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RESEARCH ARTICLE

Maternal Prenatal Anthropometry, High Education and Cesarean Delivery as Risk Factors for Low Gestational Age in Iran

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Abstract:

Background:

Preterm birth is an important contributor to the global burden of disease. Evidence indicating that maternal health, nutritional and socioeconomic status may contribute to preterm birth.

Objective:

This cross-sectional study was conducted to describe the contribution of prenatal maternal factors on low gestational age, and to assess newborns anthropometric measurements regarding gestational age.

Methods:

Data of mothers delivering a singleton live infant (n= 759) and their newborns (n= 755) during the two years up to August 2014 were collected. Data were collected from the data set of eight public health centers which were chosen from different administrative regions of Tabriz city and were analyzed. Differences between the groups were assessed by Student's t-test or one- way analysis of variance (ANOVA). Multiple linear regression was used to estimate the association between gestational age and variables studied.

Results:

Incidence of preterm birth was 2.1%. Percentage of infants with low birth weight and Head Circumference (HC) under 34 cm was significantly higher in the preterm group. Mean gestational age was lower in mothers with cesarean delivery, high education, high economic status, high BMI, pre-pregnancy weight ≥ 65 kg and medical problem. Gestational age was inversely associated with maternal pre-pregnancy weight ≥ 65 kg (B= -0.20, p= 0.02), high BMI (B= -0.33, p= 0.01), high education (B= -0.47, p= 0.002) and cesarean delivery (B= -0.74, p< 0.001).

Conclusion:

The results indicate that maternal anthropometric characteristics, education and type of delivery are associated with gestational age. Exploring potentially modifiable risk factors for unfavorable gestational age and integrating them into intervention efforts may ameliorate adverse birth outcomes.

Keywords: Gestational age, Education, Economic status, Gestational weight gain, Age, Anthropometry, Preterm birth.

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1. INTRODUCTION

Preterm birth is the birth of a baby born alive before 37 weeks of pregnancy completed[1]. Preterm birth is a universal problem and according to estimates, 15 million neonates are born preterm every year and this amount is growing [1]. The complications of preterm birth are major factors accounting for death in children under 5 years, according to the World Health Organization (WHO) report [1], and 28% of all early neonatal deaths [2]. Preterm birth has lifetime impact on neuro developmental functioning of many survivors, including impaired learning and visual and hearing disorders [3]. In 2010, rate of preterm birth was estimated 5% of live births for some developed regions, 18% for some developing countries such as Malawi and 10.1% for western Asia including Iran [4].

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Commonly, the exact cause of premature birth is not clear. Various factors may influence the risk of preterm birth. Major reasons of premature birth include multiple pregnancies [5], amniotic fluid and lower genital tract infections [6], and maternal chronic diseases such as diabetes and high blood pressure [7], maternal pre-pregnancy nutritional status (poor nutrition, being underweight or overweight) [8], stressful life events [9], inadequate interval between pregnancies, smoking, and drinking alcohol [10]. In recent decades, cesarean section delivery before full term has been recognized as another reason for enhancement of preterm birth rates [11].

Besides, there are many unexplained and unknown sociocultural factors involved in preterm birth which needs to be elucidated. Identifying and comprehensively understanding the causes and mechanisms involved in the development of preterm birth will advance implementation of appropriate public health programs and/or policies to decrease the occurrence of preterm birth and prevent its considerable adverse outcomes. According to the previous investigations, maternal health, nutritional and socioeconomic status may contribute to preterm birth [7, 8, 12]. Therefore, this study was aimed (1) to describe contribution of prenatal maternal anthropometric, education, economic status and age on undesirable gestational age and (2) to assess neonates' anthropometric measurements regarding gestational age in Iranian population.

