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THE RELATION BETWEEN BODY MASS INDEX AND INCIDENCE OF DELIVERY OUT OF DUE DATE IS DISCREPANT: AN OBSERVATIONAL STUDY

By

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ABSTRACT

Objectives: To evaluate the impact of body mass index (BMI) on the timing of labor in relation to the due date of delivery.

Patients & Methods: 553 women were evaluated for baseline BMI and classified according to WHO classification. At the time of delivery, BMI was reevaluated and excess BMI gain was determined. Time of delivery in relation to the due date of delivery and the incidence of preterm delivery (PTD) and postdate delivery (PDD) were determined. The relation between time of delivery and at-booking BMI was studied and Kaplan-Meier regression analysis was used to determine the cumulative risk of PTD and PDD at various values of BMI.

Results: 35 parturient (6.33%) had PTD with mean gestational age (GA) of 239.8±8.65 days and 20 parturient had PDD at GA of 296.5±1.55 days. Eighteen under and average weights parturient had PTD, while 17 overweight-to-obese II parturient had PTD. PDD was prevalent among overweight-to-obese II parturient. There was a significant correlation between at-booking BMI and incidence of PTD and PDD and Kaplan-Meier regression analysis showed a progressive increase of PTD risk with increased at -booking BMI and risk was 40% for women with BMI of 35 kg/m² and 80% for women with BMI >35 kg/m². Also, the risk of PDD was 100% in women with a BMI of >35 but <36 kg/m², and rise to 140% at BMI higher than 36 kg/m².

Conclusion: Preconception or at time of pregnancy diagnosis BMI strongly influences the time of delivery in relation to the due time. Extremes of BMI are associated with a high prevalence of PTD, while obesity is associated with PDD. BMI higher than 30 kg/m² is associated with a high cumulative risk of delivery out of the due time and this risk multiplies extensively with each increase of BMI by 1 kg/m².

INTRODUCTION

Preterm delivery (PTD) is a major pediatric challenge difficult to prevent and with major adverse outcomes (García-Blanco et al., 2017). Infants born at less than 37 weeks gestational age are of public health concern because of the multiplicity of PTD-associated complications (Bustos et al., 2017). Preterm delivery is strongly associated with developmental problems that may cause postnatal morbidities, lifelong disability (Ludwig et al., 2017; Sammallahti et al., 2017), and maybe the leading cause of mortality in children <5 years of age (Zdanowicz et al., 2017).

Predicting the risk of threatened preterm delivery is still a challenge and multiple studies tried to propose a model to predict the risk for PTD, Raba & Kotarski, (2016) supposed that the accumulation of the five risk factors: preconception cigarette smoking, low socioeconomic status; frequent contractions during pregnancy: bleeding and urinary tract infection during pregnancy can predict PTD within 7 days. More than a nomogram was proposed to predict the risk of PTD; a preconception PTD risk model consisted of a history of prior PTD or low birth weight baby, abortion, preconception diabetes, smoking, race, and intention to get pregnant showed a negative predictive value of >75% (Mehta-Lee et al., 2017). Another nomogram was supposed and evaluated a nomogram to predict the risk of PTD and was documented as efficient and clinically relevant in high -risk populations (Dabi et al., (2017).

Prolongation of pregnancy for >10 days beyond the estimated due date (Chabra, 2015) is the counter-side problem that complicates up to 10% of all pregnancies and is associated with increased risk to both mother and fetus (Arrowsmith et al., 2012). The major challenge of postdate delivery (PDD) is the need and mode of induction of labor and the prediction of the outcome of induction (Papoutsis et al., 2016). Another challenge is the need for assisted instrumental delivery or operative delivery (Mohamed et al., 2016). Through this dilemma of the timing of delivery, the role of constitutional maternal factors was not fully evaluated, thus the current study aimed to evaluate the impact of body mass index (BMI) on the timing of labor in relation to the due date of delivery and to try to determine a possible cutoff point for differentiation between pre, at and postdate deliveries.

