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Prevalence of Obesity and Physical Activity Among Postpartum Women Attending Primary Healthcare Centers in Jeddah, Saudi Arabia 2015

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Prevalence of Obesity and Physical Activity among Postpartum Women Attending Primary Healthcare Centers in Jeddah City

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An Abstract of a thesis submitted to:

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Hubert Department of Global Health

Abstract:

Introduction: During pregnancy, women's weight increases to accommodate fetal development, but most women do not return to their pre-pregnancy weight. Physical activity plays an important role in any weight reduction approach.

Objectives: This cross-sectional study was conducted to assess the prevalence of obesity and physical inactivity among postpartum women attending primary healthcare centers in Jeddah, Saudi Arabia. We also explore the possible associations between obesity and physical activity as well as between these and other demographic variables.

Methodology: Our sample includes 380 postpartum women attending primary healthcare centers in Jeddah. To be included in the study, women were 6 to 12 months postpartum. They were chosen using a multistage proportional random sampling technique. We used the Arabic version of the Global Physical Activity Questionnaire and weekly steps counts measured by pedometers to assess physical activity. Also, we used the World Health Organization cut-off point to determine whether a woman had met the recommended weekly physical activity or not. For obesity, we measured Body Mass index in kg/m^2 and used the World Health Organization's classification of obesity.

Results: We found that 30% of our sample were obese and 34% did not meet WHO recommendations for physical activity. There were no significant associations between obesity and total weekly physical activity or meeting WHO recommendation for weekly physical activity. Obese women were older and had more children in their household, but these characteristics were negatively correlated with daily sedentary time. Unfortunately, only 6% of

the sample returned their weekly steps counts. Homemakers and non-Saudi women walked significantly less than women in other work categories and Saudi women.

Conclusion: Obesity and physical inactivity are prevalent among postpartum women and a postpartum care program to promote mothers' health in general, encourage physical activity, and prevent obesity is highly recommended.

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Dedication

I dedicate this work to my father who supported me and wanted me to continue my higher education. He was excited about this thesis and interested in seeing the results. Unfortunately, he passed away before seeing it. I am sure he knows and is proud of me.

I dedicate this work to my mother and my sisters who supported me during difficult times. Also, I dedicate this work to my children and Dalia; I hope this work will enhance their enthusiasm about knowledge and science. A special dedication to my daughters: I hope that this work will help them in their future life.

I dedicate this work to Professor Solveig Argeseanu, who supported me during my master studies and was very helpful and patient with me.

Table of Contents

List of tables

List of Figures

1 Introduction

During pregnancy, women weight increases throughout the pregnancy with the fastest increase during the second trimester [1]. After delivery, women lose weight quickly in the first 6 months with the fastest loss during the first month [1] [2]. But most women fail to retain to their pre-pregnancy weight [1] [2]. Excessive gestational weight gain is associated with increase risk of obesity [3] and diabetes mellitus [4]. Obesity negatively affects mothers and their infants [5] [6] [7]. Many studies have connected maternal obesity to thromboembolism, gestational diabetes mellitus, and maternal and infant mortality [8] [9] [10]. Physical activity has a very low-risk profile during pregnancy and postpartum period and should is recommended to be continued during pregnancy and resumed after delivery in absence of contraindications [11] [12] [13]. Also, physical activity decreases the risk of pregnancy complication such as gestational diabetes mellitus and operative deliveries [14] [15] [16].

Although some studies showed the prevalence of obesity and physical inactivity to be high among adult women in Saudi Arabia [17] [18] [19] [20] [21], no specific study has been done to assess the magnitude of obesity and frequency and intensity of physical activity among mothers in Saudi Arabia. We calculated the body mass index (BMI) of mothers and used the World Health Organization (WHO) classification to define whether they were obese or not. We used the Global Physical Activity Questionnaire (GPAQ) to quantify the weekly physical activity, as well as distributing pedometers so that participants could track their weekly steps, the first time this had been done in Saudi Arabia. We will explore the association between obesity, physical activity, and common demographic determinants. Our study will help policymakers, healthcare providers, and researchers plan the actions necessary to improve maternal health by implementing the prevention, promotion, and treatment activities best suited to the situation.

2 Background/literature review

2.1 Weight Gain During Pregnancy

The Institute of Medicine developed recommendations for gestational weight gain in 1990, which were revised in 2009 based on the WHO cut-off-points for Body Mass Index (BMI) categories [22]. For underweight women, IOM recommends a total weight gain during pregnancy of 12.5 to 18 kg, at a rate of 0.44 -0.58 kg per week in the second and third trimesters [22]. Women of normal weight are advised to keep their total weight gain in pregnancy in the range of 11.5 to 16 kg, at a rate 0.35 - 0.50 kg per week in the second and third trimesters [22]. For overweight women, the total weight gain during pregnancy should be in the range of 7 to 11.5 kg, at a rate of 0.23 -0.33 kg per week in the second and third trimesters [22]. Total weight gain during pregnancy for obese women is advised to be in the range of 5 to 9 kg, at a rate of 0.17 - 0.27 kg per week in the second and third trimesters [22].

A study in Taipei showed that the rates of weight gain in the second and third trimester were more than two times than that of the first trimester, with fastest rate in the second trimester [1]. A large Danish study found that 51.9% of underweight participants gained weight within the Institute Of Medicine range, while 59.6% of the overweight and 47.8% of the obese participants gained more weight than was recommended [23]. Also, the study found that at a cut-off-point of BMI 26-27 kg/m^2, as the BMI increased, the mean gestational weight gain and postpartum weight retention decreased [23]. Another study in Belgium found that weight gain in excess of Institute Of Medicine recommendations was associated with postpartum weight retention [2]. The weight loss rate was fastest in the first month postpartum and continued for 6 months postpartum [1] [2].

Gunderson found that 14% to 20% of women retained their substantial weight gain of 5 kg or more at one year postpartum in the studies he reviewed [24]. The Taipei study found that participants retained 6.26% of their pre-pregnancy weight on average and only 20% of

them returned to their pre-pregnancy weight [1]. The Belgium study, only 48% of women returned to their pre-pregnancy weight [2]. The Danish study found that 13.2% of the total participants retained more than 5 kg at one year postpartum [23]. White women were at lower risk of retaining substantial weight and being classified as overweight or obese at one year postpartum compared to African American or Hispanic women [25]. Women's age was not found to be associated with a significant difference in weight-related risk [25]. The same study found that 40% of the primiparas had no weight-related risks at one year postpartum compared to 28% of the multiparas [25].

An Iranian study found that only 25.8% of women returned to their pre-pregnancy weight or lower at three years follow-up, and almost 50% of women retained 4 kg or more at three years postpartum [26]. Postpartum weight retention was higher among women who gained in excess of Institute Of Medicine recommendations, but it was inversely related to pre-pregnancy BMI [26]. Primiparas were more likely to gain weight in excess of Institute Of Medicine recommendations and to retain more weight at three years postpartum than multiparas [26].

A metal-analysis found that women who had less than adequate gestational weight gain based on Institute Of Medicine recommendations had significantly lower weight retention; they retained 2.14 kg less weight and had a 2.42 kg/m^2 lower BMI at 21 years follow up than women who had adequate gestational weight gain in the same time period [27]. On the other hand, women who had excess gestational weight gain retained 3.15 kg more weight and had a 3.78 kg/m^2 lower BMI than women who had adequate gestational weight gain in the same time period [27]. The weight of women who had gestational weight gain in excess of Institute Of Medicine recommendations followed a U shape pattern over 21 years follow-up. It decreased in the first few years postpartum and started to increase later [27].

Non-working women were found to be at increased risk of retaining more than 4.5kg 12 months postpartum [28]. Low income [29] [30] [31] and education as well as severe economic or job burden were associated with higher weight retention postpartum [29]. A study in Brazil found that there was a weak association between women's education level and postpartum weight retention [30]. The Iranian study found that less educated women had less weight retention at three years postpartum than other educational groups [26]. Overweight and obesity before pregnancy were found to be a strong predictor of postpartum retention at 24 months postpartum [30] [32]. Using Chi-square test, it has been found that multiparas and primiparas gained more weight and experienced an increase in waist-to-hip ratio compared to nulliparous [33]. In the Iranian study, age, BMI at first antenatal visit, parity, duration of breastfeeding, employment status, educational level, and urban/rural residence were not independently related to weight retention of 4 kg or more at 3 years postpartum [26]. Also, gestational weight gain was associated with high weight retention (4 kg or more) at three years postpartum [26].

In multivariable logistic regression models, excessive and inadequate gestational weight gain were associated with weight retention at 12 months postpartum [34]. Also, excessive gestational weight gain was found to be associated with an increase in waist circumference, abdominal obesity, and overall adiposity at 8 years postpartum [35]. By 21 years postpartum, excessive gestational weight gain was associated with increased risk of overweight, obesity [3] and diabetes mellitus [4]. Even an upper-limit normal BMI (> 23 kg/m^2) was found to increase the risk of diabetes mellitus in women with gestational diabetes mellitus [32].

Institute Of Medicine developed recommendations for total and rate of weight gain during pregnancy. The rate of weight gain accelerates during the second and third trimester but it is fastest during the second trimester. Studies have shown that women who gained more

than the Institute Of Medicine recommended weight during pregnancy were at increased risk of retaining more weight postpartum. They were also at increased risk of overweight, obesity, and diabetes mellitus later in life.

2.2 Postpartum Weight Management

The main challenges that women face returning to their pre-pregnancy weight are lack of time, support, and motivation [36]. Although most women plan to lose weight after delivery, they do not receive any information from healthcare providers [37]. There was an insignificant association between providers' advice and weight retention at 3 months, but advice to engage in physical activity was associated with an increase in total activity [38]. Also, interventions that included physical activity, diet, and individualized support were more likely to be associated with healthy postpartum weight [39]. Although one half of postpartum women start thinking about engaging in healthy behavior to manage their weight [40], they do not receive any advice to lose weight or engage in physical activity in the postpartum period from their healthcare providers [38]. Public health strategies to deal with this growing problem are needed to target women in the postpartum period [7]. This period represents a great opportunity to educate women about the benefits of engaging in a healthy lifestyle [41] [42] [5]. Healthcare providers need to explore postpartum weight loss goals and GWG history to provide individualized health education programs [43]. Women's access to weight management programs during and after their pregnancy could have a great public health impact on mothers and their fetuses [2] [7].

Exclusive and partial breastfeeding were associated with lower postpartum weight retention compared to formula feeding [44]. The longer the duration of exclusive breastfeeding, the greater the benefit of postpartum weight loss [44] [45]. While exclusive breastfeeding for 6 months was found to be related to lower postpartum weight retention at 6, 18, and 36 months, partial breastfeeding was found to be related to lower postpartum weight

retention at 6 and 18 months only [45]. The rate of postpartum weight loss was faster with exclusive breastfeeding [45]. During the first six months, exclusive breastfeeding was associated with a weight loss rate of 0.5 kg/month compared to a rate of 0.25kg/month with partial breastfeeding [45]. Weight loss benefit with exclusive breastfeeding was stronger among low-income postpartum women [45].

A meta-analysis found that lifestyle modification intervention that included physical activity resulted in a significant decrease in weight among postpartum women [46]. Another systematic review found that diet and supervised physical activity resulted in lower postpartum weight retention among overweight and obese women [47]. Furthermore, physical activity with objective targets on heart rate or pedometer steps were more effective [46]. One study found that better nutritional knowledge was associated with less weight retention at 12 months postpartum [48].

Although most women want guidance and support from healthcare providers to manage their weight postpartum, healthcare providers often do not give the appropriate advice in the postpartum period. The appropriate advice should focus on diet and physical activity with objective targets because these interventions might result in lower weight retention among postpartum women.

2.3 Obesity

Obesity is a chronic disease that poses significant health problems to the public in an increasing number of countries worldwide [49]. It has been linked to ischemic heart diseases, hypertension, stroke, hyperlipidemia, and type 2 diabetes [49] [50]. Furthermore, it has been linked to all-cause mortality and some cancers [50]. A high energy diet and sedentary lifestyle are thought to be the main causes of obesity [49]. Public health policies to promote physical activity, enhance obesity prevention and treatment, and facilitate behavioral changes are needed to reverse obesity's rising trend [49] [51].

Women are at higher risk of obesity than men [52]. In the U.S., the prevalence of obesity in women has increased from 27% [53] to 36.8% in the last decade [51]. Specifically, women of child-bearing age have experienced increasing rates of overweight and obesity [5] [54] [6]. A study in Ireland found that one out of six pregnant women were obese [55]. Maternal obesity has negative consequences on mothers and their infants [5] [6] [7]. It increases the risk of abortion [8] and operative deliveries [8] [56] [10]. It also increases the maternal risk of eclampsia [10], thromboembolism [8], and gestational diabetes mellitus [9] [10]. Maternal obesity has been associated with premature death and cardiovascular diseases [42] as well as fetal macrosomia [5] [8] [9] [10] and perinatal mortality [8].

Obesity is a global pandemic that causes multiple public health problems to communities worldwide. Studies showed that women, especially those were in childbearing age, were at increased risk of obesity than men. Pregnant obese women are at increased risk of gestational diabetes mellitus, pre-eclampsia, operative deliveries. Also, maternal obesity increases the risk of fetal complications including macrosomia and perinatal mortality.

2.4 Physical Activity during Pregnancy and Postpartum Period

The American College of Obstetricians and Gynecologists recommends that women with normal pregnancies engage in regular aerobic and strength conditioning exercises before, during, and after pregnancy [11]. They also recommend that pregnant women receive a thorough clinical examination to ensure they have no medical reason to avoid pregnancy [11] [12]. Pregnant women may continue their routine physical activity with some modifications due to normal anatomic and physiologic changes as well as fetal requirements [11] [12]. The American College of Obstetricians and Gynecologists advises that bed rest is rarely indicated for pregnant women [11], as exercise has a very low-risk profile during pregnancy [12] [13]. Rather, at least a half-hour of moderate physical activity a day on most days of the week is recommended during pregnancy [57]. Women may resume their routine

physical activity quickly after delivery as long as it is safe and does not pose any medical or surgical complications [11].

