Obesity and lifestyle indicators impact on obstetric complications and fetal outcome in North Lebanon population

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Abstract: Worldwide, o**besity has been shown to negatively affect women especially during pregnancy. In this work, a retrospective cohort study for 1308 women, who gave birth between 2014 and 2016 in public and private hospitals, was conducted to evaluate the impact of weight, demographic and lifestyle indicators on many pregnancy and fetal outcomes in Northern Lebanon. The frequent health complications related to pregnancy were cesarean-section (31.1%) followed by post-hemorrhage (25.1%), induced labor (23.5%) and macrosomia (11.4%). Multivariate analysis showed that the main complications were highly correlated to obesity, macrosomia, weight gain, multiparity and mother's age. High values from adjusted odds ratios were mainly associated to obesity, multiparity and weight gain. Obese pregnant women had a significant increased risk of having cesarean-section (p<0.001), pre-eclampsia (p<0.0001), labor induction (p<0.0001) and post-partum hemorrhage (p<0.0001). Adverse fetal outcomes such as macrosomia were also correlated with high BMI (p<0.0001). The risk was even greater for multiparous, older women that carried excessive weight gain. There is therefore a need to increase awareness among the target population and encourage prevention of the dangers related to obesity and weight gain.**

Keywords—Body mass index; pregnancy complications; fetal outcomes; weight gain; multiparity.

I. INTRODUCTION

Adverse obstetric and newborn complications are increasingly becoming a public health concern in many countries especially in Asia and Africa [1]. They have been mainly associated to pregnancy weight parameters, especially high early pregnancy Body mass index (BMI) [2].

Obesity and overweight are increasingly considered global health problems [3]. The prevalence of overweight adult women increased from 29.8% in 1980 to 38% in 2013 worldwide, especially in middle-income countries [4]. In developed countries particularly in the United States pre-pregnancy, overweight/obesity was evaluated at 42% [5]. Similar trends were reported during the last decades across Europe with a prevalence of obesity in pregnant women more

than 30% in the majority of European Countries [6,7] reaching over 48% in Scotland [8]. The proportion of maternal obesity in Africa ranged from 6,5% to 50.7% [9] Furthermore, the study conducted by Cheng et al [10] from 2005 to 2014 in 184 countries revealed that the number of overweight and obese pregnant women increased rapidly in middle income Asian countries especially India, China, Turkey, Iran, Iraq and Saudi Arabia [10].

Data from the MENA region (Middle East and North Africa) are relatively scarce; nevertheless, few studies have shown a correlation of obstetric complications to obesity for Egypt [11] Morocco [12], Turkey [13] and Iran [14]. In addition, the Eastern Mediterranean region is also facing an epidemic of obesity since statistics highlight an alarming rise of obesity, especially in the Arab world [15]. In Lebanon, 49.4% of the adult women are overweight while 14.3% of them struggling with obesity [16] that is becoming a national public health concern [17]. In addition, the prevalence of c-section (cesarean section) in Lebanon reached 49% [18]. Moreover, a study conducted in Lebanon has reported on the impact of excessive gestational weight gain on preterm births among normal and overweight women [19].

For weight control during pregnancy, the institute of Medicine guidelines show that underweight women can gain weight during their pregnancy between 18-40 pounds, normal weight women can gain between 25-35 pounds, overweight

women can gain between 15-25 and obese women can gain between 11-20 pounds [20].

Obesity increases the risk of pregnancy-associated disorders [21,22]. A 10% difference in pre-pregnancy BMI is associated with at least 10% change in relative risk of preeclampsia and gestational diabetes, respectively [23]. A pre-pregnancy BMI >25 kg/m^2 is associated with an increased risk of developing diabetes mellitus and cardiac disease. In addition to that, gestational weight gain of more than 15 kg increases the risk of becoming obese later in life [24]. The preterm birth rate is increased by obesity and contributes to the adverse neonatal outcomes [25, 26, 27]. The risk of medically indicated early preterm birth increases due to preeclampsia and gestational diabetes [26]. This risk is further increased in patients with gestational weight gain that is above the Institute of Medicine's recommendations [28, 29].

