



Research Article

Risk Factors for Gestational Weight Gain in 676 Pregnant Women in North Africa (Algeria)NARIMANE DJEKKOUN¹, HADJER DAOUDI^{1*}, HAMAMA GUETECHE¹, INES KHYEL¹, HAFIDA KHORSI², VERONIQUE BACH², KARIMA BENDOUKHANE³, LEYLA OUNIS¹, LEILA ROUABAH¹¹ Laboratory of Cellular and Molecular Biology, University of Mentouri Brothers, Constantine 1, Constantine 25000, Algeria.² PeriTox UMR_I 01 Laboratory, University Center for Health Research, CURS-UPJV, Picardy Jules Verne University, 80054, Amiens cedex 1, France.³ Histology, embryology and clinical genetics. Mother-child EHS, SIDI MABROUK (PMA unit), Constantine, Algeria.**ARTICLE DETAILS***Article history:*

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Excessive gestational weight gain is associated with a number of health complications for the mother and their offspring's. The aim of this study was to determine the various risk factors for excessive gestational weight gain in a pregnant Algerian population. We recruited and followed 676 healthy pregnant who attended antenatal centers in Constantine, Algeria. We measured their weight and their height before/or at the start of their pregnancy (first month), as well as the weight at the end of the pregnancy. The data was collected via a validated questionnaire. The mean BMI before pregnancy for the whole population was in order $25.4 \pm 4.74 \text{ kg/m}^2$, 40.80% were normal weight, 35.95% were overweight and 24.40% were obese at the start of pregnancy. Total weight gain was in order to $6.4 \pm 4.96 \text{ kg}$, only 24.26% of pregnant gained recommended amount of weight as the IOM recommendations vs. 25.29% gained less the recommendation and 50.44% gained more the IOM recommendation. Pregnant women who are overweight and obese before pregnancy gain more weight during pregnancy. According to our study, weight gain is also influenced by eating habits (number of meals per a day) and potentiated by the frequency and the quantity of fat and sugar containing products (such as the consumption of meat, chicken, butter/margarine and candies). GWG might be inclined in our population, by the non-practice of physical activity. This outlook will allow better management of behaviors related to weight gain in order to avoid complications during pregnancy and childbirth.

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INTRODUCTION

Adequate weight gain and proper nutrition during pregnancy are essential for growth and development of maternal and fetal tissues. Yet excessive weight gain during pregnancy is known to have a myriad of adverse health consequences for the mother and her offspring [1]. Over half of reproductive aged women (20-39 years of age) are obese or overweight, and the rates are highest amongst non-Hispanic blacks and Mexican American women [2].

In recognition of high neonatal and infant mortality rates in the United States during the 1960s, the Committee on Maternal Nutrition highlighted the positive association between weight gain and birth weight [3].

The increasing burden of the obesity epidemic in the United States and evidence of the effects of inappropriate gestational weight gain prompted the Institute of Medicine (IOM) to publish updated guidelines for weight gain in pregnancy in 2009. The 2009 IOM weight gain recommendations are as follows: underweight (BMI <18.5)-18 to 40 lb., normal weight (BMI 18.5-24.9) - 25 to 35 lb., overweight (BMI 25-29.9)-15 to 25 lb., and obese (BMI >30)- 11 to 20 lb. [4]. However, evidence suggests that pregnant women are gaining weight outside these recommendations. According to the Center for Disease Control and Prevention, only one-third (32%) of women had appropriate weight gain during their pregnancy in 2012-2013 [5]. Not only weight gain recommendations are not following, but studies have also found high rates of excessive gestational weight gain. Johnson et al., in 2013 found 73% of a large cohort of

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nulliparous women (n=8293) gained more weight than recommended by the IOM [6]. Risk factors for excessive gestational weight gain include obesity, low socioeconomic status, being overweight prior to pregnancy, and underestimating one's pre-pregnancy weight class [5]. Excessive gestational weight gain has been associated with an increased risk of hypertensive disorders during pregnancy, cesarean delivery, large for gestational age infants and post-partum maternal weight retention [7]. Excessive gestational weight gain has also been associated with increased childhood obesity suggesting that focus on gestational weight gain may be important for health at the individual, as well as familial and societal level [8].

