following standardized techniques, using a digital scale with stadiometer (Seca 703 medical scale) (Hamburg, Germany). Weight was recorded to the nearest 100gm and height to the nearest 0.1cm. BMI was calculated as weight divided by height squared (kg/m^2), and was stratified for the purpose of analysis into two categories: non-obese and obese. For adult women ≥ 20 years old, BMI was classified based on (WHO, 2012) into four categories: underweight (BMI<18.5kg/m^2), normal weight (BMI=18.5-24.9kgm^2), overweight (BMI= 25-29.9 kgm^2), and obese (MBI=> 30 kgm^2) (36). Other measurements were defined as adolescent group (≤19 years old), underweight with BMI <5th age-specific percentile, normal weight as BMI 5th–< 85th age-specific percentile, overweight as BMI 85th–< 95th age-specific percentile, and obesity as BMI ≥95th age-specific percentile. Online software was used to calculate BMI percentile from height, weight, age, and sex data, based on WHO reference populations (37).

Waist circumference was measured in order to identify abdominal obesity at the mid-point between the iliac crest and lowest rib, by a flexible non-elastic tape and recorded to the nearest 0.1 cm. Then, abdominal obesity was defined using two cut-offs; WC>88cm according to WHO criteria (39), WC>80cm according to IDF criteria among the study participants (34,35).

Physical Activity Assessment

PA was assessed using the official Arabic short version of the International Physical Activity Questionnaire (IPAQ) (40). IPAQ was subjected to a reliability and validity study carried out in 14 centers in 12 countries during the year 2000 (e.g., Australia, the United States, the United Kingdom, Japan, and South Africa) and demonstrated reasonable test-retest reliability (intra-class correlations range 0.7–0.8 and inter-method validity (median r_s = .67), with criterion validity around rho = 0.3 based on comparisons with accelerometer data (41). The findings suggest that IPAQ has acceptable properties for use in many settings and in different languages, and is suitable for national population-based prevalence studies of participation in PA. The short form of IPAQ (Arabic short version) has been validated and used by numerous studies among the Saudi Arabia adult population (3,23,24,42,43). The IPAQ has seven items (5.1a to 5.4 in study survey) relating to PA, which provided information on the time (i.e., number of days and average time per day) spent in PA performed across leisure time, work, domestic activities, and transport at each of three intensities: 1) walking, 2) moderate, and 3) vigorous in the preceding seven consecutive day periods. The outcome measures used in the present study were: 1) minutes reported in vigorous, moderate, walking and sedentary activities per week (Min week-1), and 2) MET-Min/week (Metabolic Equivalent Task minutes per week). Time spent in each activity category, was derived by multiplying the number of days per week with the minutes spent performing the activity per day. The total weekly physical activity (MET-Min/week) was calculated by multiplying the number of minutes spent in each activity category with the specific MET score for each activity. The MET intensity values that were used to score IPAQ questions were: vigorous (8 METs), moderate (4 METs) and low (3.3 METs). With the regression model, the total PA scoring was used as continuous measure, which was expressed as metabolic equivalent (MET) min/week (44). For descriptive analysis, the PA scoring was categorized as: physically inactivate (low activity <600 MET-min./week), and physically active (sufficient activity ≥600 MET-min./week).

Statistical Analysis

A complex sample design was used to select the sample. Consequently, analysis methods take into account the sample design in estimation. In the design, the anticipated effects of the complex sample design were accounted for as well through a "design effect" adjustment to the sample size. The sample design was a stratified two-stage cluster sampling design.

The sample was designed to provide a representative sample of women who were seeking services at PHCCs in Jeddah City. Clinics served as Primary Sampling Units (PSU's) and were grouped into four health sector strata. Clinics were selected from within strata either with certainty (for self-representing PSU's) or with a probability equal to the number of clinics selected divided by the number of clinics in the stratum. Women were selected within clinics at random using a sampling rate chosen to facilitate systematic selection as they entered the clinic.

Health sector 1 had only one clinic, which was selected with certainty, but when there is only one PSU selected within a stratum, there is insufficient data to compute an estimate of that stratum's variance. For analysis purposes, stratum one and two were collapsed. Similarly, for purposes of variance estimation, the selections in strata three and four were also collapsed, resulting in two final strata.

All analyses were based on the complex sampling design using the SPSS Complex Samples Software (Version 23.0). The Taylor Series Linearization (TLS) method was used for variance estimation of non-linear statistics such as means, proportions, and regression coefficients. Design variables for variance estimation included a sampling error stratum (SEST) and sampling error computing unit (SECU), as well as a sample weight. SEST variable equal to the 'health sector' collapsed into two strata, with all cases in stratum one coded as 1, and all cases in stratum two coded as 2. SECU variable corresponded to the clinics in each stratum. For example, stratum one had 5 clinics, and all cases in each clinic were coded from 1 to 5 as corresponded to their clinic number. Similarly, stratum two had 7 clinics. All completed interviews in each clinic were coded as 1 to 7, corresponding to the clinic from which the woman was selected.

Data were weighted to account for the probability of selection (PS) as follows. PS were computed for each clinic, equal to the number of selected clinics in each health sector divided by the total number of clinics in the heath sector. The PSs were also computed for each selected woman within the clinic as the number of selected women in each clinic (34 women) divided by the number of women attending the clinic during data collection. The clinic and woman probabilities were multiplied together to produce an overall PS for each woman in the sample. The inverse of the overall PS was used as a base weight (that is, $w_i = 1/PS_i$). The base weights were rescaled to sum to the sample size by dividing each base weight for each woman by the mean base weight across all women with completed interviews in the 12 sample clinics. There were thus identical weights for all women in the same clinic, but different weight values across clinics. In order to avoid potential problems in how Complex Samples SPSS handles sums of weights in calculations of standard errors, the rescaled weights were used throughout the analysis (45).

Descriptive statistics (using the SPSS subprogram CSDESCRIPTIVES) were used to describe the prevalence of obesity and the characteristics of the study population and its mean, standard error, frequency, and percentage. The anthropometric variables included height, weight, WC and BMI. Frequencies and percentages were calculated on the proportion of participants who were obese (BMI), or abdominal obese (WC). Chi-square tests (using the SPSS subprogram CSTABULATE) were used to examine the statistical significance and extent of associations between the two categorical variables, while General Linear Model (using the SPSS subprogram CSGLM) was used to conduct the Independent Samples t-test to examine the statistical significance and extent of associations between those continuous variables.

RESULTS

Socio-demographic characteristics, physical activity, and lifestyle factors of study participants

Descriptive statistics for continuous variables are presented as mean ± SE. The mean age (mean ± SE) of study participants was 30.27years ± 0.74, and the majority (51.4%) of the women were in the age group of 20-35 years, 64% were married, 53.4%, were housewives. Moreover, 54.2% had more than a high school diploma, and belonged to low (39.1%) or middle (52.8%) income levels. One-third of married women (31%) had 4 children or more, and 94% of them had breastfed their children for seven months or greater. One-third (33.0%) of the women reported having health problems (in particular, chronic conditions, such as type 2-diabetes, hypertension, cardiovascular disease, hypercholesterolemia, and hypertriglyceridemia), while, 84.7% of women reported a family health history for chronic diseases (blood relatives).

Regarding the PA levels (**see Table 3.1**), about 68% of the women were physically active, and 99.2% of them had used cars for transportation. We found that 87.6% of the women spent their leisure time in sedentary behaviors (e.g., watching TV, using phones or computers), and sat nearly 3 hours during the day (2.85± 0.1 hours/day). Moreover, their average amount of sleep per night was 6.5±0.1, and 54.1%(n=220) of them had taken afternoon naps (siesta).

The results showed 57.3% of the women preferred to do the PA outdoors during anytime of the year. More than half of the women (50.5%) preferred to exercise in public, while 45.1% of the women preferred to exercise at home. The main reasons given by women for engaging in PA were: because of health benefits (73.8%) or weight reduction (47.6%). Additionally, 85.2% of the women said that hot weather prevented them from exercising or walking outdoors, while 75% of the women said that it is not safe to walk in their neighborhoods. There was a high proportion of women (85.8%) who needed permission from their families to practice PA outside the home, while 41.6% of them found that wearing the Abaya made them feel uncomfortable about walking in public areas.

There was a significant difference between active and inactive women according to their family history of obesity (p=<.006). Nearly 52% (n=31) of the women who had family history of obesity were physically inactive, while 71.4% (n=248) of the women who did not have family history of obesity were physically active. Women with family history of obesity were 0.4 times more likely to be physical inactive as compared to women with family history of obesity (95% CI: 0.2-0.7). No statistically significant association was detected between age groups, marital status, education levels, occupation status, or income status and PA levels.

Prevalence of general obesity (BMI) among study population

Mean height and weight of participants were 156.5±0.41 cm and 67.7±1.3kg, respectively (**see Table 3.2**). The results show that mean BMI increased from 24.0 kg/m^2 in adolescent women (15-18years) to 30.6 kg/m^2 in middle-age women (36-49years) (**see Table 3.3**). Based on the WHO BMI classifications (36), the prevalence of both overweight and obesity was extraordinarily high among Saudi women who attended

JPHCCs. Nearly 63% of women included in this study population between 15 and 49 years of age were overweight or obese. Specifically, 33.8% (n= 138) were obese, 29.5% (n=121) were overweight, 26.6% had normal body weight (n=108), and 10.1% were underweight (n=41) (**see Table 3.2**).

Overall, there were significant differences in overweight and obesity rates by age, marital status, parity, and having health conditions, while there were no significant differences in overweight and obesity rates in women by education levels, having maids, income levels, occupation status, and PA levels (**see Table 3.4**). The data showed high rates of overweight and obesity among all age groups, and the obesity rates increased significantly with increasing age. Eighty-five percent (n=109) of middle-aged women (36-49 years) were classified as overweight and obese, while 35.7% (n=25) of adolescent women were classified as overweight and obese. Moreover, 71.4 % of married women were classified as overweight or obese.

There were significant differences in overweight and obesity prevalence in women according to parity. Overall, the prevalence of overweight and obesity (41.1%), was high in women with 4 and more children, and 83.8% of those women were overweight and obese. Moreover, there were significant difference in overweight and obesity rates in women according to health conditions. About 33.0% (n=134) of the women had reported having health conditions (chronic diseases), 90.7% of them were overweight and obese.

Prevalence of abdominal obesity (WC) among study population

The mean WC, a measure of abdominal obesity of the entire study population was 80.4±1.1 cm (**see Table 3.2**). The results show that mean WC increased from 70.6 cm in adolescent women (15-19 years) to 88.6 cm in middle-aged women (36-49 years) (**see Table 3.3**). Using the WC as an indicator of abdominal obesity, 25.1% of women were abdominally obese based on WHO criteria (WC≥ 88cm), and 47.1% were abdominally obese based on WC Harmonized criteria (WC≥ 80cm) (**see Table 3.2**).

Based on the WHO WC cut-off (see Table 3.5), there were significant differences in abdominal obesity rates in women by age, parity, and having health conditions (in particular chronic diseases), while there were no significant differences in overweight and obesity rates in women by marital status, education levels, having housemaids, income levels, and occupation status, and PA level. Overall, the abdominal obesity rates increased significantly with increases in age, and the highest rate of abdominal obesity was among women in the middle-aged group (44.5%). The rates of abdominal obesity significantly differed according to parity, and increased with parity. The mean WC for women who had 4 children or more was 87.4±0.9cm, and 38.8%(n=49) of them were considered abdominally obese.

Association of family history of chronic diseases with general and abdominal obesity

Table 3.6 displays the frequencies and percentages of family health history of chronic diseases (blood relatives) with general and abdominal obesity in study participants. A total of 346 (84.7%) out of 408 women reported a positive family history for chronic diseases: 68% for type 2 diabetes, 49.7% for hypertension, 14.7% for obesity, 11% for cardiovascular disease, and 10.7% for high cholesterol level (**see Appendix B.1**). Overall, there were significant differences between the women who had family health history of chronic diseases and those who did not, based on a comparison using BMI levels (classified into obese or not obese) (p=<.002), mean WC (p=<. 001), and abdominal obesity with WC≥ 80 cm (p=<. 004) or 88cm cut-off points (p=<.002), and personal history of chronic diseases (p=<. 005). The rates of general and abdominal obesity among women with a family history of chronic diseases and the women having health conditions were exceedingly high across all the family history of chronic diseases and health conditions that women reported (obesity, type 2 diabetes, hypertension, cardiovascular disease, high cholesterol or triglyceride level). The mean WC for the women with a positive family history chronic diseases were above 82 cm across all family health conditions they reported (**see Appendix B.**1).

Association of using exercise equipment with general and abdominal obesity

Table 3.7 displays percentages of exercise equipment use with general and abdominal obesity in women who had exercise equipment. The data indicated that 35.5% of women had exercise equipment, and 61.4% (n=89) of those women were using it. The analysis revealed that there was no significant difference between the women who used the exercise equipment and those who had the exercise equipment but did not use it, based on comparisons using BMI level (obese or not obese), abdominal obesity, and mean WC, p=<.406, p=<.463, and p= <.283, respectively. Furthermore, there were no significant differences between the women who used exercise equipment and who did not, based on their age grouping (p=<.246).

DISCUSSION

Prevalence of general overweight and obesity measured by BMI Based on the WHO classifications, rates of overweight and general obesity among non-pregnant Saudi women of reproductive age (15-49 years) seen in PHCCs in Jeddah City (29.5% and 33.8%, respectively) are higher than those obtained from a national representative data collected over 10 years among all U.S. women of reproductive age (15-49 years) (24.6% and 30.8%, respectively) (46). Comparing our rates with the Al-malik study (2003), we find the following: in the local study conducted in Riyadh City among Saudi women of reproductive age (16-45 years old), the prevalence of overweight in the Al-malik study (47) was slightly higher (31.5%) than our rate (29.5%), but its prevalence of obesity was lower (20.86%) than our rate (33.8%). These differences in the obesity rates are reasonable, because the women in the Al-malik study were younger than the women in our study (mean age 26 and 30 years, respectively), and the majority of them were under 30 years old (76% and 52.6%, respectively), and were unmarried (51.2% and 31%, respectively).

For further comparison, we reviewed three previous Saudi National Surveys that determined the prevalence of overweight and obesity in women using the WHO cut-offs. Our study rates are comparable to those (28% and 33.5%, respectively) reported by the latest National Saudi Health Information Survey (SHIS) (aged ≥16 years) (3), lower than those reported by Al-Nozha et al. (2005) (31.8% and 44%, respectively), and higher than those estimated by Al-Othaimeen et al., (2007) (28.4% and 23.4%, respectively) in 30–70 years old Saudi women (48,49). The rates of obesity among Saudi women declined about 10.2% from 2005 to 2013. This drop in obesity rate among women may have resulted from the difference in age groups, or due to the public health program implementations of the Saudi Ministry of Health (SMOM). These programs have focused on awareness and behavioral changes (3). However, it is too early to determine whether the decline seen in this study is due to chance or really due to the changes in health behavior. Data from national surveys conducted in Arabian Gulf countries (20–65 years old) (using the WHO cut-offs) showed a prevalence of general obesity among Kuwaiti women (53.0%) (50) and Bahrain women (40.3%) (51) and found their rates were higher than our rate, but the rate of general obesity among Omani women (22.3%) was lower than our rate (52). Furthermore, comparing our obesity rate with some results obtained throughout national surveys of other Arab countries, our rate of obesity was higher than the prevalence of obesity among Jordanian women (27.4%) (15-49 years old) (53) and Lebanese women (25.9%) (≥20 years of age) (54).

Comparing our obesity rates with the national survey rates of nearby non-Arab countries using the WHO cut-offs, our rate of obesity was lower than the prevalence of obesity among Turkish women (44%) (≥20 years of age) (55), but higher than the prevalence of obesity among Iranian women (25.2%) (15-65 years old) (56). This worldwide variation in the prevalence of general obesity could not simply be due to ethnicity, and may involve a wide range of genetic, sociodemographic, environmental, and cultural factors (57). Ethnicity is used to categorize populations on the basis of cultural characteristics such as shared ancestry, language, religious traditions, dietary preferences, and history. Although ethnic groups can share a range of phenotypic characteristics due to their shared ancestry, the term is typically used to highlight cultural and social characteristics instead of biological ones (58).

Prevalence of abdominal obesity measured by WC

In the present study, the mean WC for women (80±1.12 cm) was smaller than the mean WC (90.5 cm) of American women of reproductive age (15–49 years old) who participated in the national representative data collected over 10 years (46). Compared to some Saudi studies that measured the mean WC of women, we found our mean WC was smaller than other reported studies. The mean WC was 84.2 cm among non-pregnant Saudi women aged 18-60 years in Abha City (59), and a Saudi national representative household survey found that the mean WC was 82.9±1.43 cm among 2,416 women, age between 15-64 years old (60). Unfortunately, however, prevalence of abdominal obesity (WC) was not reported in this survey. Our finding is different from those Saudi studies found, which might be attributed to the fact that our study included only teenagers and young adult women under 50 years old, whereas these studies included women in old age (>50 years old).

Prevalence of abdominal obesity using the WHO cut-off (WC ≥ 88 cm) was 25.1% among the study population, which was lower than the prevalence of abdominal obesity in non-pregnant American women (48.8%) of reproductive age (representative data collected over 10 years). In Saudi Arabia, only a limited number of studies have examined the prevalence of abdominal obesity among Saudi women, specifically those of a reproductive age. Comparing our rate of abdominal obesity using the WC cut-off point (≥ 88 cm) to previous two national surveys (30-70 years) (61,62), we found that our rate was lower than their rates, 66.1% and 55.2% respectively. In addition, our rate was lower than that of some other Middle East countries (≥20 years of age), such as Oman (≥20 years of age) and Iran (≥15–65 years of age) (44.3% and 53.2% respectively) (63,64). Using two different WC cut-offs, the abdominal obesity prevalence among Kuwaiti adult women (≥20 years) obtained from the National Nutrition Survey was higher than our rates; the prevalence of abdominal obesity was (59.7% and 25.1%, respectively) according to WHO criteria (WC ≥ 88 cm), and the prevalence of abdominal obesity was (78.1% and 47.1%) according to IDF criteria (WC ≥ 80 cm) (65). These observed variations in the prevalence of abdominal obesity could be contributing to the differences in sample characteristics such as age or socio-demographic variables. In the current study, it seems that women are young (15-49 years old), and a high proportion of them are under the age of 35 years (68.7%), unmarried (31%), and have not had children (36%). Therefore, these characteristics may lead to lower rates of abdominal obesity among them, since the abdominal fat is lower at younger ages, and increases with age, marriage and having children.

