ORIGINAL ARTICLE

An Investigation of the Relationship between Pre-PregnancyBody Mass Index and Pregnancy Weight Gain with Successful Labor Induction by Oxytocin in Normal and Overweight Women

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ABSTRACT

Background : Successful pregnancy and childbirth are related to several factors including body mass index (BMI).
Aim: To determine the relationship between pre-pregnancy BMI and weight gain during pregnancy with successful labor induction in normal and overweight mothers.
Methods: This longitudinal comparative study was performed on 200 pregnant women referred to two hospitals affiliated to Ahvaz University of Medical Sciences. All of them were with health records and had a normal (n=100) or above normal (n=100) BMI before or at the beginning of pregnancy. Inclusion criteria were term pregnancy, singleton fetus, a Bishop score less than 4, absence of labor contractions, and induction order by physician diagnosis. After calculating the weight gain in pregnancy, the induction was started at 2 mU/min, and the mothers in both groups were compared in terms of successful labor induction (vaginal delivery) and some related factors, using descriptive statistics and chi-square and independent t-test.
Results: The mean age of the mothers was 26.86 ± 7 years and 44% of them were primiparous. The results of this study showed that pre-pregnancy BMI has no significant relationship with successful labor induction (p = 0.621) in both groups of mothers with normal and overweight mothers, and only third-trimester weight gain was significantly associated with successful labor Induction in the two groups (P <.001). Also, there was no significant difference between the two groups of mothers in terms of oxytocin dose, duration of induction and duration of the first and second stages of labor (P> .05).
Conclusion: Although successful labor induction can be affected by a variety of factors, it seems that health care providers should pay special attention to maternal weight gain in the third trimester of pregnancy, and include required education and counseling in the care program from the beginning of pregnancy.
Keywords: Body mass index, pregnancy weight gain, successful labor induction

INTRODUCTION

Labor Induction is the most common method in labor and delivery, which is applied in approximately 20 to 30% of all deliveries[1]. Induction of labor refers to the onset of contractions in the pregnant woman to help her perform vaginal delivery within 24 to 48 hours, which can be done either by pharmacological or non-pharmacological (mechanical) methods. In pharmacological methods, prostaglandin, oxytocin, or a combination of the two are used, the effect of which depends on the condition of the cervix before induction[2]. Cervical status before induction is one of the most important predictors of successful induction, which is described by Bishop scoring method. The maximum bishop score is 9 or 10, indicating imminent delivery within 2 hours of the rupture of membrane[3] and the cervix is considered undesirable when the score is ≤ 4[4].

Induction is indicated if the risk of prolonged pregnancy for the mother or fetus is greater than the risks associated with induction and delivery.Although labor induction is a safe method for termination of pregnancy, it can also have some risks such as postpartum hemorrhage, cesarean delivery, over-stimulation and rupture of the uterus[5].Generally, successful labor induction depends on several factors including cervical readiness, birth order, gestational age, neonatal weight, and duration of induction (especially in undesirable cervical status)[6].In addition, body mass index (BMI) and weight gain in pregnancy have also been mentioned as two contributing factors to the success of labor induction[7,8].

Obesity is growing at fertility ages. In the United States, 61.9% of women are overweight or obese. In Pakistan, 38.4% and in India 19.2% of women at childbearing ages are overweight[10].A study in Iran estimated the prevalence of overweight before pregnancy to be 31.3%[11].Also, it is stated that approximately 46% of pregnant women have weight changes beyond recommended levels[5]. Obesity and inappropriate weight gain during pregnancy is associated with an increased risk of preeclampsia, hypertension, and gestational diabetes and such women are more likely to undergo labor induction. On the other hand, pregnancy duration is longer in obese women, and in cases where BMI is equal to or above 35, pregnancy duration is likely to take longer than 41 weeks[9,12,13].

Although the exact cause is unknown, it may be due to altered inflammatory and metabolic responses and vascular disorders associated with maternal obesity.In fact, obesity is associated with metabolic imbalances such as hyperinsulinemia, dyslipidemia, endothelial dysfunction, hypertension, and irregular inflammation(14).Several studies have shown that the uterus of obese women is less

responsive to oxytocin, which can lead to prolonged labor and delayed delivery, eventually ending pregnancy with a cesarean. Also, moderate or higher levels of oxytocin and longer induction time may also be required[13].

A meta-analysis study estimated the risk of cesarean section to be twice in overweight women and threefold in severely obese women. Obesity is characterized by a BMI above 35, and the risk of cesarean section is increased by 13% per every 5 kg of weight gain[15].

