Prevalence and Determinants of Excessive Gestational Weight Gain in Saudi Women in Riyadh: a Retrospective Study

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Abstract

Background In developed countries, pregnant women constitute an important subpopulation with elevated risk for developing obesity, and hence obesity-related health problems. Excessive gestational weight gain (EGWG) is associated with pregnancy complications, postpartum obesity and associated chronic illnesses. The purpose of the study was to determine the prevalence of gestational weight gain and characteristics of Saudi women in Riyadh with adequate gestational weight gain and Excessive gestational weight gain. **Methods** A retrospective, descriptive, correlational design used for data from charts in Two Ministry of health centers in Riyadh. The screened charts (n=1257), 681 met the study inclusion criteria of Saudi nationality, entry into prenatal care by 28 weeks gestation, term gestation, and completion of the Comprehensive Perinatal Services. All eligible charts (n=681) were used for the prevalence analysis, and charts with adequate gestational weight gain or Excessive gestational weight gain. (n= 469) were coded for the descriptive analysis. **Results** The Results showed that the prevalence of inadequate gestational weight gain (IGWG) was 31%, adequate gestational weight gain (AGWG) was 33%, and EGWG was 36%. Compared to Saudi women with AGWG, Saudi women with EGWG had higher pre-pregnancy BMI ($p < 0.01$), and more hypertension ($p < 0.01$), Alternately, Saudi women with AGWG are more servings of grains ($p < 0.05$), had more snacks per day ($p < 0.05$) and had less educated partners ($p < 0.05$) than Saudi women with EGWG. Risk factors for EGWG in Saudi women with normal pre-pregnancy BMI were primiparity, and hypertension. **Conclusions** Excessive gestational weight gain is a critical issue for Saudi women. Although most of the Saudi women started pregnancy with a normal pre-pregnancy BMI, nearly a third gained excessively, putting them at risk for beginning the next pregnancy with a higher BMI. Saudi women who were overweight at the onset of pregnancy had the greatest degree of Excessive gestational weight gain. Further study is warranted in Saudi women to design strategies that will promote adequate gestational weight gain and reduce the risk of lifelong obesity and the associated chronic illnesses.

Key words: Pre-pregnancy BMI; Excessive gestational weight gain; adequate gestational weight gain

{**Citation:** Salma Moawed, Amany S. Badawy, Nouf Naif Al Otaibi, Wedad Mnahe Al Onazi. Prevalence and determinants of excessive gestational weight gain in Saudi women in Riyadh: a retrospective study. American Journal of Research Communication, 2013, 1(4): 1-18} www.usa-journals.com, ISSN: 2325-4076.

Introduction

The obesity rate has rapidly increased in the general population all over the world (Ogden, Carroll, Curtin, McDowell, Tabak, & Flegal, 2006). Among women, the most rapid increase has been among women of childbearing age with a key contributor being excessive gestational weight gain. Excessive gestational weight gain (Wang & Beydoun, 2007).

(EGWG) is weight gain during pregnancy that exceeds the recommendations from the Institute of Medicine (IOM). Generally, current recommendations are inversely related to pre-pregnancy body mass index (BMI) with a 40-pound maximum; however, between 1990 and 2003, the percentage of all women who gained more than 40 pounds during pregnancy increased from 20% to 25% (National Research Council and Institute of Medicine, 2007). Excessive gestational weight gain in women of all pre-pregnancy BMI categories exerts negative effects on the mother and her infant. Women with EGWG are at greater risk for cesarean delivery, and more likely to have pregnancy complications (DeVader, Neeley, Myles, & Leet, 2007).

After delivery, women with EGWG are more prone to postpartum weight retention and more likely to become overweight or obese by the next pregnancy (Gunderson, Abrams, & Selvin, 2000; Rooney & Schauberger, 2002). Infants of women with EGWG are more likely to be overweight by seven years of age, and to be obese by adolescence (Wrotniak, Shults, Butts, & Stettler, 2008; Oken, Rifas-Shiman, Field, Frazier, & Gillman, 2008).
Maternal obesity may cause adverse outcomes in offspring in addition to neonatal complications. Recent studies have reported the interrelation between the pre-pregnancy weight of mothers and children's obesity that occurred before the age of 9 years (Oken, et al., 2008; Salsberry & Reagan, 2007).

Statement of the Problem

Numerous studies have shown that weight gain during pregnancy accounts for a large part of the variability in postpartum weight change (Oken, et al., 2008; Salsberry & Reagan, 2007). To tackle maternal obesity, insight in factors related to gestational weight gain is required, as this provides essential information for the development of possible effective intervention strategies. Pregnancy affords Saudi women an extended period of interaction with health care providers and is a powerful motivator for women to reevaluate and modify health behaviors. The Saudi woman's awareness that maternal behaviors directly influence the growth and development of her dependent fetus provide an impetus for many women to alter behaviors while stimulating new interest in nutrition, vitamin supplementation, exercise and better overall self-care. The identification of risk for EGWG coupled with focused health promotion may prevent Saudi women from EGWG, postpartum weight retention, and lifelong obesity. The role of the nurse during pregnancy may be as the actual provider of prenatal care, the perinatal case manager, or the nurse administrator designing programs of improved care in at-risk populations. The paucity of studies regarding determinants of EGWG in Saudi women limits the development of culturally sensitive, research-based interventions to prevent EGWG. Saudi women possess culturally shaped health beliefs and pregnancy health behaviors that may impact their gestational weight gain. Therefore, the purpose of the study was to study determinants of EGWG in Saudi women in Riyadh.

Research Questions

Basic conditioning factors (maternal age, pre-pregnancy BMI, parity, hypertension, exercise, and maternal food intake,), self care requisite (AGWG) and self-care deficit (EGWG) provided the framework for the following research questions. In Saudi women in Riyadh,

1. What is the prevalence of IGWG, AGWG and EGWG?
2. Is there a relationship between maternal age, pre-pregnancy BMI, parity, hypertension, exercise, and maternal food intake with EGWG?
3. In Saudi women in Riyadh with normal pre-pregnancy BMI, do maternal age, parity, hypertension, exercise, and maternal food intake, increase the risk for EGWG?

