

Original Article:

The Effect of Delivery Types on Preschoolers' Weight: A Case-control Study



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Abstract

Introduction: This study was designed to determine the effect of delivery type on obesity of children.

Materials and Methods: This case-control study investigated preschoolers in Rafsanjan city in 2018. The study population was divided into two groups. The first group consisted of children who were overweight and obese as the case group, the second group included children with normal BMI as the control group. For each obese and overweight child, a normal-weight child was considered his or her control, matching the preschool center, sex and age. Logistic regression models were used to examine the relationship and calculate the odds ratio.

Results: Data for 171 paired children were collected. Results showed that 126 (73.7%) of the case group and 115 (67.3%) of the control group were born through CS. The odds of obesity and overweight in children born through Caesarean Section (CS) was 1.363 times higher than those born through normal delivery but this difference was not statistically significant ($P=0.193$). These results did not change after controlling the effect of confounding factors. Also, the risk of obesity and overweight in children born from mothers who had cesarean selective delivery was 1.523 times higher than those born through normal delivery, but this difference was not statistically significant ($P=0.275$).

Conclusion: The findings of our study did not show any evidence of a relationship between maternal type of delivery and childhood weight. In this study, obesity and childhood overweight depended on maternal characteristics.

Keywords: Obesity, Overweight, Preschoolers, Case control study

Introduction

Although vaginal delivery is the best type of delivery, sometimes it is not possible to have one. This is mainly because of the medical reasons for preventing the dangers threatening the mother and baby. Therefore, Caesarean Section (CS) can be alternately necessary. CS, however, has become one of the safest surgeries today while emergency CS still carries more risks than normal delivery, and according to the rules, it should be limited to cases where delivery through the birth canal is not possible or poses serious risks to the mother and fetus. In 1985, the International Society for Health Care considered the ideal rate for CS to be between 10 and 15 percent. Since then, CS has become increasingly common in developed and developing countries. In emergencies, a CS can effectively prevent maternal and infant mortality.

In many countries, including Iran, the number of cesarean deliveries is so high that there are concerns about short-term and long-term complications. Research shows that the rate of CS in the UK, Sweden and the US rose from 6, 8 and 10% in 1975 [1], to 19, 12 and 22% in 1999 [2], to 21, 16 and 24% in 2001 [3] to 23.9%, 16.6% and 27.6% in 2010 and finally has reached 26.2, 17.3 and 26% in 2015 [4]. According to 2010 statistics, 25.7% of all deliveries in the world were performed by CS, ranging from 2.3% in Angola to 46.2% in China [5]. Also, the rate of CS in the US increased from 24% in 1996 to 32.8% in 2011 [6].

In Iran, studies have been conducted in this area, concluding that the increase in the rate of CS in Iran can be higher than other parts of the world. This is also coupled with the evidence that many CS cases are performed without scientific indication and simply by the mother's own choice. In 2018, out of a total of 1.21 million registered births in Iran, 562828 cases of CS (46%) and 648475 cases of natural childbirth (54%) have been reported.

Excessive and unreasonable prevalence of CS has increased the financial burden on public health systems, and the portion of health care in national production will increase significantly. Studies reveal that the financial costs, the length of time a mother is hospitalized, the medications she takes, and the possible side effects of medications for CS are significantly higher than with a normal delivery [7].

While CS is an abnormal way of delivery, it can be expected that the newborn will be defective in some health characteristics compared to a normal baby. The increasing rates of CS and childhood obesity in the world have been observed at the same time, which can indicate the relationship between CS and childhood obesity. An estimated 23.5 million students in the Eastern Mediterranean region were obese or overweight between 1992 and 2001, while in 2010 it nearly doubled to 41.7 million [8]. In Iran, as a developing country, the prevalence of childhood obesity is increasing, which is mostly due to urbanization and rapid industrialization of such countries.

According to a study in Tabriz, the percentages of thin, overweight and obese elementary school children were 1.20, 7.4 and 2.1 percent in 2014, respectively [9]. A study by Agha-Alinejad et al. showed that the prevalence of obesity and overweight in preschoolers in Tehran is 7.08 and 12.07, respectively, and a total of 19.15% of these children are overweight and obese [10].

Various studies around the world have examined the association between maternal delivery and childhood obesity, and found that obesity chances of children born by CS were more than those born by natural vaginal delivery [11-13].