Lassiter et al (2016) showed that increasing BMI in obese individuals undergoing labor induction with misoprostol was associated with longer labor duration and a higher dose of misoprostol and also they had higher cases of cesarean delivery (16).In a retrospective cohort study, Gawade et al (2009) showed that increased weight gain in pregnancy was associated with increased cesarean section after the failure of labor induction[17].

Since most studies have focused on obese women and there is sufficient evidence about the relationship between obesity and successful labor induction, this study aimed to investigate the association between pre- or early pregnancy BMI and weight gain during pregnancy with successful labor induction in normal and overweight mothers.

MATERIALS AND METHODS

This study is a comparative longitudinal study approved by the Ethics Committee of Ahvaz JundiShapurUniversity of Medical Sciences(No:IR.AJUMS.REC.1398.109), which was conducted for 3 months from the beginning of June to the end of August 2019 in a hospital affiliated to the university in Ahvaz, Iran. During this period, a total of 1,630 pregnant women were referred to the hospital, of which 289 cases were referred for labor induction, of which 200 women were eligible for the study.

The sample size in this study was determined as 184 using the formula of difference between ratios. Considering 10% attrition, 100 women with normal pre- or early pregnancy BMI and 100 overweight women were included in this study.

Inclusion criteria in the present study included singleton, cephalic presentation, age between 18 and 45 years, term pregnancy (37 to 42 weeks of gestation) based on the first day of last menstrual period or first-trimester ultrasound, normal or above-normal BMI before or at the beginning of pregnancy, having physician approval for labor indication, without spontaneous contraction, having information on the BMI at first trimester, the weight gain during pregnancy, and a Bishop score of 4 or less. Exclusion criteria in this study included having a history of cesarean section or any uterine scar, performing cervical preparation, experiencing 4 deliveries or more, presence of fetal malformations, placenta previa, inability to determine gestational age, inability to determine BMI before or at the beginning of pregnancy, rupture of membrane, receiving epidural anesthesia, and not to perform classical induction. Weight gain during pregnancy was calculated by measuring the weight at admission to the maternity ward and subtracting weight before pregnancy or at early pregnancy.Afterobserving the induction instructions by physician and routine care, classic induction was performed by researcher in the morning shift and continued until the end of induction.Accordingly, 10 units of oxytocin were poured into 1000 ml of serum, and induction was started at a rate of 2MIU/min and increased to 4, 8, 12, 16, 20, 25 and 30MIU/min every 15 minutes.The researcher determined the pre-induction Bishop score by examining five cervical characteristics: dilatation, effacement, position, consistency of cervix and fetal station, based on the Bishop table scoring system. In this study, Bishop score values were examined and recorded every three hours and in all cases, amniotomy combined with oxytocin induction was performed if there were appropriate conditions (based on hospital routine).BMI of women was categorized based on the recommendations of the American Medical Association into underweight (BMI <19.8), normal (BMI = 26- 19.8), overweight (BMI = 29-26) and obese (BMI> 29).The weight gain recommended for pregnant women in each of the above categories is (18.5 -12.5), (16- 11.5), (11.5-7), and (5-9) kg, respectively. Each person may gain inadequater, adequate, or excessive weight gain specified for their BMI. This study was performed in women with normal (19.8-26) and above normal BMI (26-30), and the information on oxytocin intake, duration of induction, length of labor stages and type of delivery were recorded. In this study, data were analyzed using descriptive statistics, chi-square and independent t-test.

RESULTS

The mean age of the women in this study was 26.8 ± 7.02 years, and the mean age of their spouses was 31.28 ± 6.64 years. The mean BMI of the participant was 25 ± 13.3, and the majority of them had a high school diploma and fair family income.44% of women were primiparous, and the most common cause of induction was prolonged pregnancy (57.5%), abnormal NST (16.5%), and pregnancy hypertension (12.5%).

Of 200 participants included in this study, 182 had successful labor induction and 18 undergone cesarean section.40.5% of women gained a lower pregnancy weight than recommended, and 52.5% had appropriate weight gain. The number of primiparous women in two groups of women with normal BMI and with above-normal BMI was 62 and 26, respectively. Of 62 primiparous women in normal BMI group, 59 had successful labor induction, and of 38 multiparous women in this group, 31 had successful labor induction. This difference was significant (P = 0.022). Also, of 26 primiparous women in the above-normal BMI group, 21 had successful labor induction, and of 74 multiparous women in this group, 3 undergone cesarean section. This difference was also significant (P = 0.022). In both groups, the major cause of labor induction was post-term pregnancy followed by pregnancy hypertension and abnormal NST, however, the cesarean section in both groups was indicated due to the absence of labor progress. In this study, the highest induction time was 15 hours.

