Risk factors for childhood obesity: Do the birth weight, type of delivery, and mother's overweight have an implication on current weight status?

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Background: **The aim of this study was to identify risk factors, including the type of delivery, breastfeeding and its duration, birth weight, the timing of solid food introduction, the mother's education level at birth, and smoking status during pregnancy, that are associated with obesity in children living in Istanbul.**

Methods: **This study involving 4990 healthy children aged 2-14 years, at an outpatient clinic in a tertiary care hospital from June 2012 to July 2014.**

Results: **The overall rates of overweight and obesity in children were 13.1% and 7.8%, respectively. Results demonstrated that 44.5% of children were delivered by caesarean section. In all age groups, 7.8% of children delivered by caesarean section were obese compared with 7.9% of children born vaginally. No significant association between caesarean section delivery and obesity in childhood was found in our study [odds ratio (OR)=0.98, 95% confidence interval (CI)=0.64-2.87, *P*=0.454]. There was also no association between duration of breastfeeding and the introduction of solid foods before 4 months or after 6 months of age and childhood obesity (OR=0.95, 95% CI=0.69-1.3, *P*=0.771; OR=0.99, 95% CI=0.64-1.53, *P*=0.261). Regression analyses revealed that children with birth weights greater than 3801 g or those with maternal body mass index (BMI) equal to or greater than 30 had an increased risk of being obese or overweight (OR=1.78, 95% CI=1.19-2.65; OR=3.95, 95% CI=1.94-5.81).**

Conclusions: **This study demonstrated that increased birth weight and maternal BMI are significant risk factors for obesity in children living in Istanbul, Turkey. No relation between caesarean section delivery and childhood obesity was found in this study.**

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Key words: **birth weight;**
breastfeeding;
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Introduction

Obesity is a key public health issue in both developed and developing countries where prevalence is increasing in childhood. The World Health Organization defines obesity as "abnormal or excessive fat accumulation in fat tissues to a degree that causes a health problem".[1] Obesity is a multifactorial disease with genetic and environmental contributing factors. Increased energy intake, excessive and poor nutrition (eating fast food, eating while watching TV), and reduced energy expenditure (sedentary lifestyle, lack of physical activity) are all major causes of obesity.[2] Obesity is linked to serious complications in children, and commonly persists from childhood into adulthood.[3] Pediatric obesity is associated with an increased risk of concomitant psychological or psychiatric problems, increased health risk and morbidities (cardiovascular disease and dyslipidemia, chronic inflammation, type 2 diabetes mellitus, obesity-attributable cancers, steatohepatitis and respiratory problems).[4,5] The prevention of weight gain and the management of established overweight pose major challenges. Therefore, it is important to identify children at risk of becoming overweight and follow them with a well-designed preventive and interventional program.

Many researchers have recommended body mass

index (BMI) as the preferred measure for evaluating obesity in children 2-18 years of age.[6,7] Recently, a lot of researches have been performed to investigate the possible effects of nutritional experiences during infancy on obesity in later life. Previous studies demonstrated that caesarean section, breastfeeding and its duration, the initiation of solid foods at an early age, and the educational level of the mother were all early risk factors for obesity.[8,9] The aim of the present study was to evaluate the association between factors including caesarean section delivery, infant nutrition practice, and birth weight, with later childhood occurrence of being overweight in a cohort of Turkish children.