Of course, this effect has not yet been confirmed by the relevant experts. Due to the importance of childbirth and the high rate of CS in the Iranian female population, which is often done selectively and without any medical indications, and since the complications of CS have been confirmed in most studies, this study has determined the possible complications of obesity and overweight children after their mothers' CS. More evidence to confirm or reject the causal association between the type of delivery and childhood obesity helps health care providers make better plans for childhood obesity and overweight prevention interventions.

Materials and Methods

The current study is a case-control and community-based one designed and conducted in the population of preschoolers with the aim of determining the effect of delivery on the weight of these children in 2018 in Rafsanjan, Iran. Although in case-control studies, there is no special need to select a representative sample from the population, to achieve more accurate results, the cases were selected using probabilistic sampling methods. In doing so, through the two-stage cluster sampling method, the statistical population including 3,589 children in 73 preschool centers was first divided into 11 clusters

based on urban areas. Of these 11 clusters, 7 clusters were selected and then all units of these 7 clusters and a total of 38 centers were fully surveyed, which included 1292 preschool children.

Permission was obtained from the Department of Education to enter the preschool centers. The conditions of the study were explained to the director of the center, and the parents' oral consent was obtained.

Data on age, sex, weight, and height of children were collected by trained staff. Children were weighed in light clothes by digital scales that were precise to the nearest 100 g. Height was measured in a standing position, barefoot, with their heads being placed in the Frankfurt position [14] and shoulder blades, buttocks, and heels touching the wall [15]. The age of these children was also extracted from the medical records in years and months. Body Mass Index (BMI) was calculated by dividing weight (kg) by height (m²), based on the BMI for age percentiles developed by the World Health Organization (WHO). Obesity was defined as BMI \geq 95th percentile according to gender and age in months, overweight as BMI between the 85th and <95th percentile, normal as BMI between the 15th and <85th percentile, low weight as BMI between the 5th and <15th percentile, very low weight as BMI less than 5th percentile [16]. The sample size of cases and controls was determined based on previous studies [12], using the Equation 1:

$$1. \quad n_1 = \left(\frac{Z_{1-\frac{\alpha}{2}} \times \sqrt{pq \left(1 + \frac{1}{k}\right)} + Z_{1-\beta} \times \sqrt{p_1q_1 + \frac{p_2q_2}{k}}}{\Delta} \right)^2$$

, where: $\alpha=0.05$, $\beta=0.10$, $P_1=70.8\%$ (estimation of CS ratio in mothers of obese children), $P_2=10.1\%$ (estimation of CS ratio in mothers of children with normal weight), $k=1$ and $\Delta=14.5\%$. Thus, out of a total of 342 preschoolers, 171 participants were assigned to each group. Assuming a 15% sample fall, the number of children in each group was 201 and a total of 402 preschoolers were invited to study.

After dividing the children in terms of BMI, 201 obese and overweight children were considered to be cases and the same number with normal weight as the control so that, according to the preschool center, gender and age (with 3 months of deviation) were matched. Other pieces of information about children and their mothers including age, height, weight, smoking habits, as well as the type of infant feeding (formula or breast milk), solid food initiation, maternal gestational age (preterm,

term, past term) and parity were collected through a self-reported checklist taken home by the children. Considering the inclusion and exclusion criteria, children with special dietary restrictions in the year before the study, any congenital diseases, metabolic diseases such as diabetes and secondary obesity as well as certain diseases such as cancer were excluded from the study.

In order to compare quantitative variables, independent two-sample t-test and to compare qualitative variables, Chi-square test or Fisher's exact test, and Mann Whitney U test were used. In multivariable analysis, a multivariable logistic regression model by controlling the confounding factors was performed in order to investigate the association between CS and obesity in preschoolers. All statistical analyses were performed using SPSS software, v. 21.

Results

The height and weight of 1292 preschool children were measured. 85% of the information, 201 obese and overweight children along with 201 normal weight children as controls, was completed (171 pairs of cases and controls) and analyzed. The frequency distribution of the participants in both case and control groups is shown based on the matching variables in Table 1. In terms of maternal delivery, 126 participants (73.7%) in the case group and 115 participants (67.3%) in the control group were born by CS, but there was no significant statistical difference between the case group and the control groups. Most mothers were in the 25-35 age group at the birth of their children, with 115 (67.6%) and 125 (73.1%) in the case and control group, respectively. Also, in two groups of case and controls, the difference in all age groups of mothers at the birth of their children was not significant ($P=0.695$).