Evidence suggests physical activity is beneficial during pregnancy for mothers and infants [58]. Women who engage in continuous physical activity before and during pregnancy are at lower risk of gestational diabetes mellitus, gestational hypertension, and preeclampsia [14]. Also, it is safe and does not affect fetal growth, rather it prevents extreme fetal growth (small- and large-for-gestational-age) [14]. Although physical activity does not appear to decrease the rate of preterm labor, it does not increase the risk of preterm birth [14]. It had been found that the odds of operative deliveries were higher among women who had a low level of activity compared to those who had a high level of activity [15] [16]. Physical activity was also found to reduce the risk of stillbirth [16].

Although physical activity is recommended and has proven beneficial before and during pregnancy, the prevalence of physical activity during pregnancy varies [16] [59] [60]. In a study in Brazil, 23% of women reported exercising before pregnancy [59]. Moreover, more than half of those stopped their activity due to pregnancy [59]. A Polish study found that 55% of pregnant women were inactive during pregnancy [60]. Furthermore, physical activity prevalence decreased during pregnancy [59] [60]. A third study in UK found that only moderately-vigorous physical activity decreased during pregnancy [61]. Dumith reported in his study that 32% of pregnant women were physically active [16]. Two studies found that pregnant women reached the recommended level of physical activity in 10% or less [59] [60]. During the third trimester, this proportion was as low as 4.7% [59]. A third study in Australia found that 44% of women met the physical activity recommendations [62].

During postpartum period, women was found to increase their moderate and moderate to vigorous activity and decrease their sedentary time [63]. In one study in US, only one third of overweight and obese postpartum women had met the recommended physical activity by

national physical activity guidelines [64]. Interestingly, working overweight/obese women were less active and more sedentary [64]. Overweight and obese women who have higher education were less active [64].

The American College of Obstetricians and Gynecologists recommends women to engage in physical exercise during their uncomplicated pregnancies. Physical activity is safe and does not affect fetal growth. Furthermore, it decreases the pregnant women's risk of gestational diabetes mellitus, gestational hypertension, and operative deliveries. Studies showed that physical activity is low during pregnancy. Moreover, some women stopped or reduced their regular physical activity. During postpartum period, one study found that obese women increase their physical activity but most of them do not meet the WHO recommendations of physical activity.

2.5 Obesity and Physical Activity in Saudi Arabia

Women in Saudi Arabia perceived they were disadvantage in the community in regard to their health due to their childbearing and caretaking roles and responsibilities, social and mobility restrictions [65]. The fertility indicator, children ever born to native Saudi women, in Saudi Arabia was 3.8 in 2004 [66]. The high fertility rate increases women risk of maternal morbidity [65]. Saudi women believed that their pregnancy and delivery increase make them weaker than men and prone to diseases [65]. Also, many Saudi women think that mobility restriction negatively affects their health [65]. They believe that their inability to walk or exercise expose them to sickness [65]. Married university students were found to be less active than their unmarried peers [67].

A recent study was conducted in Saudi Arabia revealed that the prevalence of obesity among women older than 15 years of age is 33.5% [17]. Women were found to be nearly twice likely to be obese than men [18]. Based on the International Obesity Task Force cutoff points for BMI, obesity was found to be more prevalent in adolescent male than in females

[68]. On the other hand, overweight prevalence was found to be slightly more prevalent among adolescent females than males [68]. In Jeddah, 19.3% of the adolescent females were overweight and 15.5% were obese [68]. Interestingly, the risk of obesity among women increased with age, being married or previously married and having been diagnosed with a chronic disease [17]. This had been suggested to be related to less physical activity or more sedentary time [18]. On the other hand, those who had more education than high school had lower prevalence of obesity [17].

Saudi youth were found to be significantly less active, more sedentary, and more obese than their British peers [69]. Youth females were less physically active and more sedentary than youth males [69]. Also, adult females were less active [18] [19] [20] [21]and more sedentary [19] than adult males. 75.1% of Saudi women were physically inactive [17]. There was no significant association between women obesity and their physical activity level [18]. Vast majority of women consumed inadequate servings of fruit and vegetables [17]. Also, they consumed milk/diary products, and breakfast less frequently but more French fries, chocolates, and cakes than men [19].

Women in Saudi Arabia perceived that their reproductive roles and the restriction on their mobility are affecting their health. These factors with the high fertility rate increase women risk of maternal morbidity. Studies showed that the prevalence of obesity and physical activity are high in Saudi Arabia. The prevalence of obesity and physical inactivity were higher among women and adolescent females compared to men and adolescent males. Among females, the prevalence of obesity increases significantly from adolescent to adult life and between married and unmarried women.

2.6 Study Framework

High fertility rate in Saudi Arabia put women in the risk of obesity during their adult life. When the fertility rate is added with the perceived social disadvantage among women,

and the restriction on mobility, the risk of obesity is further increased among women in the reproductive age. Although their social commitments with the children decrease their leisure time available for them to engage in physical activity, these commitments might increase their level of activity at home. As a result, women find difficulty in managing their pregnancy extra weight before having their next pregnancy. Not intervening, obesity and physical inactivity prevalence would increase and increase the rate of maternal and fetal complications in Saudi Arabia in the future.

This study is the first to assess the prevalence of obesity and physical activity among postpartum women attending primary healthcare centers in Jeddah, as well as the first attempt to objectively measure physical activity in Saudi Arabia. We explored the association between postpartum obesity and physical activity as well as the associations between them and other demographic characteristics.

3 Data & Methods

3.1 Study setting

According to 2010 Saudi Census results, the population of Saudi Arabia numbered more than 26 million [70]. Three-quarters of this number were Saudis and the rest were non-Saudi immigrants [70]. Makkah region was the most populous of the 13 regions in the country with 25.5% of the population [70]. Makkah region also had the highest share of non-Saudi immigrants, with 35.3% of their total [70]. Jeddah city is one of Makkah region's cities and is the main gateway to the holy areas of Islam. Millions of Muslims come to visit the Holy Mosques in Makkah and Madinah, passing through Jeddah yearly. Also, Jeddah has the main seaport in the country. Being the main port for Muslim pilgrims and the main seaport, along with other factors, gives Jeddah significant economic importance and has led to large numbers of both Saudi and non-Saudi residents.

Saudi Arabia provides healthcare services for all Saudi citizens and the immigrant workers in the public sectors and their families free-of-charge [71] [72]. Immigrant workers in the private sector have employer-based or self-paid healthcare insurance or out-of-pocket payments [72]. The healthcare system consists of three levels: primary, secondary, and tertiary [71]. The primary healthcare level is composed of primary healthcare centers that are distributed throughout the country and represent the first contact of the patients to the healthcare system [71]. Primary healthcare centers provide preventive and promotive healthcare services that include maternal and child health and immunizations [71]. Some preventive services are free-of-charge regardless of nationality. Immunizations are free-of-charge for all, even undocumented immigrants. There are more than 80 primary healthcare centers in Jeddah. They are distributed, based on the geographic location, in five sectors. These sectors are Northeast, Northwest, Southeast, Southwest, and Central sectors. Each sector supervises a group of primary healthcare centers.

3.2 Data Collection

3.2.1 Interviewing and field methods

The sample size was determined using www.openepi.com. As we studied prevalence of obesity and physical exercise, we calculated the sample size for both conditions. Prevalence of obesity and physical inactivity among women in Saudi Arabia older than 15 years of age was found to be 33.5% and 75.1%, respectively. We chose our confidence interval to be 95%. According to the public health administration statistics, in 2014, the total number of women of childbearing age in Jeddah is around 285,728. Of those, 13% (37,145) are expected to be pregnant. The calculated sample for obesity was 340, and the sample for physical inactivity was 286; we distributed 400 questionnaire and pedometers.

Because antenatal services are not free-of-charge for all and most Saudi women seek prenatal care in private clinics, the public health administration has no current data on the postpartum women. For that reason, we calculated our sample using immunization data. Primary healthcare centers are providers of almost 80% of the immunizations services in Jeddah. Women were recruited in the study in the waiting room while they were waiting for their children's immunization services. We did not include sick postpartum women visiting the PHCs for treatment. As women come to PHCs on a random basis, we recruited them as they came to the center.

The sample was chosen out of all the five sectors. Out of each sector, we chose a sample equivalent to the weight of the sector in the target population. The distribution of the sample was as follows: 12.84% from the Northeast; 20.41% from the Northwest; 29.89% from the Central section; 16.97% from the Southeast; and 19.89% from the Southwest. Of each sector, one PHC was chosen using simple random sampling. The only exception for this was the Central sector, where we chose two centers using the same sampling strategy. This sector represents almost 30% of the data and we did not want this weight to come from one

center. Also, recruiting this number of participants from one PHC was not possible during the study timeframe.

3.2.2 Survey instrument

We wanted to see if there was an association between obesity and pedometer results paired with a number of other variables. We gathered data on a total of seven variables. Age was collected as a numerical variable, and we inquired directly about it. Nationality was categorized as Saudi or Non-Saudi and participants were asked to determine their category. Education was collected as categorical variable. We asked about the level of school completed and divided the responses into seven categories: 1) no formal education, 2) less than elementary school, 3) completed elementary school, 4) completed intermediate school, 5) completed secondary school, 6) completed university/college degree, and 7) completed postgraduate degree.

Current job was collected as a categorical variable and responses were categorized as follows: 1) governmental employee, 2) non-governmental employee, 3) self-employed, 4) student, 5) housewife, and 6) retired. Household family size was collected as a numerical variable; we recorded the number of people living with a participant, including herself. We categorized average family monthly as follows: 1) less than 10,000 SR, 2) from 10,000 to less than 20,000 SR, 3) from 20,000 to less than 30,000 SR, 4) from 30,000 to less than 40,000, and 5) 40,000 SR or more. For every variable, the participants had the choice to refuse to answer, or to say, “I do not know”. As the study was designed, all interviewed women were between 6 to 12 months postpartum.

Body Mass Index (BMI) was created and calculated using the equation:
BMI= weight (Kg)/Height (meter) ^2. Obesity was classified according to the WHO BMI index: underweight (BMI <18.5), normal (18.5 =<BMI <25), overweight (25=<BMI<30),

and obese (30=< BMI). For the purposes of our study, participants were classified as not obese (BMI < 30) and obese (BMI >= 30).

We collected the data using the Global Physical Activity Questionnaire (GPAQ) and pedometers. Global Physical Activity Questionnaire is a WHO-developed surveillance system for physical activity. It assesses multiple domains and covers various intensity levels of physical activity. The questionnaire assesses physical activity at work, while moving from place to place, and during recreation time. Physical activity at work and during recreation is divided into two subdomains, specifically, vigorous and moderate intensity physical activities. The questionnaire asks about the number of days per week each domain and subdomain are practiced and the daily duration of these activities. The activity is considered for calculation if it lasts for more than 10 minutes and results in an increase in the participant's heart rate. Also, the questionnaire includes a question on the daily sedentary time as sitting or reclining.

To strengthen our data, we used pedometers to objectively calculate the participants' weekly steps. Every participant received a tracking sheet that covered seven days for recording daily steps. At the end of each day, participants sent their number of steps by fax or WhatsApp, a mobile texting application. The pedometers were given to the participants to keep. Height and weight were measured using the PHC scales at the time of the initial interview.

3.3 Data Analysis

3.3.1 Data management

Data was entered in Epidata3.1 using the STEPS template, and it was exported and analyzed using SAS9.4. STEPS instrument is WHO surveillance to chronic diseases risk factors that include the global physical activity questionnaire as a part of it. We modified the demographic section of the template to fit our demographic data. We used "nationality"

instead of “race” and “total household contacts” instead of “adult household contacts”. Also, we modified the education and monthly income categories to better reflect the situation in Saudi Arabia. Education, work status, and income variables were reclassified to dichotomize them for further analysis. Education was divided into “intermediate certificate and below” or “secondary certificate and above”. Income was reclassified to “less than 10,000 SAR” and “10,000 SAR and more”. Work status was reclassified to “homemaker” and “other”.

We used WHO guidelines to measure the level of physical activity reflected by the global physical activity questionnaire results by performing statistical analysis. First, all the physical activity durations were converted to minutes. Then, the metabolic equivalent for each subdomain was calculated. The metabolic equivalents of vigorous activities were calculated by multiplying the duration of physical activity by 8 and the number of days per week the activity was practiced. The metabolic equivalents of moderate activities were calculated by multiplying the duration of the activities by 4 and the number of days per week the activities were performed. The total numbers in all subdomains were added to calculate the total weekly metabolic equivalents. Lastly, the metabolic equivalent was classified as meeting the weekly WHO recommendation or not if the participant achieved the threshold metabolic equivalent of 600 per week. This threshold represents a 75-minutes of vigorous physical activity or a 150-minutes of moderate physical activity per week. The equations below show how these calculations were computed:

$$PWV = P2 * P3 * 8$$

Where: PWV is the metabolic equivalent of vigorous physical activity at work

P2 is the number of days per week the physical activities were performed

P3 is the average duration of physical activity per day in minutes

$$PWM = P5 * P6 * 4$$

Where: PWM is the metabolic equivalent of moderate physical activity at work

P5 is the number of days per week the physical activities were performed

P6 is the average duration of physical activity per day in minutes

$PT = P8 * P9 * 4$

Where: PT is the metabolic equivalent of transportation (walking or cycling)

P8 is the number of days per week walking or cycling were performed

P9 is the average duration of walking or cycling per day in minutes

$PRV = P11 * P12 * 8$

Where: PWV is the metabolic equivalent of vigorous physical activity at recreation time

P11 is the number of days per week the physical activities were performed

P12 is the average duration of physical activity per day in minutes

$PRM = P14 * P15 * 4$

Where: PWV is the metabolic equivalent of moderate physical activity at recreation time

P14 is the number of days per week the physical activities were performed

P15 is the average duration of physical activity per day in minutes

$Ptotal = PWV + PWM + PT + PRV + PRM$

Obesity was reclassified into 3- and 2-levels classifications. In the 3-levels classification, underweight weight women (8 out of 380 women) were analyzed with the normal weight women. In the 2-levels classification, women were classified in obese or not obese according to WHO obesity cut-off-point. Pedometer readings were entered as whole-week counts. Out of 380 pedometers distributed, only 24 participants responded with whole-week steps counts. Because the response rate was so low, we created a new variable to see if there was an association between response rate and other variables.