Family history of chronic diseases with general and abdominal obesity

Family history of chronic disease offers valuable genomic information and environmental risk factors (5). Family members or biological relatives share their genetic information and as well, their behavior, belief, lifestyle, culture, and physical environment (6). The current study demonstrated that women with a positive history of chronic disease had significantly higher rates of both types of obesity and greater mean WC compared to women who had a negative family history of chronic diseases. The increased prevalence risk of obesity observed among women who reported a positive family history of chronic diseases is in accord with the results from other studies (7-12).

Additionally, our study also revealed a high rate of both types of obesity among the women who had a positive family history of chronic diseases and those who had chronic health conditions. These findings were confirmed in a number of studies that have reported that subjects with close relatives who have had history of chronic diseases are more likely to develop these problems if they are obese (13,14). Therefore, identification and awareness of the family history of chronic disease will serve as a practical and useful approach for public health and preventive health conditions. Also, promotion of healthy behaviors such as regular PA, nutrition education, and routine health checkups, along with keeping track of family health history to continue monitoring the obesity and other health condition risks, would be desirable for women to lower the risks of developing common chronic diseases in the future (11,13).

In the current study, using different cut-off values of WC obtained from studies in European populations (IDF WC cut-offs) have yielded different conclusions regarding the diagnosis of abdominal obesity and its related diseases. According to the Harmonized WC cut-off point (WC ≥80 cm), this study found that all women who had a family history of chronic disease were at high risk of obesity-related diseases. The mean WC cut-off points across all family health conditions they reported exceeded the Harmonized WC cut-off point, while the mean WC cut-off points of the women with a family history of obesity and hypertriglyceridemia also exceeded the WHO WC cut-off point (WC ≥88 cm). We found the same conclusion among all women who had one or more health conditions. Their mean WC cut-off points across all health condition they reported exceeded the Harmonized WC cut-off points (IDF), while the mean WC cut-off points of the women who had diabetes, hypertension, and hypertriglyceridemia also exceeded the WHO WC cut-off point. These findings support previous studies that suggest that ethnic variation among populations from different countries might require different anthropometric measurement cut-off points to diagnose obesity and its related diseases (34,35). This decision was made because studies had confirmed that disease risk in Asian people was high at WC cut-off points below those defined in European populations (66-68). Moreover, in a cross-sectional survey of 1552 Qatari nationals (aged ≥20 years), the receiver operating characteristic curve (ROC) analysis indicated that WCs at a cut-off point of 99.5 cm among men and 91 cm among women were the optimal cut-off points for the diagnosis of the metabolic syndrome. They concluded that using the traditional cut-off values of 102 cm for Qatari men and 88 cm in Qatari women might result in underestimation of metabolic syndrome among men and overestimation among women (69). Therefore, further research is essential to determine the ethnic-specific cut-off points for the Saudi Arabia population and appropriate anthropometric cut-off points may potentially be beneficial in correctly identifying individuals at high risk for developing obesity and its related diseases.

Physical activity and lifestyle behaviors

PA is an important component of a healthy lifestyle, and has been described as an essential factor in managing many health conditions and combatting the obesity epidemic (16,17). By analyzing the National Health and Nutrition Examination Survey (NHANES) data from the last 20 years (1988–2010), researchers from Stanford University discovered a sharp decrease in physical exercise and an increase in average BMI and WC, while caloric intake remained steady (22). They identified significant associations between the reported level of leisure-time PA in the U.S. population and all measures of obesity, but they did not find any evidence that average daily caloric intake increased over the last two decades.

By using the IPAQ short-form instrument, the current study found that physical inactivity among the study sample was 31.2%. These findings confirmed, and were consistent with, the high prevalence of physical inactivity (34.3%) (assessed by IPAQ) among Saudi women reported by Al-Hazzaa (2007) (23). In the Al-Hazzaa (2007) study and our study, there were low proportions (28.5% vs 29%) of women meeting the USDA

PA guidelines for adults (a minimum of 150 minutes/week of moderate activity for weight management) (21).

A number of cross-sectional and longitudinal studies have shown an inverse association between PA and obesity, suggesting that physical inactivity may precede the development of obesity (18-20). However, in current study, there were no significant associations between PA and either type of obesity and mean WC among the study group. These findings were consistent with the finding of the latest Saudi National Health Survey, which found no association between PA and general obesity among Saudi women aged 15 years and older.

Possible reasons for inconsistent results about the relationship between PA and obesity are as follows. First, most of the women in our study reported being physically active (68%). Second, some studies deal with PA as a continuous variable (Metabolic Equivalent Task [MET] minutes per week) and others treat it as a categorical variable (active and inactive level). Third, different methods were used to assess PA levels in the studies.

Despite no association found between PA levels, abdominal obesity, and women's mean WC, women who were physically active had a low rate of abdominal obesity (23.0%) and smaller WC (79.3±1.2 cm) compared to women who were physically inactive (29.4%, 82.0±1.4 cm). These findings are in agreement with the results of a review study which revealed that the short-term effects of regular PA are associated with marked reduction in WC, despite no statistically significant change in body mass (70).

Moreover, 70% (n= 191) of the women who did not have health a conditions in the present study were physically active, and had smaller WC (75.0±0.7 cm) compared to the women with health conditions (41.8%, and 90.7±1.2 cm). This finding reflects the association between PA and reduced risk for adverse health outcomes. Data from numerous studies suggest that performing physical activity on a regular basis (at least 30 minutes/day) improves life quality and health status and prevents and controls cardiovascular diseases, hypertension, diabetes, and obesity (71).

Obese family members create an obesogenic household and reflect behaviors in the family that may lead to sedentary lifestyles (72-74). Our study indicates that family history of obesity was significantly associated with increased sedentary behaviors among women with a history of obesity. This finding is in agreement with previous studies. A cross-sectional study was recently conducted at the Aga Khan University Hospital (AKUH), Karachi, Pakistan to assess the prevalence of physical inactivity in 350 obese adults (mean age 41 years, 53.4% women). The study found that subjects with a positive family history of obesity were 3.5 times more at risk of being physically inactive relative to those without a family history of obesity (75).

This study indicted some factors that make PA in public or outdoors a difficult choice for women, including being prohibited from driving, requiring a guardian for commuting, needing family permission to practice PA outside the home, wearing an abaya, hot weather, the cost of a gym, and feeling unsafe walking in the neighborhood. Any of these factors make walking or doing PA in public or outdoors a difficult choice for Saudi women. Therefore, we found a high proportion of the women (45.1%) preferred to do PA at home. Overall, 35.6% of the women had exercise equipment at home, and a high percentage of them (61.4%) used it. The analysis revealed that the women who used the exercise equipment were significantly more physically active ($p=<.031$) than the women who had the equipment but did not use it. The majority of those who had used the exercise equipment at home used it two times or more per week for at least 90 minutes or more. This finding may reflect the effect of regular exercise on increased energy expenditure, which may improve long-term weight loss outcomes (16).

Regarding high rates of obesity 70% (n=102) among the women who had exercise equipment, we could not find any significant differences between the women who used the exercise equipment and the women who had it but did not use it, based on all measures of obesity (BMI and WC). However, the mean WC for the women who used the exercise equipment (81.3±1.9 cm) was smaller than the mean WC (84.2±1.9 cm) for women who had equipment but did not use it. A randomized controlled study was conducted to determine the effects of different amounts and intensities of exercise training among 120 overweight men and women (aged 40–65 years) in the City of Durham, North Carolina, USA. The results suggested that eight months of both low (114 min/week) and high (175 min/week) amounts of PA were associated with significant reductions in WC in the study group (76). These findings highlight the association between the increasing PA and the reduction in abdominal fat. (70,77). Additionally, in studying the low proportion of women who had the exercise equipment (35.5%, n=145), we could not find any significant differences in the rates of general and abdominal obesity among the women who used exercise equipment according to the exercise duration per week, $p=<.739$, and $p= <.785$, respectively.

Study limitation

The study had a few limitations. First, the cross-sectional nature of the study would not allow for cause-effect relationships to be established. Second, the questionnaire assessments of PA are subject to recall bias, and the self-reported PA did not provide accurate estimates of absolute amounts of activity (Metabolic Equivalent Task minutes per week). A third limitation was that the results of the study could only be generalized to non-pregnant Saudi women of reproductive age (15–49 years) who obtained services at PHCCs in Jeddah City, and were not applicable to all Saudi women living in Jeddah or other cities in Saudi Arabia. Therefore, replication of this study in different populations or in different cities in Saudi Arabia (such as rural or mountainous areas) is highly suggested to allow for comparisons between study results. Comparison between studies results may provide different data and different recommendations that help develop appropriate and effective obesity prevention strategies for Saudi women.

CONCLUSION

The prevalence of general and abdominal obesity was remarkably high in Saudi women of reproductive age who obtained services at JPHCCs. Most important, our study general obesity rate is comparable to those reported by the latest National Saudi Health Information Survey (SHIS) among 16 years of age and older Saudi women (3), suggesting that our obesity rate could be also generalized to all non-pregnant Saudi women. Moreover, our study showed high levels of inactive lifestyle among the study population. Conservative Saudi society, cultural norms, and politics have a great impact on the women's PA level. Therefore, an intervention program to combat obesity is greatly needed, especially one that focuses on PA and mitigates social norms. Moreover, the study suggests that promotion of healthy behaviors such as regular PA, nutrition education, and routine health checkups, along with keeping track of family health history to continue monitoring obesity and other health condition risks, would be desirable for women to lower the risk of developing common chronic diseases in the future. We also observed that using different cut-off values for WC yielded different conclusions regarding the diagnosis of abdominal obesity and its related diseases. Thus, further research is essential to determine ethnic-specific cut-off points for the Saudi Arabia population. Appropriate anthropometric cut-off points may potentially be beneficial in correctly identifying individuals at high risk for developing obesity and its related diseases.

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TABLES

Table 3.1. Physical activity and lifestyle factors for non-pregnant Saudi women of reproductive age residing in Jeddah city, Saudi Arabia (n=408).

Variables	n	Percentage of total	Mean± SE[a]
Sleeping hours per night (mean± SE)			6.5±0.1
Sitting hours per day (mean± SE)			2.85± 0.1
Taking a nap	220	54.1	
Using cars for transportation	404	99.2	
Leisure time activities			
Walking	18	4.4	
Sport	8	1.9	
Shopping	27	6.4	
Dancing	24	5.8	
Watching TV/listening to music /using a computer or phone/ reading	358	87.8	
Other	44	10.7	
Having maid	115	28.3	
Physical activity (MET min/week)[b] (mean± SE)			953.11±62.9
Physical activity levels			
Physical inactive	131	32.0	
Physical active	277	68	
Waking 150 mints or more /week	118	29	
Physically inactive with family history of obesity	31	52	
Physically active without family history of obesity	248	71.4	
Prefer time (year) to do physical activity outdoors[c]			
Fall	6	1.5	
Winter	104	25.4	
Spring	57	14	
Summer	26	6.3	
Any time	234	57.3	
Place prefer to do physical activity[c]			
At home	184	45.1	
At gym	82	20.1	
School	6	1.7	
At work	4	1.0	
In public physical activity facility	206	50.5	
Around inside malls	23	9.5	
Main reasons for doing regular physical activities[c]			
Health benefits	301	73.8	
To lose weight	194	47.6	
Recreation	51	12.4	
Media influence their body image	291	71.4	
Celebrity stars influence on women body image	229	56.0	
Having exercise equipment at home	145	35.5	
Too expensive to purchase a exercise equipment	317	47.6	
Too expensive to join a gym	298	75.3	
Not safe to walk in neighborhood	306	75	
Permeation need family to practice physical activity outside the home	350	85.8	
Wearing the Abaya makes me feel uncomfortable to walk outside	169	41.6	
Too hot to exercise outdoors	348	85.2	

[a]mean ± standard error, [b]MET, Metabolic Equivalent Task. [c] Respondents can select more than one answer or choice (multiple response items).

Table 3.2. Anthropometric characteristics of non-pregnant Saudi women of reproductive age residing in Jeddah city, Saudi Arabia (n=408).

Anthropometric characteristics	Number	Percentage of total[a]	Mean± SE[b]
Height (cm) (mean± SE)			156.5±0.4
Weight (kg) (mean± SE)			67.7±1.3
BMI (kg/m^2) WHO cutoff			
Underweight (<18.5)	41	10.1	
Normal (18.5-24.9)	108	26.6	
Overweight (25–29.9)	121	29.5	
Obese (≥30)	138	33.8	
WC (cm) (mean± SE)			80.4±1.1
WC (cm) WHO cutoff			
Normal (<88)	306	75.0	
Health Risk (≥88)	102	25.1	
WC (cm) Harmonized cutoff			
Normal (<80)	216	53.0	
Health Risk (≥80)	192	47.1	

Abbreviations: WHO= World Health Organization, BMI=Body mass index, WC =waist circumference, kg=kilogram, m^2 = meter square, cm= centimeter. [a]Percentage may not total to 100% due to rounding, [b]mean ± standard error.

Table 3.3. Prevalence of obesity by age according to BMI[a] and WC in non-pregnant Saudi women of reproduction age resident in Jeddah city, Saudi Arabia (n=408).

	Age groups		
	Adolescent (=<19 yrs) (n=70)	**Young women (20-35 yrs) (n=210)**	**Middle-aged women (36-49 yrs) (n=128)**
BMI Mean± SE[b]	24.0±1.3	27.1±0.5	30.6±0.5
Underweight (BMI <18.5)	20(28.3%)	19(9.0%)	2(1.9%)
Normal weight (BMI=18.5-24.9)	25(35.8%)	66(31.7%)	17(13.1%)
Overweight (BMI= 25-29.9)	13(19.2)	71(33.9%)	36(28.1%)
Obesity (BMI ≥30)	12(16.7%)	53(25.4%)	73(56.9%)
WC Mean± SE	70.6±2.25	78.2±1.0	88.6±0.8
Abdominal obesity (WC ≥88)[c]	8(11.7%)	37(17.7%)	57(44.5%)
Abdominal obesity (WC ≥80)[d]	16(22.6%)	75(36.2%)	100(78.5%)

Abbreviations: WHO= World Health Organization, BMI=Body mass index, WC =waist circumference.
[a]BMI according to WHO cutoff, [b]mean ± standard error, [c]WC according to WHO cutoff, [d]WC according to Harmonized cutoff.

Table 3.4. The prevalence of general obesity (BMI[a]) according to socio-demographic characteristics among non-pregnant Saudi women of reproduction age resident in Jeddah city, Saudi Arabia (n=408).

	n	Total obesity for whole sample (n=408)	Non-obese & obese prevalence among each group		P value[b]
			Non-obese	Obese	
		n (%)	n (%)	n (%)	
Age					<.001*
Adolescent (15-19yrs)	70	25(9.7%)	46 (64.1%)	25(35.7)	
Young women (20-35yrs)	210	124(48.2%	85(40.7%)	124(59.3%)	
Middle age women (36-49yrs)	128	109(42.1%)	19(15%)	109(85.0%)	
Education level					.200
Less than high school	125	84(32.5%)	42(33.1%)	84(66.9%)	
Completed high school	99	65(125.3%)	33(33.7%)	65(66.3%)	
More than high school	184	109(42.3)	75(40.8%)	109(59.2%)	
Having maid					.963
Yes	115	73(28.4%)	42(36.4%)	73(63.6%)	
No	293	185(71.5%)	108(36.8%)	185(63.2%)	
Income level					.815
Low income (<8,000SAR)	159	98(38.0%)	61(38.4%)	98(61.6%)	
Middle income (8000-18,000SAR)	216	137(52.2%)	78(36.3%)	137(63.7%)	
High income (> 18,000SAR)	33	23(8.7%)	11(13.6%)	23(68.4%)	
Marital Status					.01*
Never married	127	58 (22.3%)	69 (54.7%)	58 (45.3%)	
Married	281	201(77.7%)	80 (28.6%)	201(71.4%)	
Occupation status					.934
Housewife	218	137(53.0%)	81 (37.2%)	137(66.2%)	
Employed	87	57 (21.9%)	30(35.0%)	57 (65.0%)	
Student	103	65(25.1%)	38(37.2%)	65(62.8%)	
Parity (Live Births) groups					<.001*
Nulliparous	149	64(24.7%)	85(57.2%)	64(42.8%)	
1-2 children	97	63(24.4%)	34(34.9%)	63(65.1%)	
3 children	36	25(9.8%)	10(28.8%)	25(71.2%)	
4 and more children	126	106(41.1%)	21(16.2%)	106(83.8%)	
Having Medical conditions					<.001*
Yes	134	122(47.2%)	13(9.3%)	122(90.7%)	
No	274	136(52.8%)	137(50.2%)	136(49.8%)	
Physical activity level					.597
Inactive (< 600 Met-min/week)	131	85(33.2%)	45(34.4%)	85(65.6%)	
Active (≥ 600 Met-min/week)	277	172(66.8 %)	104(37.5%)	172(62.2%)	

Abbreviations: BMI=Body mass index, MET: Metabolic Equivalent Task. [a]Obesity BMI ≥25 according to World Health Organization criteria, [b]chi-square test of independence, *significant p=<.05.