In general, comparing the variables in the case and control groups, it was found that participants in the two groups in terms of the type of maternal delivery, maternal age at the birth of their children, parity, child feeding, timing of solid food initiation, gestational age, and maternal obesity were not statistically significant (Table 2).

Odds of incidence of obesity and overweight in children born by CS was 1.363 times higher than in the children born through vaginal delivery, but this difference was not statistically significant (OR=1.363, 95% CI=0.885-2.174).

In the unadjusted analysis, the odds of overweight and obesity in children whose mothers were 17-24 years old at the time of birth, the third and subsequent birth children and preterm were more than other groups, but these

Table 1. Distribution of the subjects in both case and control groups is based on matching variables (n=171 in each group)

Variables	No.(%)		p*	
	Case Group	Control Group		
Age (month)	<65	42(24.6)	44(25.7)	0.142
	65-70	72(42.1)	86(50.3)	
	>70	57(33.3)	41(24.0)	
Gender	Male	85(49.7)	85(49.7)	0.999
	Female	86(50.3)	86(50.3)	

* Pearson Chi-square test was used for statistical analysis. differences were not statistically significant. However, children having a mixed feeding were more likely to be overweight and obese, with a statistically significant difference of 1.8 times (80%) than children who were exclusively breastfed (OR=1.816, 95% CI=1.055-3.126).

In addition, we differentiated elective and non-elective CS to analyze the risk of each on overweight and obesity in preschoolers. The risk of obesity and overweight in children of mothers who had a CS at their request and without medical indication (elective) was 1.523 times that of children born through vaginal (non-elective) delivery.

The mean and standard deviation of mother's BMI in the two groups of case and control were 27.62±5.26 and 26.30±3.80, respectively. The results showed that with increasing mother's BMI, the odds of obesity and overweight in children increased, which is statistically significant with t-test (P=0.010). The birth weight of the child with the mean and standard deviation of 3183.02±485.77 and 3204.14±504.73 gr in the case and control group respectively, was not statistically significant (P=0.695) (Table 3). The age and body mass indexes of the mother, in addition to being considered a qualitative variable in the raw model, were also entered as quantitative variables to examine the ratio of the adjusted odds. The re-

Table 2. Risk of obesity and overweight in relation to qualitative variables in the two groups of children

Variables		Obesity and Overweight (Case)	Normal (Control)	Total	OR	95% CI for Crude OR	p*
Maternal type of delivery	Caesarean section	126 (73.7)	115 (67.3)	241 (70.5)	1.363	0.855 – 2.174	0.193
	Vaginal	45 (26.3)	56 (32.7)	101 (29.5)	1	-	
Maternal age (y)	17-24	43 (25.3)	32 (18.7)	75 (22.0)	1.618	0.659 – 3.975	0.695
	25-35	115 (67.6)	125 (73.1)	240 (70.4)	1.065	0.473 – 2.397	
	>35	12 (7.1)	14 (8.2)	26 (7.6)	1	-	
Parity	First	99 (58.2)	89 (52.0)	188 (55.1)	0.937	0.501 – 1.751	0.572
	Second	44 (25.9)	59 (34.5)	103 (30.2)	0.646	0.327 – 1.276	
	Third and more	27 (15.9)	23 (13.5)	50 (14.7)	1	-	
Child feeding	Breast milk	114 (66.7)	130 (76.0)	244 (71.3)	1	-	0.306
	Formula feeding	14 (8.2)	14 (8.2)	28 (8.2)	1.140	0.522 – 2.493	
	Mix feeding	43 (25.1)	27 (15.8)	70 (20.5)	1.816	1.055 – 3.126	
Time of solid foods initiation	<4 months	2 (1.2)	3 (1.8)	5 (1.5)	0.672	0.110 – 4.083	0.952
	4-5 months	33 (19.4)	31 (18.2)	64 (18.8)	1.072	0.622 – 1.849	
	>6 months	135 (79.4)	136 (80.0)	271 (79.7)	1	-	
Gestational age	Preterm	16 (9.4)	9 (5.3)	25 (7.3)	1.778	0.295 – 10.719	0.999
	Full term	152 (88.9)	158 (92.4)	310 (90.6)	0.956	0.190 – 4.810	
	Past term	3 (1.8)	4 (2.3)	7 (2.0)	1	-	
Maternal body status	Low weight and Normal Obesity and overweight	51 (31.3) 112 (68.7)	61 (36.7) 105 (63.3)	112 (34.0) 217 (66.0)	1.243 1	0.786 – 1.965 -	0.393

* Fisher's exact test was used for statistical analysis.