3.3.2 Data analysis

Data analysis was done using SAS9.4. Exploratory analysis of data was done and summary statistics for all independent variables were derived. Continuous variables were

summarized with descriptive statistics (N, mean, standard deviation (std), median, and Interquartile Range (IQR)). Categorical variables were summarized with frequency counts and percentages within each category or between levels of categories as appropriate.

Continuous variables were log transformed for linear regression analyses, if they were not normally distributed. Women's weekly physical activity and steps count were not normally distributed. Therefore, we used the mathematical logarithm to adjust for that. A LOG weekly physical activity and LOG steps count variables were created and were normally distributed. The actual results were presented with the p-value of the LOG transformed variables.

The Chi-Square test was used for association of the dependent categorical variables (weight classes, meeting WHO recommendations, pedometer compliance) with each independent categorical variable (nationality, income, education, and sector) and all association between all the dependent categorical variables with each other. The results were presented in percentages and p-value. One-Way ANOVA was used for the association of the continuous variables (BMI, weekly physical activity, daily sedentary time, and steps count) with categorical variables (nationality, income, education, sector, and categorical dependent variables). The results were presented mean (std) and p-value.

Linear regression was used to study the association between continuous dependent variables (BMI, weekly physical activity, daily sedentary time, and steps count) with independent continuous variables (age and number of children in the household) and with each other. The results were presented by intercept (standard error SE), correlation coefficient (SE), and p-value. The intercept is the theoretical intersection between the dependent variable with the independent variables when the value of the independent variable is zero. A multinomial/binomial logistic regression or a generalized linear regression to study the relationship between each independent variable with the dependent variables was used as

appropriate. Figure 1 shows primary healthcare centers' distribution and the selected primary healthcare centers on Jeddah map.

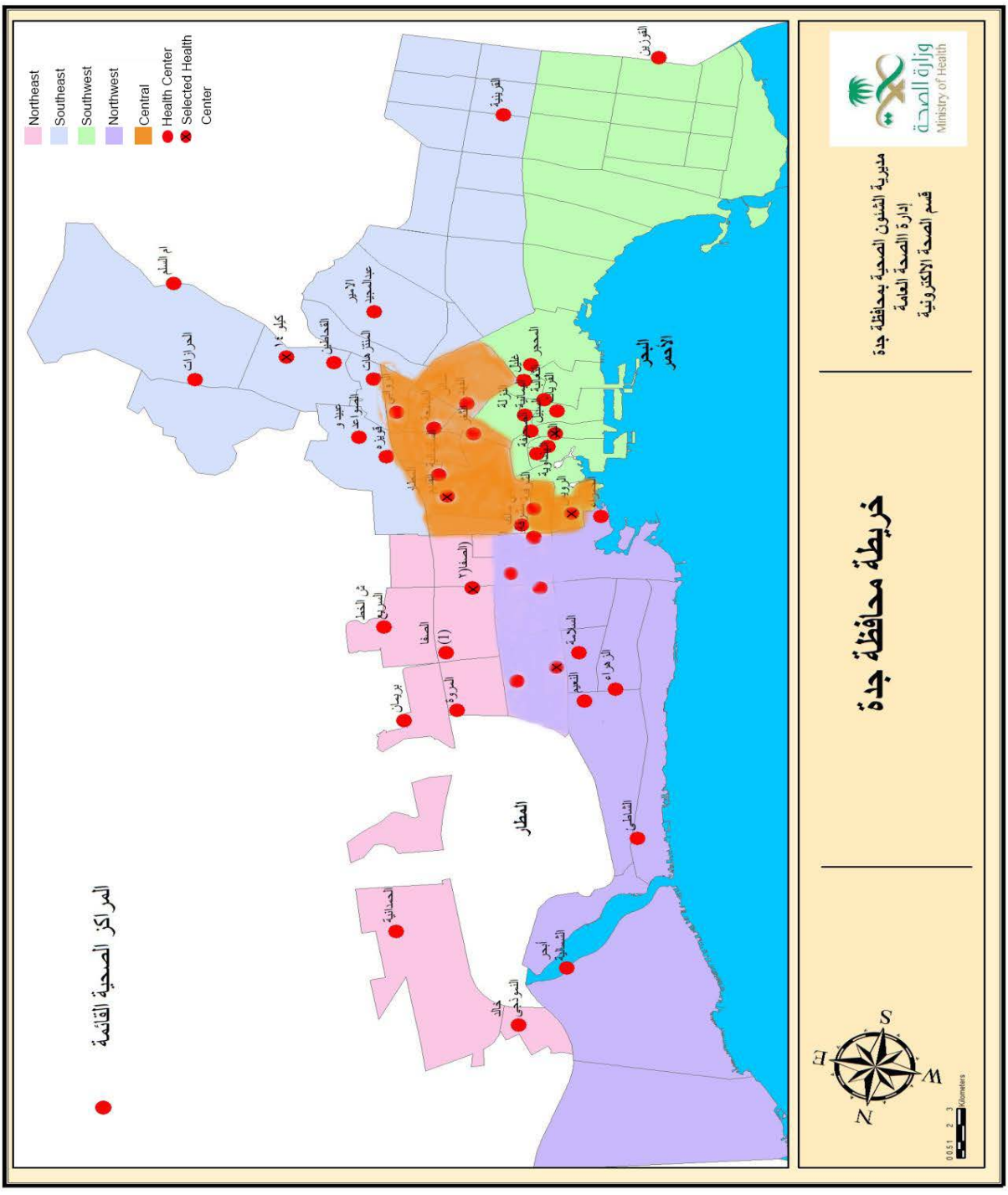

Figure 1: Primary Healthcare Centers Distribution in Jeddah Showing the Randomly Selected Centers in the Study.

4 Results

4.1 Descriptive data

Out of 400 questionnaires distributed, 380 questionnaires were completed fully. There were study participants from each of Jeddah's five sectors. From the Northeast, 47 women participated (12.4% of the sample); from the Northwest, 81 women participated (21.3% of the sample); from the Central sector, 117 women participated (30.8% of the sample); from the Southeast, 65 women participated (17.1% of the sample); and from the Southwest, 70 women participated (18.4% of the sample).

The average age of the participants was 29 years old. The youngest participant was 16 years old and the oldest was 49 years old. The median age was 28 years old. The household family size ranged from 3 to 12 people, with an average of 6 people and a median of 4 people. Two-thirds of the study population was non-Saudi. The majority of women had completed secondary school or college. Just over 12% of the women were formally employed, while 82% were homemakers. The median postpartum duration was nine months and the mean was 8.93 months. Table 1 shows the demographic distribution of the study participants.

Our data indicate that the sample is normally distributed in regard to weight, height, and BMI. Mean height was 157.9 cm and median height was 158 cm. Mean weight was 68.4 kg and median weight was 67.3 kg. Mean BMI was 27.5 and median BMI was 27.9. The tallest participant was 179 cm and the shortest was 108 cm. The highest weight was 120.3 kg and the lowest was 40.5 kg. The largest BMI was 51.4 kg/m^2 and the smallest was 17.4 kg/m^2. The obesity prevalence was 30.3% in the study sample. Overweight participants represented 31.8% of the sample, while 35.8% of the sample were of normal BMI according to WHO classification. More than 62% of postpartum women were either obese or overweight.

Only 6.8% (26 participants) of the study sample said they were involved in vigorous activities at work for at least 10 minutes a day. They performed these activities 4 days a week and 121 minutes a day on average. In their leisure time, almost 20% (75 participants) of the study sample were involved in vigorous activities. They were involved in these activities 2.76 days a week for 71 minutes per day on average. Almost half the participants were involved in moderate intensity activities (47.6%, 181 participants). Study participants engaged in these activities almost 5 days a week and for 136 minutes per day on average. More women engaged in moderate exercise: 176 women (46.3%) were involved in moderate intensity activities; on average, they performed these activities 3.23 days per week for 68 minutes a day.

Only 94 participants (24.7%) reported walking for transportation between places. They performed these activities 3.24 days a week for 42 minutes a day on average. Overall, 66% of postpartum women in our sample met the WHO recommendations for weekly physical activity. Women in our sample reported sitting or reclining for 151 minutes on average on a typical day. The median sedentary time was 120 minutes, the maximum was 600 minutes and the minimum was 0 minutes.

The pedometer reading response rate was very low. Only 6.3% of the sample reported their daily pedometer readings for a complete week. In this small subsample, the mean number of weekly steps was 31,114, and median number of weekly steps was 24,610. The highest weekly steps count was 96,878 and lowest was 3,757. The subsample of 24 responders was analyzed to minimize the effect of missing data. Also, we used the mathematical logarithm to adjust for the skewedness of data distribution.

Table 1 shows demographic characteristics, BMI and weight classes, and physical activity. Table 2 shows the results of the Global Physical Activity Questionnaire.

Table 1: Demographic and Health Characteristics of Postpartum Women, Jeddah, Saudi Arabia, 2015

Women Characteristics	N	Mean (std)	Min	Max
Age	379	28.66 (5.7)	16	49
Number of their children	380	2.59 (1.7)	1	10
Postpartum Duration	380	8.93 (2.3)	6	12
Height (cm)	380	157.9 (7.3)	108	179
Weight (kg)	380	68.4 (14.7)	40.5	120.3
BMI (kg/m^2)	380	27.5 (5.8)	17.4	51.4
Weekly Physical Activity (MET/week)	334	2815 (3286)	60	25920
Steps Count	24	31114 (25305)	3,757	96,878
Sedentary time (minutes)	380	151.3 (111.9)	0	600
			Frequency (%)	
Nationality	Saudi			125 (32.9)
	Non-Saudi			253 (66.6)
	Missing			2 (0.5)
Education	No formal schooling			27 (7.1)
	Less than primary school			20 (5.3)
	Primary school			25 (6.6)
	Intermediate school			51 (13.4)
	Secondary school			116 (30.5)
	University/college			136 (35.8)
	Postgraduate degree			5 (1.3)
Work	Government employee			19 (5)
	Non-government employee			23 (6)
	Self-employed			4 (1.1)
	Student			22 (5.8)
	Homemaker			312 (82.1)
Income	<10,000 SR			308 (81)
	>=10,000 SR			72 (19)
BMI classification	Underweight			8 (2.1)
	Normal Weight			136 (35.8)
	Overweight			121 (31.8)
	Obese			115 (30.3)
Meeting WHO Recommendations	Met			251 (66)
	Did not meet			129 (34)
Pedometer Reporting	Yes			24 (6.3)
	No			356 (93.7)

Education: as a completed school

Table 2: Descriptive Statistics and Duration of Physical Activity According to GPAQ Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Variables	Options	Frequency (%)
Does your work involve vigorous activity?	Yes	26 (6.84)
	Duration (Std)	121.9 (101.6)
	No	354 (93.16)
Does your work involve moderate-intensity activity?	Yes	181 (47.63)
	Duration (Std)	136.4 (89.7)
	No	199 (52.37)
Do you walk or cycle to and from places?	Yes	94 (24.74)
	Duration (Std)	41.8 (53.2)
	No	286 (75.26)
Do you do vigorous activity in your recreation time?	Yes	75 (19.74)
	Duration (Std)	71.4 (55.2)
	No	305 (80.26)
Do you do moderate-intensity activity in your recreation time?	Yes	176 (46.32)
	Duration (Std)	68.1 (60.9)
	No	204 (53.68)

*Duration in minutes per week.

4.2 Obesity

Age and number of children were positively correlated with BMI. As the age of the participants increased, BMI increased as well (p-value <0.001). BMI and age intersect at 22 kg/m^2 (SE=4.0). Then, with each one-year increase in age, BMI increases by 0.19 kg/m^2 (SE= 0.05). An increase in number of children was associated with a statistically significant higher level of BMI. Number of children and BMI intersect at 26.2kg/m^2. An increase in number of children by one was associated with an increase in BMI by 0.49 kg/m^2. On the other hand, postpartum duration and BMI were negatively correlated. They intersected at 28.7 kg/m^2 and a one-month increase in postpartum duration was associated with a 0.14 kg/m^2 decrease in BMI. This relationship was not statistically significant.

BMI differed by nationality, geographic distribution, education level, work, and income level. Mean BMI of Saudis was lower (26.92 kg/m^2) than that of non-Saudis (27.76

kg/m^2), but this difference was not statistically significant. Women living in the northwest sector had the highest mean BMI (28.5 kg/m^2) while those living in the central sector had the lowest mean BMI (26.5 kg/m^2). The differences in mean BMI according to the geographic distribution was not statistically significant.

The mean BMI for women who completed intermediate school or less was 27.9 kg/m^2, a little higher than that of those who had more education (27.3 kg/m^2). This difference was not statistically significant. Homemakers had a slightly lower average BMI (27.4 kg/m^2) compared to women who had other jobs (27.6 kg/m^2). Also, this difference was not statistically significant. There was no statistical difference in mean BMI by income status. Mean BMI for women in the higher income category (27.53 kg/m^2) was slightly more than the mean BMI for those in the lower income category (27.45 kg/m^2).