Review of the literature

Previous studies, however, mostly focused on the influence of pre-pregnancy overweight or obesity on pregnancy outcomes. Moreover, in relation to Saudi Arabia, there is a paucity of studies conducted on Saudi women. Therefore, this review will discuss findings from multiethnic studies, rather than Saudi or Arabic studies. Inadequate gestational weight gain and EGWG for underweight, normal weight, and overweight women were defined using the gestational weight gain recommendations issued by the IOM (1990). Based on these recommendations, IGWG was gestational weight gain less than the lower limit and EGWG is gestational weight gain that exceeded the top limit of recommended gestational weight gain for the woman's pre-pregnancy BMI. There are no separate recommendations for adolescents. The definition of EGWG for obese women (BMI > 29.0) was less clear.

Obese women were to gain a minimum of 15 pounds, approximately the weight of the products of conception, but no upper limit of gestational weight gain was specified. According to the IOM (1990), the weight of products of conception is similar among women so "lower weight gains in such women are often compatible with optimal birth weights". In studies of EGWG, researchers set the upper gestational weight gain limit for obese women as high as 25 pounds, to less than 13 pounds or "limited or no weight gain" (Jensen, Ovesen, Beck-Nielsen, Molsted-Pedersen, Sorensen, Vinter, & Damm, 2005; Kiel, Dodson, Artal, & Boehmer, 2007).

Gestational weight gain recommendations based on class of obesity have also been suggested by BMI class; Class I (BMI 30-34.9) 10-25 pounds; Class II (BMI 35-39.9),0-9 pounds and for Class III (40 and greater), a weight loss of 0-9 pounds (Kiel, et al., 2007). As most recent studies have suggested that the upper gestational weight gain for obese women be less than that for overweight women (25 pounds), the upper limit that was used for women with an obese pre-pregnancy BMI (BMI >29.0) was 20 pounds.

Asian women consistently had percentages of EGWG that were less than other ethnicities. However, there was large variation in EGWG between that reported by Schieve et al. (1998b) (19%), and by Brawarsky, et al. (2005) (47%), which may have been due the influence of the urban setting of their study, which reported the highest percentages of EGWG for all ethnicities.

In some studies, non-Hispanic white women were more likely to have EGWG, 43% to 46% (Caulfield, et al, 1996; Schieve, et al, 1998b), than women of ethnic minorities. Caulfield, et al (1996) reported the largest difference in EGWG between non- Hispanic white (43%) and African-American (25%) women. Brawarsky and colleagues (2005) reported non-Hispanic white women had the highest

percentage of EGWG (57%) after African-American women (61%). Although non-Hispanic white women have more EGWG than some minority women, the negative effects of EGWG may be less severe as non-Hispanic white women retain less postpartum weight than Hispanic and African-American women (Kim, et al., 2004). The prevalence of women in general gaining in excess of the 1990 IOM Guidelines for pregnancy weight gain ranged from 27% (Howie, et al., 2003) to 64% (Lederman, et al., 2002). However, the prevalence of EGWG varied based on ethnicity and pre-pregnancy BMI category.

In multi-ethnic studies, Hispanic women had lower percentages of EGWG than non-Hispanic white and African-American women (Brawarsky, et al., 2005; Schieve, et al., 1998; Wells, et al., 2006). However, in the only study of Hispanic women, percentage of EGWG was similar (45%) (Chasan-Taber, et al., 2008) to one multi-ethnic study stratified to Hispanic women in California (51%) (Brawarsky, et al., 2005). That nearly half of all Hispanic women in two studies had EGWG compels further study of determinants of EGWG in the largest Hispanic subgroup in the United States, Mexican American women. Higher pre-pregnancy BMI, particularly overweight BMI, was a consistent determinant of EGWG in women of all ethnicities. No studies reported percentages of EGWG by pre-pregnancy BMI in Saudi women or other Arabic women. However, the one study of Hispanic women reported high percentages of EGWG in women of normal (46%) and obese pre-pregnancy BMI (48%), though not as high as in women with overweight pre pregnancy BMI (62%).

This suggests that attention to determinants of gestational weight gain in Hispanic women, particularly Mexican American women, according to BMI categories is important as strategies may vary from prevention of obesity in normal weight women to lifestyle changes in overweight and obese women (Brawarsky, et al., 2005). Increased maternal food intake was associated with increased gestational weight gain and EGWG in other ethnicities, but a clear association in Arabic women was not reported. However, studies done in non-Hispanic women suggested that dietary quality related to density and changes in macronutrient proportions influence EGWG.

Only one small study of Mexican American adolescents included maternal food intake variables. Maternal food intake in pregnancy is a modifiable behavior. If nurses are to recommend nutrition strategies that decrease the risk of EGWG, research of macronutrients and dietary quality in Hispanic must be conducted (Brawarsky, et al., 2005). When the IOM guidelines were published, the authors admitted that studies of gestational weight gain in Hispanic women were limited by data sources that were used at the time. To date, there has been only one study of Hispanic women that included health state, demographic, sociocultural, and patterns of living variables in a study of gestational weight gain. The study population was predominantly Puerto Rican, a Hispanic group with reported health outcomes (e.g. poorer infant mortality) that are different than Mexican American women (David & Collins, 2002).

The design of interventional studies to prevent EGWG in Mexican American women depend on clear identification with non-modifiable risk factors such as age, parity and acculturation, as well as identifying modifiable factors such as pre-pregnancy BMI, and prenatal health behaviors that influence EGWG. Research of EGWG in Saudi women must not only include factors that may be influenced by acculturation, maternal food intake, exercise/physical activity, and parity, but also must include acculturation as variable that informs the entire social and health system of the mother.

Methodology

Research Design

A retrospective, correlational descriptive survey was used. Data for the study was obtained and extracted from patient records. The determinants were maternal age, pre-pregnancy BMI, parity, hypertension, exercise, and maternal food intake (protein, milk, grain, fruits and vegetables, fats and sweets, snacks). The outcomes were AGWG and EGWG.

