Comparison of maternal characteristics in low birth weight and normal birth weight infants

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مقارنة بين خصائص أمهات الأطفال الناقصي الوزن وبين خصائص أمهات الأطفال الأسوياء الوزن

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الخلاصة: يعتبر نقص الوزن عند الولادة من المحددات الرئيسية لمخاطر المراضة والوفيات في فترة الوليد وخلال فترة الطفولة. وقد أجرى الباحثون دراسة للحالات والشواهد غير المتوافقة في همدان، جمهورية إيران الإسلامية، للمقارنة بين خصائص أمهات الأطفال الناقصي الوزن وبين خصائص أمهات الأطفال الأسوياء الوزن. وقد جمع الباحثون المعطيات الاجتماعية والديمغرافية من الأمهات، بالإضافة إلى سوابق الحمل، والقياسات البشرية، ومستوى الزنك في بلاسما الحبل السري، وذلك من 134 أماً وَلَدْن أطفالاً ناقصي الوزن، و134 أماً وَلَدْن أطفالاً بوزن سوي وقت الولادة. ولاحظ الباحثون وجود اختلافات يُعْتَدُّ بها إحصائياً في خصائص الأمهات، ولاسيَّما عدد الأحمال، وعدد الولادات، ومنسب كتلة الجسم، وزيادة الوزن لدى الأمهات خلال الحمل، ومستوى الزنك في بلاسما الحبل السري؛ وذلك بين أمهات الأطفال الناقصي الوزن وأمهات الأطفال الأسوياء الوزن. ولم يلاحظ الباحثون اختلافات يُعْتَدُّ بها إحصائياً في سن الأم، والمستوى التعليمي لها، وعملها، ودخل الأسرة، ووجود إسقاط سابق، والمخاض السابق لأوانه، والفترات الفاصلة بين الأحمال، ونمط العيادة، ومكان الإقامة، بين المجموعتَيْن من الأمّهات.

ABSTRACT Low birth weight is a key determinant in the risk of morbidity and mortality in the neonatal period and during childhood. This unmatched case–control study in Hamadan, Islamic Republic of Iran, compared the characteristics of mothers of low- and normal-birth-weight infants. Maternal sociodemographic data, pregnancy history, anthropometric data and cord plasma zinc level were collected from 134 mothers of low-birth-weight infants and 134 mothers of normal infants at the time of delivery. Significant differences in maternal characteristics namely gravida, parity, body mass index, maternal weight gain during pregnancy and plasma cord blood zinc were found between low- and normal-birth-weight infants. There were no significant differences in maternal age, maternal education, maternal occupation, family income, previous abortion, previous preterm labour, birth interval, type of clinic and place of residence between the 2 groups.

Comparaison des caractéristiques des mères de nourrissons ayant un poids de naissance faible et un poids de naissance normal

RÉSUMÉ Un faible poids de naissance constitue un facteur déterminant du risque de morbi-mortalité pendant la période néonatale et l'enfance. La présente étude cas–témoins non appariés menée à Hamadan (République islamique d'Iran) a comparé les caractéristiques des mères de nourrissons ayant un poids de naissance faible ou normal. Les données sociodémographiques, anthropométriques et les antécédents gravidiques ont été recueillis et le taux de zinc plasmatique dans le cordon a été analysé à l'accouchement chez 134 mères ayant donné naissance à un nourrisson de faible poids et chez 134 mères ayant donné naissance à un nourrisson de poids normal. Des différences significatives dans les caractéristiques maternelles, à savoir la gestité et la parité, l'indice de masse corporelle, la prise de poids de la mère pendant la grossesse et le taux de zinc plasmatique dans le sang de cordon, ont été observées entre les deux groupes. En revanche, aucune différence importante n'a été retrouvée pour l'âge, le niveau d'études, la profession, le revenu familial, les antécédents d'avortement et de travail prématuré, l'espacement des naissances, le type d'établissement de soins choisi et le lieu de résidence des mères des deux groupes.

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Introduction

Low birth weight (LBW), defined as weight < 2500 g at the time of birth [1], predicts normal growth during infancy and childhood [2] and is a key determinant in the risk of morbidity and mortality in this period. The World Health Organization (WHO) reported that 11.0% of infants in the Eastern Mediterranean Region (EMR) have LBW and that LBW and prematurity was the cause of 43.0% of mortality in children < 5 years of age in the Region [3]. As the incidence of LBW is one of the best indicators for evaluating the success of maternal and child programmes [4,5] LBW has featured in the health targets of a number of international organizations. Reducing the incidence of LBW babies by at least one-third by 2010 was one of the goals of WHO [6] and a United Nations resolution in 2000 [7]. Since 38.0% of child mortality occurs during the first month of birth and is directly related to birth weight, LBW is also an important indicator for monitoring the achievement of Millennium Developmental Goal 4, to reduce child mortality by two-thirds by 2015 [6,8,9].