Participants' weekly physical activity and daily sedentary time were negatively correlated with BMI. Weekly physical activity and BMI intersected at 27.9 kg/m^2, but the decrease in BMI with one-unit increase in weekly physical activity was negligible. The same intersection point and change was seen with sedentary time. Women who did not meet the WHO recommendations for weekly physical activity actually had a lower mean BMI (27.04 kg/m^2) than that of the women who met the WHO recommendations (27.68 kg/m^2). But this difference was not statistically significant.

A T-test of the relationship between BMI and pedometer response was not statistically significant. The mean BMI for women who submitted the weekly pedometer reading was 26.3 kg/m^2 and the mean BMI for those who did not respond was 27.5 kg/m^2. Steps count and BMI were negatively correlated. Steps count and BMI intersect at 27.9 kg/m^2; with each extra step, there was only a negligible decrease in BMI. This relationship was not statistically significant. Table 3 shows the results of the one-way ANOVA of BMI and categorical

characteristics among the study sample. None of those were significantly associated with the change in BMI.

Table 3: The Results of One-Way ANOVA of the Associations of BMI and Categorical Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Variable	Categories	Mean	p-value
Nationality	Saudi	26.92	0.183
	Non-Saudi	27.76	
Meeting WHO Recommendations	Did not meet	27.04	0.302
	Met	27.68	
Income	<10,000 SR	27.45	0.912
	>=10,000 SR	27.53	
Sector	Central	26.46	0.149
	Northeast	28.09	
	Northwest	28.46	
	Southeast	27.28	
	Southwest	27.75	
Work	Home maker	27.44	0.839
	Other	27.59	
Education	Secondary or more	27.27	0.339
	Intermediate or less	27.87	
Pedometer Reporting	No	27.5	0.317
	Yes	26.3	

Education: Completed school;

Table 4 shows the results of a simple linear regression of BMI with continuous characteristics. Mother's age and her number of children living in the same household were significantly positively correlated to BMI.

Table 4: Results of Simple Linear Regression of BMI and Continuous Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

	BMI (mean (std))		
Variables	Intercept (SE)	b (SE)	p-value
Age	22 (4)	0.19 (0.05)	0.0002
Number of children	26.2 (1)	0.49 (0.17)	0.005
Weekly Physical Activity	27.9 (3)	0 (0)	0.297
Sedentary time	27.9 (0)	0 (0)	0.279
Steps Count	27.9 (9)	0 (0)	0.195
Postpartum Duration	28.72 (1.19)	-0.14 (0.13)	0.276

Intercept is the mean BMI when the variables' values are zero. Number of children: number of their children who live in the same household; weekly physical activity in MET/week

Figure 2 shows the positive correlation between BMI and mother's age. Figure 3 shows the positive correlation of BMI and the number of children in the household.

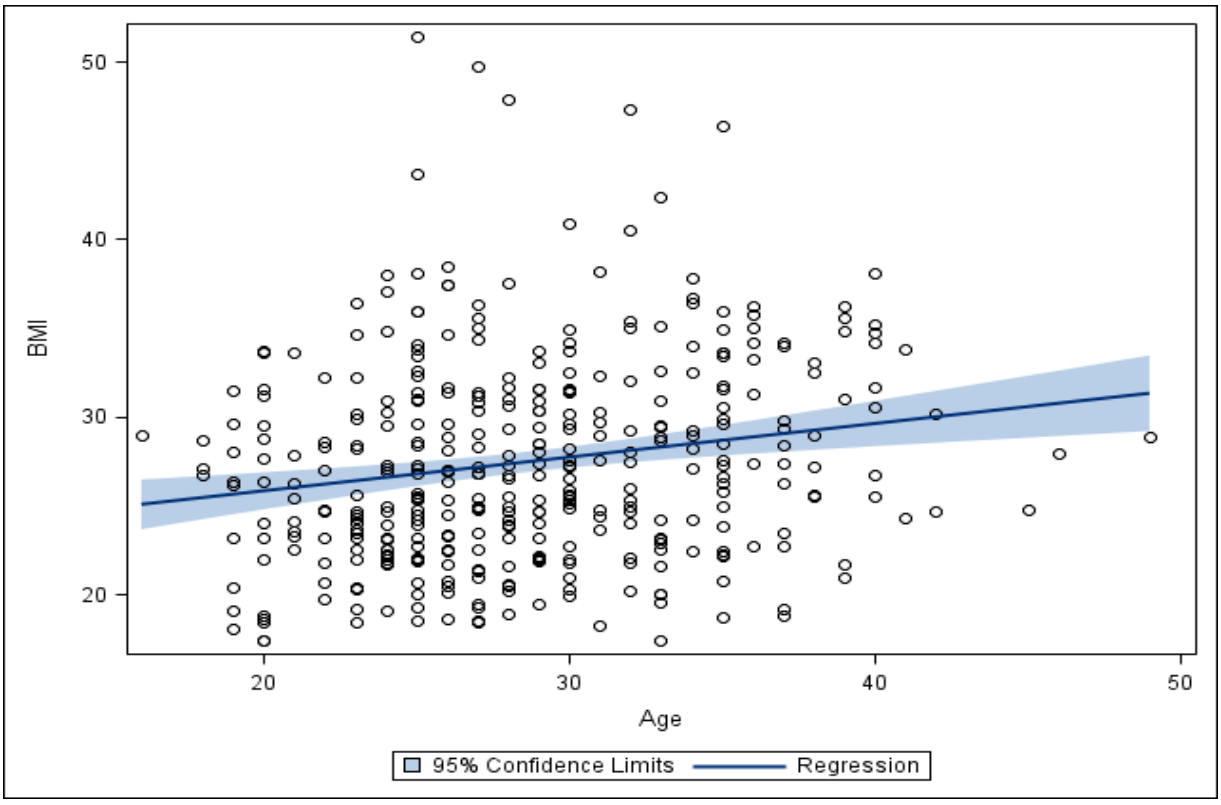

Figure 2: Correlation Between BMI and Postpartum Women's Age in Jeddah, Saudi Arabia, 2015

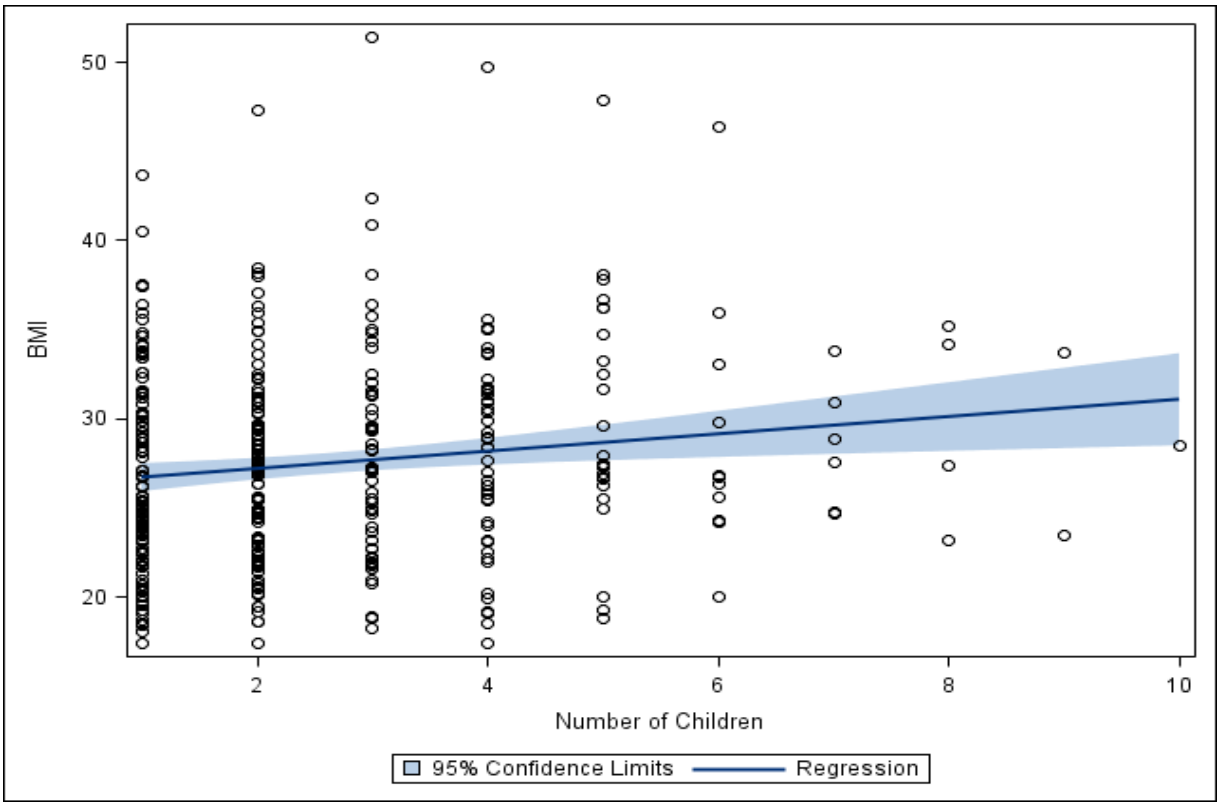

Figure 3: Correlation Between Number of Children in Postpartum Women's Household in Jeddah, Saudi Arabia, 2015

BMI classification according to WHO cut-off points showed significant association with participants' age, education, and number of children. Because there were only 8 participants who were underweight, these results might be over-estimated. We analyzed obesity on 2- and 3-level classifications. In the 3-level classification, we added the underweight participants to normal weight. As a result, we had normal weight or less, overweight, and obese. In the 2-level classification, we analyzed the participants on whether they were obese or not. We used ANOVA to test for the association between obesity and numerical variables in the 3-level classification and T-test for the association between obesity and numerical variables in the 2-level obesity classification. Chi-square was used to test for the association between obesity and categorical variables in the two classification options.

With the 3-level classification, ANOVA showed significant associations between obesity and age. The women in the higher weight categories tended to be older than those in the lower weight categories. The mean age of normal and underweight women was 27.5 years

old, for overweight women it was 28.7 years old, and for obese women it was 30.1 years old. These differences were statistically significant. This significant relationship persists with the 2-level classification. The mean age for non-obese women was 28 years old and the mean age of obese women was 30.1 years old.

There was also a significant relationship between obesity and number of children. In the 3-level classification, the mean number of children in the household was two children for normal and underweight women. On the other hand, the mean number of children in the household was three for overweight and obese women. This difference was statistically significant. With the 2-level classification, there was no statistically significant relationship between obesity and number of children at home. The mean number of children for both groups was almost equal.

The prevalence of overweight among Saudi women was 28.8% and among non-Saudi women it was 33.2%. The prevalence of obesity among Saudi women was also lower than that among non-Saudi women. These differences in overweight and obesity rates were not statistically significant. These relationships were also not significant using the 2-level classification. Lower income level was associated with higher prevalence of overweight and obesity when compared to higher income level. But these differences were not statistically significant with either the 2-level or 3-level classifications.

The Northwest sector had the highest prevalence of overweight (39.8%) and obesity (38.3%), but there was no statistically significant association between geographic locations of the participants and obesity prevalence in the 2-level and 3-level classifications. There was no statistically significant association between obesity and employment status in either the 2-level or 3-level classifications. Also, there was no significant association between education level and obesity in the 2-level and 3-level classifications.

There were no statistically significant associations between obesity and physical activity levels. Overweight women had the highest mean MET per week (3,071.1), followed by underweight and normal (2,783.8), and finally obese (2,580.6) women. These differences were not statistically significant in 2-level and 3-level classifications. Among those meeting the WHO recommendations for physical activity, normal and underweight women were the largest group (43.4%), followed by overweight women (30.2%), and obese women (26.4%). Normal and underweight women were also the largest group (35%) of those not meeting the WHO recommendations for physical activity, followed by overweight women (32.7%), and finally obese women (32.2%). These differences were not statistically significant in either the 2-level or 3-level classifications. Interestingly, obese women had the lowest sedentary time in minutes per week (142.3 minutes) compared to overweight (150.7 minutes) and normal and underweight (158.9 minutes) women. These differences were not statistically significant in the 2-level and 3-level classifications.

Table 5 shows the results of a Chi-square test of 3-levels weight categories with the categorical characteristics. Underweight women were analyzed along with normal weight women because of their small number.

Table 5: Results of Chi-square Test of Categorical Variables with Weight Categories Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Parameters	Categories	Weight Categories (%)			p-value
		Normal	Overweight	Obese	
Nationality	Saudi (n=125)	44	28.8	27.2	0.223
	Non-Saudi (n=253)	34.8	33.2	32	
Meeting WHO Recommendations	Did not meet (n=129)	43.4	30.2	26.4	0.259
	Met (n=251)	35	32.7	32.3	
Income	<10,000 SR (n=308)	37.7	31.8	30.5	0.971
	>=10,000 SR (n=72)	38.9	31.9	29.2	
Sector	Central (n=117)	44.4	30.7	24.9	0.41
	Northeast (n=47)	40.4	23.4	36.2	
	Northwest (n=81)	30.9	39.8	38.3	
	Southeast (n=65)	35.4	36.9	27.7	
	Southwest (n=70)	35.7	35.7	28.6	
Work	Home maker (n=312)	37.2	32.7	30.1	0.723
	Others (n=68)	41.2	27.9	30.9	
Education	Intermediate or less (n=123)	31.7	39.8	28.5	0.6
	Secondary or more (n=257)	40.9	28	31.1	
Pedometer Reporting	No (n=356)	37.6	31.5	30.9	0.555
	Yes (n=24)	41.7	37.5	20.8	

Normal weight category in this table includes underweight

Table 6 shows the results of a one-way ANOVA of the association between 3-levels weight categories and continuous characteristics. Underweight women were analyzed along with normal weight women due to their small number.