Fetal macrosomia, maternal obesity and excessive weight gain during pregnancy are associated with later obesity in childhood and adolescence [30, 31]. Obese women have a higher risk of caesarean section than women of normal weight [21,32], and this explains the decrease in vaginal delivery in obese women [33, 34, 35].

To our knowledge, this study is one of the first works in Lebanon. It surely has an important impact on the local national scale but also on the international one. Fewer studies are reported from Middle Eastern countries due to low data collection in these countries. Studies, such as this one from Lebanon, will help draw general guidelines to reduce pregnancy risks related to obesity that are applicable to similar countries. This work explores a sample of 1308 pregnant women from Northern Lebanon in order to delineate the influential factors on mother and baby health complications, especially early pregnancy, high Body Mass Index (BMI)I, weight gain and multiparty, in addition to social status and lifestyle indicators.

II. MATERIALS AND METHODS

This is a retrospective cohort study for 1308 women that gave birth between January 2014 and January 2016. Once women consented, anthropometric data including height, weight at the beginning of pregnancy, gestational age estimated by the last menstrual period or ultrasound examination and health status, were collected from the medical records in two private gynecology clinics and one primary health care center. Maternal and fetal health data were obtained from the medical records in five hospitals in North-Lebanon (private and public Islamic hospitals, Sayyidet Zgharta hospital, governmental hospital of Akkar and governmental hospital of Tripoli). A questionnaire including Socio-demographic (income, place of residence, parity) and lifestyle data (smoking habits, physical activity) were gathered by a telephone call to each woman, all of them were responsive with no missing data. A Body Mass Index (BMI) of each woman was calculated by using the formula: Weight (kg)/Height (m^2).

Women were divided into 3 weight groups based on WHO guidelines [36] with Normal: BMI of 18.5-24.9, Overweight: BMI of 25-29.9 and Obese: BMI of 30 and

above. Underweight group was discarded due to a negligible number of representatives. Were also discarded, samples with incomplete data, women aged under 17 or above 35 due to their high risk of developing complications, women with chronic diseases (hypertension or diabetes) or suspected to have fetuses with congenital malformation.

The final data matrix included 1308 rows and 20 columns. Descriptive statistics, Chi-square tests, Principal Component for categorical variables, binary logistic regression, and correlation were used to analyze the data and evaluate the association between the complications and the other type of variables. A probability value of 5% was used to determine statistical significance. SPSS version 23.0 was used to carry out these analyses.

III. RESULTS

Among the 1308 women constituting the study sample, 658 women had normal BMI (50.3%), 344 in were overweight (26.3%), and 306 were obese (23.4%). The majority of our sample was urban (80%), working women with high education and in a good income household (Table I). They were aged between 18-34 years. They have dominantly university level education (77%) along with their husbands (87%). About three quarters of the interviewed women (74%), reported having a job. Almost all the husbands reported having a job (96%) with a good social level (income) (79%).
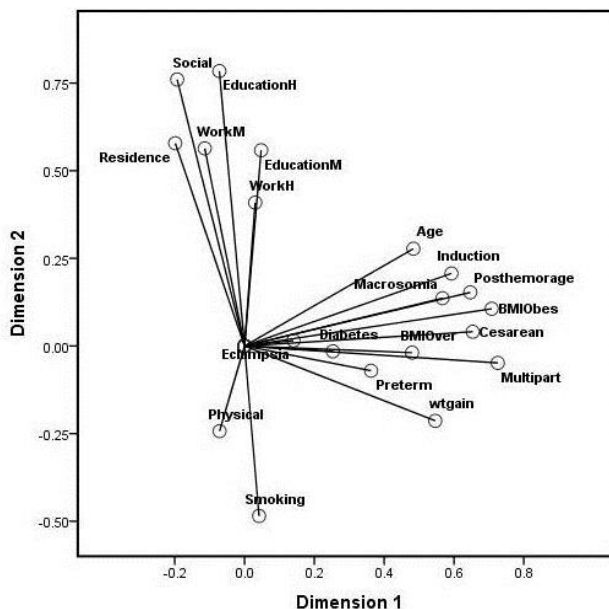

Fig. 1 Projection of the first (dimension1) and second (dimension2) axes of Principal component analysis for categorical data including all the demographic, lifestyle and health indicators.