In the Islamic Republic of Iran 8.6% of infants are borne with LBW and this represents the most important cause of infant mortality in the past 2 decades [10]. It has been established that LBW infants are at greater risk for certain diseases such as cardiovascular and metabolic diseases in adulthood [11]. LBW may also lead to a vicious cycle beginning with a stunted child, followed by a thin adolescent and leading to thin mothers during pregnancy [12]; these mothers are at increased risk of maternal morbidity and mortality [13]. It is therefore important to study the characteristics of pregnant women so that interventions can be undertaken aimed at promoting mothers' health during the antenatal period and hence to achieve the goal of healthy normal birth weight (NBW) babies. This unmatched case–control study in Hamadan, Islamic Republic of Iran, part of a larger study, compared the maternal characteristics of 2 groups of infants (LBW and NBW) at the time of birth.

Methods

Study setting and sample

This study was carried out in the labour ward of Fatemieh hospital, a referral and teaching hospital for the Hamadan University of Medical Science in Hamadan, Islamic Republic of Iran. The hospital receives pregnant women who are referred from peripheral antenatal care and other smaller hospitals in the province after screening for risks of obstetric complications. It has 1 labour ward with a capacity of 20 beds and 1 neonatal intensive care unit ward. There are nearly 20 deliveries per day.

In this study infants with birth weight < 2500 g and their mothers were selected as cases and infants with birth weight between 2500–4000 g were selected as controls. Infants with any obvious congenital anomalies were excluded from this study. Mothers with any known risk factor for delivering LBW infants were excluded from this study. We therefore excluded: mothers who were suffering from hypertension, renal disease, respiratory disease, diabetes, lupus, anaemia or other significant medical complications such as heart disease, gastrointestinal disease, infectious diseases; mothers with multiple pregnancy, prolonged labour, fever during labour or malformations of the reproductive system which cause fetal growth retardation (e.g. unicorn uterus, bicorn uterus); mothers who were smokers or consumed alcohol or illicit drugs; and mothers who had or previous record of trauma or any abuse or severe stress such as death of family member.

A sample size of 134 per group was required to detect an odds ratio (OR) of 2 for an unmatched study, with a power of 0.8 and alpha level of 0.05.

Data collection

The study was conducted from 6 December 2009 to 18 October 2010. Recruitment was conducted by 6 trained midwives who assisted in obtaining informed consent, recruiting, filling the proforma and taking blood samples.

The gestational age of infants was determined by the first day of the last menstrual period, ultrasound in the first and third trimester of pregnancy and also using the new Ballard score. All premature infants and those with intrauterine growth restriction with birth weight < 2500 g were included in this study. The infant's weight was determined to the nearest 1 g by an electronic infant scale, calibrated weekly. Then 3 mL of cord blood was taken through the umbilical cord vein immediately after delivery and before placenta delivery to avoid clotting by using 5 mL disposable plastic zinc-free syringe with a stainless needle of the same batch. The blood was put into a zinc-free uncontaminated EDTAK3 polyethylene tube labelled with the serial number of the mother. The blood samples were centrifuged at 4500 rpm for 15 minutes. The maximum time from taking specimen to freezing was < 1 hour. The plasma was kept frozen in plastic microtubes at –20 °C until atomic absorption spectrophotometry was used to determine the concentration of zinc.

Zinc status was divided into 3 categories: severe zinc deficiency < 60 μg/dL, mild to moderate zinc deficiency between 60–70 μg/dL and normal zinc level between 71–150 μg/dL [14].

Ethical considerations

Ethical approval for the study was obtained from the ethics committee

of the Faculty of Medicine and Health Sciences, University Putra Malaysia as well as the ethics committee of the Medical Science University of Hamadan, Islamic Republic of Iran. Informed consent was obtained from the mothers before participating in this study. To avoid pricking the subjects, cord blood was used.