Table 6: Results of One-Way ANOVA of the Associations of Weight Categories and Continuous Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

	Weight Categories (mean (std))			
Variables	Normal	Overweight	Obese	p-value
Age	27.5 (5.3)	28.7 (6)	30.1 (5.6)	0.001
Weekly Physical Activity	2784 (3713)	3071 (3418)	2581 (2546)	0.546
Sedentary time	158.9 (112.7)	150.7 (117.2)	142.3 (105.1)	0.488
Steps Count	39880 (32007)	26643 (21984)	21633 (7805)	0.301
Number of children	2.3 (1.5)	2.8 (1.7)	2.8 (1.8)	0.014
Postpartum Duration	9.2 (2.3)	8.7 (2.3)	8.8 (2.3)	0.155

Normal weight category in this table includes underweight. Number of children: number of their children who live in the same household; weekly physical activity in MET/week

Figure 4 shows box-plot diagrams of weight categories with mothers' age.

Underweight women were analyzed with normal weight women due to their small number.

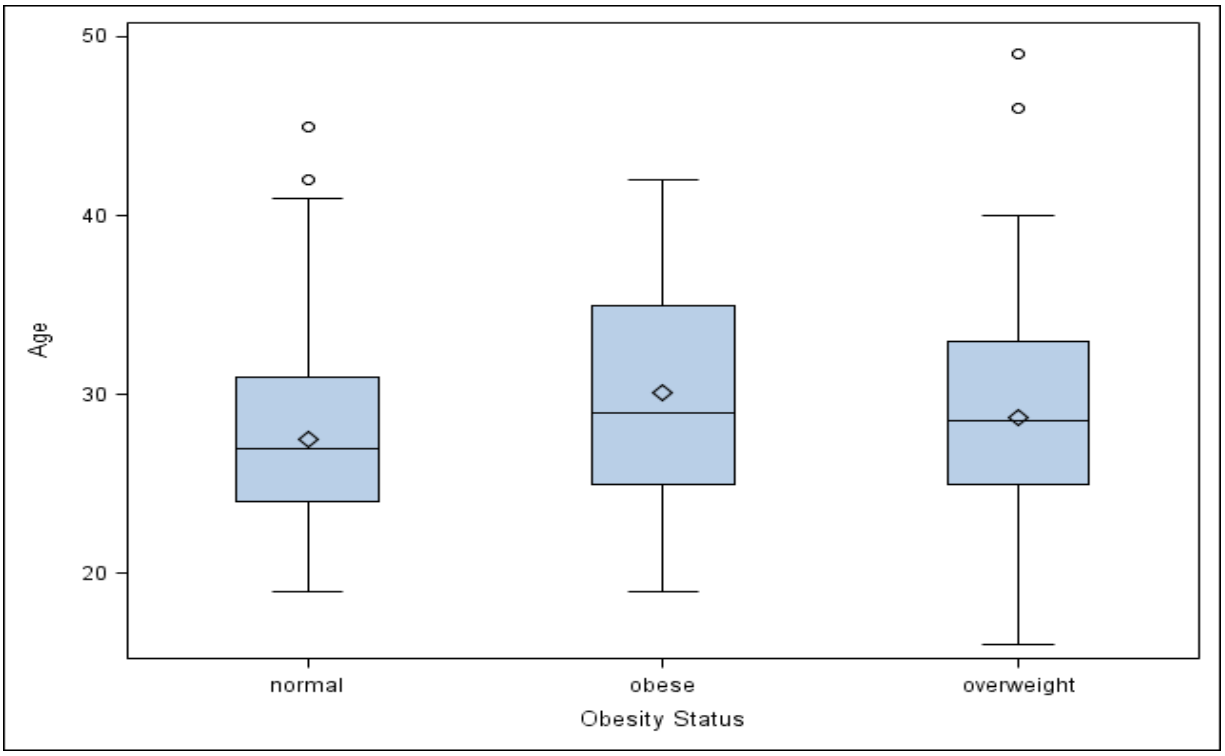

Figure 4: Box Plot Diagrams of Postpartum Women's Age with Their Weight Categories in Jeddah, Saudi Arabia, 2015. Underweight women were analyzed with the normal weight in this diagram.

Figure 5 shows box-plot diagrams of women's weight categories with their number of children in the household. Underweight women were analyzed with normal weight women due to their small number.

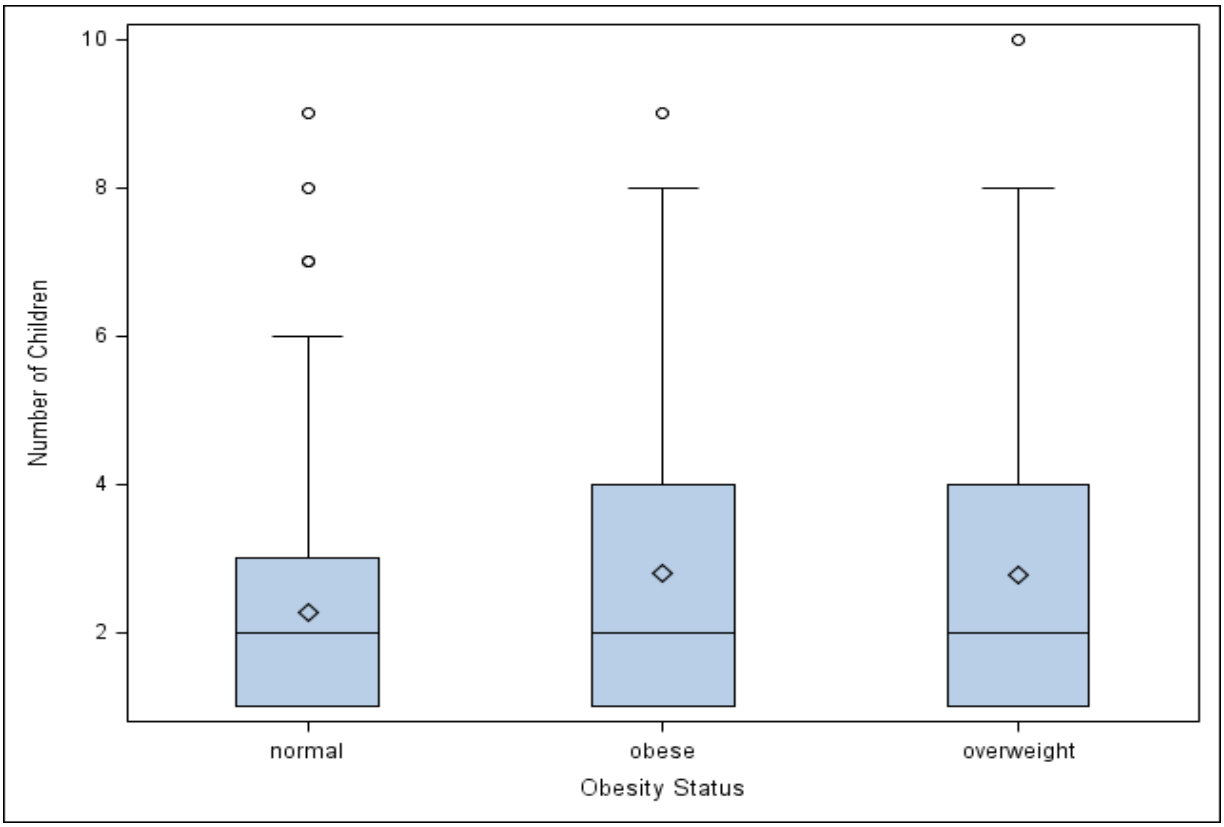

Figure 5: Box Plot Diagrams of Postpartum Women's Age with Their Weight Categories in Jeddah, Saudi Arabia, 2015. Underweight women were added with the normal weight category in this diagram.

Among those who responded with their pedometer readings, 20.8% were obese, 31.5% were overweight, and 37.6% were normal and underweight women. Among those who did not respond with pedometer readings, 30.9% were obese, 31.5% were overweight, and 37.6% were normal and underweight women. These differences were not statistically significant in 2-level and 3-level classifications. Obese women had the lowest weekly steps count (21,633 steps), followed by overweight (26,643 steps), and normal and underweight (39,880 steps) women. This difference was not statistically significant in 2-level and 3-level classifications.

Figure 6 shows box-plot diagrams of postpartum women's weight categories with their age. Non-obese category includes underweight, normal, and overweight women.

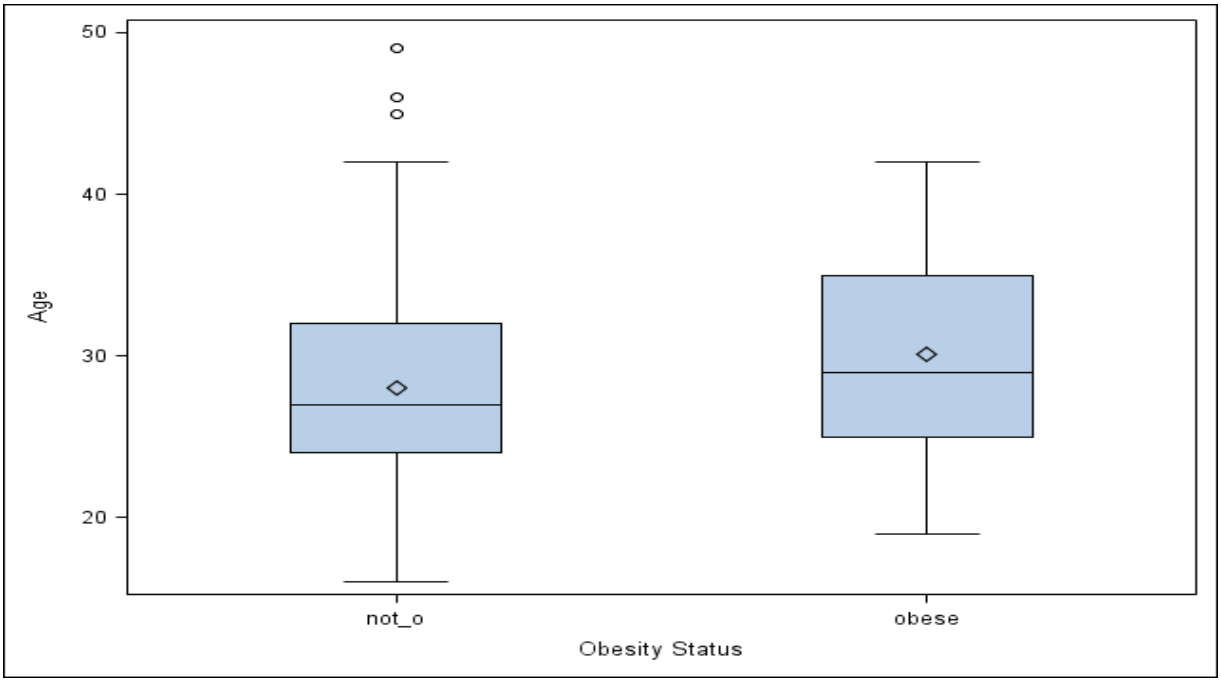

Figure 6: Box Plot Diagrams of Postpartum Women's Age with Their Weight Categories in Jeddah, Saudi Arabia, 2015. The Non-obese category includes underweight, normal, and overweight postpartum women.

Table 7 shows the results of a Chi-square test for the associations between 2-levels weight categories and categorical characteristics. Table 8 shows the results of a one-way ANOVA of the associations between 2-level weight categories and continuous characteristics. The results are shown in mean (standard deviation).

Table 7: Results of Chisq Test of Categorical Variables with Weight Categories Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Parameters	Categories	Weight Categories (%)		p-value
		Not obese	Obese	
Nationality	Saudi (n=125)	72.8	27.2	0.336
	Non-Saudi (n=253)	68	32	
Meeting WHO Recommendations	Did not met (n=129)	73.6	26.4	0.232
	Met (n=251)	67.7	32.3	
Income	<10,000 SR (n=308)	69.5	30.5	0.822
	>=10,000 SR (n=72)	70.8	29.2	
Sector	Central (n=117)	75.2	24.8	0.273
	Northeast (n=47)	63.8	36.2	
	Northwest (n=81)	61.7	38.3	
	Southeast (n=65)	72.3	27.7	
	Southwest (n=70)	71.4	28.6	
Work	Home maker (n=312)	69.9	30.1	0.903
	Others (n=68)	69.1	30.9	
Education	Intermediate or less (n=123)	71.5	28.5	0.595
	Secondary or more (n=257)	68.9	31.1	
Pedometer Reporting	No (n=356)	69.1	30.9	0.283
	Yes (n=24)	79.2	20.8	

non-obese category includes underweight, normal, and overweight in this table.

Table 8: The Results of One-Way ANOVA of the Associations of Weight Categories and Continuous Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Variables	Weight Categories (mean (std))		p-value
	Not obese	Obese	
Age	28 (5.6)	30.1 (5.6)	0.001
Weekly Physical Activity	2921 (3570)	2581 (2546)	0.371
Sedentary time	155.2 (115)	142.3 (105.1)	0.297
Steps Count	33610 (27805)	21633 (7805)	0.291
Number of Children	2.5 (1.7)	2.8 (1.8)	0.126
Postpartum Duration	9 (2.3)	8.8 (2.3)	0.422

Number of children: number of their children who live in the same household; non-obese category includes underweight, normal, and overweight in this table; results are in mean (std); weekly physical activity in MET/week

4.3 Physical activity

Saudi women were more likely than non-Saudi women to meet the WHO physical activity recommendations: 66.4% of them met those recommendations compared to 65.6% of the non-Saudi women. This small difference was not statistically significant. Almost 70% of women with higher monthly incomes met the WHO recommendations, while 65% of women with lower monthly incomes met them. Again, this difference was not statistically significant. Women living in the Northwest sector were most likely to meet the WHO recommendations: 72.8% of them in that sector did, compared to 65% in the Central sector, 61.7% in the Northeast, 66.2% in the Southeast, and 62.9% in the Southwest. These differences were not statistically significant.