Consequently, to pregnant who gain excessive weight during pregnancy and who are more likely to have a cesarean delivery [9] develop preeclampsia [10] and retain excessive weight after delivery, increasing their risk for overweight or obesity later in life [11]. where also, an infant born to a mother with excessive gestational weight gain who is more likely to be preterm [12], macrosomic [13], and overweight or obese over the course of his/her life [11], the Institute of Medicine (IOM) released guidelines for weight gain during pregnancy in 1990, and further updated them in 2009 [14]. Given that an estimated 46 % of women gain excessive weight during pregnancy [15], identifying modifiable risk factors is important. In fact, one of the Healthy People 2020 objectives is to increase the proportion of women who achieve a recommended weight gain during pregnancy and the proportion of women with a healthy weight prior to pregnancy [16].

Since pregnancy is a time when women may be motivated to improve their health behaviors, it is often considered the optimal time to intervene on health behaviors such as eating habits and physical activity so that gestational weight gain goals are met and perinatal outcomes optimized [17].

The American College of Obstetricians and Gynecologists (ACOG) recommends that all pregnant women engage in moderate exercise for 30 min or more per day on most, if not all, days of week in the absence of medical or obstetric complications [18]. Previous studies have shown that mothers who engage in exercise during pregnancy can reduce their risks of

having complications during pregnancy [19, 20]. Exercise is a known behavioral factor used to control weight among the non-pregnant population [21, 22]. Yet, empirical evidence about the effectiveness of exercise during pregnancy on weight gain management during pregnancy is limited and conflicting [1].

Trends in increasing adult weights and excessive gestational weight gain in the United States over the past two decades have shifted the focus of gestational weight gain counseling to avoid excessive gestational weight gain. Nonetheless, according to a study, nearly 50% of all women exceeded these goals in 2010–2011 [5].

As such, meeting gestational weight gain goals is important for women and their offspring's long-term health [22]. Although diet and exercise interventions can reduce excessive gestational weight gain by 20%, some critiques of these trials are that they failed to address the relationship between psychosocial factors (e.g., depression, body image, and social support) and gestational weight gain [23]. There are few studies assessing maternal knowledge of the 2009 IOM recommendations for gestational weight. Prior studies reported accurate knowledge of these recommendations ranging from 31 to 48% [24].

However, it is unclear if non-knowledge of the recommendations is associated with actual weight gained during pregnancy. Therefore, our study assessed some of the socio-economic factors, feeding habits and maternal characteristics that influence weight gain and the impact of excessive GWG on maternal health outcomes with the aim of preventing in the near future the complications during pregnancy, childbirth and prenatal life.

EXPERIMENTAL SECTION

Subjects

We recruited (n = 676) six hundred seventy six pregnant women's from the prenatal consultation service at the Specialized Mother-Child Hospital (SMK), and from the university hospital of Constantine, Algeria, due to the massive attendance of pregnant women's in this two health's structures. All the participants belonged to Arab-Berber ethnicity. The study was conducted on adult women's population to eliminate the risk of pregnant adolescent whose the needs of pregnancy are added to those of growth. The exclusion criteria for participants were any history of a chronic pathology such as

cardiovascular disease, diabetes, liver, kidney disease autoimmune and/or endocrine pathology. A written consent was obtained from all participants, and they were assured about the confidentiality of the study.

Ethics

We clearly explained our objectives to the director of the health structures by a prior request. The assurance of confidentiality, the respect for human beings and anonymity of the information collected, were assured to our participants. Our objectives are purely for scientific research purposes. Pregnant who met the inclusion criteria were informed by the study objectives and they agreed to be a part of the study until the birth of their babies. We obtained a written consent from all women before starting the investigation. We used a validated material as defined by the National Agency for the Safety of Medicines and Health Products.