PATIENTS AND METHODS

This prospective observational study was conducted from June 2017 till June 2018 at Obstetrics & Gynecology Department, Benha University Hospital (BUH). All women attending the antenatal care unit at BUH for assurance of being pregnant were eligible for evaluation. Pregnancy was diagnosed chemically and assured clinically and by ultrasonographic detection of an intrauterine pregnancy sac. After assurance of pregnancy, full medical and obstetric history was obtained and baseline blood pressure and random blood glucose were determined

Exclusion criteria:

Exclusion criteria included a history of previous PTD, gestational hypertensive disorders, gestational or current diabetes mellitus, presence of endocrinopathy especially that inducing obesity, renal, cardiac, or liver diseases. Women lost during the pregnancy duration or attended the follow-up visits and had labor outside BUH were also excluded.

Inclusion criteria

Women with singleton fetuses who have attended the follow-up visits and gave birth at BUH were included in the study.

Study protocol

Evaluation of baseline BMI

At the time of pregnancy diagnosis (Booking time) body, height and weight were determined and BMI (kg/m^2) was calculated according to **Bray**, (1992) as weight (kg)/height (m^2) , and this BMI value was considered as the baseline value due to deficient visits for preconception evaluations.

Grading of baseline BMI

Women were graded according to baseline BMI as follows: underweight if BMI was <18.5 kg/m²; average weight when BMI was ranging between 18.5 and 24.9 kg/m²; overweight if BMI was in the range of 25-29.9 kg/m²; obese class I if BMI was 30-34.9 kg/m²; class II when BMI was in the range of 35-39.9 and obese class III if BMI was >40 kg/ m² (WHO, 1995; May et al., 2013).

Evaluation of BMI during pregnancy

BMI was determined at the start of the 2nd and 3rd trimesters and at the time of labor and the percentage of excess BMI gain (%EBMI gain) was calculated as BMI at time of delivery minus atbooking BMI divided by the at-booking BMI and total is multiplied by 100.

Definition & classification of Preterm delivery (PTD)

PTD is defined as a birth that occurs before the start of the 37^{th} week of pregnancy. PTD was graded according to the gestational age as late preterm is that occurs between $34^{\text{th}} - 36^{\text{th}}$ completed gestational weeks (GW), moderately preterm is that occurs between 32^{nd} and 34^{th} GW, very preterm is that born $< 32^{\text{nd}}$ GW, but if it is born ≤ 25 GW it is considered extremely preterm (Duryea et al., 2015; Chabra, 2016).

Definition of Postdate delivery (PDD)

PDD was defined as prolongation of pregnancy for >10 days beyond the estimated due date and gestational age was determined by days not weeks (Chabra, 2015).

Study outcome

The incidence of delivery out of due time and its relation to at-booking BMI

The possible cutoff point of BMI that may discriminate women vulnerable to have delivery out of due date

Statistical analysis

Obtained data were presented as mean, standard deviation, ranges, numbers, and percentages. Possible relationships were investigated using Spearman's non-parametric correlation regression analysis. Kaplan-Meier regression analysis was used to define a possible cutoff BMI for prediction of delivery out of due date. Statistical analysis was conducted using the SPSS (Version 15, 2006) for Windows statistical package. P-value <0.05 was considered statistically significant.

RESULTS

During the study duration, 619 newly pregnant women were eligible for evaluation; 27 women were excluded for not fulfilling the inclusion criteria and 39 women were lost during follow-up, while 553 women completed the study, and their outcome was analyzed (Fig. 1). The mean age of the enrolled women was 30.8 ± 6.7 years, there were 264 multigravidas (47.7%) and 289 primigravidas (52.3%). Sixty-eight women (25.8%) had previous three deliveries, 122 (46.2%) had previous two and 74 women (28%) had one previous delivery.

According to BMI, at-booking time 286 women (51.7%) were overweight with a mean BMI of 28.47 ± 0.96 kg/m², 117 women (21.16%) were obese of grade I with a mean BMI of 31.68±1.22, 110 women (19.89%) had an average weight with mean BMI of 23.85±0.87 kg/m^2 and only 31 women (5.61%) were underweight with mean BMI of 17.78 ± 0.52 kg/m² and 9 women (1.64%) were obese grade II with mean BMI of 35.45 ± 0.56 kg/m². At the time of labor, 38 women (6.87%) had average weight with a mean BMI of 21.23 ± 1.86 kg/m², 124 women (22.42%) were overweight with a mean BMI of 27.25±1.23, 329 women (59.49%) were obese of grade I with mean BMI of 32.25 ± 1.23 kg/m² and 62 women were obese grade II with mean BMI of 36.65 ± 1.32 kg/m² (Table 1).