Setting

The settings for this study were a two qualified health centers in Riyadh (King Fahad Medical City, and King Saud Medical City) that afforded access to a large sample of women's health patient records. Over 100 women are seen weekly for their first prenatal visit and continue care for their duration of their pregnancy. In addition, the breadth of women's health services offered encourages patient compliance with visits during pregnancy and after delivery. Prenatal, postpartum and gynecological services at the center are provided by a group of certified nurse midwives and obstetricians. After delivery, most women have their postpartum visits, continue with gynecological care at the health center, and return with their babies for newborn care. The majority of patients at the health center are Saudi and use government funded programs to access health services.

Sample Selection

Following ethical approval from the two participated hospitals, the sample selection process began. The sample was a nonrandomized, nonprobability, convenience sample for a targeted population of Saudi women in Riyadh. Inclusion criteria were women with: term gestation, (last prenatal visit recorded at equal to or greater than 36 weeks gestation), a singleton pregnancy, and maternal age of at least 18 years old. Also, women must have had either a known pre pregnancy weight recorded in the chart, or, if unknown, a first clinic appointment weight documented at less than or equal to 14 weeks gestation. Women were excluded from the study (a) if they had pre-existing medical conditions known to impair metabolism, such as thyroid disease and previous gestational diabetes, and (b) if they were non Saudi.

Sample

Potential charts were identified using a clinic generated list of women who had postpartum visits between April 2009 and April 2011. A convenience sample of Saudi women who had had a postpartum visit between April 2009 and April 2011and met the sample selection criteria were considered for study enrollment. For this study, power analyses for regression were conducted to determine the sample size using a moderate effect size of 0.15, a power of 0.80, and a significance level of 0.05. The sample size for the multiple regression analysis with 13 predictor variables and one outcome variable was estimated at 131 (Cohen, 1988; Soper, 2008) and for the logistic regression analysis with 12 predictor variables and one outcome variable also was 127 (Soper, 2008). After review of all records (n=1257), 681 met the sample inclusion criteria and comprised the sample.

Data Collection

Each chart was assigned a serial number that was entered onto the coding sheet to protect patient identity and on the patient list kept in a locked file in the Medical Records Department. This file was accessible only to the investigator and the Medical Records Director. Data was manually extracted

from the patients' medical records by the researcher and two registered nurses, employees of the Hospitals who are familiar with the prenatal chart forms, and entered onto a code sheet that was developed for the study.

Instruments

The Ante partum Record is a commonly used chart form for prenatal care documentation in Saudi hospitals that uses a risk-oriented approach to highlight potential adverse outcomes and records required and optional laboratory tests. The Antepartum Record includes demographic data, pregnancy history, and patient and family medical history data, lists patient and family genetic/infection history and records findings from the patient's first physical examination in the pregnancy. It Also includes a problem/plan list, pre- pregnancy weight, calculation of estimated due date (EDD), and a prenatal visit flow sheet that is completed by a clinic medical assistant for each prenatal visit and used to record the visit date, patient weight, gestational age, blood pressure, urine and pregnancy symptoms reported by the patient. All other data on the record are entered by a certified nurse midwife or physician.

Measurement of Variables

The variables of maternal age, gestational weight gain and pre-pregnancy BMI were collected from all charts meeting the sample selection criteria. Charts that had women with IGWG based on pre-pregnancy BMI were not coded further. Charts with AGWG or EGWG were coded for all remaining study variables.

Gestational Weight Gain: Total gestational weight gain, the maternal weight gained during the pregnancy, was measured by subtracting the self-reported pre-pregnancy maternal weight from the maternal weight at the last prenatal visit (Harris & Ellison, 1998). If the maternal pre pregnancy weight was unknown, the first recorded prenatal weight during the first trimester was subtracted from the maternal weight at the last prenatal visit. For most women, first trimester weight gain is minimal (Picciano, 2007). By 10 weeks gestation, the mean amount of gestational weight gain is about 960 grams or about two pounds (Hytten, 1991). Inadequate gestational weight gain was gestational weight gain less than recommended and EGWG was gestational weight gain greater than recommended for each pre-pregnancy BMI category.

Maternal age: Maternal age was the chronologic age and was measured using the age listed on the Form.

Pre-pregnancy Body Mass Index: Pre-pregnancy BMI is the ratio of the woman's pre-pregnancy height to weight. The pre-pregnancy BMI was calculated by entering the height in inches and the pre pregnancy weight in pounds and using the formula of: BMI = (Weight in Pounds / (Height in inches) x (Height in inches) x 703. If the pre-pregnancy weight was unknown, the first recorded prenatal weight during the first trimester was used in the above formula.

Parity: Parity is the number of pregnancies achieving 20 weeks or more and was measured using ACOG Form A, *Past Pregnancies,* where the number of pregnancies achieving 20 weeks or more gestation were listed and *Total Pregnancies, Full term, Premature* that may be used to confirm parity. Parity referred collectively to the sum of term and preterm births that achieved at least 20 weeks gestation. Pregnancies less than 20 weeks gestation were classified as abortions/miscarriages and were

not counted as parity. In cases in which parity was not clear, the first obstetrical visit was referenced as the nurse midwife or physician typically listed detailed information on the pregnancy history.

Hypertension: Hypertension is blood pressure with a systolic reading greater than or equal to 140 mm Hg and/or diastolic greater than or equal to 90 mm Hg prior to or during pregnancy (D'Angelo & Colley Gilbert, 2002) and was measured in two ways: chronic hypertension in pregnancy and gestational hypertension. In the chart form, there were four data fields that were used to assess hypertension.

Exercise: Exercise was defined as present or absent based on the patient's self-report and subsequent entry into the exercise data. Exercise was measured by multiplying the number of minutes a day by the number of days a week listed in the data fields.

Maternal Food Intake: Maternal food intake was defined as the sum of the number of servings of the food categories, protein, milk, grains, fruits and vegetables and fats and sweets, and snacks. Categories for each of the maternal food intake variables were determined.

Results

Thousand two hundred fifty seven (1,257) screened charts with Saudi surnames and a postpartum visit, 681 (54%) met the study criteria. Reasons for exclusion were: (a) no completed Assessment Tool (n = 94, 7.5%), (b) not Saudi (n = 342, 27.2%), (c) entry into prenatal care later than 28 weeks gestation (n = 122, 9.7%), (d) last prenatal visit less than 36 weeks gestation (n = 150, 11.9%), (e) multiple gestation (n = 7, 0.6%), and (f) the presence of a condition known to impair metabolism [pre-GDM (n = 35, 2.8%), hyperthyroidism (n = 1, .08%) and/or hypothyroidism (n = 17, 1.4%).