Table 1: Relationship between pre-pregnancy body mass index (BMI) and successful labor induction

Variable	Successful labor induction		Unsuccessful labor induction (cesarean)		P-Value
	Number	Percent	Number	Percent	
Normal BMI	90	90	10	10	0.621
Above normal BMI	92	92	8	8	

Table 2: Relationship between pregnancy weight gain and successful labor induction

Variable		Successful labor induction		Unsuccessful labor induction (C-section)		P-Value
		Mean	St. deviation	Mean	Standard deviation	
Weight gain in pregnancy	First trimester weight gain	1.23	0.507	1.47	0.812	0.237
	Second trimester weight gain	5	1.83	6.13	4.12	0.264
	Third trimester weight gain	6.19	1.77	7	1.23	0.018
	Overall weight gain	12.37	2.78	14.61	4.46	0.055

Table 3: Relationship between weight status in two groups with normal and above normal BMI and successful labor induction

Variable		Successful labor induction		Unsuccessful labor induction (cesarean)		P-Value
		Number	Percent	Number	Percent	
Weight gain in normal BMI group	Less than recommended values	46	51.1	0	0	0.004
	Appropriate	33	36.7	6	60	
	More than recommended values	11	12.2	4	40	
Weight gain in overweight group	Appropriate	22	23.9	0	0	0.117
	More than recommended values	70	76.1	8	100	

Table 4: Comparison of quantitative variables in two groups of normal and overweight women

Variable		Normal BMI			Overweight			P-Value
		Mean	Standard deviation	Confidence interval	Mean	Standard deviation	Confidence interval	
Mother's age		24.28	6.29	25.23-52.03	29.65	6.60	28.3-30.9	<0.001
Bishop score (hours)	Upon arrival	3.35	0.65	3.3-48/21	3.42	0.60	3.3-54.29	0.435
	3	3.77	1.46	4.3-60.47	4.58	1.26	4.4-94.61	<0.001
	6	5.08	2.95	5.4-66.49	6.28	3.33	6.5-94.61	0.008
	9	5.88	3.45	6.5-56.19	4	3.97	4.3-78.21	<0.001
	12	2.35	3.75	3.1-90.60	1.23	2.33	1.0-69.765	0.012
	15	0.99	2.38	1.0-46.517	1.62	3.26	0.26-2.972	0.12
Oxytocin (units)		11.57	7.14	10.15	9.82	6.50	11.52-11.8	0.072
Induction time (min)		587.15	300.99	8.4-646.527	565.70	302.50	72.67-625.505	0.616
Weight gain in pregnancy (kg)	First trimester	1.2360	0.6781	1.10-1.37	1.274	0.36587	1.20-1.34	0.622
	Second trimester	5.3780	2.604	4.86-5.89	4.8400	1.53722	4.53-5.14	0.077
	Third trimester	5.7110	1.542	5.40-6.01	6.8200	0.76315	6.47-7.16	<0.001
	Overall	12.28	3.68	11.5-13.01	12.85	2.17	12.42-13.29	0.181
Duration of labor stages (min)	First stage	304.2	149.7	9.49-333.274	331.24	180.23	0.4-367.295	0.250
	Second stage	43.1	42.75	51.34-58.61	35.06	25.38	30.09-40	0.108

Table 5: Comparison of quantitative variables in two groups of normal and above normal BMI and successful labor induction

Variable		Normal BMI			Overweight			P-Value
		Successful labor induction (normal delivery)			Unsuccessful labor induction (cesarean)			
		Mean	Standard deviation	Confidence interval	Mean	Standard deviation	Confidence interval	
Mother's age		26.92	7.26	9.8-27.25	27.33	2.89	7.8-28.25	0.644
Bishop score	3	4.23	1.40	4.4-44.03	3.55	1.54	4.2-32.78	0.065
	6	8.83	3.29	6.5-31.35	4.11	1.13	4.3-67.54	0.036
	9	4.92	3.91	5.4-5.35	5.05	2.99	6.3-54.56	0.989
	12	1.58	3.14	2.1-40.12	3.88	2.74	5.2-25.52	0.007
Weight gain in pregnancy	Third trimester	6.19	1.771	93	7.00	1.326	7.6-61.38	0.033