At labor time, all parturient showed increased body weight; body weight was increased by <10 kg than at booking weight in 382 parturient (69.08%) and by >10 kg in 171 parturient (30.92%) with a median value of the increased weight of 9 [IQR= 8-10 kg). Subsequently, the BMI of all studied parturient was increased by a median value of 11.24% with an IOR of 10.11-12.34%. One hundred and twenty-five parturient (22.61%) had a %EBMI gain of ≤10%, 409 parturient (73.96%) had % EBMI gain in the range of >10-15%, 16 parturient (2.89%) had %EBMI gain of >15-20% and only three (0.54%) parturient had %EBMI gain of >20% (Fig. 2).

Regarding the timing of labor concerning gestational age (GA), 498 parturient (90.05%) had delivery at the calculated date of delivery according to the time of the last menstrual period and chemical and clinical diagnosis of pregnancy. However, 35 parturient (6.33%) had preterm birth (PTD) with a mean GA of 239.8±8.65; range: 218-251 days. Twenty-three of these 35 parturient (65.71%) had late PTD with mean GA of 245±4.15 (range: 238-251) days: another 10 parturient (28.57%) had moderately PTD with mean GA of 232±2.7 (range: 229-237) days, while two parturient (5.72%) had very PTD at GA of 218 and 220 days. On the other hand, 25 parturient had post-date delivery (PDD) at 296.5±1.55; range: 294-300 days and 18 of those parturient (72%) had operative delivery, while the other seven parturient (25%) had responded to induction of labor.

Analysis of incidence of abnormal timing of delivery in relation to atbooking BMI showed that 11 underweight women (31.4%) and 6 women (17.1%) with average BMI had PTD, while the remaining 18 women (51.4%) had PTD were overweight (n=10; 28.6%), obese women of grade I and II (n=4; 11.4%, respectively). On the other hand, five parturient who were of obese II grade at-booking time had PDD. Also, 8 women of obese I grade (6.8%) and 7 of overweight women at booking time had PDD delivery (Table 2).

Moreover, Spearman's correlation analysis showed a negative significant correlation (Rho= -0.086, p=0.044) between at-booking BMI and incidence of PTD, while showed a positive significant correlation (Rho= 0.214, p<0.001) between at-booking BMI and incidence of PDD. Despite the high number of women who had PTD among underweight women, Kaplan-Meier regression analysis for cumulative risk showed a progressive increase of risk to have PTD with increased at-booking BMI, where the risk was 5% till BMI of 29, 10% for women with BMI ranging between 29 and 33 kg/m², 40% for women with BMI of 35 kg/m² and 80% for women with BMI >35 kg/m² (Fig. 3). Similarly, the incidence of PDD was <10% for women had BMI up to 33 and rises to 20-30% for women who had BMI in a range of >33-35 kg/m² and jumps steadily up to 100% in women with BMI of >35 but <36 kg/m², and up to 140% at BMI higher than 36 kg/m² (Fig. 4).



Fig. (1): Study Flow Chart

Time BMI grade Findings	At-booking		At labor	
	Frequency	Mean (kg/m ²)	Frequency	Mean (kg/m ²)
Underweight	31 (5.61%)	17.78 ±0.52	0	0
Average weight	110 (19.89%)	23.85±0.87	38 (6.87%)	21.23±1.86
Overweight	286 (51.7%)	28.47±0.96	124 (22.42%)	27.25±1.23
Obese I	117 (21.16%)	31.68±1.22	329 (59.49%)	32.25±1.23
Obese II	9 (1.64%)	35.45±0.56	62(11.22%)	36.65±1.32

Table (1): Distribution of women	enrolled in the	he study	according t	to BMI	determined	at-
booking time and labor time						

Data are presented as mean, standard deviation, numbers, and percentages; BMI: Body mass index



% of EBMI gain

Fig. (2): Distribution of women according to % EBMI gain

At booking	Number of women (%)				
BMI	Enrolled	Had PTD (%)	Had PDD (%)		
Underweight	31 (5.61%)	10 (32.25%)	0		
Average weight	110 (19.89%)	11 (10%)	0		
Overweight	286 (51.7%)	6 (2.1%)	7 (2.4%)		
Obese I	117 (21.16%)	4 (3.4%)	8 (6.8%)		
Obese II	9 (1.64%)	4 (44.4%)	5 (55.6%)		