Sample Characteristics

For the sample of 681 Saudi women, the average pre-pregnancy BMI was 27.09 ± 5.40 (range 15.11 - 54.12), average maternal age was 29.37 + 6.481 years (range 18 - 48), and average gestational weight gain was 25.30 + 12.52 pounds (range 17.0 - 72.0). The range of gestational weight gain by pre-pregnancy BMI is offered in Table 1. Most of the women were in the normal pre-pregnancy BMI category (n = 306, 45%).

Table 1: Sample Gestational Weight Gain by Pre-pregnancy BMI (n= 681)

Pre-pregnancy BMI	N	%	GWG (Pounds) Range	GWG (Pounds) M + SD
UW < 19.8	23	3.4	15.0-56.0	31.00±9.55
Normal 19.8 - 26.0	306	44.9	3.0-67.0	29.40 ± 10.89
Overweight 26.1-29.0	156	22.9	-3.0-72.0	24.75 ± 12.52
Obese > 29.0	196	28.8	-17.0-58.0	18.69+12.33

Research Question 1: Saudi women in Riyadh, what was the prevalence of IGWG, AGWG and EGWG?

Of women that met the general study criteria (n = 681), gestational weight gain was inadequate in 212 (31.1%), appropriate in 223 (32.7%) and excessive in 246 (36.1%). Of the four pre-pregnancy BMI categories, more women began pregnancy with a normal BMI (44.9%, n = 306); however, 51.7% (n = 352) had a high (overweight or obese) pre-pregnancy BMI (see Table 2).

Table 2: Prevalence of Inadequate, Appropriate, and Excessive Gestational Weight Gain by Pre-pregnancy BMI (n= 681)

	Overall GWG (Pounds)			IGWG		AGWG		EGWG	
Pre-pregnancy BMI	n	%	M + SD	n	%	n	%	n	%
UW<19.8	23	3.4	31.00 ±9.55	8	34.8	13	56.5	2	8.7
Normal weight 19.8 - 26.0	306	44.9	29.40 ± 10.89	100	32.7	122	39.9	84	27.4
OW 26.1-29.0	156	22.9	24.75 ± 12.52	33	1.2	52	33.3	71	45.5
Obese > 29.0	196	28.8	18.69 ±12.33	71	36.2	36	18.4	89	45.4
Total	681	100	25.30 ±12.52	212	31.3	223	32.8	246	36.1

Note: UW = underweight, OW = overweight

The EGWG was highest in women with overweight (n = 71, 45.5%) and obese (n = 89, 45.4%) pre-pregnancy BMI, and least in women with underweight (n = 2, 8.7%) and normal (n = 84, 27.4%) pre-pregnancy BMI. Although there were very few who had an underweight pre-pregnancy BMI (n = 23, 3.4%), the majority gained appropriately (n = 13, 56.5%) as did the normal pre-pregnancy BMI women (n = 122, 39.9%).

Research Question 2: **In Saudi women in Riyadh, is there a relationship between age, pre-pregnancy BMI, parity, hypertension, exercise, and maternal food intake, with EGWG?**

Variable normality was assessed with box plots, histograms and the application of Chebeshev's theorem (Munro, 2005). Six continuous variables were not normally distributed (age, pre-pregnancy BMI, parity, fruits and vegetables, fats and sweets, and EGWG). Therefore, square root (AGWG, EGWG, maternal age) and logarithmic transformations (pre-pregnancy BMI, fruits and vegetables, fats and sweets) were performed. The normality of exercise and snacks was not improved with the transformations; however, the transformed data was retained for future analyses. Parametric (Pearson

r) and nonparametric correlations (Spearman's rho) assessed the relationships between age, pre-pregnancy BMI, parity, hypertension, exercise, maternal food intake, and EGWG. Spearman's rho was used for categorical variables (e.g. hypertension).

Age (r = -.30, $p < .01$), pre-pregnancy BMI (r = -.58, $p < .01$), and parity (r = -.41, $p<0.1$) were significantly related to EGWG. Therefore, age, and pre-pregnancy BMI, was retained in the multivariate analysis. Age, pre-pregnancy BMI, and parity, explained 41% (R^2= .41, adjusted R^2 = .40, F (4, 241) = 41.56, $p < .01$) of the variance in EGWG. While the linear combination of determinants was statistically related to EGWG, only pre-pregnancy BMI and parity accounted for a significant amount of EGWG variability (see Table 3).

Table 3: Variability in EGWG (n=246)

Variable	B	SEB	β	*t*	*P*
Age	**.053**	**.081**	**.043**	**.66**	**.51**
Pre-pregnancy BMI	**-2.28**	**.24**	**-.51**	**-9.7**	**.00**
Parity	**-.50**	**.12**	**-.28**	**-4.20**	**.00**

Research Question 3: In Saudi women in Riyadh with normal pre pregnancy BMI, do age, parity, hypertension, exercise, and maternal food intake, increase the risk for EGWG?

In Saudi women in Riyadh with normal pre-pregnancy BMI, there was a statistically significant difference (t = -19.47, p < .01) in the gestational weight gain of women in the AGWG (29.46 + 2.89 pounds) versus the EGWG (22.85 + 1.59 pounds) groups. Other variables with statistically significant differences between the AGWG and EGWG groups were: (a) age (25.74 + 6.44 years) versus (22.45 + 5.78 years), (t = 3.749, p < .01); (b) parity (1.29 ± 1.33) versus (0.63 ± 0.90), (t = 3.945, p < .01). Correlational analysis was conducted to determine the relationship between the determinants and EGWG. Determinants with $r > .1$ [age (r = -.29, $p < .01$), parity, (r = -.30, p < .01), and hypertension (r = .14, $p < .05$),] were entered into a logistic regression analysis (see Table 4). Age was treated as continuous and categorical data and the remaining variables were treated as categorical [parity (primiparous, multiparous), and hypertension (yes, no), and].

The final model (Table 4) included all entered variables except age. Hypertension was the strongest determinant as women of normal pregnancy BMI with a past history of hypertension and/or current hypertension were 3.68 times more likely to experience EGWG than women without hypertension. Primiparous women of normal pre-pregnancy BMI were two and a half times more likely to have EGWG than multiparous women.