Table 3.5. The prevalence of abdominal obesity [a] according to socio-demographic characteristics among non-pregnant Saudi women of reproduction age resident in Jeddah city, Saudi Arabia (n=408).

	n	WC Mean ± SE[b]	Total Abdominal obesity (n=408)	Abdominal obesity among/group	P value [c]
Age					.001*
Adolescent (15-19yrs)	70	70.6±2.3	8(8.1%)	8(11.7%)	
Young women (20-35yrs)	210	78.2±01.0	37(36.3%)	37(17.7%)	
Middle age women (36-49yrs)	128	88.6±0.8	57(55.6%)	57(44.5%)	
Education level					.085
Less than high school	125	82.0±1.7	39(38%)	39(31%)	
Completed high school	99	82.0±1.6	31(30.4%)	31(31.6%)	
More than high school	184	78.0±1.0	32(31.6%)	32(17.5%)	
Having maid					.541
Yes	115	80.7±1.8	31(30.6%)	31(27.1%)	
No	293	79.9±1.1	71 (69.4%)	71 (24.3%)	
Income level					.394
Low income (<8,000SAR)	159	80.7±1.1	44(42.8%)	44(27.5%)	
Middle income (8000-18,000SAR)	216	80.3±1.5	53(52.0%)	53(24.7%)	
High income (> 18,000SAR)	33	76.7±2.7	5(5.1%)	5(15.9%)	
Occupation status					.184
Housewife	218	81.4±1.35	63(61.4%)	63(28.9%)	
Employed	87	79.0±1.7	191(19%)	191(22.3%)	
Student	103	78.6±1.5	20(19.6%)	20(19.5%)	
Marital Status					.183
Never married	127	74.4±2.4	24(23.5%)	24(19%)	
Married	281	82.7±0.8	78(76.5%)	78(27.8%)	
Parity (Live Births) groups					.015*
Nulliparous	149	73.4±1.9	24(23.4%)	24(16.1%)	
1-2 children	97	80.4±1.5	18(18%)	18(19%)	
3 children	36	82.4±1.9	11(10.7%)	11(30.7%)	
4 and more children	126	87.4±0.9	49(47.9%)	49(38.8%)	
Having Medical conditions (Chronic diseases)					<.001*
Yes	134	90.7±1.3	74(72.6%)	74(55.3%)	
No	274	75.0±0.7	28(27.4%)	28(10.3%)	
Physical activity level					.212
Inactive (< 600 Met-min/week)	131	82.0±1.4	38(37.5%)	38(29.4%)	
Active (≥ 600 Met-min/week)	277	79.3±1.2	64(62.5 %)	64(23.0 %)	

Abbreviation: WC =waist circumference, MET: Metabolic Equivalent Task. [a] Abdominal obesity, WC ≥ 88 according to WHO criteria, [b]mean ± standard error, [c]chi-square test of independence, *significant p=<.05

Table 3.6. Association between family health history of chronic diseases and general and abdominal obesity among non-pregnant Saudi women of reproduction age resident in Jeddah city, Saudi Arabia (n=408).

	Family health history of chronic diseases		
	Yes n (%)[a]	**No** n (%)[a]	**P value**
Having family history of chronic disease	346(84.7)	62(15.3%)	<.001[e*]
BMI (WHO)			
Non-obese (BMI<25) (n=150)	111(74.0%)	39(26.0%)	.002[f*]
Obese (BMI≥25) (n=258)	235(91.0%)	23(9.0%)	
WC (cm) Mean ± SE[b]	81.6±1.0	72.1±1.9	<.001[g*]
Abdominal obesity (WC≥ 88)[c]			
Non-obese (n=62)	248(81.1%)	58(18.9%)	.004[f*]
Obese(n=346)	97(95.5%)	5(4.4%)	
Abdominal obesity (WC≥ 80)[d]			
Non-obese(n=216)	167(77%)	49(23.0%)	.002[f*]
Obese(n=192)	179(93.4%)	13(6.6%)	
Medical conditions (chronic diseases)			.005[f*]
No (n=274)	218(80%)	55(20%)	
Yes (n=134)	127(94.4)	7(5.6%)	

Abbreviations: WHO= World Health Organization, BMI=Body mass index, WC=waist circumference.

[a]Percentage may not total to 100% due to rounding, [b]mean ± standard error, [c]WC according to WHO cutoff, [d]WC according to Harmonized cutoff, [e]chi-squared test for homogeneity, [f]chi-squared test of independence, [g]t-test for independent means, *significant p=<.05

Table 3.7. Association between using exercise equipment and general and abdominal obesity among women who only have exercise equipment (n=145).

	Using exercise equipment		
	Yes n(%)[a]	No n(%)[a]	P value
Using exercise equipment	89(61.4%)	56(38.6%)	.019[c*]
BMI (WHO cutoff)			.406[d*]
Non-obese (BMI < 25)	29(67.0%)	14(33.0%)	
Obese (BMI ≥ 25)	61(59.7%)	41(40.3%)	
WC (cm) Mean ± SD[b]	81.3 ±1.9	84.2 ±1.9	.283[e*]
Abdominal obesity (WHO cutoff)			.463[d*]
Non-obese (WC < 88)	65(64.7%)	36(35.3%)	
Obese (WC ≥88)	24(55.0%)	20(44.7%)	
Age			.246[d*]
Adolescent (15-19yrs)	19(75.3%)	7(24.7%)	
Young women (20-35yrs)	48(63.3%)	28(36.7%)	
Middle age women (36-49yrs)	22(51.0%)	21(49.0%)	
Physical activity level			.031[d*]
Inactivity (< 600 Met-min/week)	15(39.5%)	23(60.5%)	
Active (≥ 600 Met-min/week)	75(70.0 %)	32(30.1%)	
Times of using exercise equipment (at least 30 min or more) /week			
One time (30min/week)	23(25.7%)	0%	
Two times and more (90 min or more/week)	66(74.3%)	0%	

Abbreviations: BMI=Body mass index, WC=waist circumference, MET: Metabolic Equivalent Task. [a]percentage may not total to 100% due to rounding, [b]mean ± standard error, [c]chi-squared test for homogeneity, [d]chi-squared test of independence, [e]t-test for independent means, *significant p=<.05

Appendix B.1

Differences in the percentages[a] and mean WC among non-pregnant Saudi women of reproductive age residing in Jeddah city, Saudi Arabia when comparing those with and without family or personal history of chronic disease according to general and abdominal obesity (n=408).

			Abdominal obesity (WC ≥80)[c]	**Abdominal obesity (WC ≥88)[d]**	**Non-obese (BMI<25)**	**Obese (BMI≥25)**
	n (%)	**WC Mean± SE**	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Family history of chronic diseases[e]						
No	62(15.3)	72.1±1.9	13(20.4)	4(7.2)	39(62.4)	23(37.6)
Yes	346(84.7)	81.6±1.0	179(52)	98(28.3)	111(32.1)	235(67.9)
Obesity	60(14.7)	89.7±2.2	46(76.9)	30(50.7)	9(15.1)	51(84.8)
Diabetes	277(68.0)	82.6±1.3	151(54.5)	85(30.6)	81(29.4)	196(70.6)
Hypertension	203(49.7)	83.3±1.2	117(57.6)	72(35.6)	61(29.9)	142(70.1)
Cardiovascular Disease	45(11.1)	86.1±2.2	30(66.6)	16(36.2)	7(15.1)	38(85.0)
High Cholesterol Level	44(10.7)	85.5±1.8	29(66)	15(35.3)	13(29.1)	31(71.0)
High Triglyceride Level	6(1.6)	89.8±6.8	4(62.1)	3(43.2)	0(0)	6(100)
Medical conditions (chronic diseases) [e]						
No	274(67.1)	75.0±0.7	83(30.4)	28(10.2)	137(50.2)	136(49.8)
Yes	134(32.9)	90.7±1.3	109(81.0)	74(55.3)	13(9.3)	122(90.7)
Diabetes	36(8.8)	90.5±2.1	30(84.7)	20(56.7)	3(8.4)	33(91.6)
Hypertension	34(8.2)	91.9±2.9	25(73.0)	19(56.1)	3(7.7)	31(92.3)
Cardiovascular Disease	3(0.7)	86.4±6.5	3(72.3)	2(63.6)	1(36.4)	2(63.6)
High Cholesterol Level	33(8.0)	87.5±1.8	23(70.)	13(38.7)	4(13.1)	29(87.0)
High Triglyceride Level	7(1.7)	90.2±7.3	4(56.6)	3(46.0)	2(24.0)	5(76.0)

Abbreviations: BMI=Body mass index, WC=waist circumference. [a]Percentage may not total to 100% due to rounding, [b]general obesity (BMI ≥25) according to World Health Organization (WHO) criteria, [c]abdominal obesity according to Harmonized cutoff, [d]abdominal obesity (WC ≥88) according to WHO criteria. [e]Respondents can select more than one answer or choice (multiple response items).

III. Perceived barriers to maintaining healthy body weight among Saudi women of reproductive age in Jeddah City

ABSTRACT

Background: Maintaining a healthy body weight is important for overall health and can help prevent and control many chronic conditions. However, the information surrounding the barriers to healthy eating (HE) and physical activity (PA) for weight maintenance among Saudi women of reproductive age is insufficient to design and develop intervention programs.

Objective: Using a representative sample of Saudi women, age 15-49, attending Jeddah Primary Health Care Centers (JPHCCs), this study explores personal, social, and physical environmental factors that act as barriers to maintaining a healthy weight and how these barriers vary by socio-demographic and weight status.

Methods: A cross-sectional study was conducted in 2014 using a stratified two-stage cluster sampling design comprising 408 Saudi women attending 12 JPHCCs. The sampling weight and design effect were incorporated into the analysis. Data was collected using a structured questionnaire consisting of socio-demographic factors, eating habits (EHs), PA, and perceived barriers to a maintenance of healthy weight maintenance. Body mass index (BMI) and waist circumference (WC) data also were obtained.

Results: Of the 408 women evaluated, 33.8% were obese (BMI $\geq$ 30 kg/m^2), 25.1% were abdominally obese with WC $\geq$ 88 cm, 24% had unhealthy EHs, and 31.2% were physically inactive. A high proportion of women faced significant barriers in maintaining their weight related to EHs or PA (49.2% vs. 50.7%). The most common barriers to HE and PA in the study group were lack of willpower, skills, knowledge, enjoyment, time, resources, and social influence. Social norms and hot weather had a great impact on the women's PA levels. There was a positive significant association between EHs and PA and between EHs and PA barriers, but no significant associations were found between barriers to maintaining healthy weight and either type of obesity. The personal and the social environmental barriers to HE had a significant negative association with EHs, while none of the examined barriers to PA were associated with PA. There were inversely significant associated between the HE barrier and age, and between PA barrier and income status.

Conclusion: The study findings suggest there is a need to improve women's EHs and PA by eliminating the identified barriers. These findings can be used to develop appropriate and effective obesity prevention interventions for Jeddah women.

KEY WORDS: Obesity, barriers to maintain healthy body weight, physical activity, eating habits, Saudi, reproductive-aged women

INTRODUCTION

Obesity and unhealthy lifestyle choices are growing problems associated with major health issues. Obesity is one of the ten leading health indicators used to measure health status (1). The prevalence of obesity in Saudi Arabia has been shown to be significantly higher among women (33.5%) than men (24.1%) (2). Also, Saudi women had a high rate of chronic disease: hypertension (12.5%), diabetes (11.7%), and hypercholesterolemia (7.3%) (3). Despite the high rate of obesity among Saudi women, there have been limited studies conducted to understand the barriers women perceive in attempting to maintain a healthy weight.

Maintaining a healthy body weight is important for overall health and can help prevent and control obesity and its associated diseases (4). Healthy eating (HE) and physical activity (PA) are vital strategies for losing and maintaining weight. The perceived barriers to increasing PA and improving HE that women face may vary according to their social and personal circumstances (5). Barriers are defined as factors that impede health-promoting behaviors and include perceptions about the potentially negative effects of changing. Health-promotion and disease-prevention literature have established barriers as important predictors of behavior change (6). Generally, weight management results from many impediments to PA and HE, including those related barriers to personal (e.g., lack of willpower, knowledge, motivation, cooking skills, and exercise), social environmental (e.g., social influence, family support, and commitment), and physical environmental (e.g., lack of money, limited access to exercise facilities, and a hot climate) (7). Moreover, young women are more likely than older women to experience particular life events, such as leaving the family home, starting work, entering marriage, and becoming mothers, that may influence their PA and eating habits (EHs) (5).

Diet and nutrition play important roles in maintaining health and preventing obesity and numerous diseases (4). A decrease in morbidity and mortality associated with lifestyle health related diseases may be achievable if healthy EHs are adopted early in life and maintained in the long term (8). HE reflects a complex decision-making process influenced by numerous factors or barriers, including demographic, social, personal, and emotional (9). With a view on informing policy, a recent study was conducted by Al-Jaaly (2011) to quantify the problem of overweight and obesity in adolescent girls (13–18 years old) in Jeddah City (10). The Al-Jaaly (2011) study indicated a strong association between a number of factors and weight status of adolescent Jeddah girls. These factors included individual elements, such as biological factors (e.g., age of menarche), EHs, lifestyle, and environmental factors like family influence, access to food, and societal influence. There is limited research, however, on EHs and related barriers in Saudi adult women for maintaining a healthy body.

PA is also an important component of a healthy lifestyle and has been described as an essential factor in managing many health conditions and combating the obesity epidemic (11,12). Several studies have shown that engaging in PA on a regular basis (at least 30 minutes of moderate PA per day) enhances the quality of life and health. Additionally, PA helps prevent and control obesity, type 2 diabetes, cardiovascular diseases, and hypertension (13). In Saudi Arabia, sedentary lifestyles and low levels of PA have become the norm among the Saudi population (14). According to data from the 2013 Saudi National Health Survey (2), the prevalence of physical inactivity was high among the Saudi population (15 years of age and older), revealing significantly higher levels of inactivity in women (75.1%) than in men (47.0%). Such levels of inactivity could be caused by the numerous challenges Saudi women face to being physically active, such as being prohibited from driving, hot weather, requiring a guardian for commuting, wearing an abaya (an outer garment worn by Muslim women), or needing the family's permission to engage in PA outside the home (such as walking in a public area or attending a fitness gym) (15). However, information on the levels of PA and its barriers in Saudi adult women is lacking, especially among women particularly at risk of weight gain, such as those of reproductive age.

It is important to monitor and address adverse weight transitions among women in the stage of their reproductive years, as these transitions will have adverse effects, not only on women's short- and long-term health, but also on that of their children (16). However, as most studies in Saudi Arabia have focused on the male population, children, adolescents, and women in their college years (under the age of 24 years), existing literature offers insufficient data regarding the perceived barriers to maintaining healthy body weight related to EHs and PA among Saudi women of reproductive age. Moreover, to the best of the authors' knowledge, no study has been conducted to assess EHs, PA, and perceived barriers to following a healthy lifestyle among Saudi women of reproductive age in Jeddah City, the most liberal, urban, and diverse city in Saudi Arabia, where the prevalence of obesity is high (17) and the number of reproductive-age women is increasing. This study was conducted in Jeddah to fill the gap in the literature using a representative sample of Saudi women (15–49 years) who attended services at Jeddah Primary Health Care Centers (JPHCCs) to explore personal, social, and physical environmental factors that act as barriers to maintaining a healthy weight. This study also investigated how these varied by socio-demographic factors, as well as evaluated the relationship between those barriers and EHs, PA, and obesity. Determining these factors and barriers is vital to creating the best programs for combating the prevalence of obesity for not only the women of Jeddah City but also potentially the women of other cities in Saudi Arabia.

METHODS AND PROCEDURES

Setting, population, and sampling

The study was conducted using a cross-sectional stratified two-stage cluster sampling design survey of 408 Saudi women, aged 15-49 years, who attended general clinics at JPHCCs. The sampling procedure aimed to select a representative sample of women who were only seeking services at PHCCs in Jeddah City. As a note, PHCCs are the primary sampling units (PSUs). An a-priori power analysis was conducted to determine the number of participants required to detect a small effect of design ($f^2 = 0.1$) with power = .80, and at $\alpha = .05$ (the power analysis was conducted with G*Power 3.1.4.). The analysis indicated a sample size of 201 would be sufficient. Then, this was adjusted for clustering by multiplying this sample size by a convenient design effect of 2.0, which indicated that a minimum of 402 women would be sufficient to accurately estimate results for the final sample. However, to select equal number of the women from the selected health centers (12 centers) we increased the sample size to 408 (402 women/12 centers = 33.5 women≈ 34).

In the first stage, the PHCCs (clusters) were sampled without replacement and selected with Probabilities Proportional to their Size (PPS), from the list of PHCCs in survey area. The sampling interval was determined by dividing the daily average number of women (n=90) who were attending the primary care clinic by the number of sample women (90/34=2.6 ≈3). This stage involved the selection of 12 out of 37 clusters, from four health sectors (strata). The second sampling stage involved recruitment of women from the selected PHCCs (12 centers) in order to achieve the proposed estimated sample size (n=408). The total sample size of 408 was divided by 12 selected centers, giving (34) women from each center. Within each PHCC, participants were selected by a systematic sampling from the eligible women attending on days the sampling PHCCs (General Clinics) were visited. The first woman participant who fulfilled the inclusion criteria was invited to enroll in the study. Then, every third attending woman who fulfilled the criteria was selected and soon until completion of the required sample from the PHCC was achieved. However, if a selected woman did not fulfill the inclusion criteria (exclusion criteria) or refused to participate in this study, then selection proceeded to the next sample woman attending the PHCC. The process was continued until all women meeting the inclusion criteria, were surveyed.

Inclusion/exclusion criteria

Inclusion criteria for the study included: Saudi women (who identified by national ID card) attending PHCCs in Jeddah City were: being age 15-49 years (reproductive ages), and not currently pregnant or lactating. Exclusion criteria for the study included: having serious diseases (e.g., organ failure, transplant, ascites, and cancer), and having impaired-decision capacity or mental illness.

Instruments and procedures

Survey

Participants visited the general clinic were asked to participate in answering the survey questions as volunteers. Upon agreement from study participants, informed consent information was distributed to participants before participating in the study. Then, a survey was administered, using a structured pretested questionnaire that covered socio-demographic characteristics, medical and history of chronic diseases, obstetric history, eating habits, physical activity and lifestyle information. Based on the Center Department of Statistical and Information of Kingdom of Saudi Arabia, the monthly income was categorized as: low (less than 8,000 SR), middle (8,000 SR to 18,000 SR), and high (more than 18,000 SR) levels (18). This involved the researcher conducting face-to-face interviews with each study participant to complete this questionnaire. Additionally, the researcher collected anthropometric measurements for each study participant and entered this data in the questionnaire. Moreover, the study's protocol was approved by the Institutional Review Board of University of Maryland, College Park, and by the Research and Ethics Committee of the Research Center Jeddah, Ministry of Health - Jeddah Health Affairs Directorate in Saudi Arabia.

Anthropometric measurements

Researchers argue that ethnic variation among populations from different countries might necessitate different anthropometric measurement cut-off points for diagnosing obesity (19,20). However, in Saudi Arabia or Arab countries, the best indicators for general and abdominal obesity and locally appropriate cut-off points for the prediction and diagnosis of obesity among Arab populations had not been investigated prior to this study. Furthermore, most of the current studies in Saudi Arabia and in Middle East countries have used the World Health Organization (WHO) standards for determining general ($BMI \geq 30$) and abdominal ($WC>88$ cm) obesity. Therefore, in order to compare and interpret our results in relation to the previous studies, we decided to use

WHO criteria to measure general and abdominal obesity. Also, to compare our results with worldwide the literature, we determined the abdominal obesity using another WC cut-off point (WC>80cm) based on the new harmonized guidelines for the diagnosis of metabolic syndrome recommendation (which is the International Diabetes Federation (IDF) criteria), which has suggested that the European cut-off points be used for the Eastern Mediterranean Region until more specific data are available (20).