Methods

A total of 5000 Turkish children aged 2-14 years were recruited from June 2012 to July 2014 in Istanbul, the largest city in Turkey. The sample was selected from all incoming appointments at an outpatient clinic. Anthropometric measurements were done at annual physical examinations in the Pediatric Department, Bezmialem Vakif University Medical Faculty, Istanbul. Signed informed consent was obtained from the mothers of study subjects. The study sample was fairly homogeneous in terms of ethnicity and socioeconomic status. A standardized questionnaire to evaluate possible risk factors associated with obesity was collected from the mothers who remembered early-life practice of their infants accurately. The mothers who could not give precise information were excluded from the study. During each clinical visit, the height and weight of the children and their mothers were measured to the nearest 0.5 cm using a standard height board, and weight was determined to the nearest 0.1 kg using a standard physician beam scale (medical scale DR-Mod.85), with the subject dressed only in light underwear without shoes. BMI expresses the relationship of weight to height as a ratio (weight in kg/height in m^2) and is strongly correlated with the percentage of body fat. Recently, there has been a growing consensus towards using sex and age-specific BMI percentiles as cut-off values instead of percent of reference (ideal body weight%) to assess underweight/normal/overweight/obese in children >2 years of age. Childhood BMI was classified as follows: underweight is defined as a BMI for age and gender <18.5th percentile, normal weight (BMI for age and gender 18.5th-85th percentile, as the comparison group), overweight (BMI for age and gender 85th-94th percentile), and obese (BMI for age and gender ≥95th percentile). Thinness/normal/obese was classified according to Cole's recently published BMI cut-offs for thinness/overweight/obese according to sex and age (between 2 and 18 years).[10] Height or weight data were missing for 10 children; hence, the final dataset used for analysis contained 4990 individuals. Study participants were from homes of lower or middle socioeconomic status. Data regarding special neonatal care during infancy and chronic inflammatory disease were obtained from the questionnaire administered to the mothers.

Questions regarding infant feeding practices included whether children were breastfed, the age at which children completely stopped breastfeeding, and the ages when they were first fed a formula or solid foods daily. Children with secondary obesity, metabolic disease, diseases of the digestive system, cardiovascular diseases, or endocrine diseases were excluded from the study. Stratified analyses were performed to determine potential associations between childhood obesity and caesarean section, breastfeeding and its duration, birth weight, early introduction of solid food, mother's education level at birth, and the mother's current BMI.

Feeding groups were classified as breastfed for 6 months or less, for 7-12 months, and for 13-24 months. The timing of introducing formula or solid foods was classified as <4 months, 4-5 months, and ≥6 months. Birth-weight categories were defined as 2600-3000 g, 3000-3800 g, and >3800 g. Normal birth weight classified as being: between 10th and 90th percentile of birth weight for 38-42 weeks of gestational age. 2600 g and 3800 g were respectively used as low and high birth weight for both male and female infants. We excluded the children who were born before 38 weeks of gestational age, with low birth weight (<2600 g, 10th percentile for 38-41 weeks) and who had birth defects or congenital long-term diseases. Preterm babies or babies with fetal growth retardation were excluded from the study since they were too immature at birth to initiate breastfeeding and this could have an impact on the results. We were unable to use the mothers' pre-pregnancy BMI in the study because the mothers could not remember their weight accurately. Maternal BMI was classified as underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese (≥30.0 kg/m^2). The education level of the mother was classified into three categories: less than 6 years (primary school), 6-12 years (high school), and >12 years of education (university).

SPSS 17.0 for Windows software was used for all statistical analyses. Descriptive statistics were given as number and percentage for categorical variables. Comparisons among groups for normally distributed variables were performed using the Mann-Whitney *U* test. Pearson Chi-squared analysis of categorical variables was performed to identify differences between groups. Associations of childhood risk factors with overweight and obesity were evaluated using multiple binary logistic regression analysis which accounted

for potential confounders: gender, birth weight, mode of delivery, duration of breastfeeding, timing of solid foods initiation, maternal education level, and maternal smoking during pregnancy. Statistical significance was defined as $P<0.05$.

The Research Ethics Committee at Bezmialem Vakıf University approved the study.