Table (2): Distribution of women enrolled in the study according to the timing of delivery within each at-booking BMI determined grade

Data are presented as numbers and percentages; BMI: Body mass index; PTD: Preterm birth; PDD: Post-date delivery



Fig. (3): Kaplan-Meier Regression curve for incidence of PTD in relation to at-booking BMI



Fig. (4): Kaplan-Meier Regression curve for incidence of PDD in relation to at-booking BMI

DISCUSSION

The current study included 553 newly pregnant women; determination of at-booking BMI defined 412 overweight-to-obese grade II women for a prevalence of obesity among the studied population of 74.5%. Such prevalence figure points to the necessity of evaluation of all pregnancy-associated events in relation to BMI and assured the objectives of the study to evaluate the impact of BMI on the timing of labor. In line with this assumption and objective, the Global Burden Disease Study conducted in 2015 concerning obesity documented that the rapid increase in the prevalence and disease burden of elevated BMI highlights the need for continued focus on surveillance of BMI and identification, implementation, and evaluation of evidence-based interventions to address this problem (GBD 2015 Collaborators,

2017). Another survey studies concluded that a pandemic of metabolic diseases, consisting of type 2 diabetes, nonalcoholic fatty liver disease, and obesity have imposed critical challenges for societies worldwide, prompting an investigation of underlying mechanisms and exploration of effective treatment (Zhu et al., 2017; Kim et al., 2017a).

At the time of labor, 55 parturient who had labored out of the due time; 35 parturient had PTD, and 20 had PDD. Seventeen parturient (48.6%) of those who had PTD were either underweight or of average weight at booking time, this finding indicated a relation between maternal underweight and the risk of PTD. Similarly, Girsen et al., (2016) documented that increased severity of maternal preconception underweight BMI was associated with increased riskadjusted PTD at <37 weeks with increasing risk of PTD at 28-31 and 32-36 GW.

On contrary, 18 of parturient who had PTD (51.4%) were overweight to obese II at booking time; a finding indicated a high prevalence of PTD among women with high preconception BMI. These findings provide a shred of evidence for the discrepant impact of BMI on the timing of labor. In support of this assumption, it was found that all of the nine women of obesity grade II who enrolled in the study had labored out of the due time; 4 had PTD, and 5 had PDD. This finding spots light on the deleterious effect of obesity especially of high BMI on the timing of delivery and assured discrepant impact of BMI on the timing of labor, which occurs either as pre or post-term.

These findings go in hand with Kawwass et al., (2016) who reported that among women undergoing IVF, preconception BMI affects pregnancy and obstetric outcomes and despite the limited impact of underweight status on pregnancy and live-birth rates, it is associated with increased risk of PTD and on the other side obesity negatively impacts all ART and obstetric outcomes. Also, Hermesch et al., (2016) documented that BMI is significantly associated with the likelihood of the spontaneous onset of labor at all gestational ages, and either over or underweight BMIs were associated with both PTD and PDD. Thereafter, Kim et al., (2017b) documented the presence of an association between preconception BMI and the increased risk of PTD even in the absence of chronic diseases and found such association was heterogeneous by preterm categories, gestational age, and parity.

Recently, Sung et al., (2018) reported an incidence of PTD of 14.1%. 11.9%, 16.3% of their study population of underweight/normal/overweight and obese parturient, respectively. Also, van Oers et al., (2018) suggested that preconception weight reduction in obese infertile women could decrease the rates of hypertensive pregnancy complications and PTD. Lucovnik et al., (2018) documented that preconception underweight was associated with PTD and small for gestational age neonates in IVF and non-IVF pregnancies. Also, Delnord et al., (2018) found previous PTD, and maternal short stature, underweight or obesity are risk factors for PTD, and Girson et al., (2018) found recurrent PTD among underweight women was associated with BMI, negative or weight change between pregnancies, younger age, and short inter -pregnancy interval.

CONCLUSION

Preconception or at time of pregnancy diagnosis BMI strongly influences the time of delivery in relation to the due time. Extremes of BMI are associated with a high prevalence of PTD, while obesity is associated with PDD. BMI higher than 30 kg/m² is associated with a high cumulative risk of delivery out of the due time and this risk multiplies extensively with each increase of BMI by 1 kg/m².