Anthropometric measurements were gathered for each study participant. Body weight and height were determined following standardized techniques, using a digital scale with stadiometer (Seca 703 medical scale) (Hamburg, Germany). Weight was recorded to the nearest 100gm and height to the nearest 0.1cm. BMI was calculated as weight divided by height squared (kg/m^2), and was stratified for the purpose of analysis into two categories: non-obese and obese. For adult women ≥ 20 years old, BMI was classified based on (WHO, 2012) into four categories: underweight (BMI<18.5kg/m^2), normal weight (BMI=18.5-24.9kgm^2), overweight (BMI= 25-29.9 kgm^2), and obese (MBI=> 30 kgm^2) (21). Other measurements were defined as adolescent group (≤19 years old), underweight with BMI <5th age-specific percentile, normal weight as BMI 5th–< 85th age-specific percentile, overweight as BMI 85th–< 95th age-specific percentile, and obesity as BMI ≥95th age-specific percentile. Online software was used to calculate BMI percentile from height, weight, age, and sex data, based on WHO reference populations (22,23).

Waist circumference was measured in order to identify abdominal obesity at the mid-point between the iliac crest and lowest rib, by a flexible non-elastic tape and recorded to the nearest 0.1 cm. Then, abdominal obesity was defined using two cut-offs;

WC>88cm according to WHO criteria (24), WC>80cm according to IDF criteria among the study participants (19,20).

Eating Habits (EHs) Assessment

EHs were assessed in the questionnaire by taking a selection of items from the reliable (Cronbach's alpha = .75) EHs questionnaires for adolescents (25,26), while others were generated from the literature (27-32,) with expert advice from nutritionists, as well from the information obtained from the pilot study. The EHs section of the survey consisted of 24 questions (items) that were designed to investigate the actual eating behaviors of the study population. The items referred to both healthy and unhealthy EHs as well as to other behaviors. Overall EHs were assessed with a mean composite score for the 13 items. These items had the following response categories: always, often, sometimes, never. The 6 items of the response categories ranged from always (highest score = 4) to never (lowest score =1), while the scores of other 7 items were reversed (always = 1 and never = 4). Non-scored items in this questionnaire (11 items) were used to obtain further information on Saudi women's dietary practices and behaviors. The total score (52) was divided into tertiles (26), where the lowest tertile (score ≤33) referred to "inadequate eating habits," the medium tertile (score ≥ 34 to 37) referred to "partially satisfactory eating habits" and the highest tertile (score ≥ 38) referred to "satisfactory eating habits."

The eating habits questionnaire (13items) that were used to determine the overall eating habits score) was piloted with 20 women (from PHCCs in Jeddah City) to test the reliability using Cronbach's alpha coefficient. The value of Cronbach's alpha coefficient for eating habits items was 0.648, indicating an acceptable level of internal consistency (34).

Physical Activity Assessment

PA was assessed using the official Arabic short version of the International Physical Activity Questionnaire (IPAQ) (35). IPAQ was subjected to a reliability and validity study carried out in 14 centers in 12 countries during the year 2000 (e.g., Australia, the United States, the United Kingdom, Japan, and South Africa) and demonstrated reasonable test-retest reliability (intra-class correlations range 0.7–0.8) and inter-method validity (median r_s = .67), with criterion validity around rho = 0.3 based on comparisons with accelerometer data (36). The findings suggest that IPAQ has acceptable properties for use in many settings and in different languages, and is suitable for national population-based prevalence studies of participation in PA. The short form of IPAQ Arabic version has been validated and used by numerous studies among the Saudi Arabia adult population (2,14,15,37,38). The IPAQ has seven items (5.1a to 5.4 in study survey) relating to PA, which provided information on the time (i.e., number of days and average time per day) spent in PA performed across leisure time, work, domestic activities, and transport at each of three intensities; 1) walking(low); 2) moderate; and 3) vigorous in the preceding seven consecutive day periods. The outcome measures used in the present study were: 1) minutes reported in vigorous, moderate, walking and sedentary activities per week (Min week-1); and 2) MET minutes per week (Metabolic Equivalent Task). Time spent in each activity category, was derived by multiplying the number of days per week with the minutes spent performing the activity per day. The total weekly physical activity (MET-Min/week) was calculated by multiplying the number of minutes spent in each activity category with the specific MET score for each activity. The MET intensity values that were used to score IPAQ questions were: vigorous (8 METs), moderate (4 METs) and low (3.3 METs). With the regression model, the total PA scoring was used as a continuous measure, which was expressed as metabolic equivalent (MET) min/week (39). For descriptive analysis, the PA scoring was categorized as: physically inactivate (low activity <600 MET-min./week), and physically active (sufficient activity ≥600 MET-min./week).

Perceived barriers to weight maintenance questionnaire

The barriers questionnaire was designed to provide extensive data about the perceived barriers that Saudi women face in healthy eating (HE) and being physically active. Study participants were presented with a list of 91 possible barriers (items), 41 items to identify the EHs barriers set, and 50 items to identify PA barriers set (See Appendix B.1). The participants were inquired to select those that would be perceived as presenting major difficulties when trying to maintain their body weight. Participants were asked, 'How important are the following as barriers to maintaining a healthy body weight?'. Most of the items included in the questionnaire were adopted from previous research (5,7,40-47).

The perceived barrier items formed different groupings around the major barrier themes in the literature, including those related to HE (41 items) and those related to PA (50 items). Each set of perceived barriers had three main categories, namely, personal, social environmental, and physical environmental barriers. The personal barriers for PA were grouped into 8 subsets: lack of willpower, of self-confidence, of skills, of knowledge, of energy, of enjoyment, fear of injury, and health problems, while the personal barriers for HE were grouped into 4 subsets: lack of willpower, of knowledge, of skill, of enjoyment (e.g., does not enjoy eating healthy foods such as low salt, low sugar and fat diet, and following a meal plan would take the pleasure out of eating). The social environmental barriers for PA were grouped into 4 subsets: lack of support, lack of time, social influence, and social norms. Social influence is defined as "change in an individual's thoughts, feelings, attitudes, or behaviors that result from interaction with another individual or a group," while social norms are the rules for how people should act in a given group or society. Any behavior that is outside these norms is considered abnormal (48). The social environmental barriers to HE were grouped into 4 categories: lack of social support, lack of time, social influence, and lifestyle changes. The physical environmental barriers for PA were grouped into 3 subsets: lack of resources (e.g., lack of money, limited access to exercise facilities, and safe neighborhood areas), lack of transportation, and hot weather. The physical environmental barriers to HE had one subset: lack of resources (e.g., lack of money, food availability, and cooking facilities). Each category consists of two or more items and rates of questions were summed up to find the score of the category.

All barriers on the questionnaire were scored on a 4-point Likert scale that ranged from "very likely" (3) to "very unlikely" (0) (49). All barriers items were positive statements, which meant that the higher the score, the higher the likelihood that the item was a barrier. Then, the sum-scores of the categories' barriers and subgroups were computed to define the overall barriers sets scores, from adding the sum-scores of personal, social environment, and physical environment barriers together. The median split method was then used to divide respondents into high-scoring and low-scoring groups (important and not important barriers) (50).

The barriers questionnaire was piloted with 20 women (from PHCCs in Jeddah City) to test the reliability Likert-Type Scales using Cronbach's alpha coefficient. Cronbach's alpha coefficient was calculated for overall perceived barriers to maintaining body weight, as well for individual barriers set, HE and PA barriers. The values of Cronbach's alpha coefficient for overall perceived barriers to maintaining body weight (91 items) were 0.913, for HE barriers (41 items) was 0.884, and for PA barriers (50 items) was 0.837, indicating a high level of internal consistency (34,51).

Statistical Analysis

A complex sample design was used to select the sample. Consequently, analysis methods take into account the sample design in estimation. In the design, the anticipated effects of the complex sample design were accounted for as well through a "design effect" adjustment to the sample size. The sample design was a stratified two-stage cluster sampling design.

The sample was designed to provide a representative sample of women who were seeking services at PHCCs in Jeddah City. Clinics served as Primary Sampling Units (PSU's) and were grouped into four health sector strata. Clinics were selected from within strata either with certainty (for self-representing PSU's) or with a probability equal to the number of clinics selected divided by the number of clinics in the stratum. Women were selected within clinics at random using a sampling rate chosen to facilitate systematic selection as they entered the clinic.

Health sector 1 had only one clinic, which was selected with certainty. But when there is only one PSU selected within a stratum, there is insufficient data to compute an estimate of that stratum's variance. For analysis purposes, stratum one and two were collapsed. Similarly, for purposes of variance estimation, the selections in strata three and four were also collapsed, resulting in two final strata.

All analyses were based on the complex sampling design using the SPSS Complex Samples Software (Version 23.0). The Taylor Series Linearization (TLS) method was used for variance estimation of non-linear statistics such as means, proportions, and regression coefficients. Design variables for variance estimation included a sampling error stratum (SEST) and sampling error computing unit (SECU), as well as a sample weight. SEST variable was equal to the 'health sector' collapsed into two strata, with all cases in stratum one coded as 1, and all cases in stratum two coded as 2. SECU variable corresponded to the clinics in each stratum. For example, stratum one had 5 clinics, and all cases in each clinic were coded from 1 to 5 as corresponded to their clinic number. Similarly, stratum two had 7 clinics. All completed interviews in each clinic were coded as 1 to 7, corresponding to the clinic from which the woman was selected.

Data were weighted to account for the probability of selection (PS) as follows. PS were computed for each clinic, equal to the number of selected clinics in each health sector divided by the total number of clinics in the heath sector. The PSs were also computed for each selected woman within the clinic as the number of selected women in each clinic (34 women) divided by the number of women attending the clinic during data collection. The clinic and woman probabilities were multiplied together to produce an overall PS for each woman in the sample. The inverse of the overall PS was used as a base weight (that is, $w_i = 1/PS_i$). The base weights were rescaled to sum to the sample size by dividing each base weight for each woman by the mean base weight across all women with completed interviews in the 12 sample clinics. There were thus identical weights for all women in the same clinic, but different weight values across clinics. In order to avoid potential problems in how Complex Samples SPSS handles sums of weights in calculations of standard errors, the rescaled weights were used throughout the analysis (52).

Descriptive statistics (using the SPSS subprogram CSDESCRIPTIVES) were used to describe the characteristics of the study population and its mean, standard error, median, frequency, and percentage. Frequencies and percentages were calculated on the proportion of participants according to different variables. Multiple regression (using the SPSS subprogram CSGLM) and a binary logistic regression (using the SPSS subprogram CSLOGISTIC) were conducted to assess the associations between perceived barriers to maintaining body weight (HE and PA barriers), general obesity (BMI) and abdominal obesity (WC), respectively. Chi-square tests (using the SPSS subprogram CSTABULATE) were used to examine the statistical significance and extent of associations between barriers and socio-demographic variables. The General Linear Model (using the SPSS subprogram CSGLM) was used to assess the correlation between the perceived barriers to maintaining body weight, and EHs and PA level, as well to assess the correlation between EHs, and PA level. A p-value $<.05$ was considered statistically significant. In the logistic regression analysis, the BMI levels (dependent variable) were divided into two groups: obese (BMI$\geq$ 25kg/m^2) and non-obese (BMI<

25kg/m^2). The distribution of PA level was skewed to the right, and hence the log-transformed PA levels had been used for regression analysis.

RESULTS

Socio-demographic characteristics, obesity prevalence, eating habits (EHs), physical activity (PA) level, and lifestyle behaviors of study participants

Descriptive statistics for continuous variables are presented as mean ± SE. The mean age (mean ± SE) of study participants was 30.27years± 0.74, and the majority (51.4%) of the women were in the age group of 20-35 years, 64% were married, 53.4%, were housewives. Moreover, 54.2% had more than a high school diploma, and belonged to low (39.1%) or middle (52.8%) income levels.

Based on the WHO BMI classifications (21), the prevalence of both overweight and obesity was extraordinarily high among Saudi women who attended JPHCCs. **Table (4.1)** showed that Nearly 34% (n=138) of women included in this study population between 15 and 49 years of age were obese, 29.5% (n=121) were overweight, 26.6% had normal body weight (n=108), and 10.1% were underweight (n=41). The mean WC, a measure of abdominal obesity of the entire study population was 80.4±1.1 cm. Using the WC as an indicator of abdominal obesity, 25.1% (n=102) of women were abdominally obese based on WHO criteria (WC≥ 88cm).

Regarding eating habits (EHs) (**see Table 4.2**), 46% (n=189) of the women had healthy EHs (satisfactory eating habits), and more than half of the women had two main meals daily. We found 10.6% (n=43) of the women had skipped breakfast, while eating snacks between meals was a common practice among the majority of the women, with only 8.6%(n=18) of the women reported that they had never ate snacks. Only 26%

(n=105) of women consumed at least two portions (200gms) of vegetables per day, and 13% (n=53) consumed at least two portions of fruit per day (200gms). Also, more than half of the women (56.2%, n=229) drank less than the recommended amount of water daily (at least eight cups of water/day) (53), and consumed a high amount of Western fast foods. Western fast food consumption was a common practice among women (87.7%, n=345), and 72.8% (n=234) of them consumed fast foods more than twice a week. The data showed that women usually prefer to eat Saudi traditional foods (97.6%, n=398), local fast foods (50.2%, n= 205), and American fast foods (46.0%, n= 187).

Regarding the PA levels, about 64.2% of the women engaged in moderate PA, and 99.2% (n= 404) of them had used cars for transportation. We found 87.8% of the women spent their leisure time in sedentary behaviors (e.g., watching TV, using the phone, or using the computer), and they sat nearly 3 hours during the day (2.85± 0.1 hours/day). Moreover, their average amount of sleep per night was 6.5±0.1, and 54.1% (n=220) of them took an afternoon nap (siesta). The main reasons for women to engage in PA were for health benefits (73.8%, n=301), or for weight reduction (47.6%, n=194).

Perceived barriers to healthy eating (HE)

According to perceived barriers to HE, a total of 201 (49.2%) out of 408 women had barriers to HE (**see Table 4.3**). The overall potential range of scores on the HE barriers scale was 0 to 123. The mean and the median of the HE score were 61.6±1.66, 63.5 score, respectively. Physical environmental barriers ranked as the important barriers to HE (53.5%), followed by social environmental (51.1%), and personal barriers (49.2%). The study found that overall barriers to HE was significantly higher among adolescents

(15-19 years) (p=<.028, 58.8%), but not significantly associated with education, income, marital, and occupation status (**see Table 3.4**).

Regarding personal barriers to the HE subgroups score, the lack of enjoyment (58.5%) was found to be the most important personal barriers to HE reported by women, followed by lack of skills (57.7%), willpower (52.6%), and knowledge (51.8%) (see Table 4.3). Ranking the women who responded "very likely" to personal barriers to HE items, identified five important barriers including: (1) I do not like artificial sweeteners (69.2%); (2) I enjoy eating traditional Saudi food (63.3%); (3) The taste, color and appearance of foods are very important for me (53.4%); (4) I have not been counseled about importance of HE by a doctor or dietitian (44.0%); and (5) I do not like to drink (tea, coffee, or juice) without sugar (42.2%) (**Appendix C.1**). The analysis revealed that personal barriers to HE was significantly higher in adolescents (15-19 years) (p=<.001, 69.7%), and in the women with low-income levels (p=<.011, 62.9%, n=100), and never married women (p=<.049, 60.9%), but was not significantly associated with education and occupation status (**see Table 3.4**).

According to social environmental barriers to HE subgroups score, the lack of time (61.7%), was found to be the most important social environmental barriers to HE reported by women, followed by social influence (51.8%), and lifestyle changes (46.3%) (**see Table 4.3**). Ranking the women who responded "very likely" to social environmental barriers to HE items identified five important barriers including: (1) Usually healthy food is not served at social activities (56.5%), (2) It can be hard to stick with a HE plan when family and friends don't want to join me (43.6%), (3) I eat out sometimes when my family or I do not have time to cook (36.6%), (4) I feel pressured to eat during social gatherings because if I refuse, the host might be offended (34.3%), and (5) My kids don't like everything I want to eat (32.4%) (**Appendix C.1**). The analysis indicated that the overall social environmental barriers score to HE were not significantly associated with all social-demographic variables (age, education, income, marital, and occupation status) (**see Table 4.4**).

Regarding physical environmental barriers to HE subgroup score, the lack of resources (53.5%) was found to be the most important barriers to HE reported by women (**see Table 4.3**). Ranking the women who responded "very likely" to physical environmental barriers to HE items identified three important barriers including: (1) There's not much choice of foods when I eat out (at work or school) (48.9%), (2) The food shops around us don't offer much healthy choices of foods (35.6%), and (3) The low-calorie food products (diet products) are too expensive (e.g., sweets, jam, cookies, or chocolate diet) (29.3%) (**Appendix C.1**). The results indicated that overall physical environmental barriers score to adapting healthy eating habits were not significantly associated with all social-demographic variables (age, education, income, marital, and occupation status) (**see Table 4.5**).

Perceived barriers to physical activity (PA)

According to perceived barriers to PA, a total of 207 (50.7%) out of 408 women had barriers to engaging in PA. The overall potential range of scores on the PA barriers scale was 0 to 147. The mean and the median of the PA barriers score were 76.4±1.5, 78.0 score, respectively. Physical environmental barriers to PA ranked as the most important barriers to PA (56.6%), followed by social environmental (51.6%), and personal barriers (48.6%) (**see Table 4.3**). The analysis revealed that overall barriers to engaged PA score was significantly higher among women in low-income level (p=<.025, 59.9%), but not significantly associated with age, education, marital, and occupation status (**see Table 4.5**).

Regarding personal barriers to PA subgroups score, lack of willpower (60.0%), was found to be the most important personal barriers to PA reported by women, followed by lack of knowledge (57.3%), fear of injury (55.9%), lack of energy (52.7%), lack of skills (50.5%), lack of self-confidence (43.8%), having healthy problems (38%), and lack of enjoyment (34.1%) (**see Table 4.3**). Ranking the women who responded "very likely" to personal barriers to PA items identified five important barriers including: (1) I do not know how much time I should exercise every day (51.9%); (2) I do not know which PA is suitable for me (49.8%); (3) I have not been counseled about importance of PA (by a doctor or dietitian)(42.5%); (4) It is too easy for me to find excuses not to exercise (42.4%); and (5) I've been thinking about getting more exercise, but I just can't seem to get started (40.1%) (**Appendix D.1**). The personal PA barriers score was significantly higher among women with less than a high school diploma (p=<.001, 63.3%,), and was significantly higher among women in low-income levels (p=<.027, 58.9%), but not significantly associated with age, marital, and occupation status (**see Table 4.5**).