Analysis

The data were revised, coded and analysed using *SPSS*, version 16. Descriptive statistics were computed for all variables. Non-parametric tests were used since the distributions of some variables were not normal. Chi-squared or Fisher exact tests were used to test the differences between maternal characteristics among LBW and NBW for categorical variables, while Student *t*-test was used for continuous variables. $P < 0.05$ was considered statistically significant.

Results

Mothers' demographic characteristics

Data were collected from 268 newborns (134 cases, 134 controls). Table 1 shows a comparison between LBW and NBW infants in terms of maternal sociodemographic characteristics. The median age was 24 years (range 15–50 years) and 24 years (range 15–41 years) in cases and controls respectively. There were no significant differences in mother's age, education or occupation or family income between cases and controls.

Mothers' obstetric history

Table 2 shows the comparison between the obstetric history of mothers in the case and control groups. There were significant differences in gravida ($P < 0.001$) and parity ($P < 0.001$) between cases and controls, whereas there were no significant differences between previous abortion, previous LBW, birth interval and previous preterm labour among cases and controls. Primigravida and primiparous mothers were more at risk of having a LBW infant than multigravida and multiparous mothers.

Mothers' anthropometric characteristics

Fewer mothers in the LBW group than the mothers of NBW infants were classified as underweight (7.0% versus 14.6%), 78.6% of LBW infants had normal weight mothers compared with 58.5% of NBW mothers and fewer LBW than NBW infants had overweight or obese mothers (14.7% versus 26.9%). The range of maternal BMI in the LBW infants group was between 17.0 and 35.2 kg/m^2 and in the NBW group was between 15.6–37.7 kg/m^2. Mean maternal pre-pregnancy BMI

Table 1 Sociodemographic characteristics of mothers of low-birth-weight (LBW) and normal-birth-weight (NBW) infants

Maternal characteristic	Infant birth weight group				χ^2-test	*P*-value
	LBW (*n* = 134)		NBW (*n* = 134)			
	No.	%	No.	%		
Age (years)[a]					0.262	0.877
< 20	21	15.8	21	15.9		
21–35	104	78.2	101	76.5		
> 35	8	6.0	10	7.6		
Education[b]					7.01	0.220
Non-formal education	11	8.3	9	6.7		
Primary school or literate	50	37.6	49	36.6		
Middle school certification	20	15.0	36	26.9		
High school certification	12	9.0	11	8.2		
Intermediate or post high school diploma	32	24.1	25	18.7		
Graduate or postgraduate	8	6.0	4	3.0		
Occupation					2.06	0.357
Housewife	127	94.8	131	98.0		
Clerical	7	5.2	3	2.2		
Family income (×10³ rials/month)[c]					6.95	0.326
≤ 1000	9	6.7	6	4.5		
1000–< 3000	42	31.3	37	28.0		
3000–< 5000	56	41.8	71	53.8		
5000–< 7000	18	13.4	15	11.4		
≥ 7000	8	3.8	3	2.3		

[a]*Missing = 3 cases;* [b]*Missing = 1 case;* [c]*10 000 rials = approx. US$ 1.*

Table 2 Obstetric history of mothers of low-birth-weight (LBW) and normal-birth-weight (NBW) infants

Maternal obstetric history	Infant birth weight group				*P*-value
	LBW (*n* = 134)		NBW (*n* = 134)		
	No.	%	No.	%	
Gravida					< 0.001[b]
Primigravida	92	68.7	59	44.0	
Multigravida	42	31.3	75	56.0	
Parity					< 0. 001[b]
Primipara	100	74.6	64	47.8	
Multipara	34	25.4	70	52.2	
History of abortion					0.260[c]
No	121	90.3	115	85.8	
Yes, 1	12	9.0	17	12.7	
Yes, ≥ 2	1	0.7	2	1.5	
Birth interval (years)[a]					0.714[b]
< 3	3	6.2	7	10.4	
≥ 3	30	93.8	60	89.6	
Previous LBW					0.103[b]
No	126	94.0	132	98.5	
Yes	8	6.0	2	1.5	
Previous preterm labour					0.622[b]
No	131	97.8	133	99.3	
Yes	3	2.2	1	0.7	

[a]There were 4 missing values, and because birth interval was only relevant for multiparous women and there were 100 multiparas, values for primiparous mothers were not computed; [b]Fisher exact test; [c]$\chi^2 = 4.015$.

was significantly lower in LBW [21.9 (SD 3.14) kg/m^2] than NBW infants [22.8 (SD 4.01) kg/m^2] ($t = 2.74$, df = 244, $P = 0.033$) (Table 3).