At the time of the recruitment, 46 % of the women had no child, 24% had one, 11% had 2 children, 15% had 3 children and 4% had 4 or more. The percentage of mothers who smoked during pregnancy was 6.7%. The majority (93%) of women did not exercise at all with 67.5% having normal weight gain during pregnancy according to their BMI.

The most frequent health complications related to pregnancy were emergency cesarean-section (c-section surgery

to deliver a baby due to medical risk) with 407 cases, followed by post-partum hemorrhage (blood loss higher than 500 mL/day) with 328, induced labor (stimulation of uterine contractions during pregnancy) with 307 and macrosomia (newborn weight > 4000 grams) with 149 cases (Table I). The least frequent complications were preterm (delivery before 37th week of gestation), gestational diabetes (woman without diabetes develops high blood sugar levels during pregnancy), low birth weight (weight < 2500 grams), eclampsia (high blood pressure results in seizures during pregnancy) and finally stillbirth (baby death) with only two cases.

In order to explore the relation between the pregnancy and fetal complications along with the rest of the confounding factors, the 1308 profiles were analyzed using Principal Component Analysis (PCA) for categorical data (Fig. 1). The analysis revealed a high variability in the data with the first two axes extracting only 33% of the total variance. Nevertheless, the two axes (Fig. 1) were clearly defined by different indicators with the first axis reflecting the obesity-complication relation, while the second axis was defined by social and lifestyle indicators of such as income, educational level, parental jobs, residence, physical activity and smoking habits. The main contributions to the first axis were the mother's BMI, weight gain, parity and age along with the pregnancy complications, especially the most prevalent ones. Hence, the mother and baby complications seem to be mainly correlated with weight indicators in particular the mother's BMI.

Indeed, the Chi-square tests results (Table II) also shows that for almost all adverse health effects for the mother and the baby, the proportion of obese women was significantly greater with a p-value less than 0.05 except for stillbirth (Table II). For C-section, that is a common adverse outcome for obese women, the proportion increased from 17.9% for normal weight mothers to 56.9% for obese women. Similarly, for induction of labor, the proportion rose from 13.5% for normal weight mothers to 46.1% for obese mothers,

Table I: Demographic, social and health characteristics (N: number among 1308 women and percentage).

	N	Percentage
Age		
18-24 years	562	43
25-34 years	746	57
Education of mother		
Primary	52	4
Secondary	249	19
Post-secondary (University)	1007	77
Education of husband		
Primary	0	0
Intermediate	170	13
Post-secondary (University)	1138	87
Wife working status		
Yes	970	74.1
No	338	25.9
Husband's working status		
Yes	1259	96.3
No	49	3.7
Husband's Income level		
Low	104	8
Middle	171	13
Good	1033	79
Place of residence		
Urban	1050	80.35
Rural	258	19.65
Number of parities		
0	602	46
1	314	24
2	144	11
3	196	15
4 plus	52	4
Smoking during pregnancy		
Yes	219	6. 73

No	1089	93.27
Do you exercise?		
No	1107	93.27
Yes	201	6.73
BMI categorical		
Normal	658	50.3
Overweight	344	26.3
Obese	306	23.4
Weight gain		
Normal	883	67.5
Excess	425	32.5
Maternal Complications		
Gestational diabetes	52	4.0
Eclampsia	24	1.8
C-section	407	31.1
Induction of labor	307	23.5
Post hemorrhage	328	25.1
Baby complications		
Macrosomia	149	11.4
Preterm	67	5.1
low birth weight	54	4.1
APGAR score		
5	12	0.9
6	21	1.6
7	62	4.7
8	155	11.9
9	1058	80.9
Baby complications		
Macrosomia	149	11.4

along with post-partum hemorrhage proportions that increased from 4.9% for normal weight to 58.8% for obese mothers. This complication is defined as the loss of more than 500 mL or 1,000 mL of blood within the first 24 hours following childbirth. This increase in proportions for obese women was also observed for the other less frequent complications such as eclampsia and gestational diabetes even if the differences were smaller. For adverse fetal outcomes, comparable findings were also observed with macrosomia proportion increasing from 1.5% for normal weight mothers to 31% for obese mothers.