According to social environmental barriers to PA subgroups score, the lack of time (63.6%) was found to be the most important social environmental barriers to PA reported by women, followed by lack of support (57.6%), social norms (56.6%), and social influence (55.7%) (**see Table 3.2**). Ranking the women who responded "very likely" to social environmental barriers to PA identified five barriers including: (1) If I wanted to practice PA outside the home (e.g., in public or in the gym), I would need to ask permission first from my father or husband (74.2%), (2) My family does not allow me to use transportation services (such as a taxi) to go outside to do exercise. (72.7%), (3) If I wanted to buy exercise equipment (e.g., treadmill), I would need to ask permission first from my father or husband (62.9%), (4) My family (father, husband, or brother) does not allow me to walk alone outside in public areas (58.8%), and (5) My family does not allow my friend to pick me up to or from a gym (41.8%) (**Appendix D.1**). Social environmental PA barriers score was significantly higher among adolescents (15-19 years) (p=<.024, 64.8%), but was not significantly associated with education level, income, marital, and occupation status (**see Table 4.5).**

Regarding the physical environmental PA barriers subgroups score, the hot weather (59.9%) was found to be the most important physical environmental barrier to PA reported by women, followed by lack of resources (53.3%), and lack of transportation (52.7%) (**see Table 4.3**). Ranking the women who responded "very likely" to physical environmental PA barriers items identified five important barriers including: (1) There is no walking track in a mall that I can walk on it in the summer time (86.9%), (2) It's too hot to exercise outdoors (66.8%), (3) It is not safe to walk in my neighborhood (60.2%), (4) There is lack to access to PA facilities such as jogging trails, sidewalks, or swimming pools (56.5%), and (5) Usually, I have difficulty in transportation to go outside home to do exercise (54.0%) (**Appendix D.1**). Physical environmental PA barriers score was significantly higher among women in age group (20-35 years) (p=<.040, 62.6%), but was not significantly associated with education level, income, marital, and occupation status (**see Table 4.5**).

Relationship between total perceived barriers scores to maintaining healthy body weight (HEs and PA barriers) and eating habits (EHs) and PA levels (PA)

The maximum possible score of perceived barriers to HE was 123, with a mean of 61.6±1.6, and a median of 63.5 score. While the maximum possible score of EHs was 52 with mean of 37.5±0.27, the results show a significant negative correlation between EHs score and the total score of perceived barriers to HE (p=<.001, r= -0.26) among the study population. In addition, there was a significant negative correlation between EHs, personal (p=<.001, r= -0.3) and the social environmental barriers (p=<.026, r= -0.2) to HE, while there was no correlation with the physical environmental barriers to HE (p=<.676, r= -0.03).

The maximum possible score of perceived barriers to PA was 150 score with a mean of 76.4±1.5 and a median of 78.0 score, while the mean for PA level was 953.1±63.0 (MET min/week). The results show no significant correlation was found between PA level and the total score of perceived barriers to PA (p=<.546, r= 0.06) among the study population, or with the score of PA barriers subgroups (personal, social, and environmental barriers). Moreover, the results show a significant positive correlation between perceived barriers to HE and perceived barriers to PA (p=<.001, r= 0.62), as well a significant positive correlation between EHs and PA levels (p=<.001, r= 0.16) (**see Table 4.6**).

Logistic regression analysis and obesity (BMI) and perceived barriers to maintaining healthy body weight

A binary logistic regression was run to test the predictive relationship between the perceived barriers that Saudi women face in HE and PA and general obesity ($BMI \geq 25 kg/m^2$) (**see Table 4. 7**). The overall regression model was not significant, and explained 1.5% (Cox & Snell) and 1.2% (Nagelkerke) of the variance in obesity, Wald F (2) = 5.22, p=.074. The perceived barriers to PA was a significant predictor within the model (p=.024), but not the perceived barriers of HE (p=.183).

Multiple linear regression analysis and abdominal obesity and perceived barriers to maintaining healthy body weight

A multiple linear regression was run to test the predictive relationship between the perceived barriers that Saudi women face in healthy eating and being physically active and abdominal obesity (WC). The overall regression model was not significant, and explained 0.6%, R^2=.006, Wald F (2) = 0.994, p=.608. Neither of the predictor variables (HE and PA barriers) were significant within the model (p=.319, p=.455, respectively) (**see Table 4.8**).

DISCUSSION

Obesity and unhealthy lifestyle choices are growing problems associated with major health issues. In order to develop appropriate and effective obesity prevention strategies for Saudi women, the key point is to understand the barriers they perceive in attempting to maintaining a healthy weight. To the best of the authors' knowledge, this is the first study conducted to identify how conservative Saudi cultures, and politics affect the EHs and PA among a representative sample of non-pregnant Saudi women of reproductive age (15–49 years) obtaining services at PHCCs in Jeddah.

This study produced some important findings among the study population: (1) it estimated a high prevalence of overweight (29.5%), obesity (33.8%), abdominal obesity (25%), physical inactivity (31.2%), sedentary behaviors (87.8%), and unhealthy EHs (24%); (2) it identified considerable perceived personal, social, and physical environmental barriers to HE and PA; (3) it recognized some associations between perceived barriers to maintain healthy body weight (HE and PA barriers) and different socio-demographic characteristics; (4) it found a significant association between overall HE barriers score and age and between overall PA barriers score and income level; and (5) it illustrated a positive relationship between EHs and PA level, as well as a negative relationship between EHs score and overall HE barriers score, and HE barriers categories—personal, and social environmental barriers.

Perceived barriers to maintaining a healthy body weight

Maintaining a healthy body weight is important for overall health and can help prevent and control many diseases and conditions (4). Previous studies in Saudi Arabia and Arab countries have concluded that Arab women face more perceived barriers to healthy lifestyle than men, particularly for PA (42,54-57). The findings of the current study illustrate that a high proportion of Saudi women face great barriers to maintaining their healthy weight related to adapting healthy EHs or engaging in PA. Overall, nearly half of the women had high scores in HE and PA barriers, which indicated that both barriers played important roles in being unable to maintaining their body weight and having unhealthy lifestyles. These findings confirmed and were consistent with the high prevalence of overweight, obesity, physical inactivity, and unhealthy EHs among the study population. The sum score for each barrier category (personal, social, and environmental barriers) showed that nearly half or more of the women had high-score barriers for HE and PA across all barrier categories. However, the women tended to rate physical environmental barriers as the key perceived barriers to HE and PA, followed by social environmental then personal barriers. These findings are in line with those in the literature, in which there was a consensus that the physical environmental barriers are more likely to be an important source of influence on obesity-related behaviors (58). Therefore, these findings highlight that the effort to prevent obesity should not ignore the physical environmental barriers related to the lack of recourses, facilities, and the cost to HE and PA among women who are at a high-risk of weight gain.

Eating habits and perceived barriers to healthy eating

Diet and nutrition play important roles in maintaining health and preventing numerous diseases (4). A decrease in morbidity and mortality associated with lifestyle health diseases may be achievable if healthy EHs are adopted early in life and maintained in the long term (8). However, the present study showed a high proportion of the women (54%) had unhealthy EHs and (30%) partially satisfactory EHs. Some unhealthy EHs common among the study population included (1) consuming less amounts of fruits and vegetables, (2) drinking less than the recommended amount of water daily, and (3) a high prevalence of fast-food consumption. This finding indicates that there is a need to improve those women's eating habits and for intervention to promote healthy dietary habits to reduce the prevalence of obesity.

Nearly half of the women (49.3%) had personal barriers to HE. Moreover, the sum score of the personal barriers subgroups to HE showed that the lack of personal enjoyment to healthy foods, lack of personal skills to plan, shop for, prepare, or cook healthy foods, the lack of personal willpower, and knowledge were the most important personal barriers to HE among the study population. These findings are in line with those reported by previous studies (55,59). Al-Farwan (2011) found that the most important personal barriers among 302 Saudi women (overweight and obese), age 16–60 years old, were the lack of personal information on healthy foods combined with the lack of skills to prepare and cook healthy foods (61.2%) and the lack of personal motivation to eat healthy foods (56.6%) (59). Similar findings were observed among 327 young Kuwaiti women (age 19–26), the lack of personal skills (70%), enjoyment (59.3%), motivation (57.2%), and knowledge (56.3%) seemed to be the most important barriers to eat healthy foods among those young women (55).

Personal barriers to HE were significantly higher among adolescents, low-income, and women who had never married. The personal barriers were also seen as barriers to HE in adolescents (2240 males and 2458 females), age 15–18, in seven Arab countries (Algeria, Jordan, Kuwait, Libya, Palestine, Syria, and the United Arab Emirates) (56). In the present study, the personal barriers to HE were significantly higher among low-income women and women who had never married and could be due to the fact that 60.1% (n = 75) of the low-income women and 37.3% (n = 47) of the women who had never married were less educated (less than a high school diploma) and were more likely to not have enough knowledge in nutrition and healthy foods. These findings highlight the central role of cognitive factors as barriers to healthy eating, and there is a need to improve those women's knowledge of nutrition and their skills to plan and prepare tasty healthy foods. Therefore, it is important to promote healthy eating as well as a healthy lifestyle among those women practically in the adolescent age group, and in low-income and never-married women.

Our study indicated a high prevalence of social environmental barriers to HE (51.1%) among the study population. The sum score of the social environmental barriers subgroups to HE (lack of time, social influence, and lifestyle changes) showed that the lack of time to prepare and plan healthier meals (due to family commitments and social activities) was the most important social environmental barriers to HE among the study population. In previous studies, lack of time was one of the most frequently reported barriers in developed and developing countries (42,55,60,61). In the current study, when the response categories very likely and somewhat likely were combined, the lack of time related to family and social commitment (reported by 39.5%) was more common than the lack of time due to job demands (34.1%) in the study population. The women's lack of time for HE could be related to the fact that 46.6% (n = 190) of the study sample were students and employees, with 71% (n = 73) of the students being married and 41% (n = 42) of them having four or more children and with 65.6% (n = 57) of the employed women being married and 27.5% (n = 24) of the them having four or more children. Therefore, it seems difficult for them to find time to plan and cook healthy foods, and it seems that they need time-management help.

Additionally, social relationships and interactions can have positive and negative influences on lifestyle and weight status (62). The current study also revealed that there was a high social influence on the women's EHs (51.8%); 56.5% of the women reported that "usually healthy foods are not served at social activities," and 43.6% of the women reported that "it can be hard to stick with an HE plan when family and friends do not want to join" them. Therefore, the weight management interventions should include strategies that solicit support to help women lose and maintain their weight and overcome social influences and interactions that undermine HE efforts. However, no significant differences were found among the study group across all socio-demographic variables according to HE social environmental barriers. Perhaps this was due to those women living in a very conservative society, hence sharing the same influence of traditional socio-cultural factors and a less-supportive society.

The results revealed that more than half of the women had a lack of resources barrier (e.g., lack of money, food availability, and cooking facilities) that related to the HE physical environmental barriers. Among the lack of recourses barriers, “there’s not much choice of healthy foods when eating outside of the home” was the main barrier reported by the women related to HE physical environmental barriers. This finding was consistent with a previous Saudi study that demonstrated the lack of recourses to HE was stated by 60.2% of the study group (144 men and 306 women), age 15–80, and was significantly higher among the younger age group (15–30 years) (71.7%) and the never-married group (91.9%) (42). However, no significant associations were found between HE physical environmental barriers across all socio-demographic variables among the current study’s population. The lack of associations found between socio-demographic variables and physical environmental barriers to HE could be because the women in the current study belonged to a young age group, the same social class, and the majority of them were married.

Physical activity level and its perceived barriers

PA is an important component of a healthy lifestyle and has been described as an essential factor in managing many health conditions and to combating the obesity epidemic (11,12). Using the IPAQ short-form instrument, this study showed that physical inactivity among the study sample was 31.2%. These findings confirmed and were consistent with the high prevalence of physical inactivity (assessed by the IPAQ) among Saudi women reported by Al-Hazzaa (2007) (14). Al-Hazzaa (2007) found that the physical inactivity prevalence among 362 Saudi women (age 15–75) was 34.3%. In the Al-Hazzaa (2007) study and our study, the portion of the women walked for 150 minutes or more per week had only met (28.5% vs 29%) from the current USDA PA guidelines for adults, which recommend a minimum of minutes/week of moderate activity for weight management (13). Low levels of walking among the current study population may contribute to a high dependency of the women on using cars for daily commuting, which may have limited their movements.

Consistent with other studies, the current study found that a high proportion of women faced great barriers to PA (5,42,56,57). The sum scores in the current study showed that the women had high score barriers across all personal barriers subgroups for PA. The lack of willpower (60%) was ranked as the most important personal barrier to PA, and the lack of enjoyment was ranked as less important (34.1%). The Al-Quaiz (2009) study found that the personal barrier to PA was higher among women than men; a lack of willpower (78.9%) was ranked as the most important personal barrier to PA among women, followed by a lack of energy (77%), lack of skills (48.9%), and fear of injury (22.9%) (42). Furthermore, in the present study, the personal barrier to PA was significantly higher among less-educated and low-income women. These findings are parallel with the high physical inactivity levels observed among those women. Nearly 38% of those with less education and 34% of those with a low-income level were physically inactive. Previous studies have concluded that a lower social class background serves as a barrier to engage in any PA or sport (63,64). These findings suggest that community-based interventions and public health strategies should concentrate efforts on these subgroups in order to reach and help them overcome such barriers and increase their PA level (65).

Our study indicated a high proportion of the women had high scores in social environmental barriers to PA (49.9%). The sum score of social environmental barriers subgroups to PA (lack of support, lack of time, social influence, and social norms barriers) showed that the lack of time engaged in PA was the most important subgroup barriers for PA social environmental barriers among the study population. These findings were in agreement with previous studies (55,60,65). However, in our study, the other social environmental subgroups barriers that also had a considerable impact on the women's PA included the lack of support from family and friends and a lack of social influence and norms. The analysis indicated a considerable proportion of the women need to have permission from their fathers or husbands to practice the PA outside of the home (in a public area or in a gym) (74.2%) or to have and buy any exercise equipment (62.9%). Since the Saudi women are prohibited from driving, a large proportion of the women reported that their family did not allow them to use public transportation services if they went out home to practice the PA (72.7%), or they were not allowed to have friends pick them to take them to or from the gym (41.4%). Furthermore, social environmental barriers to PA were significantly higher among adolescents ages 15–19. This relationship could be due to 74.9% of the adolescents unmarried and living with their parents or guardians. These findings highlight the great impact of the conservative Saudi society, norms, and politics on women's PA levels. Therefore, to help those women be more active and have a healthy life, efforts should be concentrated to mitigate these social barriers and norms.

Additionally, the data revealed a high proportion of the women had faced physical environmental barriers to PA (56.6%). The sum score of physical environmental barriers subgroups to PA (lack of resources, lack of transportation, and hot weather barriers) showed that the most important barriers for women across those barriers subgroups was the hot weather in Jeddah, which prevented them for exercising outdoors. Also, Musaiger (2014) found that 58.7% of the young Kuwaiti women (age 19–26) had barriers to practicing PA due to the hot weather (55). It is well known that Saudi Arabia and the Arab Gulf countries all have long (six months) and hot summer season (43 °C, 109 °F). Therefore, the chance for outdoor PA or sports during the year is limited for Saudi and Arab Gulf people. Furthermore, in the present study we found a considerable proportion of the women reported that the absence of walking track in the malls (indoor mall walking track roof with air conditioner) prevented them from walking during the summertime (86.9%). When considering the lack of PA resources and transportation, 60.2% of the women reported that walking in their neighborhood was unsafe, 56.5% reported there was a lack of access to PA facilities (e.g., jogging trails, sidewalks, or swimming pools), and 54% had difficulty finding transportation to go outside the home to exercise. These findings were not surprising, since in Saudi Arab, women are prohibited from driving and practicing PA at the public schools, and there is limited access to join gym clubs or walking outdoors in the hot temperature (15). As with the social environmental barrier to PA, the physical environmental barrier to PA was significantly higher among adolescents, age 15–19. This association also could be due to those women being unmarried and living with their parents or guardians and needing their permission to access a PA facility to practice the PA. In order to facilitate the promotion of PA in

Saudi Arabia, specific gender-based barriers should be taken into consideration when making recommendations to promote PA, which means that intervention and motivation programs should be customized to suit the needs of the individual, with gender as a primary consideration.

Relationship between perceived barriers to maintaining healthy body weight and eating habits and physical activity

A systematic review of peer-reviewed studies of PA among adults found a positive association between EHs and PA (66). Al-Hazzaa (2014) found a positive significant association for many healthful dietary habits with PA among 2822 Saudi adolescents (15–19 years old, 51% female) conducted in three major cities in Saudi Arabia (Al-khober, Al-Riyadh, and Jeddah) (67). The results of the current study, in agreement with those findings, found a positive significant association between EHs and PA among the study population

Multiple personal, social, and physical environmental barriers influence the EHs and PA in women (5,42,55,59). The current study findings confirmed the relationships between EHs and these barriers. There was a significant inverse association between the women's EHs and overall HE barriers and the HE categories barriers: personal, and social environmental barriers. However, there were no significant associations found between PA level, overall PA barriers, and the PA subgroup barriers: personal, social, and physical environmental barriers. While a review of the correlations of PA in adults demonstrated a significant inverse association between the PA and the environmental and personal barriers, the magnitude of their association with physical inactivity depends on the population studied (66). Moreover, in a convenience sample of 285 Hispanic/Latino women age 20–50 living in Northern Virginia, USA, the social environmental barrier had a significant negative association with PA, while personal and physical environmental barriers were not significantly associated with PA (68). One possible explanation for the divergent findings may be due to the high proportion of women in the current present study who suffered from PA barriers, even if they were active. The data revealed 52.1% (n = 145) of the active women faced PA barriers.

Association between obesity and barriers to maintaining healthy body weight

This study found a relatively high prevalence of overweight and obesity among the study population, and only 26.6% (108) of the women fell within normal or healthy weight. However, no significant differences were found between obese and non-obese women (BMI and WC) regarding the overall barriers score to maintaining healthy body weight (HE or PA barriers). These findings are in agreement with a previous study's finding that investigated the barriers to weight maintenance among 530 university students (203 men and 327 women), ages 19–26, in Kuwait (55). They did not find any significant associations between obese and non-obese women regarding barriers to HE and PA. This finding could be due to the highly prevalent perceived barriers to maintaining healthy body weight among our study population even among women with normal weight.