Pre-survey

We carried out a pre-survey of 20 pregnant adult women's in order to test the feasibility of the questionnaire and to familiarize the anthropometric material. This pre-survey allowed us to obtain a clear and an understandable questionnaire suited to the needs of the survey.

BMI and Gestational Weight Gain

The BMI of pregnant women's was calculated as per WHO guidelines [25]. The BMI was taken over two periods; the first period was before or at the start of the pregnancy (during the first month). The second period was at the end of the pregnancy (during the last days of the pregnancy period) in order to assess the amount of weight gained during the pregnancy period (9 months of pregnancy). So as to, classify them according to the reference of the Institute of Medicine (IOM) of 2009 (that published and revised gestational weight gain guidelines that are based on pre-pregnancy body mass index (BMI) ranges for underweight, normal weight, overweight, and obese women recommended by the World Health Organization) in insufficient, sufficient or excessive weight gain during their pregnancy period.

Data Collection

We collected data in an individual validated questionnaire [26]. Eating practices were analyzed through the number of meals and the frequency of consumption of foods and/or a group of foods

from meat substitutes, type of oils usually used, sugary drinks and others ...etc. we considered the non-exhaustive list of foods based on the main nutritional observations of pregnant women's and their potential influence on health and particularly on weight gain during the pregnancy period. Besides, we assessed nutrition habits, educational level, BMI and others.

Statistical Analysis

Statistical analysis was performed by the SPSS version 17.0 program and was used to compare the difference between parameters in the study groups. The data were analyzed using the bivariate analysis that consists in comparing the percentages by using the Pearson Chi 2 test. All data in tables considered p-value 0.05 statistically significant.

RESULTS

Characteristics of the Participants

We divided pregnancy participants (676) into three groups: pregnant with insufficient weight gain during the 9 months of pregnancy (n=171), pregnant with sufficient weight gain (n=164) and pregnant participants with excessive weight gain during the 9 months of pregnancy (n= 341) [IOM, 2009]. The average age of the participants was in order to 29.5 ± 4.89 years old with 18 pregnant mince than 20 years old, 552 aged between 20 and 30 years old and 106 pregnant aged more than 35 years old.

BMI before and/or at the Start of the Pregnancy According to Pregnancy Weight Gain

The mean weight before pregnancy for the whole population was in order to 68.18 ± 13.01 kg, the overall mean BMI before pregnancy was around 25.44 ± 4.74 kg / m². Total GWG was in order to 6.42 ± 4.96 kg. The majority of women (39.3%) started pregnancy with a normal body mass index (BMI), the second largest group of BMIs was for overweight (35.9%) than for obese pregnant (24.2%).

The BMI in early pregnancy as mentioned in Table 1, shows that 55.80% of overweight pregnant before and/or at the start of their pregnancy gain excessive weight at the end of the pregnancy vs 49.70% of obese pregnant vs 44.90% of normal weight pregnant and about 100% of lean pregnant.

We observed that 28.7% of the normal weight pregnant participants showed a normal weight

gain at the end of the pregnancy against 21.5% of overweight pregnant vs 22.10% of obese ones.

Physical Activity According Pregnancy Weight Gain

According to the results mentioned in the Table 2, the minority of pregnant women's, so mince

than 10 % of each group declare the practice of sports during the pregnancy period. A high significant difference between the study groups was observed (8.1% of pregnant with excessive weight gain vs 4.7% of pregnant with normal weight gain vs 7.5% of pregnant with insufficient weight gain, $p < 0.001$).

Table 1: Distribution of the study populations according to the pre-pregnancy BMI

		Weight gain			Total
		Insufficient	Sufficient	Excessive	
BMI before pregnancy	Thinness	0	0	4	4
		0.00%	0.00%	100.00%	100.00%
	Normal	70	76	119	265
		26.40%	28.70%	44.90%	100.00%
	Overweight	55	52	135	242
		22.70%	21.50%	55.80%	100.00%
	Obesity	46	36	81	163
		28.20%	22.10%	49.70%	100.00%
Total	171	164	339	676	
	25.40%	24.30%	50.30%	100.00%	
p-value< 0.07					

Table 2: Distribution of the study populations according to the practice of physical activity.