Table4: Risk Factors for EGWG in Saudi Women with Normal Pre-pregnancy BMI (n=206)

Determinant	B	SE	*p*	Odds Ratio	95% CI
Parity (primiparous)	*0.92*	0.31	0.003	2.50	1.35-4.6
Hypertension (yes)	1.30	0.65	.045	3.68	1.07-1.70

Saudi women with normal pre-pregnancy BMI and AGWG were coded as 0;
Saudi women with normal pre-pregnancy BMI and EGWG were coded as 1.

Discussion

The prevalence of gestational weight gain in Saudi women in Riyadh has never been described; therefore, the finding that only one third of Saudi women in this sample gained appropriately for their pre-pregnancy is a novel finding. The prevalence of gestational weight gain was divided roughly into thirds: IGWG (31%), AGWG (33%) and EGWG (36%). However, this finding was consistent with the literature regarding women of all ethnicities (Olson & Strawderman, 2003**).**

The Saudi women in this study were largely urban dwellers and/or regularly accessed health services in Riyadh. Influences specific to the place of residence (urban vs. rural) have been associated with gestational weight gain (Wells et al, 2006) and with factors associated with EGWG, such as high pre-pregnancy BMI. Of note is that the new guidelines use the World Health Organization cutoff points for BMI categories instead of the previous ones based on the Metropolitan Life insurance tables.

The new lower BMI cutoffs for underweight (<18.5) and normal (18.5 - 24.9) categories will result in fewer women who are classified as underweight and therefore fewer who should gain in excess of 35 pounds. Conversely, in the 2011 guidelines, women with a pre-pregnancy BMI of 25 to 26 who were previously in the normal pre-pregnancy BMI category are reclassified in the new overweight BMI category (25.0 -29.9), thereby decreasing their recommended gestational weight gain from 25-35 to 15-25 pounds.

The IOM 1990 guidelines for women in the obese pre-pregnancy BMI category suggested a minimum gain of 15 pounds, but did not specify an upper limit. Earlier studies challenged these recommendations for obese women (Schieve, Cogswell, & Scanlon, 1998a), but most studies of gestational weight gain to date applied the same recommendations (15-25 pounds) for overweight women to obese women. However, for women in the obese pre-pregnancy BMI category, the new guidelines (11-20 pounds) have lowered the range overall. The impact of the 2011 IOM guidelines on this study sample would likely result in fewer women with IGWG and more women with EGWG.
Similarly, a comparison of characteristics in a homogeneous group of Saudi women with AGWG and EGWG has not been described. The Saudi women in the study were in their mid-twenties, had slightly

more than 10 years of education, and exercised less than 20 minutes per day. About one third of the women in each AGWG and EGWG group were having their first baby. Saudi women with AGWG had a normal pre-pregnancy BMI, while the EGWG group had an overweight pre-pregnancy BMI. The EGWG group was more likely to have the influence of hypertension, and ate less grains and snacks.

Previous studies have also investigated models of gestational weight gain using demographic, behavioral, and sociocultural variables. In their study of non-Hispanic white women, Olson and Strawderman (2003) reported that the factors in their "biopsychosocial model" of both IGWG and EGWG explained 27% of the variance in gestational weight gain overall. Factors in their final model that were associated with greater gestational weight gain were decreased physical activity, consuming more food, overweight pre-pregnancy BMI, and low income.

However, although this study of Saudi women demonstrated associations between pre-pregnancy BMI, age, and parity, there were no associations with patterns of living or health behavior variables (exercise and maternal food intake). Further, although the study variables collectively accounted for more (41%) of the variation in EGWG, there were only two determinants, pre-pregnancy BMI and parity, that remained in the final model. Pre-pregnancy BMI was the key determinant of EGWG and contributed most (34%) along with parity (6%). As an indicator of maternal nutritional status, pre-pregnancy BMI is a key determinant of gestational weight gain in general (National Research Council and IOM, 2007).

According to the IOM guidelines, this is an inverse relationship. In other words, lower BMI women should gain more and higher BMI women should gain less during pregnancy. However, the pre-pregnancy BMI and EGWG relationship is more complex. In this study, Saudi women with too much weight gain or EGWG, similarly had pre-pregnancy BMI as the primary determinant, and this was inversely related to the degree of EGWG. Therefore, the degree of EGWG decreased with an increase of pre pregnancy BMI, meaning that when women in the highest BMI category, obese Saudi women, gained excessively, their degree of EGWG was less than overweight BMI women.

This was seen in differences in the upper limit of gestational weight gain in the pre-pregnancy BMI categories in which the most extreme gestational weight gain was not in obese women (58 pounds), but in overweight (72 pounds) and normal (67 pounds) pre-pregnancy BMI women. This is easier to understand if the characteristics of the EGWG group are recalled. The typical Saudi woman with EGWG had an overweight BMI and gestational weight gain of 35.86 + 9.65 pounds which is not only in excess of recommended for overweight women (15-25 pounds) but is in also in excess for normal weight women (25-35 pounds). In contrast, most Saudi women with AGWG in this study had normal pre-pregnancy BMI (25.53+ 4.48 kg/m2) and gained at the lower end of the recommended guidelines (25.76 + 5.96 pounds). Therefore, in Saudi women with EGWG, a typical scenario is an overweight pre pregnancy BMI which, when compounded by a proportionally higher degree of EGWG and increased risk for postpartum retention, will move her into an obese pre-pregnancy BMI category.

Most women believe that at least some gestational weight gain is necessary for a healthy pregnancy outcome. However, overweight women may not perceive themselves as in a category in which recommended gestational weight gain (15-25 pounds) is substantially less than their normal BMI counterparts (25-35 pounds). Studies have reported that overweight and obese women were more likely to receive advice to gain above the recommended guidelines (Cogswell, et al., 1999; Stotland, et

al., 2005). This point to the need for greater attention to the role of the provider in ensuring accurate advice on target gestational weight gain, particularly for women in high pre-pregnancy BMI categories and in women of ethnic minorities who are at greater risk for postpartum weight retention.