Table 3. Risk of obesity and overweight in relation to quantitative variables in the two groups of children

Variables	Obesity and Over-weight (Case)	Normal (Control)	Total	Odds Ratio (OR)	95% CI for Crude OR	P
Maternal BMI (kg/m ²)	27.62±5.26 (n=163)	26.30±3.80 (n=166)	26.99±4.96 (n=329)	1.048	1.001 – 1.098	0.010
Maternal age (y)	28.38±4.88 (n=170)	28.27±4.51 (n=171)	28.36±4.69 (n=341)	1.005	0.960 – 1.051	0.841
Child birth weight	3183.02±485.77 (n=169)	3204.14±504.73 (n=169)	3186.83±494.21 (n=338)	0.999	0.999 – 1.001	0.695

sults after adjustment for confounding factors showed that the odds of obesity and overweight in children after elimination of the effect of confounding factors were higher in children born by CS than in children born through vaginal delivery, but this difference was not statistically significant (P<0.448) (Table 4).

Comparing the other variables in the two case and control groups after stratification, it was found that the two groups in parity, child feeding, timing of solid food initiation, gestational age, maternal BMI and maternal age at the birth of their children did not have a statistically significant difference.

Discussion

Our case-control study in an urban area in Iran revealed that mothers of overweight and obese children had 6.4% more CS than mothers of children with normal weight. Also, in our study, the prevalence of obesity and overweight in children born by CS was 53%, but in vaginal

delivery it was 41%. Salehi et al. reported the prevalence of obesity and overweight in CS to be 29.8% compared to 20% in VD [11]. Although in our study the odds of obesity in women with CS was higher in the crude analysis, this association was not statistically significant (P=0.193) and adjustment for confounding factors did not alter these findings. In addition, we distinguished elective and non-elective CS to analyze the risk of each on overweight and obesity in preschool children. We found that elective CS at the request of the mother was associated with an increased risk of 1.52 times compared to VD, but the odds of obesity and overweight in children in non-elective CS and VD were equal. In a study by Rutayisire et al., out of 67.3% of children born by cesarean delivery 15.7% were obese, in unadjusted analysis, cesarean section was associated with childhood obesity and overweight (P<0.001) and adjustment for confounding factors did not alter these findings. The researchers found that the risk of overweight increased by 24% and obesity by 26% in children by CS, both in elective and emergency CS [17]. These results contradict our results.

Table 4. Association between type of delivery and children obesity and overweight after adjustment for confounding factors

Variables		Adjusted Odds Ratio (OR)	95% CI for Adjusted OR	P
Maternal type of delivery	Caesarean section	1.214	0.736 – 2.001	0.448
	Vaginal	1	-	
Parity	First	1.170	0.526 – 2.601	0.196
	Second	0.691	0.329 – 1.448	
	Third and more	1	-	
Child feeding	Breast milk	1	-	0.250
	Formula feeding	1.142	0.501 – 2.600	
	Mix feeding	1.674	0.915 – 2.963	
Time of solid foods initiation	<4 months	0.600	0.088 – 4.092	0.847
	4-5 months	0.922	.0519 – 1.641	
	6 months	1	-	
Gestational age	Preterm	2.040	0.303 – 13.736	0.282
	Full term	0.917	0.176 – 4.768	
	Past term	1	-	
Maternal BMI (kg/m ²)		1.162	0.715 – 1.887	0.544
Maternal age (year)		1.035	0.974 – 1.101	0.267
Child birth weight		1.000	0.999 – 1.001	0.601

Goldani et al. showed that people born by CS had a significantly increased risk of obesity in adulthood, a 58% increase that was much higher than this study and the recent studies that reported subsequent obesity and overweight in childhood. It seems that other factors during life can affect the increase obesity rate, or it may have been due to a un-adjustment of the confounding factors [18]. However, our assessment in the present study was the effect of type of delivery on childhood obesity, which should perhaps be carefully compared with the findings of Goldani et al. In a study by Li et al., crude analysis indicated an increased risk of cesarean section by 24% compared to vaginal delivery for overweight children. After extensive adjustment for confounding factors, this increased risk reduced to 13% and remained statistically significant [19], which also contradicts our results.