		Weight gain			Total
		Insufficient	Sufficient	Excessive	
Physical activity	Yes	51	32	55	138
		7.50%	4.70%	8.10%	20.40%
	No	120	132	286	538
		17.80%	19.50%	42.30%	79.60%
Total		171	164	341	676
		25.30%	24.30%	50.40%	100.00%
p-value <0.001					

Table 3: Distribution of the study populations according to the number of meals.

		Weight gain			Total
		Insufficient	Sufficient	Excessive	
Number of meals	1 meal	14	2	1	17
		2.10%	0.30%	0.10%	2.50%
	2 meals	52	36	44	132
		7.70%	5.30%	6.50%	19.50%
	3 meals	102	112	102	316
		15.10%	16.60%	15.10%	46.70%
	More than 3 Meals	3	14	194	211
		0.40%	2.10%	28.70%	31.20%
Total		171	164	341	676
		25.30%	24.30%	50.40%	100.00%
	p-value <0.0001				

Eating Habits Between Pregnant With Insufficient, Sufficient and Excessive Weight Gain

The high frequency of more than three meals per a day was observed in pregnant with excessive weight gain during the pregnancy with 28.7% compared to pregnant with normal (2.1%) and insufficient weight gain (0.4%, $p < 0.0001$, Table 3).

The high frequency and the amount of products containing fat (i.e. meat/chicken, butter/margarine and vegetable oil, $p < 0.0001$) were significantly higher in pregnant with excessive weight gain. At 1 to 2 times a week

30.9% from pregnant with excessive GWG consume meat substitutes, where 27.2% declares 225g like usual serving of red or white meat against respectively 1.8% from 8.7% from pregnant with sufficient weight gain who declares 225g like usual serving of meat vs 5.8% from the 4.3 % from pregnant with insufficient GWG. The distribution of the population according to the type of fat using in cook show that the majority of the population was that of pregnant with excessive GWG who declares vegetable oil with a frequency of 35.4% vs 9.2% and 8.7% respectively to pregnant with sufficient and insufficient weight gain ($p < 0.0001$, Table 4).

Table 4: Distribution of the study populations according to the consumption of fat containing products.

		Weight gain			Total
		Insufficient	Sufficient	Excessive	
Meat substitutes	1 -2 times a week	29	59	209	297
		4.30%	8.70%	30.90%	43.90%
	3 times a week	1	4	13	18
		0.10%	0.60%	1.90%	2.70%
	Sometimes	35	88	82	205
		5.20%	13.00%	12.10%	30.30%
	Rarely	0	6	1	7
		0.00%	0.90%	0.10%	1.00%
	Never	106	7	36	149
		15.70%	1.00%	5.30%	22.00%
Total		171	164	341	676
		25.30%	24.30%	50.40%	100.00%
Usual serving of red or white meat	75g	45	35	53	133
		6.70%	5.20%	7.80%	19.70%
	150g	62	104	92	258
		9.20%	15.40%	13.60%	38.20%
	225g	39	12	184	235
		5.80%	1.80%	27.20%	34.80%
	No meat	25	13	12	50
		3.70%	1.90%	1.80%	7.40%
Total		171	164	341	676
		25.30%	24.30%	50.40%	100.00%
Types of oils and fats	Butter / margarine	24	26	54	104
		3.60%	3.80%	8.00%	15.40%
	Vegetable oil	59	62	239	306
		8.70%	9.20%	35.40%	53.30%
	A bit of all these options	88	76	48	212
		13.00%	11.20%	7.10%	31.40%
Total		171	164	341	676
		25.30%	24.30%	50.40%	100.00%
p-value <0.0001					

The same observation was noted in the consumption of dairy supplements, sodas and juices, where pregnant with excessive GWG consume these latter (respectively 33% and 32.7% and 10.4%) more than pregnant with normal (16.9% and 10.5% and 9.9% respectively) and insufficient GWG (5.8% and

11.4% and 7.1% respectively, $p < 0.0001$). However, pregnant with insufficient (3% and 3.6% respectively) and normal gestational weight gain consume more coffee/tea and water (respectively 0% and 1.5%) than pregnant with high weight gain (0% and 1% respectively, Table 5).