Results

The characteristics of all subjects are presented in Table 1 and Fig. We found that the overall rates of overweight and obesity in children aged 2-14 were 13.1% and 7.8%, respectively. The female:male ratio among obese children was 1.32. The data of birth weight and types of delivery are represented in Tables 2 and 3. Our results revealed that 2222 children (44.5%) were delivered by caesarean section. Of these 173 (7.8%) were obese, and 284 (12.7%) were overweight. Of children delivered vaginally, 219 (7.9%) were obese, and 370 (13.4%) were overweight. No significant association between caesarean section delivery and obesity in childhood was found in our study [odds ratio (OR)=0.98, 95% confidence interval (CI)=0.64-2.87, P=0.454].

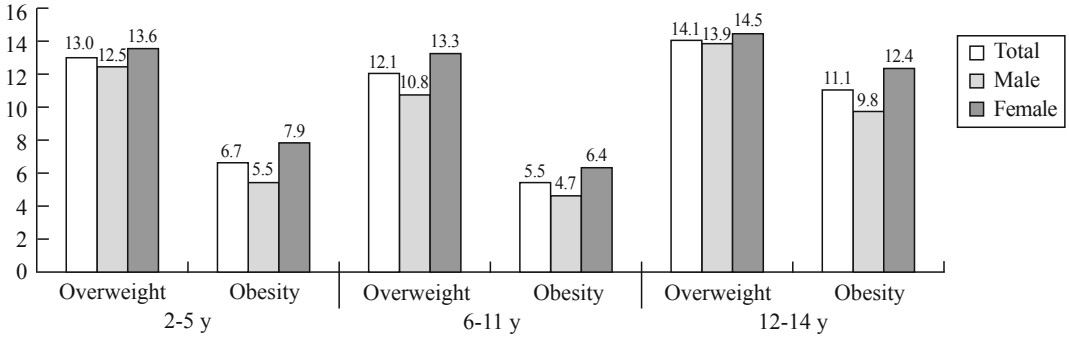

Fig. Prevalence of children at risk of overweight and obesity by different age-groups.

Table 1. Comparison of some demographic and clinical child-mother characteristics of underweight, normal, overweight and obesity groups

Characteristics	Underweight	Normal	Overweight	Obesity	*P* value
Children, *n* (%)	364 (7.3)	3583 (71.8)	654 (13.1)	389 (7.8)	
Sex, *n* (%)					
Female	176 (7.0)	1752 (70.2)	344 (13.8)	222 (8.9)	<0.001
Male	188 (7.5)	1832 (73.4)	309 (12.4)	167 (6.7)	
Birth weight, *n* (%)					
2600-2999 g	104 (8.7)	911 (76.4)	112 (9.4)	69 (5.8)	
3000-3500 g	198 (7.4)	2025 (76.1)	274 (10.2)	174 (6.5)	<0.001
3501-3800 g	40 (6.0)	380 (57.3)	164 (24.7)	79 (11.9)	
>3801 g	22 (4.8)	267 (58.0)	104 (22.6)	67 (14.6)	
Mode of delivery, *n* (%)					
Caesarean delivery	141 (6.3)	1624 (73.1)	284 (12.7)	173 (7.8)	0.454
Vaginal delivery	210 (7.5)	1969 (71.1)	370 (13.4)	219 (7.9)	
Breastfeeding duration, *n* (%)					
0-6 mon	90 (7.0)	926 (78.9)	156 (13.3)	102 (8.0)	
7-12 mon	94 (7.7)	736 (71.0)	140 (13.5)	76 (7.7)	0.711
13-24 mon	180 (6.7)	921 (71.7)	358 (13.4)	215 (8.2)	
Timing of solid foods initiation, *n* (%)					
<4 mon	123 (7.5)	1178 (71.4)	222 (13.5)	127 (7.7)	
4-5 mon	52 (13.3)	262 (66.8)	46 (11.7)	32 (8.1)	0.261
≥6 mon*	189 (6.4)	2143 (72.7)	386 (13.0)	230 (7.8)	
Mother's BMI, *n* (%)					
Normal (*n*=2028)	154 (7.6)	1521 (75.0)	239 (11.3)	124 (6.1)	<0.001
Obese (*n*=987)	31 (3.2)	531 (53.8)	254 (25.7)	171 (17.3)	
Maternal characteristics					
Mother's BMI (kg/m^2), mean±SD	23.7±4.2	23.6±3.8	26.5±6.5	29.1±9.2	<0.001
Mother's education level, *n* (%)					
Primary school	154 (6.1)	1854 (73.4)	319 (12.6)	200 (7.9)	
High school	184 (8.9)	1434 (69.8)	280 (13.6)	156 (7.6)	0.327
University	26 (6.5)	295 (72.1)	55 (13.4)	33 (8.0)	
Maternal smoking during pregnancy, *n* (%)					
Never	303 (83.2)	3217 (89.8)	583 (89.2)	351 (90.3)	0.690
Regularly	61 (16.8)	366 (10.2)	71 (10.8)	38 (9.7)	