2. MATERIALS AND METHODS

2.1. Field of Study and Participants

A cross-sectional, mother-infant pairs study was carried out in Tabriz, capital of East Azerbaijan province located in Northwest of Iran. Data included in this study were collected by random sampling from data set of eight primary health care centers which were selected based on high coverage of population from existence administrative regions of the city (n= 8, one center from each region), during the two years up to August 2014. As this study did not contain any participation of human subjects, no written human subject consent was necessary. Access to the health records within the centers was facilitated by written permission of provincial health bureau affiliated to Tabriz University of Medical Sciences (reference numbers: 548-550).

Data of 759 urban mothers who gave birth to live infant and their newborns were obtained and included in the analysis. In order to avoid the confusion of multiple deliveries, twin or triplet deliveries were excluded. Information of all maternal and neonatal factors which were speculated to affect gestational age was collected.

Neonates with birth weight less than 2500 g were defined as Low Birth Weight (LBW) [13] and babies born alive fall into one of the four groups of preterm (≤ 36 weeks), early term (37- 38 weeks), full term (39-40 weeks) and late term (≥ 41 weeks), with respect to gestational age. Regarding age at the time of delivery, mothers were classified into three groups as follows: age <18, 18- 34.9 and ≥ 35 years given the fact that pregnan-cies under 18 years and over 35 years are accompanied with maternal and neonatal complications and considered as high-risk pregnancy [14, 15]. Optimal cut-off values of the maternal height, pre-pregnancy weight and infant birth Head Circumfe-rence (HC) were determined using Receiver Operating Charac-teristic curves (ROC) and also from previous studies [16, 17].

Three levels of education were defined for mothers as follows: low education (Illiterate or primary education), moderate education (junior or senior high school level) and high education (college or university). Considering subjects' occupation and education level, three levels of low, middle and high were defined for economic status [18]. Medical problem was defined as having any disease during the gestational period.

2.2. Statistics

All analyses were performed using SPSS version 16.0 (IBM SPSS statistics, IL, Chicago, USA). The Kolmogorov-Smirnov normality test was used to identify the distribution of data. Mean ± Standard Deviation (SD) was computed for data with normal distribution including infants' birth weight, height, HC, and gestational age. Data with non-normal distribution including gestational weight gain were presented as median (percentile 25, 75) and proportional data as frequency (%). Differences between the groups were assessed by Student's t-test for continuous variables with two categories. For variables with ≥ 3 categories, differences between groups were assessed by one- way analysis of variance (ANOVA). Multiple linear regression (general linear model) was used to estimate the association between gestational age and maternal factors. Gestational age was used as dependent variable. P values less than 0.05 were considered statistically significant. Data of 4 neonates were not available, therefore we excluded them and data of 755 neonates were used in the analysis.

3. RESULTS

3.1. Characteristics of Newborns and their Mothers

Characteristics of the neonates and their mothers are shown in Table **1**. Among newborns, only 39.81% were born full term and 42.64% of them were first born. Of mothers, 5.1% were found with medical problems, such as hypertension, diabetes, depression, cardiovascular problems during pregnancy. All mothers were not smoking or drinking.

3.2. Anthropometric Characteristics of Neonates Regarding Gestational Age

As shown in Table **2**, birth weight, height and HC of infants was significantly lower in preterm neonates (all, $p< 0.001$) compared to other gestational age groups. Percent of infants with LBW and HC< 34 was significantly higher in preterm group ($p= 0.007$ and $p= 0.02$, respectively).

3.3. Factors Contributing to Gestational Age

As shown in Table **3**, the gestational age was greater in mothers with vaginal delivery than mothers with cesarean delivery ($p< 0.001$). Gestational age was low in mothers with high education level in comparison to low and moderately educated mothers ($p< 0.001$) (Table **3**). Gestational age was low in mothers with high economic status than low economic status ($p= 0.04$). Mothers with pre-pregnancy weight ≥ 65 kg had low gestational age than mothers with pre-pregnancy weight < 65 kg ($p= 0.001$) (Table **3**). Gestational age was low in obese mothers (BMI≥ 30) compared with normal weight mothers ($p= 0.03$). Gestational age was lower in mothers with medical problem during pregnancy compared with mothers without medical problem (p= 0.001). Gestational age did not differ among different mothers' age or height groups (data not shown).