The odds ratios were calculated for normal BMI women with those versus obese BMI women and then versus overweight BMI women.

The risk of developing complications during pregnancy, based on adjusted logistic regression odds ratios, was statistically significant ($p < 0.05$) and much higher in obese group except for gestational diabetes and eclampsia (Table III). The adjusted odds ratios for the complications were 2.1 (1.3 - 3.2) for C-section, 2.4 (1.5 – 3.7) for labor induction, 7.4 (2.9 – 18.5) for preterm, 9.8 (5.7 – 16.8) for post hemorrhage and 15.3 (6.9 - 34) for macrosomia. The lowest values of odds ratios were observed for the less frequent complications (pre-eclampsia, gestational diabetes).

In addition to the obese mother's BMI, parity and weight gain during pregnancy showed statistically significant odds ratios in the logistic regression models of many pregnancy complications (Table IV). complications the values in bold In Table V are significant at the level 5%.

Moderate to low correlations (correlation coefficients ≤ 0.606) were found between the complications and the rest of the variables. The highest correlation coefficients were obtained for the BMI for obese women and multiparity (Table V). As the number of children increases, the percentage of complications increases. The age gave also a similar effect even though the correlation values were not as high as for the multiparty variable.

Table II: Prevalence and statistical significance (p: Probability for Chi-square test) of maternal and fetal complications for the different BMI groups.

Maternal complications	BMI			
	Normal	Overweight	Obese	*P*-value
Pre-eclampsia	1.40%	2.90%	5.90%	<0.0001
Eclampsia	1.10%	1.70%	3.60%	<0.02
C-section	17.90%	33.70%	56.90%	<0.001
Gestational diabetes	2.10%	3.80%	8.20%	<0.0001
Induced labor	13.50%	22.40%	46.10%	<0.0001
Post-partum hemorrhage	4.90%	33.70%	58.80%	<0.0001
Sever post hemorrhage	0.30%	1.70%	3.60%	0.037
Fetal complications				
Low Apgar score	0.3%	2.6%	7.2%	<0.0001
Preterm	1.1%	6.4%	12.4%	<0.0001
Very preterm	0.2%	1.5%	2.6%	0.002
Macrosomia	1.5%	12.8%	31%	<0.0001
Low birthweight	5.8%	3.8%	1%	0.002
Stillbirth	0.2%	0%	0.3%	0.568

Among the different complications, weight gain showed the highest correlation with emergency c-section, which may explain at least part of these interventions. It is also noteworthy that weight gain was the only indicator that showed relatively significant correlation with gestational diabetes. In fact, all women that presented gestational diabetes had excessive weight gain. Finally, it seems that incidence of cesarean was inversely correlated with living in the village (Table V).

IV. Discussion

This retrospective study showed that mother and baby weight parameters seem to be good indicators of pregnancy complications such as emergency c-section, post-partum hemorrhage, induction of labor, preterm delivery and macrosomia. An important body of published work have shown similar results in particular the correlation of obstetric complications to obesity [37] including in the MENA region [12, 14].

High rates of c-section delivery constitute an important health problem that was mainly associated to maternal obesity [38]. In our sample, the incidence of emergency c-section increased from about 17.9% for normal weight group to 56.9% in the obese group comparable to the incidence in Thai obese women of 52% [39]. Obese women present a higher risk to undergo c-section [40]. The elevated incidence of intra-partum c-section, among pregnant obese women, has been related predominately to failure to progress [41] due to the inefficient uterine activity in labor. Particularly, obesity affects the intra-partum myometrium contractility, the tract diameter (route of delivery) and the size of the baby due to macrosomia [41].

Table III: Adjusted odds ratios values compared for the groups of obese and overweight women based on their BMI.