P values are from Pearson Chi-square for categorical characteristics and *t* test for continuous characteristics, $P<0.05$. *: These infants were only breastfed during the first 6 months, underweight is defined as a BMI for age and gender <18.5th percentile, normal group (BMI <85th percentile), overweight group (BMI ≥85th to <95th percentile), obesity group (BMI ≥95th percentile). BMI: body mass index; SD: standard deviation.

Of the infants who weighed 3000-3500 g at birth, 10.2% were overweight and 6.5% were obese. Of those who weighed >3801 g at birth, 22.6% were overweight and 14.6% were obese. Results of the multivariate analyses are shown in Table 4. In the unadjusted logistic regression analyses, higher birth weight (>3801 g), compared to normal birth weight (3000-3500 g), was found to be associated with being overweight in childhood (OR=1.43, 95% CI=1.02-2.01) and obesity (OR=1.78, 95% CI=1.19-2.65, *P*=0.002); adjustment for confounding factors did not alter these findings.

When feeding was assessed, 25.5% of children were breastfed for ≤6 months as infants, 20.7% were breastfed until 7-12 months of age, and 53.7% until 13-24 months of age. The association between overweight-obesity and birth weight, breastfeeding duration, and timing of solid food introduction are represented in Table 3. There was no association between duration of breastfeeding and the introduction of solid foods before 4 months or after 6 months of age and childhood obesity (OR=0.95, 95% CI=0.69-1.3, *P*=0.771; OR=0.99, 95% CI=0.64-1.53, *P*=0.261).

Of the mothers analyzed, 34.7% were overweight (25.0-29.9 kg/m^2) and 19.6% were obese (obese ≥30.0 kg/m^2). In unadjusted analyses, maternal BMI ≥30 was associated with being overweight (OR=3.04, 95% CI=2.1-4.72) and being obese (OR=3.95, 95% CI=1.94-5.81) in their children. The mean current BMIs of the mothers of overweight and obese children were 26.5 kg/m^2 and 29.1 kg/m^2, respectively. The mean BMI of mothers of normal-weight children (23.6 kg/m^2) was lower than that of either the overweight or obese groups (*P*<0.001). In the unadjusted logistic regression analyses, obese mothers had a significantly increased odds of having an overweight child (OR=3.04, 95% CI=2.1-4.72) and an obese child (OR=3.95, 95% CI=1.94-5.81) compared to normal weight mothers; adjustment for confounding factors did not alter these findings. Analyses of these data indicated that the strongest predictor of the BMI of a child was the BMI of the mother (Table 4). Of children whose mothers had lower education levels, 12.6% overweight and 7.9% obese. Similarly, 13.4% of children whose mothers having higher education levels were overweight, and 8% were obese (*P*=0.327). Of the children whose mothers having smoking habitude during pregnancy, 10.2% had normal weight, 10.8% were overweight, and 9.7% were obese. (*P*=0.69). Therefore, the education level of the mother and her smoking pattern were not associated with the child's being obese or overweight.