The mean age of women who met WHO physical activity recommendations was 28.6 years old compared to 28.7 years old for women who did not meet the recommendations. This trivial difference was not statistically significant. Furthermore, the mean number of children in the household was three for both groups. Homemakers were less likely to meet WHO physical activity recommendations than others: 65.1% of them met the recommendations compared to 70.6% among those who were employed. This difference was not statistically significant. Interestingly, women with lower education levels were more likely to meet the recommendations: 66.5% of women with intermediate certificate or less met the recommendations compared to 65% of those who had secondary certificate or more. This difference was not statistically significant. The mean number of months after delivery of those who met the WHO recommendations was 8.9; it was 9.1 months for those did not meet the recommendations. This difference was not statistically significant.

The percentage of meeting the physical activity recommendations was slightly higher among those who submitted their weekly steps count: 66.7% of the responders met the recommendations compared to 66% of those who did not respond. As expected, this narrow

difference was not statistically significant. Among the responders, the mean steps count of those who met the recommendations was slightly lower than that of those who did not meet the recommendations. Those who met the WHO physical activity recommendations according to GPAQ walked an average of 30,968 steps per week. On the other hand, the average steps count for those who did not meet the recommendations was 31,409 steps per week.

Obese women were more likely to meet WHO physical activity recommendations: 70.4% of them met these recommendations compared to 64.2% of non-obese women. This difference was not statistically significant. Mean BMI for women who met the recommendations was 27.7 kg/m^2 compared to a mean BMI of 27 kg/m^2 for those did not meet the recommendations. This difference was not statistically significant. Moreover, women who met the recommendations had less sedentary time than women who did not meet the recommendations. The average sedentary time for women who met the recommendations was 146 minutes per week compared to 162 minutes per week for those who did not meet the recommendations. This difference was not statistically significant.

The average weekly physical activity of Saudi women was 2,294 METs and the median was 1,440 METs. For non-Saudi women, the average weekly physical activity was 3,048 METs and the median was 1,680 METs. The difference between the two means was statistically significant, but there was no statistically significant difference between the means of LOG weekly physical activity of Saudi and non-Saudi women. The mean weekly physical activity among those who submitted pedometer steps counts (4,300 METs) was higher than that of those who did not (2,715 METs). This difference was statistically significant. There was no statistically significant difference between the two means of the LOG variable in regard to pedometer response. Table 9 shows the results of Chi-square tests for the associations between meeting WHO recommendations' categories and categorical

characteristics. Table 10 shows the results of a one-way ANOVA between meeting WHO recommendations categories and continuous characteristics.

Table 9: Results of Chi-square Test of Categorical Variables with Meeting WHO Recommendations Categories Among Postpartum Women in Jeddah, Saudi Arabia, 2015

		Meeting WHO Recommendation (%)		
Variables	Categories	Did not meet	Met	p-value
Nationality	Saudi (n=125)	33.6	66.4	0.879
	Non-Saudi (n=253)	34.4	65.6	
Obesity	Not obese (n=265)	35.8	64.2	0.232
	Obese (n=115)	29.6	70.4	
Income	<10,000 SR (n=308)	34.8	65.2	0.497
	>=10,000 SR (n=72)	30.6	69.4	
Sector	Central (n=117)	35	65	0.646
	Northeast (n=47)	38.3	61.7	
	Northwest (n=81)	27.2	72.8	
	Southeast (n=65)	33.8	66.2	
	Southwest (n=70)	37.1	62.9	
Work	Home maker (n=312)	34.9	65.1	0.379
	Others (n=68)	29.4	70.6	
Education	Intermediate or less (n=123)	33.5	66.5	0.774
	Secondary or more (n=257)	35	65	
Pedometer Reporting	No (n=356)	34	66	0.948
	Yes (n=24)	33.33	66.7	

The results are shown in percentages

Table 10: Results of One-Way ANOVA of the Associations of Meeting WHO Recommendations Categories and Continuous Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

	Meeting WHO Recommendation (mean (std))		
Varibles	Did not meet	Met	p-value
Age	28.7 (5.9)	28.6 (5.6)	0.875
Number of Children	2.6 (1.8)	2.6 (1.7)	0.934
BMI	27 (5.6)	27.7 (5.8)	0.298
Months Postpartum	9.1 (2.4)	8.9 (2.3)	0.435
Steps Count	31409 (25305)	30968 (24044)	0.967
Sedentary time	161.6 (121.5)	145.9 (106.4)	0.197

Number of children: number of their children who live in the same household; results are in mean (std)

Age and weekly physical activity were positively correlated. They intersected at 2,188 METs and increased by 22 METs with each year increase in age. This relation was not statistically significant with LOG weekly physical activity and weekly physical activity. Number of children at the household and weekly physical activity were positively correlated. They intersected at 2,650 METs and increased by 64 METs with each additional child. The relationship between physical activity and number of children was not statistically significant between the weekly physical activity and LOG weekly physical activity. Postpartum months and weekly physical activity were positively correlated. They intersected at 2,741 METs and increased by 8 METs each month after delivery. This relation was not statistically significant in weekly physical activity and LOG weekly physical activity.

A lower level of education was associated with higher average (3,168 METs) and median (1,920 METs) weekly physical activity compared to the mean (2,661 METs) and median (1,440 METs) physical activity of women with a secondary school certificate or higher. These differences were not statistically significant on adjusted or non-adjusted weekly

physical activity. Mean weekly physical activity of homemakers was 2,805 METs compared to a mean of 2,856 METs for others. The reverse was true for the median measurements: median weekly physical activity of homemakers was 1,610 METs compared to a median of 1,560 METs for others. These differences were not statistically significant for adjusted and non-adjusted weekly physical activity. Although mean weekly physical activity among those with higher incomes was higher (3,041 METs) than that of the lower income participants (2,762 METs), the median weekly physical activity followed a reverse pattern. These differences were not statistically significant with either weekly physical activity or LOG weekly physical activity. Women living on the southwest side of the city had the highest mean (3,759) and median (2,240) weekly physical activity of all the women. The geographic variations were not statistically significant for either weekly physical activity or LOG weekly physical activity.

BMI, sedentary time, and weekly steps count were negatively correlated to the women's weekly physical activity. They intersected at 3,707 METs and decreased by 32 METs with each kg/m^2 increase in BMI. This relationship was not statistically significant with adjusted and non-adjusted weekly physical activity. Sedentary time and weekly physical activity intersected at 2,945 METs and decreased by 1 MET with each one-minute increase in sedentary time. This relationship was not statistically significant with adjusted and non-adjusted weekly physical activity. Weekly steps count and weekly physical activity intersected at 4,383 METs, but the decrease with each step was almost zero. This relationship was not statistically significant with adjusted and non-adjusted weekly physical activity.

Table 11 shows the results of a one-way ANOVA for the associations between weekly physical activity and the categorical characteristics. Table 12 shows the results of simple linear regression tests of the associations between weekly physical activity and continuous characteristics. p-values in both tables are of the LOG numbers.

Table 11: Results of One-Way ANOVA of the Associations of Weekly Physical Activity in MET/week and Categorical Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Variable	Categories	Mean	p-value
Obesity	Not obese	2921	0.84
	Obese	2581	
Nationality	Saudi	2294	0.097
	Non-Saudi	3048	
Income	<10,000 SR	2762	0.909
	>=10,000 SR	3042	
Sector	Central	2656	0.66
	Northeast	1995	
	Northwest	2676	
	Southeast	2768	
	Southwest	3759	
Work	Home maker	2806	0.639
	Others	2857	
Education	Secondary or more	2662	0.094
	Intermediate or less	3169	
Pedometer Reporting	No	2716	0.231
	Yes	4300	

p-value of the LOG numbers

Table 12: Results of Simple Linear Regression of Weekly Physical Activity in MET/week and the Continuous Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

	Total Weekly physical activity		
Variables	Intercept (SE)	b (SE)	p-value
Age	2188 (911)	22 (31)	0.82
Number of Children	2650 (330)	64 (106)	0.969
BMI	3707 (872)	-32 (31)	0.993
Postpartum Duration	2741 (720)	8 (79)	0.948
Steps Count	4383 (1599)	0 (0.04)	0.763
Sedentary time	2945 (300)	-1 (2)	0.991

Number of children: number of their children who live in the same household; Intercept is the mean total weekly physical activity when the variables' values are zero; p-value of the LOG numbers

4.4 Sedentary time

Age, number of children in the household, and postpartum duration were negatively correlated with sedentary time. Age and sedentary time intersected at 230 minutes and sedentary time decreased by almost 3 minutes with each year increase in age. This relationship was statistically significant. Number of children in the household intersected with sedentary time at 177 minutes and sedentary time decreased by 10 minutes with each additional child. This relationship was statistically significant. Postpartum duration and sedentary time intersected at 159 minutes. As postpartum duration increased by one month, sedentary time decreased by one minute. This relationship was not statistically significant.

There were differences in the mean sedentary times by nationality, geographic distribution, education, work, and income. None of these was statistically significant. Saudi women spent more time being sedentary than non-Saudi women. Mean sedentary time among Saudi women was 158 minutes compared to 147 minutes among non-Saudi women. This difference was not statistically significant. Women living in the northwest sector spent the most time being sedentary per day on average (174 minutes), while women living in the southwest spent the least time being sedentary per day on average (131 minutes). The differences between different geographic regions were not statistically significant.

Women who completed secondary school or higher spent more time being sedentary time than those who completed intermediate school (at the most). Mean sedentary time for women with higher education level was 154 minutes compared to a mean of 145 minutes for those with a lower education level. This difference was not statistically significant. Also, homemakers had an average sedentary time of 154 minutes. This is slightly higher than the average sedentary time of other working women, who had 136 minutes of sedentary time per day. This difference was not statistically significant. Women with higher incomes had an

average of 163 minutes of sedentary time per day compared to 148 minutes for women with lower incomes. This difference was not statistically significant.

Mean sedentary time on a typical day differed by obesity, meeting WHO recommendations for physical activity, and pedometer compliance, but none of those was statistically significant. Non-obese women had a mean of 155 minutes of sedentary time per day compared to 142 minutes of sedentary time on average for obese women. This difference was not statistically significant. Women who did not meet WHO physical activity recommendations had 162 minutes of sedentary time on average compared to 146 minutes for those who met the recommendations. This difference was not statistically significant. Those who sent in their pedometer readings had 152 minutes of sedentary time on average per day compared to a mean of 139 minutes for those who did not send their weekly pedometer readings. This was not statistically significant.

BMI, weekly physical activity, and steps count were negatively correlated to sedentary time. None of these relationships was statistically significant. BMI and sedentary time intersected at 181 minutes and sedentary time decreased by one minute with each kg/m^2 increase in BMI. This relationship was not statistically significant. Weekly physical activity intersected with sedentary time at 149 minutes and there was an incremental decrease in sedentary time with each unit increase in physical activity. This was not statistically significant. Weekly steps count and sedentary time intersected at 163 minutes, but with each extra step, there was only a trivial decrease in sedentary time. This relationship was not statistically significant.

Table 13 shows the results of a one-way ANOVA for the associations between daily sedentary time in minutes and the categorical characteristics. Table 14 shows the results of simple linear regression tests of the associations between daily sedentary time in minutes and continuous characteristics.

Table 13: Results of One-Way ANOVA of the Associations of Daily Sedentary Time in Minutes and Categorical Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Variable	Categories	Mean	p-value
Obesity	Not obese	155.15	0.303
	Obese	142.26	
Meeting WHO Recommendations	Did not meet	161.63	0.195
	Met	145.92	
Nationality	Saudi	157.64	0.403
	Non-Saudi	147.39	
Income	<10,000 SR	148.4	0.304
	>=10,000 SR	163.47	
Sector	Central	141.32	0.139
	Northeast	155.11	
	Northwest	173.7	
	Southeast	160.15	
	Southwest	131.01	
Work	Home maker	154.41	0.239
	Others	136.76	
Education	Intermediate or less	145.16	0.464
	Secondary or more	154.17	
Pedometer Reporting	No	152.11	0.566
	Yes	138.54	

Table 14: Results of Simple Linear Regression of Daily Sedentary Time in Minutes and the Continuous Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

	Sedentary Time		
Variable	Intercept (SE)	b (SE)	p-value
Age	229.51 (29.24)	-2.72 (1)	0.007
No. of Children	177.28 (10.37)	-10.06 (3.35)	0.003
BMI	180.96 (28.01)	-1.08 (1)	0.279
Weekly Physical Activity	149.33 (7.95)	0 (0)	0.589
Postpartum Duration	159.17 (23.15)	-0.89 (2.51)	0.724
Steps Count	163.3 (30.12)	0 (0)	0.305

Number of children: number of their children who live in the same household. Intercept is the mean Sedentary time when the variables' values are zero.

Figure 7 shows the negative correlation between daily sedentary time in minutes and mother's age. Figure 8 shows the negative correlation of daily sedentary time in minutes and the number of their children in the household.