Characteristic	Adjusted odds ratio obese vs normal (95% confidence interval)	p value	Adjusted odds ratio overweight vs normal (95% confidence interval)	p value
Gestational diabetes	-	NS	-	NS
Eclampsia	-	NS	-	NS
Cesarean delivery	2.1 (1.3-3.2)	0.001	1.8 (1.2 – 2.7)	0.005
Labor induction	2.4 (1.5 – 3.7)	0.000	-	NS
Post-partum hemorrhage	9.8 (5.7 – 16.8)	0.000	10.1 (5.7- 17.7)	0.000
Macrosomia	15.3 (6.9 - 34)	0.000	4.1 (1.7 – 9.5)	0.001
Preterm	7.4 (2.9 – 18.5)	0.000	4.1 (1.7- 9.5)	0.001

NS: not statistically significant.

Failure to progress may also explain the high prevalence of labor induction observed in our sample (odds ratio 2.4 in obese women). Previous studies have also reported that women with high BMI were more likely to have their labor induced [42]. Many studies have reported that the size of the fetus can also be a determinant factor for delivery mode. Our findings corroborate this since 70% of women who underwent c-section had macrosomic babies that can cause dystocia due to the large size of the fetus [43]. Furthermore, our sample showed a high incidence of macrosomia that is probably related to the prevalence of obese mothers that accounted for 64% of the macrosomic babies.

The risk of macrosomia depends on the pre-pregnancy weight [44]. Nevertheless, macrosomia can also be associated to gestational weight gain (GWG). In fact, being overweight and obese before pregnancy, and excessive weight gain during pregnancy may lead to increased concentrations of glucose, amino acids and free fatty acids in pregnant women [45], thereby increasing the risk of macrosomia.

Our results showed a statistically significant correlation between GWG and macrosomia in accordance to those to those of Deruelle [46] and Yang *et al.* [47]. For Lebanese women in our study, weight gain was significantly associated to many maternal complications and macrosomia probably due to inadequate diet affecting the baby and the mother's weight. Indeed El-Rafei *et al.* [19] suggested that

Lebanese culture still equates newborn's health and growth to its high birth weight.

Obesity has also been associated to post-partum hemorrhage [41]. Another study [40] found that post-partum hemorrhage is considered as one of several adverse maternal outcomes associated with obesity. Our data support this with a high prevalence of post-partum hemorrhage in the obese women sample even after adjustment of odds ratios by potential confounding factors. It is certainly, at least partially, associated to the high incidence of c-section leading to complications of surgery in obese patients as was reported in other investigations [41]. A cohort study [48] including 1,114,071 women showed a rapid but small increase of uterine hemorrhage risk with increasing BMI. The high incidence observed in our sample maybe related to defining post-partum hemorrhage as a loss of blood higher than 500 ml per day instead of 1000 ml per day.

Mother age and multiparity seem to be additional important confounding factors that correlated well with the weight indicators as well as the pregnancy complications. Maternal complications proportions increased from 29.8% for women aged lower than 24 to 66.5% for those aged above 25. In addition, obese women tend to be older and more likely multiparous [39]. In our sample, 98.5% of the mothers who underwent c-section were also multiparous. Women parity can also increase the incidence of c-section [49]. Similarly, to c-section, macrosomia seems correlated with multiparity as other studies have also reported [50].

Table IV: Probability values for odds ratios between complications and confounding parameters of weight and social indicators.

	BMI Obese	Weight gain	Parity	Age	Smoking	Physical activity	Residence
Cesarean section	0.000	0.000	0.000	0.000	0.250	0.026	0.000
Labour Induction	0.000	0.011	0.003	0.001	0.000	0.267	0.001
Post-partum hemorrhage	0.000	0.004	0.000	0.734	0.003	0.000	0.159
Macrosomia	0.000	0.004	0.000	0.742	0.206	0.004	0.000
Diabetes	0.114	0.988	0.104	0.000	0.194	0.997	0.001
Eclampsia	0.401	0.074	0.010	0.522	0.037	0.742	0.822
Preterm	0.000	0.006	0.053	0.687	0.620	0.014	0.028

Smoking and physical activity have also been shown to affect complications during pregnancy [51]. Pregnant smokers in our study were more likely to have complications with 67%. In Jordan, smoking during pregnancy was found to increase the risk of induced labor by 71% [52]. In contrast, regular physical activity during pregnancy provides many health and social benefits and lowers the risk of many pregnancy complications [51]. Indeed, the proportion of mothers who experienced pregnancy complications was lower among mothers who exercised with only 36 %.