Mean maternal weight gain during pregnancy was lower in mothers of LBW than NBW infants. Mean weight gain during pregnancy was also significantly lower in mothers of LBW [10.2 (SD 4.36) kg] than NBW [12.2 (SD 5.68) kg] infants ($t = 3.26$, df = 265, $P < 0.001$) (Table 3). In both LBW and NBW groups some mothers had hyperemesis gravidarum in first trimester of pregnancy, so their weight loss was more than weight gain during pregnancy. In this study we had 4 mothers with weight loss during pregnancy (3 mothers in NBW group and 1 mother in LBW group), but the effect of weight loss was not taken into consideration.

Cord plasma zinc concentration

Table 4 showed the cord blood plasma zinc concentration was significantly different between LBW and NBW infants. Significantly more LBW infants had severe zinc deficiency than NBW infants ($\chi^2 = 6.93$, $P = 0.031$).

Mothers' antenatal care

Almost all mothers in both case and control groups had attended government clinics. There was no association between the type of clinic and infant birth weight ($\chi^2 = 3.06$, $P = 0.271$). The percentage of NBW infants was higher in urban mothers. However Fisher exact

Table 3 Pre-pregnancy body mass index (BMI) and weight gain characteristics of mothers of low-birth-weight (LBW) and normal-birth-weight (NBW) infants

Variable	Infant birth weight group				*t*-test	df	*P*-value
	LBW (*n* = 134)		NBW (*n* = 134)				
	Mean (SD)	Range	Mean (SD)	Range			
Pre-pregnancy BMI (kg/m^2)	21.9 (3.14)	17.0 to 35.2	22.8 (4.01)	15.6 to 37.7	2.14	244	0.003
Weight gain during pregnancy (kg)	10.2 (4.36)	–3 to +22	12.2 (5.68)	–5 to +34	3.25	265	< 0.001

SD = standard deviation; df = degrees of freedom.

Table 4 **Cord blood plasma zinc levels in low-birth-weight (LBW) and normal-birth-weight (NBW) infants**

Cord blood plasma zinc level	Infant birth weight group				χ^2-test	*P*-value
	LBW (*n* = 134)		Normal (*n* = 134)			
	No.	%	No.	%		
Normal	116	86.6	121	90.3	6.93	0. 031
Mild to moderate zinc deficiency	9	6.7	12	9.0		
Severe zinc deficiency	9	6.7	1	0.7		

test did not show any significant association between place of maternal residence and infant birth weight (P = 0.434) (Table 5).

Discussion

Our study showed that there was no significant difference in maternal age among LBW and NBW infants, a finding which is consistent with some previous research [15,16], although other studies suggested that maternal age was a risk factor for LBW infants [4,10]. A study in Poland showed that mother's age < 20 years was a protective factor against LBW infants [16]. Conversely, in Taiwan LBW was more common in mothers < 20 years old and > 30 years old [17]. Mothers' age > 40 years can be a strong risk factor for extremely LBW [15]. This contradictory effect may be related to the socioeconomic status of teenage mothers and other risk factors such as smoking, alcohol use, illicit drug use and pregnancy outside of marriage in teenage groups. Generally the risk of LBW in mothers aged between 20–35 years is lower than in teenage mothers as well as older mothers due to many reasons. A possible explanation for higher risk of LBW among younger mothers is that they are still developing and their need for minerals and vitamins is greater than among older mothers. Another reason may be the limited knowledge of these younger mothers about healthy lifestyles and preparation during the antenatal period. The risk of LBW among older mothers may be related to many risk factors such as cardiovascular disease, hypertension, diabetes and other diseases that frequently affect older mothers. The reason for the non-significant difference in maternal age between LBW and NBW groups in this study may be the new protocol for high-risk mothers during prenatal care in the Islamic Republic of Iran. Mothers aged < 18 years and > 35 years are considered an at-risk group and receive special prenatal care during pregnancy, which may compensate for the effect of age on infant birth weight.

The present study showed that there were no significant differences between maternal education among LBW and NBW infants, which is consistent with some other studies suggesting that mothers' levels of education did not affect infants' birth weight [4,15]. Other studies showed that a low level of maternal education was a predictor of LBW [10,14,18]. Maternal "dietary literacy" has been shown to influence the zinc status of mothers [14,18].