DISCUSSION

The results of this study showed that BMI before or at the beginning of pregnancy had no relationship with successful labor induction in the two groups of mothers. Although in countries with a high cesarean section including Iran, pregnancy termination or induction can reduce the rate of cesarean sections, performing induction, especially in women with the undesirable cervix, can alter the normal physiology of labor and increase the rate of cesarean section[18,19]. Although obesity has always been considered as a risk factor for cesarean section[13,15], the results of this

study, unlike most previous research, found similar results with the retrospective study by Hirshberg et al (2014) and showed that above-normal BMI before or at the beginning of pregnancy is not associated with failure of induction and cesarean section.

The results of this study showed that approximately 80% of overweight mothers experienced more weight gain than recommended. Also, there was a significant difference in third-trimester weight gain between the two groups of BMI (P <0.001) as well as between the two groups of mothers with successful and unsuccessful labor induction (cesarean) (P = 0.018). Thus, weight gain in the third trimester has been a more effective factor in successful labor induction of women with normal and above normal BMI at the beginning of pregnancy compared to initial BMI and weight gain in the first and second trimesters. Gawad et al (2011) also found that the rate of unsuccessful labor induction (cesarean section) increased by 13% for every 5 kg of weight gain in pregnancy[17]. Similar to our study, they did not consider diabetes and preeclampsia as exclusion criteria, which could affect maternal weight gain.

In this study, of 10 cases of cesarean sections in normal-weight mothers, 7 were multiparas, and of 8 cases of cesarean section in overweight mothers, 3 were multiparas. Thus, unsuccessful labor induction was more common in multiparous' mothers with normal BMI, but in women with above-normal BMI, unsuccessful labor induction was more common in primiparas. Generally, many studies have reported that induction is independently associated with an increased risk of cesarean delivery in both primiparous and multiparous women[17,21]. Also, a study by Yousef et al (2016) showed that the risk of unsuccessful induction is more common in obese primiparous women than in women with normal BMI (22).O'Dwyer et al (2013)[23] also showed that compared to women with normal primary BMI, the risk of labor induction and unsuccessful induction (cesarean section) is more in primiparous obese women than in multiparous obese women. Fyfe et al (2011)[24] showed that initial weight higher than normal and obesity were risk factors for unsuccessful induction and cesarean section in the first stage of labor, but in the second stage of labor, there was no significant difference between the primiparous and multiparous mothers. According to the results of this study, the rate of unsuccessful induction (cesarean section) was significantly associated with parity, but due to the low sample size used in this study, further research is required to confirm this finding.

In this study, no significant difference was found in oxytocin dose and induction duration between the two groups of mothers with normal and above normal BMI (p <.05).In this regard, the results of a study have shown that induction success is mostly related to Bishop's score at the time of induction, not to maternal BMI[25]. However, Vaharatian et al (2004)[26] showed that labor progression in overweight and obese women is slower than those with normal BMI. In their study, Rellof et al (2015)[27]compared women with a BMI above 30 (obese) and those with normal BMI and reported that although there was no difference in labor duration, the need for oxytocin increased with increasing maternal BMI. In this regard, the results of a study indicated that uterine contractility was not significantly different between normal BMI and overweight women, and a significant difference was only observed in obese mothers and those with a BMI above 25[28] which supports the results of the present study.

In this study, there was no significant difference in the duration of the first, second and third stages of delivery between the two groups of mothers with normal and above normal BMI. In this regard, a study has shown that the labor duration at the first stage from 4 to 10cm dilatation was higher in obese women than in women with normal BMI, but there was no difference in the second stage of labor, intrauterine pressure during pregnancy, and maternal effort to childbirth among all BMI groups[26]

Low sample size, the inclusion of mothers with gestational hypertension, and magnesium sulfate intake, which may have influenced the development of labor, can be considered as the main weaknesses of this study. On the other hand, the strengths of the study were its longitudinal and controlled conditions by calculating gestational age, initial BMI, evident-based pregnancy weight gain, vaginal examinations, induction control, oxytocin intake, and measuring labor duration by one person (researcher). However, further research is needed to understand how BMI can affect induction failure.

CONCLUSION

Although successful labor induction is influenced by several factors, it seems that effective maternal care and education, and the emphasis on proper weight gain, especially in the third trimester of pregnancy, are two leading factors in successful induction and cesarean section in addition to beneficial effects on other aspects of reproductive health.

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