Table 2. Distribution of birth weight by gender and type of delivery

Birth weight (g)	Mean±SD (median)	*P* value
Sex		
Female	3194.2±397.0 (3100)	<0.001
Male	3308.8±460.3 (3200)	
Mode of delivery		
Vaginal delivery	3243.0±412.4 (3200)	0.756
Caesarean delivery	3262.3±458.4 (3200)	

Pearson Chi-square test was used for statistical analysis, *P*<0.05. SD: standard deviation.

Table 3. The association between overweight-obesity and birth weight, breastfeeding duration, timing of solid food introduction

Variables	Underweight	Normal weight	Overweight	Obesity	*P* value
Birth weight (g), mean±SD (median)	3166.1±417.1 (3015)	3223.1±421.4 (3100)*,†	3314.0±447.9 (3300)‡	3333.5±458.6 (3250)‡	<0.001
Breastfeeding duration (mon), mean±SD (median)	14.5±7.3 (15)	14.4±8.2 (15)*	15.5±8.3 (18)‡	14.8±8.3 (15)	0.037
Timing of solid food introduction, mean±SD (median)	4.3±2.3 (6)	4.4±2.1 (6)	4.6±2.1 (6)	4.6±2.2 (6)	0.155

Pearson Chi-square test was used for statistical analysis, *P*<0.05. *: differences from overweight group; †: differences from obesity group; ‡: differences from normal weight group. SD: standard deviation.

Table 4. Unadjusted and adjusted odds ratio (95% confidence interval) for obesity (BMI ≥95th percentile) and overweight (BMI ≥85th to <95th percentile) at all age groups according to birth weight of the children and maternal BMI

Variables	Odds of being overweight*	Odds of being obesity*	Odds of being obesity adjusted for confounders†	Odds of being obesity adjusted for confounders‡
Birth weight (g)				
3000-3500	1.0	1.0	1.0	1.0
3501-3800	1.39 (1.0-1.86)	1.62 (1.77-2.60)	1.59 (1.77-2.68)	1.56 (1.71-2.53)
>3801	1.43 (1.02-2.01)	1.78 (1.19-2.65)	1.72 (1.74-2.81)	1.69 (1.55-2.64)
Mother's BMI (kg/m^2)				
Normal (18.5-25)	1.0	1.0	1.0	1.0
Obese (≥30.0)	3.04 (2.10-4.72)	3.95 (1.94-5.81)	3.91 (2.02-5.93)	3.84 (1.92-5.88)

Odds ratios were calculated multiple binary logistic regression. *: unadjusted odds ratio; †: adjusted for child age and gender, mode of delivery, breastfeeding duration, timing of solid foods initiation; ‡: adjusted for maternal education level, maternal smoking during pregnancy. BMI: body mass index.

Discussion

Previous reviews identified caesarean section, breastfeeding and its duration, early solid food initiation, high birth weight, and maternal weight as important risk factors for childhood obesity.[11,12] Based on our sample, we have not been able to find the association between caesarean section, breastfeeding and its duration, early introduction to solid foods, and the education and smoking status of the mother and childhood obesity. We found higher birth weight and maternal current higher BMI as potential risk factors for childhood obesity. After adjusting for several important confounding variables, those effects remained unchanged.

In the United Kingdom, the prevalence of overweight and obese children have increased and in 2008, 31% of males and 29% of females aged 2-15 years were classified as overweight or obese.[13,14] In the 1970s, 5% of children aged 2-19 years in the United States were obese; by 2008 nearly 17% were obese.[15] The prevalence of obesity and its complications in children has also increased dramatically in Turkey, reflecting the rising general trend in weight due to changes in nutrition and lifestyle, particularly for children in high-income families, those with obese parents, and those with high birth weight. Studies performed during 2006-2012 in Turkey demonstrated that the prevalence of overweight and obesity were in the range of 10.3%-17.6% and 1.9%-7.8%, respectively, in children aged 6-16 years.[16,17] In another study, the rate of overweight or obesity in children in Istanbul was 17.9% in 2001, which increased to 23.4% in 2009.[18] The Turkish Ministry of Health recently introduced childhood obesity prevention guidelines, suggesting that healthcare professionals should undertake regular growth monitoring and provide advice to parents with low levels of knowledge concerning the risks of obesity.