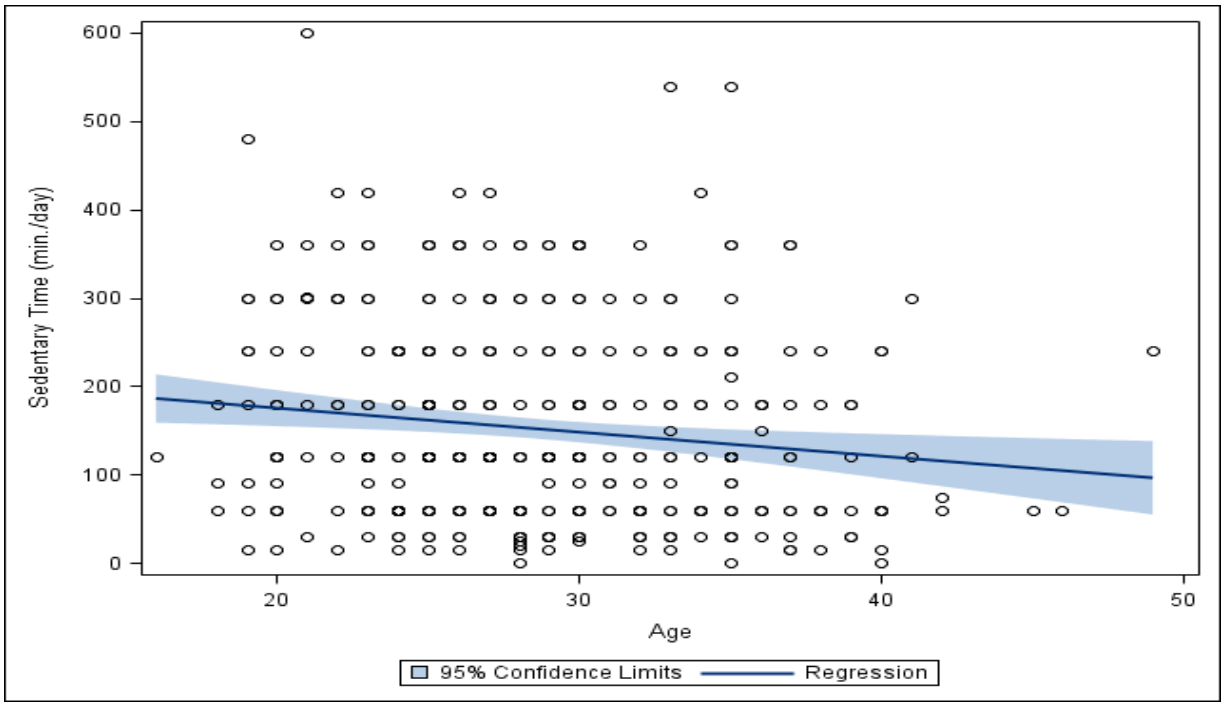

Figure 7: Correlation between Daily Sedentary Time in Minutes Postpartum Women's Age in Jeddah, Saudi Arabia, 2015

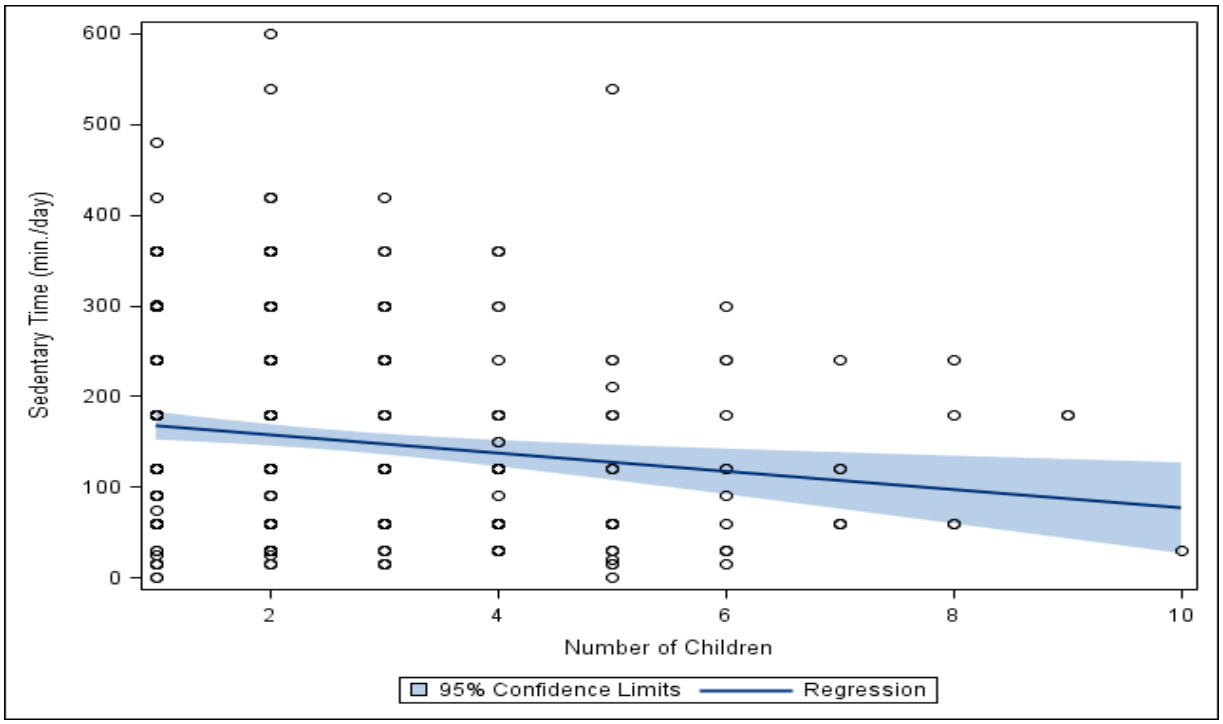

Figure 8: Correlation between Daily Sedentary Time in Minutes and the Number of Postpartum Women's Children in Household in Jeddah, Saudi Arabia, 2015

4.5 Pedometer

The mean total steps count in a week was 52,367 steps among Saudi women and 24,031 steps among non-Saudi women. This difference was statistically significant in the log transformed steps count. There was no statistically significant difference in the mean mathematical steps count logarithm by geographic distribution in the city. The highest mean total steps count in a week (47,553 steps) was seen among women in the Central sector, while the lowest (22,999 steps) occurred among women in the Southwest sector.

Women with a higher education level had a higher total steps count in a week (33,028 steps) compared to women with a lower education level (23,845 steps). This difference was not statistically significant in the LOG transformed variable. The mean total steps count in a week among homemakers was 26,417 steps compared to a mean of 82,791 steps for women in the other work category. The difference was statistically significant. The mean total steps count in a week was 42,264 steps among women in the higher income group compared to 27,398 steps for those in the lower income group. This difference was not statistically significant in the log transformed steps count.

Age and postpartum duration were positively correlated with mathematical steps count logarithm, while number of children in the household was negatively correlated with it. Age and steps count intersected at 12,290 steps. With each additional year in age, steps count increased by 665 steps. This relationship was not statistically significant in the log transformed steps count. Postpartum duration intersected steps count at 9,253 steps. Steps count increased by 2,452 with each additional month in postpartum duration. This relationship was not statistically significant in the log transformed steps count. Number of children in the household intersected steps count at 43,704. Steps count decreased by 5036

steps with each additional child in the household. This relationship was not statistically significant in the log transformed steps count.

Mean steps count among obese women was 21,633 compared to a mean of 33,610 among non-obese women. This difference was not statistically significant. Similarly, there was no statistically significant difference in the mean mathematical logarithm based on achievement of the WHO recommendations for physical activity. Women who met WHO recommendations for physical activity had a mean total steps count in a week of 30,968 steps compared to a mean of 31,409 steps for those who did not meet the recommendations.

While BMI and sedentary time were negatively correlated with the mathematical logarithm of steps count, weekly physical activity was positively correlated with it. BMI intersected steps count at 67984 steps. As BMI increased by 1 kg/m^2, steps count decreased by 1401 steps. This relationship was not statistically significant. Sedentary time intersected steps count at 39432. As sedentary time increased by a minute daily, the steps count decreased by 60 steps. This relationship was not statistically significant. Women's weekly physical activity intersected steps count at 30089. Steps count decreased by 9 with 100 MET increase in women's weekly physical activity. This relationship was not statistically significant.

Table 15 shows the results of a one-way ANOVA for the associations between steps count in a week and the categorical characteristics. Table 16 shows the results of simple linear regression tests of the associations between steps count in a week and continuous characteristics. the p-values in the 2 tables are for the LOG counts.

Table 15: Results of One-Way ANOVA of the Associations of Steps Count and Categorical Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Variable	Categories	Mean	p-value
Obesity	Not obese	33610	0.746
	Obese	21633	
Meeting WHO Recommendations	Did not meet	31409	0.668
	Met	30968	
Nationality	Saudi	52367	0.05
	Non-Saudi	24031	
Income	<10,000 SR	27398	0.314
	>=10,000 SR	42264	
Sector	Central	47553	0.599
	Northeast	36234	
	Northwest	37213	
	Southwest	22999	
Work	Home maker	26417	0.02
	Others	82790	
Education	Intermediate or less	23845	0.14
	Secondary or more	33028	

p-value of the LOG counts

Table 16: Results of Simple Linear Regression of Steps Count and the Continuous Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

	Steps Count		
Variables	Intercept (SE)	b (SE)	p-value
Age	12290 (30198)	665 (1051)	0.215
Number of Children	43705 (9356)	-5036 (3163)	0.208
Weekly Physical Activity	30089 (7966)	-0.09 (1.28)	0.402
BMI	67984 (28072)	-1401 (1049)	0.41
Postpartum Duration	9253 (19354)	2452 (2093)	0.203
Sedentary Time	39432 (9447)	60 (57)	0.521

Number of children: number of their children who live in the same household; Intercept is the mean steps count when the variables' values are zero; p-value of the LOG counts

Figure 9 shows box-plot diagrams of postpartum women nationalities with their LOG steps count in a week. Figure 10 shows box-plot diagrams of postpartum women's work categories with their LOG steps count in a week.

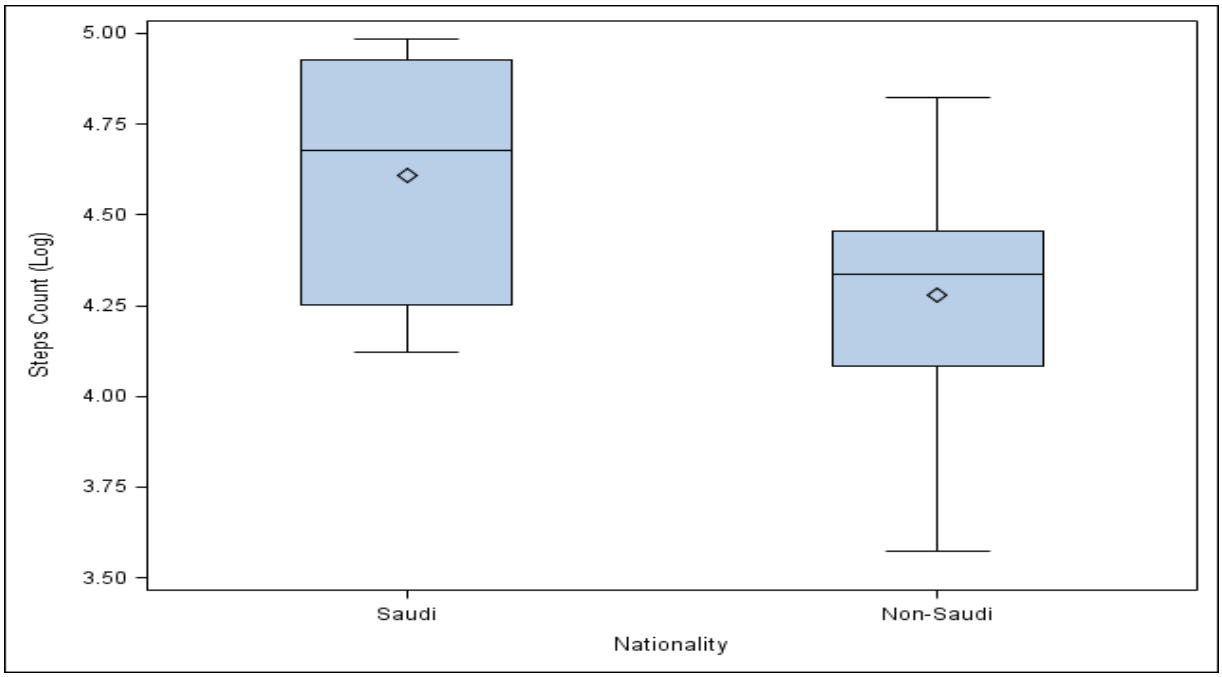

Figure 9: Box Plot Diagrams of Postpartum Women's LOG Steps Count with Their Nationality in Jeddah, Saudi Arabia, 2015.

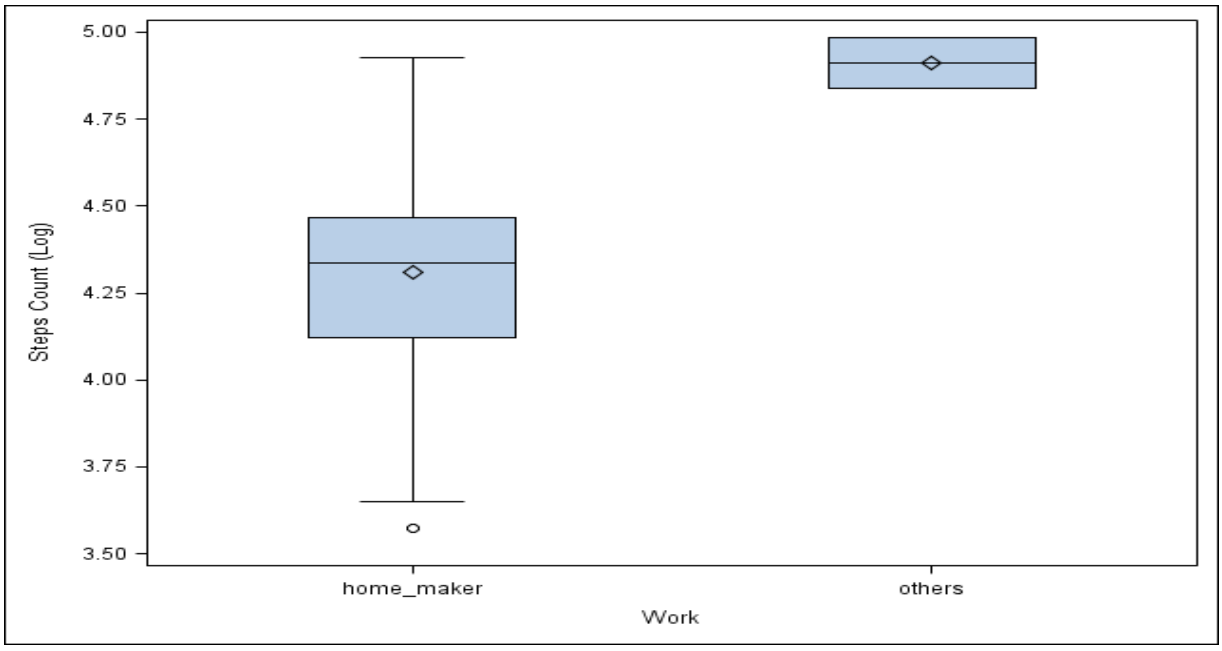

Figure 10: Box Plot Diagrams of Postpartum Women's LOG Steps Count with Their Work in Jeddah, Saudi Arabia, 2015.