Table 5: Distribution of the study populations according to the type of drinks consumed.

		Weight gain			Total	
		Insufficient	Sufficient	Excessive		
Types of drinks	Soda	77	71	221	369	
		11.40%	10.50%	32.70%	54.60%	
	Coffee and tea	21	0	0	21	
		3.10%	0.00%	0.00%	3.10%	
	Milk	1	5	43	49	
		0.10%	0.70%	6.40%	7.20%	
	Water	24	10	7	41	
		3.60%	1.50%	1.00%	6.10%	
	Natural juice	48	67	70	185	
		7.10%	9.90%	10.40%	27.40%	
	All	0	11	0	11	
		0.00%	1.60%	0.00%	1.60%	
	Total		171	164	341	676
			25.30%	24.30%	50.40%	100.00%
p-value <0.004						

Table 6: Distribution of the study populations according to the consumption in fast food restaurants.

		Weight gain			Total	
		Insufficient	Sufficient	Excessive		
Fast food	Yes	91	93	240	424	
		13,50%	13,80%	35,50%	62,70%	
	No	80	71	101	252	
		11,80%	10,50%	14,90%	37,30%	
Total		171	164	341	676	
		25,30%	24,30%	50,40%	100,00%	
Frequency of fast food consumption	Less than once a week	27	19	6	52	
		4,00%	2,80%	0,90%	7,70%	
	1 time per week	68	56	81	205	
		10,10%	8,30%	12,00%	30,30%	
	2 - 3 times a week	49	48	176	273	
		7,20%	7,10%	26,00%	40,40%	
	4 - 5 times a week	23	37	67	127	
		3,40%	5,50%	9,90%	18,80%	
	6 times and more	4	4	11	19	
		0,60%	0,60%	1,60%	2,80%	
	Total		171	164	341	676
			25,30%	24,30%	50,40%	100,00%
p-value <0,0001						

Pregnant women with excessive GWG report the high frequency of consumption in fast food restaurants (respectively 35.5% with 26% at 2 to 3 times a week) compared to the population of pregnant with normal (13.8%, with 7.1% at 2 to 3 times a week) and insufficient weight gain (13.5% with 7.2% at 2 to 3 times a week respectively, Table 6).

Socioeconomic and socio-professional status between pregnant with insufficient, sufficient and excessive GWG

We observed with a high significant difference ($p < 0.0001$) that the weight gained during the pregnancy period was not correlated to the level of instruction.

According to the results mentioned in the Table 7, the frequency of pregnant with excessive weight gain was more higher than the frequency of women's with normal and insufficient weight gain in all the socioeconomic status of the study ($p < 0.1$).

DISCUSSION

Pregnancy could be a key time to target a weight control or weight loss intervention to help curb the rapidly increasing prevalence of obesity in the population. Nutrients intake and weight gain during pregnancy are the two main factors affecting maternal and infant outcomes [27].

It has been previously shown that women who are obese at the pre-pregnancy period gain excessive weight during pregnancy [28]. Our results showed the same observation with a non-significant difference between the study groups. Above the IOM recommendations, the frequency of excessive weight gain was observed in 49.7% of the population of obese women vs 55.8% of overweight ones vs 44.9% of the normal weight population. In contrast, below the IOM recommendations, our results shows 28.7% of pregnant with normal weight vs 21.5% overweight pregnant vs 22.1% of obese ones ($p < 0.07$).

Table 7: Distribution of the study populations according to the socioeconomic and the socio-professional status.