However, some other studies confirm the findings of the present study [20-27]. These studies did not report an association between maternal delivery and overweight-obesity in children. Fleming's et al study found that children born by cesarean section were 49% more likely to be obese. Yet after adjustment, association became weak and not statistically significant [21]. A study in Brazil conducted on two birth cohorts from two cities with distinct socioeconomic backgrounds demonstrated that prevalence of obesity in developed areas was significantly higher in children delivered by CS compared with those born by vaginal delivery (15.7% vs 9.8%, $P=0.022$), while in children living in poor areas where the prevalence of childhood obesity was lower, obesity was not significantly associated with type of delivery ($P=0.091$). These results remained consistent after adjustment, which can justify the impact of economic factors more than the mother's childbirth [24]. Childhood obesity in the 2-14 age group of Istanbul, born by cesarean and vaginal delivery, was 7.8% and 7.9%, respectively, and the association between childhood obesity and maternal delivery was not confirmed [25]. Pei et al. also showed that childhood obesity is more dependent on mother's characteristics than the mother's type of delivery [28]. In these two recent studies, as noted, economic factors and maternal characteristics play a greater role in childhood obesity. This is consistent with the findings of our study indicating that mothers with a higher BMI are more likely to have obese and overweight children ($P=0.010$).

Yuan et al. came to the conclusion that cesarean section was associated with higher risk of childhood obesity in crude analyses. They reported that cesarean section was more common in women with higher pre-pregnancy BMI, gestational diabetes and high blood pressure, and with previous cesarean section. After adjustment, the

association attenuated, most of the attenuation resulted from adjustment for maternal pre-pregnancy BMI [29]. In the present study, mothers with higher BMI were more likely to have obese children and delivery more by CS. Thus, pre-pregnancy maternal BMI must be considered a strong confounder in the association between CS and childhood obesity.

As pointed out earlier, the results of our study showed 1.52% increased risk of childhood obesity in elective CS vs vaginal delivery; however, the association was not statistically significant. Some studies have tried to explain the association between CS and childhood obesity by hypothesizing that the gut microbiota is different in cesarean and vaginal delivery, causing childhood obesity. In our study, which examined the association of cesarean delivery by elective and non-elective CS, infants were not in contact with their mothers' vaginal microbiota in the non-elective CS, but did not differ in terms of obesity or overweight from those born through vaginal delivery although the risk of obesity was higher in those born by elective CS. Masukume et al. also found that infants in elective CS, not coming into contact with the maternal microbial flora, are not at increased risk of obesity and overweight [30]. Perhaps these results indicate the different normal flora of the birth canal in different areas that need further study.

Zhou et al. confirmed that in addition to CS, early initiation of solid foods and fetal education is associated with childhood obesity and overweight [12]. However, our study did not find any associations between time of solid foods initiation and childhood obesity ($p=0.952$).

Our results also found that children who have mixed feeding were 1.8% more likely to be obese and overweight than breastfed children. Blustein et al. also found that children who had less breastfeeding were at higher risk of overweight and obesity [31]. Findings from other studies have also shown that breastfeeding has a protective effect on childhood overweight and obesity [32].

A few studies have suggested that high birth weight is associated with an increased risk of childhood obesity [33]. The present study, in line with a number of previous studies [34], does not confirm this association.

The results of this study also found that preterm infants are at higher risk (1.77 times) of obesity and overweight in childhood. Also, in this study, the association between time of solid foods initiation (before 4 months or later 6 months old) and childhood obesity was not reported.

This part of the results was consistent with the evidence obtained in the study of Vehapoglu et al. [25].

Our study has several strengths. The sample size of our study was sufficient according to the literature and potential confounding factors were controlled by matching preschool center, gender, and age.

Our study is a case-control; the questionnaire collected the data. In addition, since some studies have reported antibiotic use during pregnancy to reduce intestinal flora and childhood obesity [35], it could have been overlooked as a potential confounder in this study.

Conclusion

In general, the findings of our study did not show an association between cesarean delivery and increased risk of obesity and overweight in children. In addition, according to the findings of this study, childhood obesity and overweight are more dependent on the characteristics of the mother, including the mother's high BMI and also the type of child feeding.

Ethical Considerations

Compliance with ethical guidelines

The Ethics Committee of Rafsanjan University of Medical Sciences approved the study (IR.RUMS.REC.1397.083).

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Author's contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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