The incidence of caesarean section has increased in the last decade in middle and high-income families in countries worldwide. In the United States, the proportion of births by caesarean section increased from 20.7% in 1996 to 32.9% in 2007.[19] In Brazil, caesarean section overtook vaginal delivery in 2009 (50.1%).[20] In Turkey, the proportion of births by caesarean section increased from 42.7% in 2009 to 46.2% in 2013.[21] In this study, we investigated whether the increased incidence of caesarean section might be a cause for the increased prevalence of obesity, but our results did not support this hypothesis. Several studies have reported conflicting results regarding the association between caesarean section and childhood obesity. In a meta-analysis, Li et al[22] found a moderately strong association between caesarean section and later obesity. Pei et al[23] reported that caesarean section might increase the risk of obesity at age 2 years (OR=1.74, 95% CI=1.12-2.70) but not at age 6-10 years. In a previous study of 1255 US subjects, delivery by caesarean section was associated with increased risk of childhood obesity at 3 years of age;[24] however, the participants in that study had a relatively high level of education and income, and the confounding effects of socioeconomic status were not considered adequately. Zhou et al[25] performed a small case-control study of 162 Chinese children aged 3-6 years and reported an association between obesity and caesarean delivery. In contrast, Barros et al[26] reported that caesarean section was not associated with increased risk of obesity during childhood and adolescence. The participants in our study had relatively lower socioeconomic status compared with the average population in Istanbul. Infant birth weight is related to the nutrition and weight of the mother during pregnancy. Therefore, the correlation between caesarean section and obesity may be associated indirectly with high birth weight, as caesarean section is often selected when fetal weight is high.[27] In our study groups, the mean birth weights were significantly greater for the overweight and obese groups compared with the normal group. In addition, maternal pre-pregnancy body mass index may influence the decision to perform a cesarean delivery. Children from families of high socioeconomic status are also more likely to be overweight. In the present study, we have not been able to find any association between caesarean section and childhood obesity (OR=0.98, 95% CI=0.64-2.87, P=0.454). Multiple risk factors other than type of delivery may play important roles on development of obesity such as family dietary habits, parental obesity, obesogenic environment and physical activity.

Several studies have identified high birth weight as a potential risk factor for childhood obesity.[28-30] Dubois et al[31] reported that infants weighing ≥4000 g at birth had a 2.3-fold (95% CI=1.30-7.20) greater likelihood of being overweight at 4.5 years compared with those weighed 3000-4000 g at birth. Rooney et al[32] also found that infants weighing ≥3860 g were 2.17 times (95% CI=1.22-3.87) more likely to be overweight at 4-5 years compared with infants weighing 3180-3850 g. Our study confirmed this finding, showing that infants weighing >3801 g had a higher risk of being obese compared with those weighing 3000-3500 g at birth. In unadjusted logistic regression analyses, higher birth weight was associated with 1.7-fold higher odds of obesity (OR=1.78, 95% CI=1.19-2.65). After adjustment for child age and gender, mode of delivery, breastfeeding duration, timing of solid foods initiation, maternal education level, and maternal smoking during pregnancy, the association did not change. Our study

results may confirm the strong association between higher birth weight and child obesity. It is important to manage birth weight for reducing the occurrence of obesity in later childhood.