Our data also indicated that maternal occupation was not different between the case and control groups and this supports the findings of other researchers [3,10,15]. A possible reason for this finding is the homogenous nature of occupation, as the great majority of the mothers in our study were

Table 5 **Location of clinic and place of residence of mothers with low-birth-weight (LBW) and normal-birth-weight (NBW) infants**

Variable	Infant birth weight group				χ^2-test	*P*-value
	LBW (*n* = 134)		NBW (*n* = 134)			
	No.	%	No.	%		
Clinic					3.06	0.217
Government	127	94.8	124	92.5		
Private	7	5.2	7	5.3		
Both	0	0.0	3	2.2		
Place of residence						0.434[a]
Urban	40	29.9	47	35.1		
Rural	94	70.1	87	64.9		

[a] *Fisher exact test.*

housewives. Hence it was not possible to study the effect of job on birth weight in this study.

Mean family incomes for LBW and NBW infants were similar. Other studies showed that higher socioeconomic status reduced the risk of LBW especially very LBW and prematurity [18]. The findings of Aydemir et al. showed that there were significant differences between plasma zinc levels among mothers of different socioeconomic status. Moreover, they did not find any relationship between plasma zinc levels and infant anthropometric parameters [19]. Maternal nutritional needs increase during pregnancy. Unfortunately, lack of knowledge about diet and lower family income are important risk factors for inadequate intake of nutrients in the majority of pregnant mothers.

Our study showed significant differences between the case and control groups for mothers' gravida and parity. Primiparous mothers were more at risk having LBW infants in comparison with multiparous mothers. The risk of very LBW in these mothers is greater than multiparous mothers [1,17]. The possible explanation for higher birth weight in multiparous mothers compared with primiparous mothers, except in older mothers, is the higher uterine blood circulation in multiparous mothers [20].

Other obstetric history variables—birth interval, previous LBW and previous preterm labour—were not significantly different between case and control groups. This non-significant difference may be related to the small sample size in the group of mothers with < 3 years birth interval. Conversely, the results of Roudbari et al. and Bernabe et al. were contradictory [10,21]. They reported that birth intervals of < 3 years had a significant effect on pregnancy outcome and increased risk of LBW. O'Connor et al. also stated that adequate birth interval and using family planning were one of the best ways to reduce the risk of LBW infants [22]. According to the new protocol for prenatal care in Islamic Republic of Iran mothers with a history of previous LBW or preterm labour receive increased prenatal care under the supervision of an obstetrician/gynaecologist during pregnancy, so this extra level of care may have decreased the risk of LBW and premature birth.

Our study also showed that maternal pre-pregnancy BMI was significantly different between the case and control groups. Likewise, obese women were at more risk for delivering LBW infants, because obesity increases the risk of hypertensive disease and diabetes [20]. However, findings by other researchers suggested that the maternal pre-pregnancy BMI is associated with infant birth weight [17,23]. Both underweight and overweight in mothers can affect pregnancy outcomes [24]. Higher BMI and multiparity were associated with increased risk of having large gestational age infants. Also the risk of LBW was higher in thin and normal weight mothers compared with overweight and obese mothers [23]. The findings by Goldenberg et al. showed that a lower pre-pregnancy BMI may cause preterm in these mothers [25]. Conversely the association between maternal pre-pregnancy BMI and LBW infants was not significant in a study in Rasht, Islamic Republic of Iran [3]. The possible explanation for higher risk of LBW among overweight and obese mothers in our study may be related to advice on weight gain limitation given by health-care workers to overweight and obese mothers during pregnancy. Tamura et al. also found that there was a negative and significant relationship between pre-pregnancy BMI and maternal zinc concentration [26].

According to WHO the recommended weight gain during pregnancy is ≥ 15 kg for underweight mothers, 10–14.99 kg for normal weight mothers and < 10 kg for overweight and obese mothers [27]. In this study the maternal weight gain during pregnancy in the case and control groups was significantly different. This result was similar to the findings of several studies which demonstrated that maternal weight gain during pregnancy was an important risk factor for LBW infants [10,17]. The risk of LBW was significantly lower in mothers who had sufficient weight gain during pregnancy compared with mothers who did not have adequate weight gain [28–30].

The type of clinic and place of residence were not significantly different between case and control groups.

Conclusion

Maternal pre-pregnancy BMI, maternal weight gain during pregnancy, gravida, parity and cord blood plasma zinc were significantly different between LBW and NBW infants, but there was no significant difference in maternal age, maternal education, maternal occupation, family income, previous abortion, previous preterm labour, birth interval, type of clinic or place of maternal residence between LBW and NBW infants.

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