		Weight gain			Total
		Insufficient	Sufficient	Excessive	
Level of instruction	Primary	22	9	27	58
		3,30%	1,30%	4,00%	8,60%
	Secondary short	40	41	176	257
		5,90%	6,10%	26,00%	38,00%
	Long secondary	29	23	54	106
		4,30%	3,40%	8,00%	15,70%
	University	80	91	84	255
		11,80%	13,50%	12,40%	37,70%
Total		171	164	341	676
		25,30%	24,30%	50,40%	100,00%
socio-economic status	Inferior	50	45	71	166
		7,40%	6,70%	10,50%	24,60%
	Lower middle	41	38	88	167
		6,10%	5,60%	13,00%	24,70%
	middle	51	59	109	219
		7,50%	8,70%	16,10%	32,40%
	Upper middle	80	80	80	80
		2,40%	2,50%	7,10%	12,00%
	Superior	13	5	25	43
		1,90%	0,70%	3,70%	6,40%
Total		171	164	341	676
		25,30%	24,30%	50,40%	100,00%
p-value <0,0001					

Pre-pregnancy BMI is the best predictor of gestational weight gain, and women who were overweight or obese before pregnancy were significantly more likely to exceed weight recommendations. Being underweight before pregnancy was significantly correlated with too little weight gain compared to the guideline of weight gain. Consistent with our results, Weisman et al., in 2010, in a study around 103 pregnant women in the United States, reported that being overweight or obese increased significantly the chances of excess weight gain during pregnancy [29]. Being underweight leads to a higher risk of insufficient gestational weight gain, while being overweight and / or obese at the time of conception is linked to a higher risk of excessive gain [30]. Heerman et al., in 2014, found excessive gestational weight gain in 55% of pre-pregnant overweight mother's vs 43.7% of obese mothers and only 37.5% of pre-pregnant underweight mothers [31].

Begum et al., in 2012, have indicated that a higher BMI before pregnancy is a significant predictor of excessive weight gain during pregnancy; 80% of overweight or obese pregnant women gained more weight than recommended [32].

The results of a prospective multicenter Australian cohort, study of 1950 nulliparous women corroborated the association of BMI in early pregnancy with gestational weight gain. These researchers found that overweight women were 3 times more likely to exceed recommended weight gain parameters, while obese women were 2.5 times more likely [33]. Similar associations have been found in additional studies that examined the relationship between pre-pregnancy BMI and excessive gestational weight gain in overweight and obese women ranging from 44% to 69% [20, 34, 35]. In addition, Deputy et al., in 2015, showed that overweight and obese pregnant women were approximately 2 and 3 times more likely to have excess weight gain above the IOM recommendations, respectively [5].

In another recent study, the significant prevalence of insufficient and excessive gestational weight gain (GWG) observed among the participants, show that only 30% of the participants fell into the correct GWG according the IOM guidelines. Specifically, 32% and 39% had insufficient and excessive GWG, respectively [36].

We did not find any association between socioeconomic status and instruction levels with weight gain during pregnancy, according to our results, the frequency of pregnant with excessive GWG was more higher in all socioeconomic status and in the majority of instruction levels of the study ($p < 0.1$). The literature is inconsistent regarding the association of socioeconomic status and GWG [5, 37].

According to Ogden et al, in 2010 women of low socioeconomic status (SES) are more likely to be obese than those of higher socioeconomic status [38]. In most studies, a higher risk of gaining weight outside of the recommendations was found in pregnant with lower education levels [5, 37].

Much of this is due to a lack of understanding the importance of healthy eating during pregnancy as well as limited access to healthy eating. However, Guilloty et al., in 2015, found that socio-demographic characteristics were not associated with GWG [39].

Excess of caloric intake, largely contributed by fat overconsumption, seems to be one of the factors implicated in weight gain, during or not the pregnancy period [40]. We noticed that pregnant with excessive weight gain consume more than 3 meals per a day than the two others populations of the study, as, they declare by almost their food preparation. Moreover, it has been showed that the overconsumption of high fat diet contributes not only to weight gain, but it is also associated with dyslipidemia, cardio-metabolic disorders, diabetes type 2, hypertension and other [41]. Meat and especially processed one, is rich in saturated fatty acids and cholesterol, and its overconsumption has been associated with high BMI [42]. Rouhani et al., in 2014, also reported a direct association between consumption of red or processed meat intake and obesity, high BMI and waist circumference [43]. We noticed a high frequency of the consumption of products containing fat in the group of pregnant women with excessive weight gain during pregnancy compared to the group of women with sufficient and insufficient weight gain. These results were noted by the overconsumption of meat and chicken by pregnant women with excessive GWG and also by the quantity of the consumption of these latter, so that 30.9% from pregnant with excessive GWG consume meat substitutes at 1 to 2 time a week. 27.2% of this latter declares 225g