Table 1. Characteristics of the newborn infants and their mothers.

Newborn weight[a](kg)	3.20 (2.95, 3.50)
Newborn length[a](cm)	50.00 (48.00, 51.00)
Newborn head circumference[a](cm)	35.00 (34.00, 35.50)
Gestational weight gain[a] (kg)	10.52 (8.01, 13.50)
Age[b] (year, n= 759)	
< 18	20 (2.60)
18- 34.9	640 (84.40)
≥ 35	99 (13.00)
Education[b] (n= 759)	
low	185 (24.40)
moderate	486 (64.00)
high	88 (11.60)
Economic status[b] (n= 754)	
low	271 (35.90)
moderate	374 (49.60)
high	109 (14.50)
Gestational age[b] (n= 759)	
preterm	16 (2.11)
early term	424 (55.90)
full term	302 (39.81)
late term	17 (2.20)
Birth order[b] (n= 758)	
first birth	326 (43.00)
second birth	316 (41.70)
≥ third birth	116 (15.30)
Medical problem (n= 585)	
Yes	30 (5.11)
No	555 (94.90)

[a] median (percentile 25, 75), [b] expressed as frequency (percent).

Table 2. Anthropometric characteristics of neonates (n= 755) regarding gestational age.

-	Preterm (n=16)	Early Term (n=422)	Full Term (n=301)	Late Term (n=16)	p-value
Birth weight (kg)[a]	2.72 ± 0.56	3.16 ± 0.47	3.28 ± 0.43	3.38 ± 0.43	<0.001
Height (cm)[a]	47.47 ± 3.69	49.31 ± 2.41	49.82 ± 2.46	50.37 ± 1.75	<0.001
HC (cm)[a]	32.70 ± 2.75	34.56 ± 1.51	34.67 ± 1.53	35.00 ± 1.28	<0.001
LBW[b]	3 (18.8)	26 (6.2)	10 (3.3)	0 (0)	0.007
HC < 34[b]	9 (56.3)	87 (20.6)	55 (18.3)	2 (12.5)	0.02

[a]presented as mean ± SD and analyzed by One-Way ANOVA test, [b]presented as frequency (percent) and analyzed by chi-square test.
LBW= low birth weight; HC= head circumference.

3.4. Association of Gestational Age with Maternal Factors

As shown in Table **4**, an inverse association was observed between gestational age with maternal pre-pregnancy weight ≥ 65 kg (B= -0.20, p= 0.02), overweight (B= -0.25, p= 0.02) and obesity (B= -0.33, p= 0.01), high education (B= -0.47, p= 0.002) and cesarean delivery (B= -0.74, p< 0.001). Gestational age did not correlate with maternal height, age and economic status.

Table 3. Factors contributing to gestational age (n= 759).

-	Mean Gestational Age (weeks)	p[a]
Type of delivery		<0.001
Cesarean (n= 405)	37.85 ± 1.15	
Vaginal (n= 318)	38.64 ± 1.09	
Education		<0.001
Low (n= 185)	38.36 ± 1.31	
Moderate (n= 486)	38.24 ± 1.16	
High (n= 88)	37.68 ± 1.56	
Economic status		0.04
Low (n= 271)	38.33 ± 1.45	
Moderate (n= 374)	38.17 ± 1.16	
High (n= 109)	37.99 ± 1.09	
Pre-pregnancy weight (kg)		0.001
<65 (n= 418)	38.34 ± 1.22	
≥65 (n= 327)	38.03 ± 1.30	
Mother BMI		0.03
< 18.5 (n= 27)	38.26 ± 0.99	
18.5-24.99 (n= 309)	38.31 ± 1.10	
25-29.99 (n= 248)	38.06 ± 1.22	
≥ 30 (n= 118)	37.98 ± 1.56	
Medical problem		0.001
Yes (n= 30)	37.60 ± 0.77	
No (n= 555)	38.12 ± 1.02	

[a] Differences between groups were assessed by ANOVA for variables with three or more categories and an independent t-student test for variables with two categories.