Study limitation

The study had a few limitations. First, the cross-sectional nature of the study would not allow for cause-effect relationships to be established. Second, the questionnaire assessments of PA are subject to recall bias, and the self-reported PA did not provide accurate estimates of absolute amounts of activity (Metabolic Equivalent Task minutes per week). A third limitation was that the results of the study could only be generalized to non-pregnant Saudi women of reproductive age (15–49 years) who obtained services at PHCCs in Jeddah City, and were not applicable to all Saudi women living in Jeddah or other cities in Saudi Arabia. Therefore, replication of this study in different populations or in different cities in Saudi Arabia (such as rural or mountainous areas) is highly suggested to allow for comparisons between study results. Comparison between studies results may provide different data and different recommendations that help to develop appropriate and effective obesity prevention strategies for Saudi women.

CONCLUSION

The current study's data show that obesity, unhealthy eating habits, and physical inactivity are major health problems in Saudi women in Jeddah. Findings from this study demonstrated that there were several personal, personal, social, and physical environmental barriers related to HE and PA facing Saudi women in Jeddah. To our knowledge, this is also the first study to explore a range of personal, social, and physical environmental factors that act as barriers to maintaining a healthy weight through healthy EHs and PA levels among the study population. Determining these factors and barriers is vital to creating effective programs for combating obesity not only among the women of Jeddah City but also, potentially, women in other Saudi Arabian cities. Barriers related to the physical environment had the greatest effect on HE and PA, with significant associations between overall HE barriers score and age, and between overall PA barriers score and income level. Adolescents faced the most barriers to eating healthy foods, while women with low incomes faced the most barriers to engaging in PA. As well, low-income and married women were the most likely to experience personal barriers to eating healthy foods, while women with low incomes and low education levels were the most likely to report personal barriers to engaging in PA. Adolescents were also highly influenced by social and physical environmental barriers to be inactive. These findings suggest that community-based interventions and public health strategies should concentrate on adolescents and women with low incomes. The most common barriers to HE and PA in the study group were lack of willpower, skills, knowledge, enjoyment, time, and resources, as well as social influences. Efforts should therefore focus on mitigating these personal, physical environmental, and social barriers. In addition, we found that hot weather and the absence of walking tracks in malls stopped women from walking or exercising during summer. Thus, we recommend creating air-conditioned walking tracks inside malls to encourage PA during summer. Ultimately, such information can be used to design gender- and culture-sensitive interventions that could enhance adherence to EHs and PA that are relevant to the Saudi society.

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TABLES

Table 4.1. Anthropometric characteristics of non-pregnant Saudi women of reproductive age residing in Jeddah city, Saudi Arabia (n=408).

Anthropometric characteristics	Number	Percentage of total[a]	Mean± SE[b]
Height (cm) (mean± SE)			156.5±0.4
Weight (kg) (mean± SE)			67.7±1.3
BMI (kg/m^2) WHO cutoff			
Underweight (<18.5)	41	10.1	
Normal (18.5-24.9)	108	26.6	
Overweight (25–29.9)	121	29.5	
Obese (≥30)	138	33.8	
WC (cm) (mean± SE)			80.4±1.1
WC (cm) WHO cutoff			
Normal (<88)	306	75.0	
Health Risk (≥88)	102	25.1	

Abbreviations: WHO= World Health Organization, BMI=Body mass index, WC =waist circumference, kg=kilogram, m^2 = meter square, cm= centimeter. [a]Percentage may not total to 100% due to rounding, [b]mean ± standard error.

Table 4. 2. Eating habits, physical activity and sedentary lifestyles in non-pregnant Saudi women of reproductive age residing in Jeddah city, Saudi Arabia (n=408).

Variables	n(%)[b]	Variables	n(%)[b]
Eating Habits Scores (mean± SE)[a]	37.5±0.27	Eat while watching the TV	
Inadequate Eating Habits	97(24.0)	Always	84(20.5)
Partially Satisfactory Eating Habits	122(30.0)	Often	99(24.2)
Satisfactory Eating Habits	189(46.0)	Sometime	104(25.5)
Number of main meals/day (mean± SE)	2.4±.04	Never	121(29.8)
One	17(4.1)	Fast food Consumption	
Two	219(53.8)	Yes	345(87.7)
Three	172(42.1)	No	63(15.3)
Breakfast Consumption		Number of fast food Consumption/week	
Always	174(42.5)	One	111(27.2)
Often	70(17.1)	Two or more	234(72.8)
Sometime	121(29.6)	Types of foods usually consumed [d]	
Never	43(10.6)	Traditional Saudi foods (e.g., Kabsa, Qursan, or Jarish)	398(97.6)
Consume (200gm) of fruit/day		Local fast foods (e.g., falafel, Shawarma, Masoob, or Motabag)	205(50.2)
Always	53(13.0)	American fast foods (e.g., McDonalds, or Burger King)	187(46.0)
Often	82(20.0)	Mediterranean foods (e.g., Lebanese, or Egyptian, foods)	157(38.5)
Sometime	225(55.3)	Asian foods (e.g., Indian, Chains, or Thai foods)	32(7.8)
Never	47(11.6)	Physical activity and sedentary lifestyles	
Consume (200gm) of vegetables/day		Waking 150 mints or more /week	118(29)
Always	105(25.9)	Sitting hours/day (mean± SE)	2.85±0.1
Often	144(35.2)	Physical activity (MET min/week)[c](mean± SE)	953.11±62.9
Sometime	141(34.6)	Low activity	131(32.0)
Never	18(4.3)	Moderate activity	262(64.2)
Snacks consumption		Vigorous activity	15(3.8)
Always	92(22.6)		
Often	115(28.2)	Sleeping hours per night (mean± SE)	6.5±0.1
Sometime	166(40.6)	Taking a nap	220(54.1)
Never	35(8.6)	Leisure time activities [d]	
Drink 8 cups of water/day		Walking	18(4.3)
Always	69(16.9)	Sport	8(1.9)
Often	36(8.8)	Shopping	27(6.4)
Sometime	74(18.1)	Dancing	24(5.8)
Never	229(56.2)	Watching TV/listening to music /using a computer or phone/ reading	358(87.8)
Drink a cup of milk products/day		Main reasons for doing regular physical activities [d]	
Always	169(41.4)	Health benefits	301(73.8)
Often	74(18.3)	To lose weight	194(47.6)
Sometime	114(27.8)	Recreation	51(12.4)
Never	51(12.5)	To lose weight	194(47.6)
Eating late after 8pm		Using cars for transportation	404(99.2)
Always	195(47.9)		
Often	100(24.5)		
Sometime	69(16.9)		
Never	44(10.7)		

[a]mean ± standard error, [b]Percentage may not total to 100% due to rounding, [c]MET, Metabolic Equivalent Task, [d] Respondents can select more than one answer or choice (multiple response items).

Table 4.3. Perceived barriers[a] scoring to healthy eating habits and physical activity among non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

Perceived barriers to maintain body weigh	Not. Imp. B. n(%)	Imp. B. n(%)	Rank-items	Rank-subgroups
Over all healthy eating barriers	207(50.7)	201(49.2)		
a. Personal to healthy eating barriers	207(50.8)	201(49.2)		3
Lack of Willpower	193(47.4)	215(52.6)	5	a(3)
Lack of Knowledge	197(48.2)	211(51.8)	7	a(4)
Lack of Skills	173(42.3)	235(57.7)	3	a(2)
Lack of Enjoyment	169(41.5)	239(58.5)	2	a(1)
b. Social environmental to healthy eating barriers	199(48.9)	209(51.1)		2
Lack of time	205(38.3)	252(61.7)	1	b(1)
Social Influence	196(48.2)	212(51.8)	6	b(2)
Lifestyle changes	151(53.7)	257(46.3)	8	b(3)
c. Physical environmental to healthy eating barriers	190(46.5)	218(53.5)		1
Lack of resources	190(46.5)	218(53.5)	4	c(1)
Overall physical activity barriers	201(49.3)	207(50.7)		
a. Personal barriers to physical activity	210(51.9)	198(48.6)		3
Lack of Willpower	163(40.0)	245(60.0)	2	a(1)
Lack of self-confidence	229(56.2)	179(43.8)	12	a(6)
Lack of Skills	202(49.5)	206(50.5)	11	a(5)
Lack of Enjoyment	269(65.9)	139(34.1)	14	a(8)
Lack of Knowledge	174(42.7)	234(57.3)	5	a(2)
Lack of Energy	193(47.3)	215(52.7)	10	a(4)
Fear of Injury	180(44.1)	228(55.9)	7	a(3)
Health Problems	200(62.0)	155(38.0)	13	a(7)
b. Social environmental to physical activity barriers	205(51.1)	203(49.9)		2
Lack of Support	173(42.9)	235(57.6)	4	b(2)
Lack of Time	149(36.4)	259(63.6)	1	b(1)
Social Influence	181(44.3)	227(55.7)	8	b(4)
Social Norms	176(43.2)	232(56.8)	6	b(3)
c. Physical environmental to physical activity barriers	177(43.3)	231(56.6)		1
Lack of resources	191(46.7)	217(53.3)	9	c(2)
Lack of Transportation	193(47.3)	215 (52.7)	10	c(3)
Hot Weather	164(40.1)	244(59.9)	3	c(1)

Abbreviations: Imp. B., important barrier; Not. Imp. B., not important barriers.

[a]Barriers were rated on 4-point Likert scale that ranged from "very likely" (3) to "very unlikely" (0).

The median score for the scale was used to divide barriers score into important versus not important barriers.

Table 4.4. Socio-demographic characteristics by perceived barriers[a] to healthy eating (HE) among non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

	Over all HE barriers			Personal HE barriers			Social environmental HE barriers			Physical environmental HE barriers		
	Imp. Barriers	Not. Imp Barriers	P value[b]	Imp. Barriers	Not. Imp. Barriers	P value[b]	Imp. Barriers	Not. Imp. Barriers	P value[b]	Imp. Barriers	Not. Imp. Barriers	P value[b]
Age groups			.028*			.001*			.671			.572
Adolescents (15-19yrs)	41(58.8)	29(41.2)		49(69.7)	21(30.3)		34(48.8)	36(51.2)		41(58.5)	29(41.5)	
Young women (20-35yrs)	112(53.3)	98(46.7)		106(50.7)	103(49.3)		113(54.0)	96(46.0)		109(52.0)	101(48.0)	
Middle age (36-49yrs)	48(7.9)	80(62.5)		45(35.3)	83(64.7)		61(47.9)	76(52.1)		68(53.3)	60(46.7)	
Education level			.160			.193			.086			.061
Less than high school	59(53.1)	67(46.9)		66(52.8)	59(47.2)		53(47.3)	72(57.7)		73(58.4)	52(41.6)	
Completed high school	57(58.1)	41(49.9)		56(56.9)	42(43.1)		58(58.8)	41(41.2)		59(60.4)	39(39.9)	
More than high school	85(46.3)	99(53.7)		79(56.9)	106(57.3)		98(53.2)	86(46.8)		86(53.3)	98(46.7)	
Income level			.227			.011*			.094			.178
Low income (< 8,000SAR)	74(46.2)	86(53.8)		100(62.9)	59(37.1)		74(46.7)	85(53.3)		97(61.1)	62(38.9)	
Middle income (8000-18,000SAR)	65(48.6)	111(51.4)		93(43.0)	123(57.0)		123(57.0)	93(43.0)		106(49.1)	110(50.9)	
High income (> 18,000SAR)	11(32.7)	22(67.3)		8(23.4)	25(76.6)		12(34.9)	22(65.1)		15(46.1)	18(53.9)	
Marital status			.136			.049*			.711			.590
Never married	72(56.5)	55(43.5)		77(60.9)	50(39.1)		63(49.8)	64(50.2)		71(56.2)	56(48.0)	
Married	129(46.1)	152(53.9)		123(43.9)	158(56.1)		146(48.2)	135(51.8)		147(52.3)	134(47.7)	
Occupation status			.175			.369			.803			.838
Housewife	116(57.8)	102(49.1)		115(52.8)	103(47.2)		113(51.8)	105(48.2)		120(55.0)	98(51.8)	
Employed	41(47.4)	46(52.6)		42(48.2)	45(51.8)		47(53.7)	40(46.6)		45(52.1)	42(47.9)	
Student	44(42.3)	59(57.7)		44(42.4)	59(57.6)		49(47.8)	54(52.2)		53(51.8)	50(48.2)	

Abbreviations: Imp. B., important barrier; Not. Imp. B., not important barriers. [a]Barriers were rated on 4-point Likert scale that ranged from “very likely” (3) to “very unlikely” (0). The median score for the scale was used to divide barriers score into important versus not important barriers. [b]chi-square test of independence, *significant p=<.05.

Table 4.5: Socio-demographic characteristics by perceived barriers[a] to physical activity (PA) among non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

	Over all PA barriers			Personal PA barriers			Social environmental PA barriers			Physical environmental PA barriers		
	Imp. Barriers	Not. Imp Barriers	P value[b]	Imp. Barriers	Not. Imp. Barriers	P value[b]	Imp. Barriers	Not. Imp. Barriers	P value[b]	Imp. Barriers	Not. Imp. Barriers	P value[b]
Age groups			.188			.083			.024*			.040*
Adolescents (15-19yrs)	44(62.6)	26(37.4)		44(62.5)	26(37.5)		46(64.8)	25(35.5)		41(58.3)	29(47.7)	
Young women (20-35yrs)	106(50.6)	104(49.4)		92(43.9)	118(56.1)		111(53.0)	99(47)		131(62.6)	78(37.4)	
Middle age (36-49yrs)	57(44.2)	71(55.8)		62(48.5)	66(51.5)		51(59.7)	76(40.0)		58(45.7)	69(54.3)	
Education level			.106			.001*			.427			.514
Less than high school	75(59.9)	50(40.1)		79(63.3)	46(36.7)		67(53.6)	58(46.4)		66(52.4)	60(47.6)	
Completed high school	47(52.2)	51(47.8)		48(48.9)	50(51.1)		54(54.8)	44(45.2)		55(55.6)	44(44.4)	
More than high school	85(54.0)	100(46.0)		71(38.3)	114(61.7)		87(47.2)	97(52.8)		111(60.0)	74(40.1)	
Income level			.025*			.027*			.067			.551
Low income (< 7,999SAR)	94(59.9)	64(40.1)		94(58.9)	65(41.1)		94(58.7)	66(41.3)		96(60.3)	63(39.7)	
Middle income (8000-17,999SAR)	99(46.0)	116(54.0)		95(55.9)	120(44.1)		98(45.3)	118(54.7)		118(54.6)	98(45.4)	
High income (> 18,000SAR)	12(36.3)	21(63.7)		9(27.3)	24(72.7		17(51.8)	16(48.2)		17(512)	16(48.8)	
Marital status			.074			.782			.396			.078
Never married	72(56.6)	55(43.4)		63(49.6)	64(50.4)		68(53.9)	59(46.1)		79(62.4)	48(37.6)	
Married	135(48.0)	146(52.0)		135(48.1)	146(51.9)		140(49.7)	141(50.3)		152(54.0)	129(46.0)	
Occupation status			.383			.237			.107			.344
Housewife	117(53.8)	101(46.2)		114(52.3)	104(47.7)		120(55.3)	97(44.7)		125(57.4)	93(42.4)	
Employed	44(50.1)	44(49.9%)		42(47.9)	45(52.1)		43(49.6)	44(50.4)		54(62.1)	33(37.9)	
Student	46(44.6)	57(55.4)		43(41.3)	60(58.7)		45(43.2)	58(56.8)		52(50.2)	51(49.8)	

Abbreviations: Imp. B., important barrier; Not. Imp. B., not important barriers. [a]Barriers were rated on 4-point Likert scale that ranged from "very likely" (3) to "very unlikely" (0). The median score for the scale was used to divide barriers score into important versus not important barriers. [b]chi-square test of independence, *significant p=<.05.

Table 4.6. Correlation between perceived barriers to maintaining body weight (healthy eating and physical activity barriers) and eating habits score and physical activity level among non-pregnant Saudi women of reproductive age residing in Jeddah city, Saudi Arabia (n=408).

	PA (MET min/week)[a]	
	r[b]	**P value**
EHs score	0.16	.001*
	Overall PA barrier score	
	r[c]	**P value**
Overall HE barrier score	0.62	<.001*
	EHs score	
	r[c]	**P value**
Overall HE barrier score	-0.26	<.001*
• Personal HE barrier	-0.3	<.001*
• Social environmental HE barrier	-0.2	.026*
• Physical environmental HE barrier	0.03	.676
	PA (MET min/week)[a]	
	r[c]	**P value**
Overall PA barrier score	0.06	0.564
• Personal PA barrier	0.05	0.537
• Social environmental PA barrier	0.5	0.127
• Physical environmental PA barrier	0.08	0.143

Abbreviation: MET: Metabolic Equivalent Task, HE: healthy eating, PA: physical activity, EHs: eating habits. [a] logarithm of PA, [b] Spearman correlation, [c] Pearson Correlation. * Correlation is significant at the 0.05 level (2-tailed).

Table 4. 7. Logistic regression of association between general obesity (BMI) and the perceived barriers to maintaining body weight in non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

Barriers	B	SE	Wald x^2	P value	Odds ratio	95%CI
Perceived barriers of healthy eating	0.02	0.02	1.80	.18	1.02	0.97-1.70
Perceived barriers to being physically activity	0.19	0.01	5.10	.02	0.98	0.96-1.00
Constant	-0.38	0.60	0.53	.531	0.70	0.18-2.62
Wald x^2	5.22(df=2), P value= .074					
Cox and Snell pseudo R^2		0.051				
Nagelkerke pseudo R^2		0.021				

Abbreviations: B Coefficient, SE stander error, CI confidence interval.

Table.3.8. Multiple linear regressions of association between Abdominal obesity (WC) and the perceived barriers to maintaining body weight in non-pregnant Saudi women of reproduction age residing in Jeddah city, Saudi Arabia (n=408).

Risk factors [a]	B (95%CI)	SE	Wald x^2	P value
Constant	80.2(71.2,89.1)	4.0	400.6	<.001
Perceived barriers of healthy eating	0.074(-0.1,0.2)	0.07	0.99	.319
Perceived barriers to physical activity	-0.09(-0.4, 0.2)	0.12	0.58	.445
Wald x^2 0.99(df=2)				**.608**
R^2 0.006				

Abbreviations: WC waist circumference B Coefficient, SE stander error, CI confidence interval.
[a] Only significant factors are presented.