Response to pedometer was not changed by age, nationality, education, work, and income. Only geographic location was associated with significant response percentage. Number of children in household and postpartum duration were almost equal for those who sent their pedometer readings and those did not. The mean age of women who sent their pedometer readings was 28.3 years old, and it was 28.7 years old for those who did not send in their readings. This difference was not statistically significant. By nationality, 7.1% of non-Saudi women sent their pedometer readings to us, and only 4.8% of Saudi women. This difference was not statistically significant.

No women in the Southeast sector sent in their pedometer readings while 18.6% of women in Southwest did. Other sectors' percentages ranged from 3.4% to 6.4%. This difference was statistically significant. By education level, 7.4% of those in the higher-level education category sent in their pedometer readings compared to 4.1% of those in the lower education category. This difference was not statistically significant. By employment, 7.1% of homemakers sent in their pedometer readings compared to 2.9% of those in the other work category. This difference was not statistically significant. Women who had higher income responded more (8.3%) than those who had lower income (5.8%), but this difference was not statistically significant.

By physical activity level, 6.4% of women who met the WHO recommendations sent in their pedometer readings to us compared to 6.2% of women who did not. This difference was not statistically significant. Mean weekly physical activity of women who sent their pedometer readings was 4,300 MET/week compared to 2,715 MET/week for those who did not respond. This difference was not statistically significant. Mean sedentary time of women who sent their readings was 138.5 minutes/day compared to a mean of 152.1 minutes/day for those who did not. This difference was not statistically significant. By weight, 7.2% of non-obese women sent in their pedometer readings compared to 4.3% of obese women, but this

difference was not statistically significant. Mean BMI of women who sent their pedometer readings was 26.3 kg/m^2, while mean BMI of those who did not was 27.5 kg/m^2. This difference was not statistically significant.

Table 17 shows the results of Chi-square tests for the associations between pedometer reporting's categories and categorical characteristics. Table 18 shows the results of a one-way ANOVA between pedometer reporting's categories and continuous characteristics.

Table 17: Results of Chi-square Test of Categorical Variables with Pedometer Reporting Among Postpartum Women in Jeddah, Saudi Arabia, 2015

Variables	Categories	Pedometer Compliance		p-value
		No	Yes	
Meeting WHO Recommendations	Did not meet(n=129)	93.8	6.2	0.948
	Met (n=251)	93.6	6.4	
Nationality	Saudi (n=125)	95.2	4.8	0.375
	Non-Saudi (n=253)	92.9	7.1	
Obesity	Not obese (n=265)	92.8	7.2	0.283
	Obese (n=115)	95.7	4.3	
Income	<10,000 SR (n=308)	94.2	5.8	0.45
	>=10,000 SR (n=72)	91.7	8.3	
Sector	Central (n=117)	96.6	3.4	<0.001
	Northeast (n=47)	93.6	6.4	
	Northwest (n=81)	95.1	4.9	
	Southeast (n=65)	100	0	
	Southwest (n=70)	81.4	18.6	
Work	Home maker (n=312)	92.9	7.1	0.169
	Others (n=68)	97.1	2.9	
Education	Intermediate or less (n=123)	95.9	4.1	0.196
	Secondary or more (n=257)	92.6	7.4	

Table 18: Results of One-Way ANOVA of the Associations of Pedometer Reporting and Continuous Variables Among Postpartum Women in Jeddah, Saudi Arabia, 2015

	Pedometer Compliance		
Variables	No	Yes	p-value
Age	28.7 (5.7)	28.3 (5.1)	0.744
Number of Children	2.6 (1.7)	2.5 (1.6)	0.793
Weekly physical activity	2716 (3163)	4300 (4611)	0.059
BMI	27.5 (5.8)	26.3 (4.9)	0.303
Sedentary time	152.1 (113.1)	138.5 (92.1)	0.558
Postpartum Duration	8.9 (2.3)	8.9 (2.5)	0.969

Number of children: number of their children who live in the same household

5 Discussion

Obesity and physical inactivity are major public health problems in Saudi Arabia [17]. In the childbearing age group, obesity increases the risk of pregnancy complications for mothers and their infants [5] [8] [9] [10]. In our study, more than 60% of the study sample was either obese or overweight. As women's age and number of children in the household increased, the probability of being obese also increased. Interestingly, those two variables were associated with significantly less sedentary time. Almost one-third of our sample did not meet WHO recommendations for weekly physical exercise. Non-Saudi women were more physically active than Saudi women. Physical activity was not associated with the socioeconomic variables included in this study. Unfortunately, only 6% of the sample sent back their pedometer readings. Among those who did, we found that nationality and type of work were associated with a significant difference in weekly steps count. Any future study in Saudi Arabia should develop a follow-up plan before using pedometers in community-based research.

We found the prevalence of obesity to be high. Multiple studies have also found a high prevalence of obesity in adult women in Saudi Arabia [17] [18]. We also found that the risk of obesity increased as the mother's age and number of children at home increased. These results are consistent with those found in other studies [54] [55] [10] [17] [73]. We found that the prevalence of obesity was higher among women of childbearing age than among adolescent females in Saudi Arabia [68] [69] [19]. Memish found that the risk of obesity increased among women if they were married or previously married [17]. The increased risk of obesity among married or previously married women might be related to their weight gain during pregnancy and postpartum obesity. Also, the cultural aspects of the Arab family cannot be excluded as a possible factor in this difference [65] [74]. The increased obesity risk for women as they age and have more children, combined with the high

fertility rate in Saudi Arabia, threatens the healthcare system. More obese women will be at risk of pregnancy complications, affecting them and their infants. Women are at increased risk of cardiovascular diseases, diabetes mellitus, and have a higher overall mortality rate [10]. In their subsequent pregnancies, the prevalence of gestational diabetes, gestational hypertension, and operative deliveries are expected to increase too [10]. Furthermore, their infants will be at risk of macrosomia and have a higher likelihood of dying [10].

We found that two-thirds of our sample were physically active enough to meet the WHO recommendations for physical activity. This result is higher than what others have found [64] [17] [69] [19] [20]. We used a different tool for assessing physical activity, which could account for this difference; as well, some previous studies involved different age groups. Married adolescent females were more active than unmarried adolescent females [67] and postpartum women were found to increase their moderate and moderate-to-vigorous activity and decrease their sedentary time [63]. We think the increase of activity among married women with the increase in the activity among postpartum women might explain the high percentage of women who met WHO recommendations for physical activity. During the postpartum period, physical activity is safe and can be resumed as early as the mother wants in the absence of medical complications [11]. Choosing to engage in physical activity will help them manage their weight [39].

Women in our sample had more than 2 hours of sedentary time daily. Sedentary time was defined as the time sitting or reclining. This result is lower than what has been found in other studies [69] [19], but we studied a different age group. Also, one study reported that the average sedentary among overweight and obese women was more than 15 hours, but that study was done only on overweight and obese women at 6 weeks postpartum [64]. Compared to this study, our study included women in all BMI categories and was later in the postpartum period. Sedentary time was negatively correlated to mothers' age and number of their

children in household. Increases in family demands might play role in this difference [73]. Also, it has been found that sedentary time decreased in the postpartum period [63]. In combination with the previous results, we found that women were more active with increasing age and number of children but not to the level that met the WHO recommendations.

There were no association between BMI or weight status and meeting the WHO recommendations for physical activity. The associations between obesity and physical activity were not consistent in the previous studies. Al-Nakeeb, et al. found a significant association between BMI and physical activity [69], while Morgan, et al. found no significant association between them [15]. Although two-thirds of our sample met the WHO recommendations for physical activity, more than 60% of them were either overweight or obese. That might point to women's diets during pregnancy and in the postpartum period.

We found weak evidence for association of nationality with BMI, obesity, physical activity, meeting WHO physical activity recommendations, and sedentary time. Saudi women had a lower average BMI compared to non-Saudi women. Also, they were less likely to be obese or overweight. Saudi women were actually less physically active on average but met WHO recommendations more frequently. That means that more Saudi women were active but for a shorter time compared to fewer non-Saudi women who were active but for a longer time. Saudi women were more sedentary compared to non-Saudi women. This result might be explained by the previous result: that Saudi women were active for a shorter time.

Unfortunately, most women did not send their pedometer readings for a week; only 6% of our sample responded. The response rate was much higher in pregnant women in different articles [75] [76], but this is the first time a study utilizing pedometers was conducted in Saudi Arabia. Postpartum women's pedometer response rate was not related to any demographic variables. In a small subsample of 24 postpartum women, the median

weekly steps count was 24,610 steps/week. Within this subsample, nationality and type of work were associated with a significant change in weekly steps counts. Saudi women walked more steps than non-Saudis. Homemakers walked fewer than women in other work categories. One study found that Latino postpartum women had pedometers readings of around 5,000 steps daily [77]. That study was conducted among women in their early postpartum period (6 weeks to 6 months) in contrast to our study, which was done later in the postpartum period. Also, there is a cultural difference between the two studied groups.

Our study is the first to our knowledge to use pedometers in community-based research in Saudi Arabia. Also, it is the first to explore obesity and physical activity in postpartum women there. The major limitation in our study was the very low pedometer reading response rate. Because of this, we cannot generalize the results to the population. Our study opens the door to further studies using pedometers there, studies in which the researchers are advised to develop socially acceptable follow-up tools. We could not set up a follow-up plan due to the time constraints. Also, some women, due to social norms, refused to provide their phone numbers to the research team to be contacted in the future. Another limitation is not being able to factor in women's previous weights. We did not ask for women's pre-pregnancy weights to compare with the current weight they reported. Therefore, we do not know how much of those obesity cases are due to the last pregnancy. Also, the use of GPAQ has its own limitations including recall problems.

6 Recommendations

6.1 Recommendations for policy

In Saudi Arabia, there is an antenatal care program in the PHC where women can follow-up during pregnancy free of charge. We recommend that the MoH start a postnatal care program where women can receive recommended care and advice. Although they start at 8 weeks postpartum, immunization visits are excellent opportunities to explore women's postpartum weight, diet, and physical activity. The MoH might start a postpartum-weight management program based on the schedule of immunization visits where every mother could have personalized weight management advice and/or treatment.

Policies to change the environment and culture to promote physical activity are greatly needed. These policies require a multidisciplinary approach, including the involvement of the MoH and local city governments. Building climate-controlled walk areas in the neighborhoods might be a cost-effective strategy to make Saudi culture more active.

6.2 Recommendations for practice

Healthcare providers should develop individualized weight management guidance for women during pregnancy and immediately after delivery. They should also explore women's goals for weight loss and help them adjust those goals to be achievable. Women and their husbands should receive advice on the best practices regarding pregnancy spacing options. After an initial pregnancy, subsequent pregnancies should be delayed until a woman's body returns to the best possible shape; only then should the next pregnancy be planned.

Physical activity history and personalized advice should be integral parts of antenatal care. Women should be asked about any contraindications for physical activity and given advices on recommended level of activity. During postpartum, women should be advised to start physical activity as early as possible if there are no contraindications. This messaging

should come from obstetricians and nurses in the hospitals starting immediately after delivery. The guidance should be continued at every visit to the PHCs (i.e., immunization appointments). Incorporating physical activity with mothers' social commitments might increase women activity and empower them to pursue healthy lifestyle, e.g. carrying her baby in strength exercises.

6.3 Recommendations for research

Future research is needed to explore any possible associations between ante- and postnatal maternal diets in Saudi Arabia. Studies that involve other regions of the country to discover any regional variations are recommended too. Women in Saudi Arabia might be consuming an especially high-calorie diet during their early postpartum period that might increase the likelihood of obesity. Finally, any community-based research plans to use pedometers should include the use of follow-up tools used in a socially accepted manner. For example, to increase the level of responsiveness, groups could be created consisting of women only who share pedometer results among themselves.

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Appendix A

Field Notes:

- On my first day in the field, I talked to all the women in the waiting area in the Primary Healthcare Center about the participation in the research but no women accepted to participate. On the subsequent days, I approached each participant individually; this increased the participation response. Individualized message was better approach for postpartum ladies to participate in the study and I think this might be generalized to health education and promotion messages.
- Some women refused to participate in the study because they did not want to know how much their weights are. Others refused to measure their weight in the nursing station and wanted a very private place to measure their weight. I found that is interesting. They perceived their weight to be high but did not want to know. I think they were in denial for their weight status and do not want or cannot make any decision to deal with their weight problems.
- One lady insisted to participate in the study although she was only two months post her delivery. Also, some non-participating ladies called me to use the pedometers after obtaining them from participating ladies. We politely explained the research purpose and did not follow them up. One of them perceived that she was obese but was not in the postpartum period. I thought they might think pedometer would motivate them to lose weight.
- I found it difficult to explain for women in Saudi Arabia how to use the pedometers. The pedometers were to be attached to their pants at the hip joint where some of them do not wear pants on their regular days. This might play role in the low response rate too. Future studies might use different type of pedometers.

- Non-Saudi women reported that they walked to the primary healthcare center because they did not afford buying a car. Because they could not access all the healthcare services in the primary healthcare centers, they walked to the center rarely.