Limitations:

The study was limited to being a single-center study

Recommendations:

Wide-scale multicenter studies with a large study population were required to assure the assumed cutoff point of BMI for prediction of delivery out of due time

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العلاقة بين مؤشر كتلة الجسم ووقوع الولادة الموعد المتوقع مسبقا علاقة متناقضة: دراسة قائمة على الملاحظة وجدي عامر قسم التوليد والنساء –كلية الطب – جامعة بنها

<u>الأهداف:</u>

تقييم أثر مؤشر كتلة الجسم في وقت حدوث المخاض، وذلك فيما يتعلق بموعد تحديد الولادة.

المرضى والوسائل:

خضعت خمسمائة وثلاث وخمسون امرأة لتقييم أولي لمؤشر كتلة الجسم، حيث تم تقسيمهن طبقًا لتصنيف منظمة الصحة العالمية. في وقت الولادة، خضع مؤشر كتلة الجسم لإعادة تقييم، بالإضافة إلى تحديد معدل حدوث الزيادة فيه. أيضاً تم تحديد وقت الولادة فيما يتعلق بالموعد المحدد مسبقا للولادة ومعدل حدوث الولادة المبكرة والمتأخرة. وتم دراسة العلاقة بين وقت حدوث الولادة ومؤشر كتلة الجسم عند بدء الدراسة، بالإضافة إلى استخدام تحليل الانحدار لمقياس كابلان ماير من أجل تحديد مقدار الخطر التراكمي للولادة المبكرة والمتأخرة عند قيم متعددة من مؤشر كتلة الجسم.

حدثت ولادة مبكرة لخمس وثلاثين امرأة (٦.٣٣%) بعد متوسط عمر حمل مقداره ٢٣٩.٨ يومًا، بينما حدثت ولادة متأخرة لعشرين امرأة بعد متوسط عمر حمل مقداره ٢٩٦.٥ يومًا. كان مؤشر كتلة الجسم متوسط أو منخفض عند ١٨ امرأة ممن حدثت لهن ولادة مبكرة، بينما ١٧ امرأة ممن حدثت لهن ولادة مبكرة كن أولي زيادة في الوزن أو السمنة من الدرجة الثانية. علي الجانب الأخر كانت الولادة المتأخرة شائعة بين النساء التي تعاني من زيادة في الوزن أو السمنة من الدرجة الثانية. وكان هناك ارتباط ملحوظ بين مؤشر كتلة الجسم عند بدء الدراسة وحدوث الولادة المبكرة والمتأخرة، حيث أوضح تحليل انحدار مقياس كابلان ماير زيادة تجريدية لخطر الولادة المبكرة مع زيادة في مؤشر كتلة الجسم عند بدء الدراسة. وكانت نسبة الخطر ٤٠% بالنسبة للنساء التي لديهن مؤشر كتلة جسم يبلغ ٣٥ كجم/م٢، و٨٠% للنساء التي لديها مؤشر كتلة جسم أكبر من ٣٥كجم/م٢. وكان أيضًا خطر الولادة المتأخرة ١٠٠% في النساء ذوات مؤشر كتلة جسم أكبر من ٣٥كجم/م٢ لكن أصغر من ٣٦ كجم/م٢ ويرتفع إلى ١٤٠% بعد ٣٦ كجم/م٢.

الخلاصة:

يؤثر مؤشر كتلة الجسم بشدةعند تشخيص الحمل على وقت الولادة علي موعد الولادة. وترتبط متطرفات مؤشر كتلة الجسم بزيادة انتشار الولادة المبكرة، بينما ترتبط السمنة بالولادة المتأخرة. ويرتبط مؤشر كتلة الجسم الأعلى من ٣٠ كجم/م٢ بالخطر المتفاقم تدريجيا فيما يخص الولادة خارج الموعد المحدد مسبقا للولادة، ويتضاعف هذا الخطر بشكل مستمر مع كل زيادة في مؤشر كتلة الجسم بنسبة اكجم/م٢.

٢٣. المجلة المصرية للعلوم الطبية ٣٩ (٢) ديسمبر ٢٠١٨: ٢٧ ٩- ٩٤.