Chapter 5: Conclusion

The current study, a survey of 408 Saudi women aged (15-49 years old) (non-pregnant women of reproductive age) who attended general clinics at JPHCCs, used a cross-sectional stratified two-stage cluster sampling approach. Notable strengths of the study include the study design, study population, and a representative sample with a high response rate (96.2%) to participate in the study. The study was selected from the most urbanized, liberal, diverse city in Saudi Arabia, Jeddah City. The sample was drawn from a large population to update the data on the prevalence of general (BMI) and abdominal (WC) obesity, and provide new data on (1) factors associated with these two types of obesity, (2) barriers to maintaining a healthy weight, (3) eating habits (EH), and (4) the level of PA and the practice of using exercise equipment at home. Moreover, taking a complex sample approach using specialized software resulted in unbiased parameter estimates, as well as robust standard errors that accurately reflect the variability in the population of interest.

The study had three aims: (1) to identify how socio-demographic, parity, family history of obesity, EH, and PA factors correlate with obesity assessed by BMI and WC in a sample of Saudi women attending JPHCCs; (2) to explore a range of personal, social, and physical environmental factors that act as barriers to maintaining a healthy weight and how these vary by socio-demographic factors and weight status; and (3) to explore obesity rates and PA levels, as well as evaluate the relationship among obesity measurements, family history of chronic disease, and use of exercise equipment at home within the study group.

The finding of remarkably high prevalence of overweight, obesity, and abdominal obesity in the study population confirms and highlights the need for increased attention on the health and well-being of women of reproductive age to reduce and prevent obesity and related health problems. Most important, our study obesity rate is comparable to those reported by the latest National Saudi Health Information Survey (SHIS) among 16 years of age and older Saudi women, suggesting that our obesity rate could be also generalized to all non-pregnant Saudi women. Since the weight gain in this age stage have adverse effects not only on women's short- and long-term health but also on the health of their children, health service providers should adopt, implement, and monitor policies that support healthy weight gain before and during pregnancy and postnatally through primary care physicians and obstetricians/gynecologists.

In addition, this is the first study to identify risk factors associated with general and abdominal obesity among non-pregnant Saudi women of reproductive age attending JPHCCs. Age, family history of obesity, and EHs were significant positive predictors for both general and abdominal obesity, while a fast-food habit was a predictor for general obesity only. Being a student, being in a higher-income level, and eating three main meals were the three factors with significant negative associations with abdominal obesity, while hours of sitting had significant positive associations. An intervention that identifies and targets high-risk individuals will help control and prevent obesity-related disease in this transitional age group. Healthcare practitioners should routinely collect family health history to help identify people at high risk of obesity-related disease, and should utilize every opportunity to include family members in health education.

An important finding of the study was the high proportion of women (54%) with unhealthy EHs. Unhealthy EHs common among the study population included consuming low amounts of fruits and vegetables, drinking less than the recommended amount of water daily, and consuming high levels of fast foods. This finding indicates a need for PHCC education programs that promote healthy eating and healthy lifestyles.

Data on levels of PA and other lifestyle practices among Saudi adult women are lacking, especially among women of reproductive age. The present study provides new information with regard to PA levels, lifestyle, and use of exercise equipment at home among the study group. By using the IPAQ short-form instrument, our study shows a high level of inactive lifestyle among the study population, and a low proportion (29%) of women meeting the USDA PA guidelines for adults (a minimum of 150 minutes/week of moderate activity for weight management). Conservative Saudi society, cultural norms, and politics have a great impact on women's PA levels, such as requiring a guardian for commuting, needing family permission to practice PA outside the home, wearing an abaya, and feeling unsafe walking in the neighborhood. Therefore, an intervention program that mitigates the effect of cultural and societal barriers on PA levels is greatly needed.

Also, we found a high proportion of study participants (45.1%) preferred to do PA at home; 35.5% had exercise equipment and of these women, 61.4% were using it. Women who had and used the exercise equipment were significantly more physically active than those who had it but did not use it. However, we did not find any significant differences in the rates of general and abdominal obesity among the women who used exercise equipment according to the exercise duration per week. Therefore, we greatly recommend that those women to increase workout intensity level and times during the week to get a significant impact to weight loss. In general, the opportunities for PA should be readily available for a wide range of people, and efforts must be made to increase the number of outdoor and indoor walking trails. National recommendations about how much PA Saudi people need for preventing and managing obesity-related disease should be part of this promotional effort. As well, there is a need for a national study with a representative sample to address the issue of sedentary behaviors in Saudi Arabia at large.

To our knowledge, this is also the first study to explore a range of personal, social, and physical environmental factors that act as barriers to maintaining a healthy weight through healthy EHs and PA levels among the study population. Determining these factors and barriers is vital to creating effective programs for combating obesity not only among the women of Jeddah City but also, potentially, women in other Saudi Arabian cities. Barriers related to the physical environment had the greatest effect on HE and PA, with significant associations between overall HE barriers score and age, and between overall PA barriers score and income level. Adolescents faced the most barriers to eating healthy foods, while women with low incomes faced the most barriers to engaging in PA. As well, low-income and married women were the most likely to experience personal barriers to eating healthy foods, while women with low incomes and low education levels were the most likely to report personal barriers to engaging in PA. Adolescents and young women (20-35years) were also highly influenced by social and physical environmental barriers to be inactive, respectively. These findings suggest that interventions and public health strategies should target women of reproductive age and especially adolescents and women with low incomes. The most common barriers to HE and PA in the study group were lack of willpower, skills, knowledge, enjoyment, time, and resources, as well as social influences. Efforts should therefore focus on mitigating these personal, physical environmental, and social barriers. In addition, we found that hot weather and the absence of walking tracks in malls stopped women from walking or exercising during summer. Thus, we recommend creating air-conditioned walking tracks inside malls to encourage PA during summer.

In our study, using different cut-off values of WC (WHO and IDF WC cut-offs) yielded different conclusions regarding the diagnosis of abdominal obesity and its related diseases. Further research is essential to determine ethnic-specific cut-off points for the Saudi Arabia population. Appropriate anthropometric cut-off points may be beneficial in providing criteria for deciding obesity and in correctly identifying individuals at high risk of developing obesity and its related diseases.

Our study has some limitations. First, the cross-sectional nature of the study would not allow for cause-effect relationships to be established between socio-demographic factors and barriers to maintaining a healthy weight and obesity. A second limitation was that the results of the study could only be generalized to non-pregnant Saudi women of reproductive age (15-49 years) who obtained services at PHCCs in Jeddah City, and were not applicable to all Saudi women living in Jeddah or in other cities in Saudi Arabia. We strongly recommend replication of this study using representative sample of Saudi population (National study). The National study should investigate the abdominal obesity using WC beside the general obesity (BMI), and determine the HEs and PA barriers to maintaining a healthy body weight. This study may provide accurate data and result in population-specific recommendations that help develop appropriate and effective obesity prevention strategies for different groups of Saudi women.

APPENDICES

Appendix A.1

Dear Respondent:

I am a graduate student seeking my doctoral degree in the Department of Nutrition and Food Science at the University of Maryland, College Park. The study is being conducted with funding from the Ministry of Health in Saudi Arabia. The enclosed questionnaire has been approved by the IRB (539976-1) on January 14, 2014.
Obesity is a complex, multifactorial condition in which excess body fat may put a person at health risk. The Saudi National health survey indicated that the prevalence of obesity in Saudi Arabia was significantly more in women than in men. The purpose of the enclosed survey is to determine the prevalence of obesity and to identify the most common risk factors that are associated with obesity among Saudi women of reproductive age who are attending Jeddah Primary Health Care (JPHCC). Moreover, it helps identify perceived barriers to weight maintenance among them.

I'm inviting you to participate in this research project because you will be a valued participant in helping to find solution for the problem of increasing prevalence rates of obesity and its complications among Saudi women. With your participation, this study will provide information to reverse these trends that requires changes in individual behavior and the elimination of societal barriers to healthy lifestyle choices.
Be assured that this study will cause you no harm and it will take 30 to 35 minutes to complete. After you have read and signed this consent and agreed to participate, I will ask you some questions in an empty room on how you manage your weight, your knowledge and attitude about eating habits and physical activity and lifestyle. If you give me permission, I will also need to take some physical measurements such as, weight, height, and waist circumference (WC). A trained nurse will take these measurements.
If you choose to participate, all your responses will be kept confidential and your name will not be identified on the questionnaire. Your information will be protected to the maximum extent possible. The information will not be seen by anyone else except me and my professor in the United States.
Your participation in this research is completely voluntary. You may choose not to take part at all. If you do decide to participate in this research, you can stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized and this will not influence your benefits and services provided by the clinic.
Thank you for taking the time to assist me in this research.

Sincerely,

Muneera Alharbi
University of Maryland Department of
Nutrition and Food Science
(240) 264-7054
malharbi.sa@gmail.com

Date: / /	Health sector name:
File number: PHC name:	Application No:

Section 1. Socio-demographic

1.1 Age ………years

1.2 How many years of academic education have you completed?

………years

1.3 What is your current occupation?

(1) housewife (2) student (3) employee (4) Other --- (specify)

1.4 What is your marital status?

(1) never married (2) married (3) separate (4) divorced (5) widowed

1.5 Average monthly household income:

(1) less than 8000 SR (2) 8,000 to SR-17.999 SR (3) 18.000 SR and more (4) Unknown

1.6 Do you have a maid (household help)? □yes □ no

1.7 How many servants do you have at home? (a)-------------- servants (b) none

1.8 Do you: (1) own home (2) rent home (3) Installment (4) government

1.9 How many persons do you live with? --------------Person (s)

1.10 How many rooms in your house? --------------Room(s)

> **Check items in section (2) if you are married or you had married before**
> OTHERWISE (never married and not have been pregnant or abortion, and not have children), go to section (3)

Section 2. Obstetric history

2.1 How many times had you been pregnant (regardless of whether the pregnancies were interrupted (by abortion, or fetal death) or resulted in a live birth.)? …………… times

2.2 How many parity do you have? (Parity refers to the number of pregnancies of 24 weeks (6months) gestation or more).

…………… times

2.3 How many children do you have? …………… children

2.4 How many children had you been breastfed? …………… children □ none

2.5 How long did an average of breastfeed your children? …………months □ never

Section 3. Medical and Family History of Chronic Diseases

3.1 Do you have any of the following health conditions (you can select more than one):

(1). Obesity (2) diabetes (3) hypertension (4) cardiovascular diseases (5) high cholesterol level
(6) high triglyceride level (7) none

3.2 Does anyone in your family (blood relatives) have any of the following health conditions (you can select more than one):

(1). Obesity (2) diabetes (3) hypertension (4) cardiovascular diseases (5) high cholesterol level
(6) high triglyceride level (7) none

Section 4. Eating habits

4.1 How many regular main meals (breakfast, lunch, and dinner) do you eat daily?

(1) one (2) two (3) three (4) none

4.2 Do you eat breakfast?

(1) always (2) often (3) sometimes (4)never

> **If you do not eat breakfast, please go to item number (4.5)**

4.3 Which beverage do you consume at breakfast?

(1) milk/coffee with milk/tea with milk/buttermilk
(2) fresh fruit juice
(3) canned fruit juice or tetra pack fruit juice/cappuccino/hot chocolate
(4) black tea/black coffee
(5) nothing/water
(6) soft drink

4.4 At breakfast, do you eat?

(1) breakfast cereals/oatmeal

(2) fruit/ fruit salad/ veg salad/yogurt
(3) mortadella /liver /turkey with bread
(4) cheese/egg/tuna/hommus/foul with bread
(5) pizza/ croissant /fatayer/biscuits/ daunt / cakes/masoub
(6) indomie

4.5 Do you eat at least 2 portions (200gm) of fruit every day? (One portion of fruits equal to one piece of fruit (size of a tennis ball), 1/2 cut-up fruit, raw, cooked, frozen, or canned , or one-quarter cup dried fruit, or three quarters cup 100 % fruit juice).

(1) always (2) often (3) sometimes (4)never

4.6 Do you eat at least 2 portions (200gm) of vegetables every day (1/2 cut up vegetables, raw, cooked, frozen, or canned, ½ cup cooked, canned or frozen legumes, one-cup leafy greens, or three quarters cup 100 % vegetable juice)?

(1) always (2) often (3) sometimes (4)never

4.7 Do you usually eat whole grain bread? (A whole grain contains all edible parts of the grain, including the bran, germ, & endosperm).

(1) always (2) often (3) sometimes (4)never

4.8 Do you usually eat a cake or a dessert right after meals?

(1) always (2) often (3) sometimes (4)never

Fats in food are always a mix of different types of fatty acids – when we say "saturated fat", we really mean the saturated fatty acids in the particular fat source. Typically, we get the greatest proportion of our saturated fat intake from cooking fats like lard, butter, margarine, palm and coconut oil.

4.9 Do you usually use these types of fat when you cook your meals?

(1) always (2) often (3) sometimes (4)never

4.10 Do you eat snacks?

(1) always (2) often (3) sometimes (4)never

If you do not eat snacks, please go to item number (4.12)

4.11 If you eat snacks, your snacks are based mainly on:
(1) fruit/yogurt/butter milk/vegetable salad
(2) biscuits/fatayer/popcorn/ nuts/sandwich
(3) fried potatoes/donuts /chips/pizza
(4) sweets/chocolate/ice cream/cakes

4.12 Which beverages do you usually drink between meals?
(1) soft drinks (Cola, 7 UP, Fanta, beer, iced tea, tonic water, "sport drink", etc.)/fruit and milk shakes
(2) tea/coffee/ Nescafe
(3) fruit juice
(4) nothing
(5) green tea/ herbal drinks

4.13 Do you usually consume at least 1 cup of milk products every day such as milk, yogurt, buttermilk, or cheese?

(1) always (2) often (3) sometimes (4)never

4.14 Do you drink at least 8 cups of water every day?

(1) always (2) often (3) sometimes (4)never

4.15 Do you usually eat late at night (after 8 pm)?

(1) always (2) often (3) sometimes (4)never

4.16 Do you usually eat while watching the TV?

(1) always (2) often (3) sometimes (4)never

4.17 Do you usually add sugar to drink?

(1) always (2) often (3) sometimes (4)never

4.18 Do you usually add table salt to your foods (after cooking)?

(1) always (2) often (3) sometimes (4)never

4.19 Do you eat fast food?

(1) always (2) often (3) sometimes (4)never

4.20 How many times usually eat fast food per week?

(1) one time (2) two times (3) three times (4) more than 3 times (5)none

4.21 Do you usually eat (you can choose more than one)?
(1) in response to hunger
(2) in response to negative emotions (such as stress, depression, anxiety, sadness, boredom, anger, loneliness, frustration, confusion, loss, resentment, relationship problems, and poor self-esteem)
(3) in response to positive emotions (such as happiness & contentment)
(4) in response to other reasons

4. 22 Do you usually eat?

(1) alone (2) with family (3) with friends or colleges

4. 23who do usually cook at you home? (you can choose more than one)?

(1) myself (2) my mother (4) my sister (5) my aunt (6)my grandmother or grandfather

(7) housemaid (8) none (9) other --- (specify)

4. 24 what kind of foods usually do you eat (you can choose more than one)?

(1)Traditional foods (e.g., Kabsa, Qursan, Jarish, or Saliq)
(2) Local fast foods (e.g., falafel, Shawarma, Motabag, or Masoob)
(3) Mediterranean foods (e.g., Lebanese, Egyptian, Turkish, or Iranian foods)
(4) North Africa foods (e.g., Moroccan, Tunisian, or Algerian foods)
(5) Asian foods (e.g., Indian, Chains, Thai, or Japanese foods)
(6) African foods (e.g., Sudanese, or Ethiopian foods)
(7) Western foods (e.g., Italian, Furnish, or Mexican foods)
(8) American fast foods (e.g., McDonalds, Burger King, or Kentucky Fried chicken)

Section (5): Physical activity and lifestyle

(Physical activity is any body movement that works your muscles and requires more energy than resting (that increase energy expenditure above a basal level such as, walking, running, dancing, swimming, yoga, and gardening, walking up the stairs).

a. Physical activity

5.1a. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, aerobics, using a stair climber machine at a fast pace, or fast bicycling?

Think about only those physical activities that you did for at least 10 minutes at a time.

________ days per week or □ No vigorous physical activities (Skip to question 5.2a)

5.1b. How much time in total did you usually spend on one of those days doing vigorous physical activities?

_____ hours ______ minutes □ Don't know/Not sure

5.2a. Again, think only about those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, using a stair climber machine at a light-to- moderate pace, bicycling at a regular pace, or doubles tennis? Do not include walking.

________ days per week or □ No moderate physical activities (Skip to question 5.3a)

5.2b. How much time in total did you usually spend on one of those days doing moderate physical activities?

_____ hours ______ minutes □ Don't know/Not sure

5.3a. During the last 7 days, on how many days did you walk for at least 10 minutes at a time? This includes walking at work and at home, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure.

________ days per week or □ No walking (Skip to question 5.4)

5.3b. How much time in total did you usually spend walking on one of those days?

_____ hours ______ minutes □ Don't know/Not sure

The last question is about the time you spent sitting on weekdays while at work, at home, while doing course work and during leisure time. This includes time spent sitting at a desk, visiting friends, reading traveling on a bus or sitting or lying down to watch television.

5.4. During the last 7 days, how much time in total did you usually spend sitting on a week day?

____ hours ______ minutes □ Don't know/Not sure

b. Lifestyle:

5.5 What time of the year is reasonable for you to exercise outdoors? (you can choose more than one)

(1) Fall (2) Winter (3) Spring (4) Summer (5) Any time (7) none

5.6 Where do you usually do exercise (you can choose more than one)?

(1) home (2) gym (3) school (5) at work (6) in public (8) around inside malls

(9) other--- (specify) (10) nowhere

5.7 What are the main reasons for doing regular physical activities or sports,? (you can select more than one)

(1) health (2) social (3) competition (4) to lose weight (5) recreation

(6) other-- (specify)   (7) none

5.8 What do you prefer to do during leisure time?
(1) walking   (2) practicing a sport   (3) shopping   (4) dancing

(5)watching TV/listening to music /using the computer or phone/ reading a book

(6) other-- (specify)

5.9 Do you usually take an afternoon siesta (nap) soon after a meal?
(1) always   (2) often   (3) sometimes   (4)never

5.10 How money hours per night do you usually sleep (on average)?
…………….hours/night

5.11 Do you usually use a car?
(1) always   (2) often   (3) sometimes   (4)never

5.12 Does TV media influence your body image?
(1) always   (2) often   (3) sometimes   (4)never

5.13 Do you wish to look like celebrity stars?
(1) always   (2) often   (3) sometimes   (4)never

5.14 Do you have exercise equipment at home (e.g., treadmills, or exercise bikes)? (1) yes   (2) no

5.15 If yes, do you usually use them (90 min or more/week)?
(1) one time/week   (2) two-times/week   (3) more then tow times/week   (4) never

Appendix A.2

How important are the following as barriers to maintaining a healthy body weight?