Table 4. Association of maternal factors with gestational age.

-	B (95% CI)	p
Mothers age (year)		
<18	0.18 (-0.36, 0.72)	0.51
18-34.9	-	
≥ 35	-0.14 (-0.39, 0.12)	0.30
Mother height (cm)		
<160	-0.01 (-0.18, 0.17)	0.92
160-169.9	-	
≥ 170	0.06 (-0.28, 0.40)	0.73
Pre-pregnancy weight (kg)		
<65	-	
≥65	-0.20 (-0.38, -0.03)	0.02
Mother BMI (kg/m^2)		
< 18.5	-0.05 (-0.53, 0.43)	0.83
18.5-24.99	-	0.02
25-29.99	-0.25 (-0.45, -0.04)	
≥ 30	-0.33 (-0.59, -0.07)	0.01
Education		
low	0.02 (-0.20, 0.24)	0.85
moderate	-	
high	-0.47 (-0.78, -0.17)	0.002
Economic status		
low	0.16 (-0.03, 0.36)	0.10
moderate	-	
high	-0.18 (-0.45, 0.09)	0.20
Mode of delivery		
Cesarean	-0.74 (-0.91, -0.56)	<0.001
Vaginal	-	

The univariate general linear model was used for the analysis. Gestational age was used as a dependent variable.

4. DISCUSSION

The results of the present study indicate that maternal anthropometric status, type of delivery and high education are associated with gestational age. Gestational age was inversely associated with maternal pre-pregnancy weight ≥ 65 kg and BMI. The findings are in agreement with earlier studies linking pre-pregnancy obesity with an elevated risk of preterm birth [8, 19 - 23]. Parker *et al.* reported that pre-pregnancy obesity is associated with higher risk of preterm birth [8]. McDonald *et al.* in a systematic review of 84 studies showed that maternal pre-pregnancy obesity is related to a 1.24-fold higher risk of preterm birth [19]. Smith *et al.* in a cohort study of 187 290 women demonstrated that the risk of an elective preterm delivery increased with enhancement of BMI [20]. Cnattingius *et al.* in a cohort study of 1,599,551 deliveries suggested that maternal overweight and obesity are associated with increased risks of preterm delivery [23]. In the most previous investigations, the association between maternal obesity and preterm birth has been attributed in part to common co-morbidities of obesity (hypertensive disorders and gestational diabetes) during pregnancy that are also linked with medically-induced preterm birth. In the present study, total number of women with medical problem was 30 (5.1%) people, and none of them had preterm delivery. Therefore, contribution of preterm delivery to medical conditions of obese women will be of debate due to a smaller number of women with medical problem.

Our study showed that cesarean delivery has the strongest association with premature births. In agreement with the finding, cesarean delivery has previously been implicated as a potential driver involved in increased preterm birth rate [11, 24]. Chang *et al.* in a study on 39 very high human development index countries found cesarean delivery as an important driver of preterm birth, particularly in the United States [11]. VanderWeele *et al.* reported that along with the rising trend of preterm births from 1989-2004, the rate of medically induced deliveries increased 94% [24]. Bond *et al.* in a meta-analysis study including 12 trials involving 3617 women found that premature birth was associated with an increased rate of cesarean section [25]. Barros *et al.* in a study 2,903,716 hospital-delivered singletons also showed that low gestational age was associated with high cesarean section rate [26].