Parity was the other determinant in the model of EGWG in Saudi women. The contribution of parity to the model was much less (6%) than pre-pregnancy BMI (34%), but like pre-pregnancy BMI, was inversely related to EGWG. A multiethnic study showed the same relationship between parity and gestational weight gain in general, and in Puerto Ricans, Chasan-Taber et al. (2008), which also showed a negative relationship between parity and EGWG. However, in a British study of determinants of gestational weight gain, in which an ANCOVA analysis was used to assess whether parity and gestational weight gain were independently related, parity was independently related to gestational weight gain in a bimodal relationship.

The first pregnancy had the highest gestational weight gain at 28 pounds, the second was 22 pounds, the third was 26 pounds, and the fourth was 25 pounds (Harris, et al., 1997). In this study, parity was treated as a continuous variable rather than ordinal in the regression analysis, so that the strength and direction of relationship to EGWG could be assessed. However, this precluded the researcher from assessing whether a similar relationship existed between EGWG and parity. Positively, most of the Saudi women in the study sample started pregnancy with a normal pre-pregnancy BMI (n = 306, 45%). This was less than in non- Hispanic white (49-65%), African-American (57- 65%), and Hispanic (53%-60%) women (Caulfield, et al., 1996; Keppel & Taffel, 1993; Olson, Strawderman, Hinton, & Pearson, 2003; Siega-Riz, et al., 1994; Strychar, et al., 2000; Walker & Kim, 2002), but the same as a recent study of Puerto Rican women (45%) (Chasan-Taber, et al., 2008) and twice that reported in African-American adolescents (22%) (Nielsen, et al., 2006). However, although 40% of normal weight women gained within the recommended guidelines, 28% gained excessively, which was less than the sample overall (36%). Saudi women with normal BMI who were most likely to gain EGWG were younger, primiparous, than normal BMI women with AGWG.

The risk of EGWG was more than tripled if there was any history of hypertension or hypertension in the study pregnancy. Primiparity has been reported as a determinant of EGWG in women (Harris, et al., 1997) and adolescents (Howie, et al, 2003; Scholl, et al., 1988). In this study, primiparity increased the risk of EGWG two and a half times in normal weight Saudi women, suggesting the possibility of unique behavioral components (e.g., less dietary discretion and less exercise) and/or biologic factors related to the index pregnancy, such as reported in the CARD LA study (Smith, et al., 1994). This was similar to Puerto Rican women of all pre-pregnancy BMI categories in which the risk of EGWG was about two times greater in primiparas (Chasan-Taber, et al., 2008). Logically, in childbearing women, age and parity are positively correlated and, in fact, age did have a small correlation with EGWG. However, only primiparity was predictive of EGWG.

Pregnancy in general has been referred to as a teachable moment (McBride, et al., 2003), but even more so, women in their first pregnancy seek advice on self-care topics such as appropriate gestational weight gain. In one study of the impact of the provider's weight gain advice and actual gestational weight gain, 27% of the women received no advice, and of those who received advice, 22% were advised to gain more than recommended (Cogswell, et al., 1999). Therefore, if normal weight Saudi women in their first pregnancy are more than twice as likely to have EGWG, accurate, repetitive

attention to the provision of appropriate gestational weight gain advice may be beneficial in preventing EGWG.

Increased risk of hypertensive disorders of pregnancy have been observed in overweight or obese women and in women with EGWG (Caulfield, et al., 1996; Scholl, et al., 1988; Wells, et al., 2006). Hispanic women (predominantly Central American), had twice the risk of preeclampsia, but less risk of gestational hypertension than non-Hispanic white women (Wolf, et al., 2004). In Puerto Rican women, while controlling for pre-pregnancy BMI, EGWG was associated with a three-fold risk of hypertension and four-fold risk of preeclampsia (Wolf, et al., 2004). This was similar to this study as Saudi women with normal pre-pregnancy BMI and EGWG were three and a half times more likely to have a history of hypertension and/or hypertension in the current pregnancy than the AGWG group. This suggests that Saudi women are similar to Puerto Ricans in that EGWG has an independent relationship with hypertensive disorders apart from high pre-pregnancy BMI. Further, this relationship should prompt practitioners to be vigilant to assess for a history of hypertension as well in order to identify women at risk for EGWG.

Summary and Recommendations for Future Research

Saudi women who are overweight at the beginning of pregnancy are at greater risk than any other BMI category of gaining excessively. Coupled with increased potential for postpartum weight retention, the likelihood of starting the next pregnancy in an obese BMI category is significant.

Obesity during pregnancy not only imposes risk on the mother's health, but confers risk of sequel on the newborn through adolescence and even middle-age. The Saudi woman who begins pregnancy in a normal BMI category is at risk for increasing her BMI by the next pregnancy. Factors associated with EGWG in Saudi women with normal pre-pregnancy BMI, such as primiparity, are readily identified by the provider on the first prenatal visit. The recurrent visit schedule of pregnancy allows the provider time for educational reinforcement and the mother time to incorporate more healthy behaviors into her lifestyle that she can continue in the postpartum period.

Interventional studies should be conducted in which Arabic-speaking primiparas are targeted to receive culturally appropriate, accurate education on gestational weight gain per pre-pregnancy BMI as well as on behaviors that may reduce the possibility of EGWG, such as more frequent, smaller meals with carbohydrate snacks. Being vigilant at the outset of pregnancy to assess prior hypertension is critical because it is not only a risk factor for recurrent or superimposed hypertension but also because of its relationship with EGWG.

However, the impact of the mother's weight gain during pregnancy on the longterm health for her family is increasingly evident. The life cycle perspective of obesity prevention begins with attention to pregnancy as the vector of infant and maternal obesity (Johnson, Gersten, Evans, & Woodward-Lopez, 2006). An increasing body of research is investigating determinants of gestational weight gain from the perspective of models incorporating biologic, behavioral, and sociocultural influences. Studies focused on factors associated with EGWG in Saudi women are critical to protect the mother's long term health and to prevent a trajectory of obesity-related illnesses in the next generation.