Section (6): Perceived barriers to adopting healthy eating habits

Please read each statement and indicate how likely you are to say each of the following statements:

I. Personal barriers to healthy eating	3 = very likely	2 = somewhat likely	1 = somewhat unlikely	0 = very unlikely
Lack of willpower				
1. I do not have the motivation to eat a healthy diet.				
2. I'll be criticized or made fun of if I eat health food.				
3. I feel like diet planning would be too hard for my family.				
4. I afraid I will get hungry if I follow a diet plan.				
5. I'll never be able to change how I eat.				
6. I really crave sweets and high-fat foods.				
7. I stop following a diet when I do not lose weight.				
Lack of knowledge				
8. I don't know how to make my diet healthier.				
9. From my knowledge, following a diet plan would not help me lose weight.				
10. I have not been counseled about importance of healthy eating (by a doctor or dietitian).				
11. I do not learn in a school what a healthy food is.				
Lack of skill				
12. I do not have the skills to plan, shop for, prepare or cook healthy foods.				
Lack of enjoyment				
13. I do not enjoy eating healthy foods (low salt, sugar, and fat).				
14. I enjoy eating Saudi traditional food (such as Kabsa "rice with meat").				
15. The taste, color and appearance of foods are very important for me.				
16. I think following a meal plan would take the pleasure out of eating.				
17. I do not like artificial sweeteners (such as Splenda, Equal, or Sweet'n Low).				
18. I do not like low fat products (such as low-fat milk, laban, yogurt, cheese, or cake).				
19. I do not like to drink (tea, coffee, or juice) without sugar.				
II. Social environmental barriers to healthy eating				
Lack of time				
20. Healthy meals take too long to prepare.				
21. I don't have enough downtime to think and plan for our meals.				
22. I have no time to prepare or eat healthy foods because of (job, study).				
23. I have no time to prepare or eat healthy foods because of (family commitments, social activity).				
24. I eat out sometimes when my family or I do not have time to cook.				
Social influence				
25. It can be hard to stick with a healthy eating plan when family and friends don't want to join me.				
26. I do not have family support to eat a healthy diet.				
27. My kids don't like everything I want to eat.				
28. It's kind of difficult for me to eat healthy foods because my family is not the healthiest eaters.				
29. I feel embarrassed to eat healthy foods when I am around my family.				
30. I feel pressured to eat during social gatherings because if I refuse, the host might be offended.				
31. Usually healthy food is not served at social activities.				
Lifestyle changes				
32. I usually meet my friends out (at a cafe or restaurant).				
33. When my family and friends have an event, they usually prefer to celebrate at a restaurant rather at home.				
34. We usually order food when we have a home party.				
35. We usually order food for dinner.				
36. Usually, the housemaid takes care of cooking our meals.				
II. Physical environmental barriers to healthy eating				
Lack of resources				
37. I am not able to buy healthy foods that are inexpensive.				
38. There's not much choice of foods when I eat out (work or school).				
39. The food shops around us don't offer much healthy choice foods.				
40. My cooking facilities are not very good (such as griller, or oven).				
41. The low-calorie food products (diet products) are too expensive (such as sweets, jam, cookies, or chocolate diet).				

42.What is the one thing that makes it hardest for you to eat a healthy diet?---
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Section (7): Perceived barriers to engaging in regular physical activity

Please read each statement and indicate how likely you are to say each of the following statements:

I. Personal barriers to physical activity	**3 = very likely**	**2 = somewhat likely**	**1 = somewhat unlikely**	**0 = very unlikely**
Lack of willpower				
43. I do not have the motivation to do physical activity (exercise).				
44. Other recreational activities with my friends are more entertaining than exercise.				
45. I've been thinking about getting more exercise, but I just can't seem to get started.				
46. It is too easy for me to find excuses not to exercise.				
Lack of self-confidence				
47. I've been worried about my looks when I exercise.				
48. I feel embarrassed while doing physical activity.				
Lack of skill				
49. I don't get enough exercise because I have never learned the skills for any sport.				
50. I'm not good enough at any physical activity to make it fun.				

Lack of enjoyment				
51. I do not enjoy physical activity (exercise).				
52. I do not feel comfortable when I sweat during exercise.				
Lack of knowledge				
53. From my knowledge, physical activity has no positive effects on my health.				
54. I have no information about the importance of physical activity for health and maintaining a healthy body weight.				
55. I have not been counseled about importance of physical activity (by a doctor or dietitian).				
56. I do not know which physical activity is suitable for me.				
57. I do not know how much time I should exercise every day.				
Lack of energy				
58. I'm just too tired (after school, job, or household work) to do any exercise.				
59. I don't get enough sleep as it is. I just couldn't get up early or stay up late to get some exercise.				
60. I'm too tired during the week and I need the weekend to catch up on my rest.				
Fear of injury				
61. I'm afraid I might injure myself during exercise.				
62. I think exercise is physically painful.				
Health problems				
63. I have health problems (such as joint pain, stroke, and paralysis) that keep me from exercising.				
64. My leg pain is too bad for me to exercise.				
II. Social environmental barriers to physical activity	**3 = very likely**	**2 = somewhat likely**	**1= somewhat unlikely**	**0 = very unlikely**
Lack of support				
65. None of my family members or friends likes to do anything active, so I don't have a chance to exercise.				
66. None of my family members or friends encourage me to exercise, so I don't have a chance to exercise.				
67. My parents give academic success priority over exercise.				
Lack of time				
68. My day is so busy I just don't think I can make the time to include physical activity in my regular schedule.				
69. I have no time for exercise because of my social and family commitments.				
Social influence				
70. My usual social activities with family or friends do not include physical activity.				
71. Frequent social gatherings and social obligations do not allow me to exercise.				
72. I have been thinking about exercise, but I have no one else to look after my children .				
Social norms				
73. My family (father, husband, or brother) does not allow me to walk outside (in public) alone.				
74. My family (father, husband, or brother) does not allow me to walk outside (in public) at all.				
75. My family (father, husband, or brother) does not allow me to join the gym.				
76. If I wanted to practice physical activity outside the home (such as in public or in the gym), I would need to ask permission first from my father or husband.				
77. If I wanted to buy exercise equipment (such as treadmill or cycling bike), I would need to ask permission first from my father or husband.				
78. Wearing the Abaya makes me feel uncomfortable to walk outside.				
79. Prohibition on driving affects my activity/mobility for getting to/from exercise places.				
II-Physical environmental barriers to physical activity	**3 = very likely**	**2 = somewhat likely**	**1 = somewhat unlikely**	**0 = very unlikely**
Lack of resources				
80. There is lack to access to physical activity facilities such as jogging trails, sidewalks, or swimming pools.				
81. If I had exercise facilities and showers at work, then I would be more likely to exercise.				
82. I do not have enough space to do indoor exercise in my house.				
83. It is just too expensive to have the right equipment to do exercise.				
84. It is just too expensive to join a gym to exercise.				
85. It is not safe to walk in my neighborhood.				
86. I think having a housemaid contributed to decreasing my physical activity level by her performing household activities, such as cleaning, instead of myself.				
Lack of transportation				
87. Usually, I have difficulty in transportation to go outside to do exercise.				
88. My family does not allow me to use transportation services (such as a taxi) to go outside to do exercise.				
89. My family does not allow my friend to pick me up to or from a gym.				
90. If I could drive, I would not have any problem to go outside to do exercise.				
Hot weather				
91. It's too hot to exercise outdoors.				
92. There is no walking track in a mall that I can walk on it in the summer time.				

93. What is the one thing that makes it hardest for you to be physical active? --
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Appendix B.1

Differences in the percentages[a] and mean WC among non-pregnant Saudi women of reproductive age residing in Jeddah city, Saudi Arabia when comparing those with and without family or personal history of chronic disease according to general and abdominal obesity (n=408).

	n (%)	WC Mean± SE	Abdominal obesity (WC ≥80)[c] n (%)	Abdominal obesity (WC ≥88)[d] n (%)	Non-obese (BMI<25) n (%)	Obese (BMI≥25) n (%)
Family history of chronic diseases[e]						
No	62(15.3)	72.1±1.9	13(20.4)	4(7.2)	39(62.4)	23(37.6)
Yes	346(84.7)	81.6±1.0	179(52)	98(28.3)	111(32.1)	235(67.9)
Obesity	60(14.7)	89.7±2.2	46(76.9)	30(50.7)	9(15.1)	51(84.8)
Diabetes	277(68.0)	82.6±1.3	151(54.5)	85(30.6)	81(29.4)	196(70.6)
Hypertension	203(49.7)	83.3±1.2	117(57.6)	72(35.6)	61(29.9)	142(70.1)
Cardiovascular Disease	45(11.1)	86.1±2.2	30(66.6)	16(36.2)	7(15.1)	38(85.0)
High Cholesterol Level	44(10.7)	85.5±1.8	29(66)	15(35.3)	13(29.1)	31(71.0)
High Triglyceride Level	6(1.6)	89.8±6.8	4(62.1)	3(43.2)	0(0)	6(100)
Medical conditions (chronic diseases)[e]						
No	274(67.1)	75.0±0.7	83(30.4)	28(10.2)	137(50.2)	136(49.8)
Yes	134(32.9)	90.7±1.3	109(81.0)	74(55.3)	13(9.3)	122(90.7)
Diabetes	36(8.8)	90.5±2.1	30(84.7)	20(56.7)	3(8.4)	33(91.6)
Hypertension	34(8.2)	91.9±2.9	25(73.0)	19(56.1)	3(7.7)	31(92.3)
Cardiovascular Disease	3(0.7)	86.4±6.5	3(72.3)	2(63.6)	1(36.4)	2(63.6)
High Cholesterol Level	33(8.0)	87.5±1.8	23(70.)	13(38.7)	4(13.1)	29(87.0)
High Triglyceride Level	7(1.7)	90.2±7.3	4(56.6)	3(46.0)	2(24.0)	5(76.0)

Abbreviations: BMI=Body mass index, WC=waist circumference. [a]Percentage may not total to 100% due to rounding, [b]general obesity (BMI ≥25) according to Word Health Organization (WHO) criteria, [c]abdominal obesity according to Harmonized cutoff, [d]abdominal obesity (WC ≥88) according to WHO criteria. [e]Respondents can select more than one answer or choice (multiple response items).

Appendix C.1

Ranking the important healthy eating barriers[a] items based on the responses of non-pregnant Saudi women (at reproduction age residing in Jeddah city, Saudi Arabia (n=408)

Rank-overall	Rank-items	a. Personal barriers to healthy eating items (19 items)	Subgroups	V. Likely n(%)	SW.likely n(%)
1	1	I do not like artificial sweeteners (such as Splenda, Equal, or Sweet'n Low).	Lack of enjoyment	282(69.2)	37(8.1)
2	2	I enjoy eating traditional food (e.g. Kabsa "rice with meat").	Lack of enjoyment	258(63.3)	102(25.1)
4	3	The taste, color and appearance of foods are very important for me.	Lack of enjoyment	218(53.4)	123(30.1)
6	4	I have not been counseled about importance of healthy eating (by a doctor or dietitian).	Lack of knowledge	179(44)	44(10.7)
8	5	I do not like to drink (tea, coffee, or juice) without sugar.	Lack of enjoyment	172(42.2)	119(29.1)
9	6	I do not enjoy eating healthy foods (low salt, sugar, and fat).	Lack of enjoyment	152(37.2)	94(23)
14	7	I do not have the skills to plan, shop for, prepare or cook healthy foods.	Lack of skill	122(29.8)	113(27.7)
16	8	I really crave sweets and high-fat foods.	Lack of willpower	110(27.0)	104(25.4)
19	9	I don't know how to make my diet healthier.	Lack of knowledge	103(25.3)	108(26.4)
18	10	I think following a meal plan would take the pleasure out of eating.	Lack of enjoyment	107(26.1)	134(32.9)
		b. Social environmental barriers to healthy eating items (17 items)	Subgroups	V. Likely n(%)	S.W.likely n(%)
3	1	Usually healthy food is not served at social activities.	Social influence	230(56.5)	150(36.7)
7	2	It can be hard to stick with a healthy eating plan when family and friends don't want to join me.	Social influence	178(43.6)	94(23.1)
10	3	I eat out sometimes when my family or I do not have time to cook.	Lack of time	145(36.6)	150(36.7)
12	4	I feel pressured to eat during social gatherings because if I refuse, the host might be offended.	Social influence	140(34.3)	127(31.1)
13	5	My kids don't like everything I want to eat.	Social influence	133(32.4)	69(17.0)
17	6	We usually order food when we have a home party.	Lifestyle changes	107(26.3)	174(43.0)
20	7	It's kind of difficult for me to eat healthy foods because my family is not the healthiest eaters.	Social influence	102(25.1)	97(23.7)
21	8	I do not have family support to eat a healthy diet.	Social influence	97(23.7)	99(24.3)
22	9	I don't have enough downtime to think and plan for our meals.	Lack of time	89(21.9)	118(28.8
23	10	I have no time to prepare or eat healthy foods because of (job, study).	Lack of time	76(18.5)	63(15.6)
		c. Physical environmental barriers to healthy eating items (5 items)	Subgroups	V. Likely n(%)	S.W.likely n(%)
5	1	There's not much choice of healthy foods when I eat out (work or school).	Lack of resources	200(48.9)	133(32.5)
11	2	The food shops around us don't offer much healthy choices of foods.	Lack of resources	145(35.6)	142(34.9)
15	3	The low-calorie food products (diet products) are too expensive (such as sweets, jam, cookies, or chocolate diet).	Lack of resources	120(29.3)	136(33.4)
24	4	I am not able to buy healthy foods that are inexpensive.	Lack of resources	54(13.1)	(60(14.7)

Abbreviation: V. Likely: very likely, SW.likely: somewhat likely. [a]Barriers were rated on 4-point Likert scale that ranged from "very likely" (3) to "very unlikely" (0). Ranking the top 10 important barriers items "very likely' among barriers categories, then ranking of overall healthy eating barriers items (41 items)

Appendix D.1

Ranking the important physical activity barriers[a] items based on the responses of non-pregnant Saudi women (at reproduction age residing in Jeddah city, Saudi Arabia (n=408)					
Rank-overall	**Rank-items**	**a. Personal barriers to PA items (22 items)**	**Subgroups**	**V. Likely n(%)**	**SW.likely n(%)**
11	1	I do not know how much time I should exercise every day.	Lack of knowledge	212(51.9)	63(15.4)
12	2	I do not know which physical activity is suitable for me.	Lack of knowledge	203(49.8)	71(17.4)
15	3	I have not been counseled about importance of physical activity (by a doctor or dietitian).	Lack of knowledge	173(42.5)	89(21.9)
16	4	It is too easy for me to find excuses not to exercise.	Lack of willpower	173(42.4)	168(41.2)
18	5	I've been thinking about getting more exercise, but I just can't seem to get started.	Lack of willpower	164(40.1)	133(32.5)
21	6	I'm just too tired (after school, job, or household work) to do any exercise.	Lack of energy	149(36.6)	133(32.6)
22	7	I'm too tired during the week and I need the weekend to catch up on my rest.	Lack of energy	141(34.7)	91(22.2)
25	8	Other recreational activities with my friends are more entertaining than exercise.	Lack of willpower	121(29.7)	134(32.9)
26	9	I'm not good enough at any physical activity to make it fun.	Lack of skill	111(27.1)	110(27.1)
30	10	I do not feel comfortable when I sweat during exercise.	Lack of enjoyment	50(12.3)	64(15.6)
		b. Social environmental barriers to PA items (15 items)	**Subgroups**	**V. Likely n(%)**	**S.W.likely n(%)**
2	1	If I wanted to practice physical activity outside the home (e.g. in public or in the gym), I would need to ask permission first from my father or husband.	Social norms	303(74.2)	47(11.6)
3	2	My family does not allow me to use public transportation services to go outside to do exercise.	Social norms	296(72.7)	25(60.0)
5	3	If I wanted to buy exercise equipment (e.g. treadmill), I would need to ask permission first from my father or husband.	Social norms	257(62.9)	51(12.5)
7	4	My family (father, husband, or brother) does not allow me to walk outside (in the public areas) alone.	Social norms	240(58.8)	32(8)
8	5	My usual social activities with family or friends do not include physical activity.	Social influence	236(57.8)	99(24.3)
17	6	My family does not allow my friend to pick me up to or from a gym.	Social norms	171(41.8)	55(13.4)
23	7	None of my family members or friends encourages me to exercise, so I don't have a chance to exercise.	Lack of support	131(32.2)	87(21.4)
24	8	None of my family members or friends likes to do anything active, so I don't have a chance to exercise.	Lack of support	129(31.7)	86(21.1)
28	9	My day is so busy I just don't think I can make the time to include physical activity in my regular schedule.	Lack of time	83(20.5)	156(38.2)
29	10	Prohibition on driving affects my activity/mobility for getting to/from exercise places.	Social norms	76(18.7)	94(22.9)
		c. Physical environmental barriers to PA items (13 items)	**Subgroups**	**V. Likely n(%)**	**S.W.likely n(%)**
1	1	There is no walking track in a mall that I can walk on it in the summer time.	Hot weather	355(86.9)	46(11.3)
4	2	It's too hot to exercise outdoors.	Hot weather	273(66.8)	75(18.4)
6	3	It is not safe to walk in my neighborhood.	Lack of resources	248(60.2)	61(14.9)
9	4	There is lack to access to physical activity facilities such as jogging trails, sidewalks, or swimming pools.	Lack of resources	230(56.5)	116(28.4)
10	5	Usually, I have difficulty in transportation to go outside to do exercise.	Lack of transportation	220(54.0)	98(23.9)
13	6	If I had exercise facilities and showers at work, then I would be more likely to exercise.	Lack of resources	192(47.1)	55(13.3)
14	7	It is just too expensive to have the right equipment to do exercise.	Lack of resources	177(43.4)	140(34.2)
19	8	If I could drive, I would not have any problem to go outside to do exercise.	Lack of transportation	161(39.5)	75(18.2)
20	9	It is just too expensive to join a gym to exercise.	Lack of resources	154(37.9)	153(37.4)
27	10	I do not have enough space to do indoor exercise in my house.	Lack of resources	90(22)	90(22)

Abbreviation: V. Likely: very likely, SW.likely:. [a]Barriers were rated on 4-point Likert scale that ranged from "very likely" (3) to "very unlikely" (0). Ranking the top 10 important barriers items "very likely' among barriers categories, and then for overall PA barriers items (50 items)

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