Breastfeeding is the preferred method of feeding infants, as it confers unique immunological, growth, and developmental benefits.[33,34] The initiation and duration of breastfeeding may influence obesity in later life, although this remains controversial. Some studies have suggested that breastfeeding protects against the development of obesity in children.[35-38] The higher protein/nitrogen content of infant formula compared with breast milk may cause a metabolic response that results in increased insulin and insulin-like growth factor-1 secretion in formula-fed infants, and this could lead to excessive weight gain.[39] Although some studies reported that breastfeeding exerted significant protective effects against childhood obesity, others[40-42] found no significant association. A meta-analysis of 17 studies assessing the duration of breastfeeding found that each additional month that infants were breastfed was associated with a 1% lower risk of obesity in later life.[43] However, Hediger et al[44] reported that the association between breastfeeding and its duration and risk of being overweight in children is inconsistent. We conclude that prolonged breastfeeding does not appear to decrease a child's risk of being overweight or of having obesity. Nevertheless, it remains important to recommend breastfeeding for its multiple other benefits to both mother and child.

There was some evidence suggesting that the early introduction of solid food was a risk factor for childhood obesity. Huh et al[24] reported that formula-fed infants who were given solid food before 4 months of age were 6.3 times more likely to be overweight at 3 years of age compared with those given solid foods between 4 and 5 months. Consistent with this, Seach et al[45] found that later introduction of solid foods was significantly associated with reduced prevalence of overweight in children. In contrast, Neutzling et al[46] found no association between the early introduction of solid foods and childhood obesity. We also found no association between childhood obesity and the timing of solid food introduction. Among infants who were introduced to solid foods before 4 months of age, 7.6% were obese, compared with 7.8% of those introduced after 6 months of age (P=0.261). The proportion among infants who were fully breastfed for 6 months was only 39%. The current recommendation is to allow supplementation with solid foods at 4-6 months while continuing breastfeeding for at least 12 months.

By far the strongest predictor of BMI status in children was the current BMI of the mother. Parsons et al[47] reported a strong positive correlation between offspring and parental anthropometry. They suggested that the environment interacts with genetic components such as a genetic predisposition to a preference for fatty foods or limited ability to perform physical activity. Gestational weight gain and maternal obesity are the strongest predictors of obesity in children and adolescents.[48] Isabela da Costa et al[49] reported that birth weight >3500 g and parental BMI >30 kg/m^2 were positively associated with childhood obesity. Current maternal BMI was found to be associated with children being overweight and obese. Overweight mothers had a significantly increased odds of having an obese child compared to normal weight mothers (OR=3.95, 95% CI=1.94-5.81). Normal weight mothers were more likely to have normal weight children than overweight mothers. This association between parental obesity and the risk for obesity in offspring has been noted previously.[50]

Yi et al[51] reported that increased maternal education was protective against childhood obesity and that parental obesity and a family history of diabetes were associated with increased obesity risk. In contrast, our data indicate that maternal education level is not significantly related to obesity in offspring.

There are several limitations in the present study. First, this study was retrospective. Data were collected from the mothers who remembered the accurately recall of early life practice of their infants. But most of the mothers have remembered birth weight and breastfeeding practices certainly. Second limitation of this study is the lack of information on maternal pre-pregnancy BMI. We were unable to analyze the mothers' pre-pregnancy BMI in the study because the mothers could not remember their weight accurately. Mother's BMI is known to influence the child's birth weight and is an independent determinant of the child's BMI later in life. We used unselected healthy full-term infants in our analyses, whereas most previous studies did not exclude preterm or small for gestational age infants.

Our study suggested that caesarean section, breastfeeding and its duration, the early initiation of solid foods, and the education level of the mother were not significant risk factors for childhood obesity. Increased birth weight and maternal BMI was well correlated with childhood obesity. A more comprehensive study evaluating measures for prevention of obesity onset in children is needed. Public health interventions designed to prevent childhood obesity should promote overall healthy living to prevent high birth weight in infants and maternal obesity.

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