Conclusions

Excessive gestational weight gain is a critical issue for saudi women. Although most of the Saudi women started pregnancy with a normal pre-pregnancy BMI, nearly a third gained excessively, putting them at risk for beginning the next pregnancy with a higher BMI. Normal weight women most at risk for gaining excessively are those in their first pregnancy, and those having any influence of hypertension in the past or in the current pregnancy. Saudi women who were overweight at the onset of pregnancy had the greatest degree of EGWG and more commonly had EGWG. Further research is needed to better understand determinants of EGWG in Saudi women and to design culturally sensitive interventions to prevent EGWG.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

We received oral consents from the women after explaining every aspect of the research. Authors are keen about women's health and reproductive health in the Middle East region in general and in the kingdom of Saudi Arabia in particular. The authors had oral agreements from the authorized personnel at the setting, in order to allow them to collect the data from the patients. All authors contributed in writing, reading and approved the final manuscript.

References

1- Brawarsky, P., Stotland, N. E., Jackson, R. A., Fuentes-Afflick, E., Escobar, G., Rubashkin, N., et al. Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. *International Journal of Gynecology and Obstetrics, 91,* 125-131. doi: 10.1016/j.ijgo. 2005.08.008.

2- Caulfield, L. E., Witter, F. R., & Stoltzfus, R. Determinants of gestational weight gain outside the recommended ranges among white and black women. *Obstetrics & Gynecology,* (1996). *87(5),* 760-766. doi: 10.1016/0029-7844 (96)00023-3

3- Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Manson, J., & Markenson, G. Correlates of physical activity in pregnancy among Latina women. *Maternal and Child Health Journal, 11(A),* 353-363. doi: 10.1007/s 10995-007- 0201-8

4- Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Solomon, C. G., & Markenson, G. Predictors of excessive and inadequate gestational weight gain in Hispanic women. *Obesity (Silver Spring, Md.),* (2008) *16(1),* 1657-1666. doi: 10.1038/oby.2008.256

5- Cogswell, M. E., Scanlon, K. S., Fein, S. B., & Schieve, L. A. Medically advised, mother's

personal target, and actual weight gain during pregnancy. *Obstetrics & Gynecology,* (1999). *94(4),* 616-622. doi: 10.1016/S0029-7844(99)00375-0

6- Cohen, J. *Statistical Power Analysis for the Behavioral Sciences* (1988). (2nd ed.). New York: Lawrence Erlbaum Associates.

7- D'Angelo, D., & Colley Gilbert, B. (Eds.). (2002). *From data to action: Using surveillance to promote public health, examples from the Pregnancy Risk Assessment Monitoring System (PRAMS), Executive Summary.* Atlanta, GA: Division of Reproductive Health, National Centers for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention.

8- David, R. J., & Collins, J. W. (2002). Differing birthweight among infants of U.S.-born blacks, African-born blacks, and U.S.-born whites. In T. LaViest (Ed.), *Race,Ethnicity and Health: A Public Health Reader.* San Franscisco: Jossey-Bass.

9- DeVader, S. R., Neeley, H. L., Myles, T. D., & Leet, T. L. (2007). Evaluation of gestation weight gain guidelines for women with normal pre-pregnancy body mass index. *Obstetrics & Gynecology, 110(4),* 745-751. doi: 10.1097/01.AOG.0000284451.37882.85

10- Gunderson, E. P., Abrams, B., & Selvin, S. The relative importance of gestational gain and maternal characteristics associated with the risk of becoming overweight after pregnancy. *International Journal of Obesity,* (2000). *24,* 1660-1668. doi: 10.1038/sj.ijo.0801456

11- Harris, H. E., & Ellison, G. Practical approaches for estimating pre-pregnant body weight. *Journal of Nurse-Midwifery,* (1998). *43(2),* 97-101.

12- Harris, H. E., Ellison, G. T., & Holliday, M. Is there an independent association between parity and maternal weight gain? *Annals of Human Biology,* (1997). *24(6),* 507- 519. doi: 10.1080/03014469700005272

13- Howie, L. D., Parker, J. D., & Schoendorf, K. C. Excessive maternal weight gain patterns in adolescents. *Journal of the American Dietetic Association,* (2003). *103(12),* 1653-1657. doi: 10.1016/j.jada.2003.09.040

14- Hytten, F. E. (1991). Weight gain in pregnancy. In F. E. Hytten & G. Chamberlain (Eds.), *Clinical Physiology in Obstetrics.* London: Blackwell Scientific Publications.

15- Institute of Medicine. (1990). *Nutrition in pregnancy: Part 1-Weight Gain.* Washington, D.C.: National Academy Press.

16- Institute of Medicine. (2009). *Weight Gain during Pregnancy: Reexamining the Guidelines.* Washington, D.C.: National Academy Press.

17- Jensen, D. M., Ovesen, P., Beck-Nielsen, H., Molsted-Pedersen, L., Sorensen, B., Vinter, C, et al. Gestational weight gain and pregnancy outcomes in 481 obese glucose-tolerant women. *Diabetes Care,* (2005). *28(9),* 2118-2122. doi: 10.2337/diacare.28.9.2118

18- Keppel, K. G., & Taffel, S. M. Pregnancy-related weight gain and retention: Implications of the 1990 Institute of Medicine guidelines. *American Journal of Public Health,* (1993). *83(B),* 1100-1103. doi: 10.2105/AJPH.83.8.1100

19- Kiel, D. W., Dodson, E. A., Artal, R., & Boehmer, T. K. Gestational weight gain and pregnancy outcomes in obese women. *Obstetrics & Gynecology* (2007)., *110(1),* 752- 758.

20- Lederman, S. A., Alfasi, G., & Deckelbaum, R. J Pregnancy-associated obesity in black women in New York City. *Maternal and Child Health Journal,* (2002). *6(1),* 37- 42. doi: 10.1023/A: 1014364116513

21- McBride, C. M., Emmons, K. M., & Lipkus, I. M. Understanding the potential of teachable moments: The case of smoking cessation. *Health Education Research,* (2003). *18(2),* 156-170. doi: 10.1093/her/18.2.156

22- Munro, B. H. (2005). *Statistical Methods for Health Care Research* (5th ed.). Philadelphia: Lippincott Williams & Williams.

23- National Research Council and Institute of Medicine. (2007). *Influence Of pregnancy weight on maternal and child health workshop report.* Washington, D.C.: The National Academies Press

24- Nielsen, J. N., O'Brien, K., Witter, F. R., Chang, S.-C, Mancini, J., Nathanson, M. S., et al. High gestational weight gain does not improve birth weight in a cohort of African American adolescents. *American Journal Clinical Nutrition,* (2006). *84,* 183- 189.

25- Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (20) Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA,* (2006). 295(13), 1549-1555. doi: 10.1001/jama.295.13.1549

26- Ogden, C. L., Carroll, M. D., Tabak, C. J., & Flegal, K. M. Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA,* (2006). 295(13), 1549- 1555.

27- Oken, E., Rifas-Shiman, S. L., Field, A. E., Frazier, A. L., & Gillman, M. W. Maternal gestational weight gain and offspring weight in adolescence. *Obstetrics & Gynecology,* (2008). *112(5),* 999-1006. doi: 1010.1097/AOG.1000bl013e31818a31815d31850.

28- Olson, C. M., & Strawderman, M. S. Modifiable behavioral factors in a biopsychosocial model predict inadequate and excessive gestational weight gain. *Journal of the American Dietetic Association,* (2003). *103(1),* 48-54. doi10.1053/jada.2003.50001

29- Picciano, M. F. (2007). Pregnancy and lactation: Physiological adjustments, nutritional

requirements and the role of dietary supplements. *The Journal of Nutrition,* 33(Supplement), 1997-2002.

30- Rhodes, J. C, Schoendorf, K. C, & Parker, J. D. Contribution of excess weight during pregnancy and macrosomia to the cesarean delivery rate. *Pediatrics,* (2003). *111(5),* 1181-1185. doi: 10.1542/peds.lll.5.S1.1181

31- Rooney, B. L., & Schauberger, C. W. Excess pregnancy weight gain and longterm obesity: One decade later. *Obstetrics & Gynecology,* (2002). *100(2),* 245-252.

32- Salsberry, P. J., & Reagan, P. B. Taking the long view: The prenatal environment and early adolescent overweight. *Research in Nursing and Health,* (2007). *30,* 297-307. doi: 10.1002/nur.20215

33- Schieve, L. A., Cogswell, M. E., & Scanlon, K. S. An empiric evaluation of the Institute of Medicine's pregnancy weight gain guidelines. *Obstetrics & Gynecology,* (1998a). *91(6),* 878-884.

34- Schieve, L. A., Cogswell, M. E., & Scanlon, K. S. Trends in pregnancy weight gain within and outside ranges recommended by the Institute of Medicine in a WIC population. *Maternal and Child Health Journal,* (1998b). *2(2),* 111-116. doi: 10.1023/A: 1022992823185

35- Scholl, T. O., Salmon, R. W., Miller, L. K., Vasilenko, P., Furey, C. H., & Christine, M. Weight gain during adolescent pregnancy: Associated maternal characteristics and effects on birth weight. *Journal of Adolescent Health Care: Official Publication of the Society for Adolescent Medicine,* (1988). 9(4), 286-290. doi: 10.1016/0197-0070(88)90251-3

36- Siega-Riz, A. M., Adair, L. S., & Hobel, C. J. Institute of Medicine maternal weight gain recommendations and pregnancy outcome in a predominantly Hispanic population. *Obstetrics & Gynecology,* (1994). *84(4),* 565-573.

37- Smith, D. E., Lewis, C. E., Caveny, L. L., Perkins, G. L., Burke, G. L., & Bild, D. E. Longitudinal changes in adiposity associated with pregnancy. The Coronary Artery Risk Development in Young Adults Study. *Journal of the American Medical Association,* (1994). *271(22),* 151-158. doi: 10.1001/jama.271.22.1747

38- Soper, D. (2008). Statistics Calculators [The Free Statistics Calculators Website Online Software]. Retrieved from http://www.danielsoper.com/statcalc/

39- Stotland, N. E., Haas, J. S., Brawarsky, P., Jackson, R. A., Fuentes-Afflick, E., & Escobar, G. Body mass index, provider advice, and target gestational weight gain. *Obstetrics & Gynecology,* (2005). *105(3),* 633-638. doi: 10.1097/01. AOG.0000152349.84025.35

40- Walker, L. Managing excessive weight gain during pregnancy and the postpartum period. *JOGNN,* (2007). *36,* 490-500. doi: 10.1111/j.l552-6909.2007.00179.x

41- Walker, L., Freeland-Graves, J. H., Milani, T., Hanss-Nuss, H., George, G., Sterling, B. S., et al. Weight and behavioral and psychosocial factors among ethinically diverse, low-income women after childbirth: I. Methods and context. *Women and Health,* (2004). *40(2),* 1-17. doi: 10.1300/J013v40n02_02

42- Walker, L., Freeland-Graves, J. H., Milani, T., George, G., Hanss-Nuss, H., Kim, M., et al. Weight and behavioral and psychosocial factors among ethnically diverse, low-income women after childbirth: II.: Trends and correlates. *Women and Health,* (2004). *40(2),* 19-34. doi: 10.1300/J013v40n02_02

43- Walker, L. O., & Kim, M. Psychosocial thriving during late pregnancy: Relationship to ethnicity, gestational weight gain, and birth weight. *Journal of Obstetric, Gynecologic and Neonatal Nursing: JOGNN/NAACOG,* (2002). *31(3),* 263- 274. doi: 10.1111/j.l552-6909.2002.tb00048.x

44- Wells, C. S., Schwalberg, R., Noonan, G., & Gabor, V. Factors influencing inadequate and excessive weight gain in pregnancy: Colorado, 2000-2002.*Maternal & Child Health Journal,* (2006). *10(1),* 55-62. doi: 10.1007/s 10995-005-0034-2

45- Wolf, M., Shah, A., Jimenez-Kimble, R., Sauk, J., Ecker, J. L., & Thadhani, R. Differential risk of hypertensive disorders of pregnancy among Hispanic women. *Journal of the American Society of Nephrology,* (2004). *15(5),* 1330-1338. doi: 10.1097/01.asn.0000125615.35046.59

46- Wrotniak, B. H., Shults, J., Butts, S., & Stettler, N. Gestational weight gain and risk of overweight in the offspring at age 7 years in a multicenter, multiethnic cohort study. *American Journal of Clinical Nutrition,* (2008). *87(6),* 1818-1824.