like usual serving of red or white meat against respectively 8.7% and 1.8% for pregnant with sufficient GWG vs 4.3 % and 5.8% respectively from pregnant with insufficient GWG, $p < 0.0001$. We also observed that pregnant women with excessive weight gain consume more butter and margarine (51.9%) and use more vegetable oil (66.4%) than pregnant with normal (25% and 17.2% respectively) and insufficient weight gain (23.1% and 16.4% respectively). In particular, we have noted that pregnant with excessive weight gain declare more cravings and more food consumption compared to the other two study groups. Our results corroborate to the results of several other studies, which showed a positive association between meat consumption and the risk of obesity [44, 45]. About drinks, pregnant with excessive weight gain declare by the most the intake of milk, soda and juice.

The American College of Obstetricians and Gynecologists (ACOG) recommends that all pregnant women engage in moderate exercise for 30 min or more per a day on most, if not, all days of week in the absence of medical or obstetric complications [46]. Our results showed a minority of each group that practice physical activity (8.1% of pregnant with excessive weight gain vs 4.7% of pregnant with normal weight gain vs 7.5% of those with insufficient weight gain, $p < 0.001$). Previous studies have shown that mothers who engage in exercise during pregnancy can reduce their risks of having complications during pregnancy [47, 48]. Exercise is a known behavioral factor used to control weight among the non-pregnant population [49]. Yet, empirical evidence about the effectiveness of exercise during pregnancy on weight gain management during pregnancy is limited and conflicting. Several observational studies found physical activity during pregnancy to have a significant protective effect on excessive gestation weight gain [1, 19, 48, 50].

However, two observational studies that used validated physical activity questionnaires and included various domains of physical activity did not observe significant associations between type or intensity of physical activity during pre-early, mid, and late pregnancy with measures of gestational weight gain among Hispanic women living in western Massachusetts (Burkart et al., 2020; Hawkins et al., 2019). The majority of these observational studies were conducted in predominantly non-Hispanic white or Hispanic women [51].

None of these studies has included a large proportion of African American women, despite the fact that more African American women enter pregnancy overweight or obese [52] and a higher proportion of African American women appear to gain excessive weight during pregnancy than non-Hispanic white women [53]. Additionally, our study was restricted to full term births to avoid concern about bias between total gestational weight gain and duration of pregnancy. This restriction can still result in misclassification because women continue to gain weight in the last several weeks of pregnancy when they are considered full term.

Furthermore, the findings from studies restricted to full term births are not generalizable to women with preterm deliveries. Given that the risk of preterm delivery is higher among obese women [54], these studies may have unintentionally included fewer overweight or obese women. Finally, all of these studies recruited women from prenatal care clinics in a specific geographic area [55] rather than using a population-based sample, thus limiting generalizability [20].

CONCLUSION

Interventions to prevent excessive gestational weight gain are potentially most effective when they parallel effective behavioral lifestyle programs in non-pregnant populations. As such, further research in pregnant are needed, this is an important concepts because so few studies have been able to demonstrate that health behavior interventions improve gestational weight gain and other health outcomes. We propose that we should evaluate prenatal care models in more rigorous methods that clearly define and primarily evaluate gestational weight gain outcomes.

CONFLICTS OF INTEREST

Authors declare that they have no conflict of interests.

AUTHORS' CONTRIBUTION

RL, KH, BV, BK and DN designed the study. GH, KI and DN developed the interview guides. DN, OL and DH conducted the interviews. DH RL and DN analyzed the data, revised it critically and wrote the final manuscript.

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