Place of residence was significantly associated with adverse outcomes with 67.7% mothers residing in a rural setting experiencing complications versus 46.4% for city dwellers. Indeed, pre-eclampsia [53] and pre-mature delivery

[54] have been reported to be more common for rural women in other countries.

Although pre-eclampsia and preterm were less frequent complications, they presented higher proportions for the obese group in agreement with data reported by Scott-Pillai *et al.* [55]. Sujathaa *et al.* [2] have reported significantly higher frequencies in obese group in comparison to normal group. The effect of obesity on preterm delivery remains

controversial with some authors relating it to maternal underweight [56]. In fact, a systematic review and meta-analyses [57] showed that singletons born to underweight women have higher risks of preterm birth and LBW than those born to women with normal weight. Other authors relate it to high BMI [58]. Kosa *et al.* [59] attributed the controversial

results to differences in race and ethnicity along with inconsistent definitions of obesity and preterm delivery. Increased risk of preterm delivery was also reported for overweight/obese pregnant women [55].

Similarly, to pre-eclampsia and preterm, gestational diabetes prevalence was also rather low as reported by Sabbagh *et al.* [60] in another study from Lebanon. Even if diabetes did not seem to be correlated to the BMI or other weight indicators, all women with gestational diabetes presented an excess weight gain.

Table V: Pearson correlation coefficients between obstetric complications and mothers' characteristics (numbers in bold were statically significant at the level 5%).

	Multiparity	Age	BMI Obese	Weight gain	Residence
Cesarean section	**0.366**	**0.295**	**0.394**	**0.377**	-0.191
Post-partum hemorrhage	**0.432**	0.225	**0.606**	0.083	-0.020
Labor Induction	**0.301**	**0.328**	**0.356**	0.249	-0.071
Macrosomia	**0.321**	0.197	**0.441**	0.184	0.062
Preterm	0.145	0.098	0.251	0.203	-0.007
Diabetes	0.117	0.052	0.143	0.287	0.022
Eclampsia	0.103	0.051	0.087	0.012	-0.004

These low incidences of gestational diabetes, preterm and pre-eclampsia in our study could be related to the nature of the sampled women that were in majority highly educated with a good social status and hence would have benefited from a better medical assistance and awareness of the dangers of these complications.

V. CONCLUSION

Obesity has becoming an epidemic. Women tend to have complications during pregnancy due to their high pre-pregnancy BMI, which contributes to several outcomes, such as c-section, postpartum hemorrhage, induction of labor, preterm and macrosomia in newborns. Other factors affect maternal outcomes such as sedentary lifestyle, smoking, excessive weight gain and lack of health care.
This study showed that most pregnancy complications in a Northern Lebanon population seem to be related to weight indicators especially early pregnancy obese BMI, weight gain and macrosomia. Hence, there should be an increased awareness of the dangers of these factors in this population, through programs of more adequate dieting, consulting and frequent follow up during the whole pregnancy.
 This study is local and conducted in Lebanon. However, obesity and overweight among women is widespread all over the world. The results of other studies in various countries from Africa, Asia and Europe are similar as mentioned in the text, which show that the problem is not only of interest in developing countries such as Lebanon, but is also a global issue. We focused in this study on the effect of weight gain during pregnancy and its link to health problems. This would

help doctors in the world to guide pregnant women to follow a diet to prevent excessive weight gain, which leads to reducing the risk of some health problems such as gestational diabetes and c-section during pregnancy and possibly a normal delivery.

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Contribution of individual authors to the creation of a scientific article (ghostwriting policy)

Mayssa Traboulsi collected the data and wrote the first draft of the paper.
Abdellatif Boussaid carried out the statistical analysis, writing the paper and supervising.
Zainab E. El Alaoui-Talibi provided guidance for conducting the study and writing the paper.