Of interest, in the current work, gestational age was adversely associated with maternal high education. In mothers with high education, the number of pregnancy weeks was lower. The result is in-consistent with observed evidence in a recent Brazilian study. Analysis of a national database of over 2.9 million mothers and singleton newborns in Brazil showed that low gestational age was considerably more common among high educated women (39.8%) compared with those who had less schooling (24.9%) [26]. However, several other countries obtained opposite findings. Morgen *et al.* in a study on 75890 singleton pregnancies have reported that mothers with less than 10 years of education had an increased risk of preterm birth compared with those of more than 12 years of education [27]. Jansen *et al.* in a cohort study have found that pregnant women with low education had a nearly twofold higher risk of preterm birth than women with high education [28]. Low education was also determined as a risk factor for preterm birth in a study done by Heaman *et al.* [29].

Although the exact reasons for high premature birth rate among women with high education are not clear, it is proposed that expansion of obstetric interventions, particularly pre-labour cesarean section might be contributed to the high rate of premature birth in this group of population. Barros *et al.* showed that the prevalence of cesarean section was nearly 80% in high educated women, and 62% of these procedures were carried out before labour initiated [26]. Conducting a large part of cesarean section procedures before the onset of labour, indicates that iatrogenic premature births might arise. Besides, the most scheduled cesarean section operations are performed on highly educated women who deliver in private health settings. Leal *et al.* showed that elective cesarean section had obviously higher rates in private (61%) than in public hospitals (32%) [30]. Inaccurate estimation of gestational age in the private health services might influence the prevalence of premature births. In the recent decades, elective cesarean section has extremely propagated among Iranian women, more specially among women with high education and economic status [31, 32]. High cesarean delivery rate among highly educated mothers [75% (63 of 84 mothers), data not shown] and dropped number of pregnancy weeks in mothers with cesarean delivery in present study further support the idea.

In the present study, the chance of having preterm or early term labor was independent of mothers' economic condition, in high educated mothers. Generally, high education results in high income which may improve health status both at individual, household or community level. However, the association between education and health outcomes *via* income varies by country. According to previous researches, the relationship between education and health outcomes such as obesity, diabetes, hypertension, *etc.* is deeply connected to developmental level of the country such that negative associations are more common in high income countries and direct associations are more common in low income countries [33 - 35]. A study in China indicated that, regardless of educational level, the prevalence of diabetes was higher in the high-income group [36]. Also, Monteiro *et al.* found that high education did not possess any impact on the risk of obesity in the less developed region of the Brazil, but slightly reduced in the more developed regions [35]. Min *et al.* could not find any strong compensating effect between education and income in patients with diabetes and hypertension [37]. Zimmerman *et al.* [38] indicated that educational outcomes themselves are conditioned on the many social and environmental contexts and interact with other sociocultural factors and in particular person's individual endowments and experiences. Thus, understanding factors involved in causal pathways between maternal education and negative health outcomes, in particular preterm birth, will be of help to identify targets for intervention.

4.1. Implication of the Study

The clarification of risk factors for preterm birth is of great public health importance given its extreme impact on infant growth and health. Our findings suggest another area for public health policy makers for the prevention of preterm birth. Surveillance for preterm birth should be considered for women with high weight and high education. High weight women need to receive pre-pregnancy nutrition education interventions to optimize their anthropometric condition. As maternal high educational level may be the strongest predictor of preterm birth in our target population, against many other countries, further investigation on women with high education can be conducted to confirm the risks they are facing. Therefore, more population-based studies are required to identify factors along the causal pathway.

4.2. Limitations of the Study

The study was limited by lack of optimal cut-off values for maternal height, pre-pregnancy weight and infants' birth HC at the national level for Iranian population. Sampling method and source of data may act as impossible biases which may influence the data.

CONCLUSION

The results indicate that maternal anthropometric characteristics, education and type of delivery are associated with gestational age. Exploring potentially modifiable risk factors for unfavorable gestational age and integrating them into intervention efforts may ameliorate adverse birth outcomes.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Written permission was obtained from provincial health bureau affiliated to Tabriz University of Medical Sciences (reference numbers: 548-550).

HUMAN AND ANIMAL RIGHTS

No animals/humans were used for studies that are the basis of this research.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The authors confirm that data supporting the findings of this research are available within the article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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