Breastfeeding and Overweight/Obesity Among Children and Adolescents: A Cross-Sectional Study

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Abstract

Background Overweight and Obesity are a major public health crisis among children and adolescent and contributes to significant economic burden. We aim to investigate the relationship between breastfeeding duration and overweight and obesity in children and adolescents aged 6 to 16 from Shibei District of Qingdao, China in 2017.

Methods Data on breastfeeding and children and adolescent anthropometric measurements were collected in a cross-sectional study in Qingdao, China (n=11732). Differences between groups were compared using t-test and chi-square test. Multiple linear regression model and generalized linear model were used to analyze the relationship between duration of breastfeeding and BMI. Logistic regression analysis model was used to analyze the relationship between breastfeeding duration and the prevalence of overweight and obesity. Other factors potentially related to children and adolescents' overweight and obesity were also considered.

Results The prevalence of overweight and obesity was 35.21%, overweight and obesity being 15.45% and 19.76%, respectively. After adjusting covariates, there was a significant negative correlation between breastfeeding duration and BMI in children and adolescents ($\beta=-0.025$, 95%CI: -0.033, -0.005, $P<0.01$). Among boys, the BMI in childhood and in adolescence of those who have been breastfed for more than 12 months is significantly lower than others whose breastfeeding duration was less than 12 months ($\beta=-0.440$, 95%CI -0.655, -0.224, $P<0.01$). After classifying subjects into age groups, among boys aged 9 to 11, breastfeeding has a particularly positive effect on the prevalence of obesity (OR=0.978, 95%CI: 0.958,0.999, $P<0.05$), and the prevalence of obesity was lower among those whose breastfeeding duration was more than 12 months (OR=0.787, 95%CI: 0.653,0.975, $P<0.05$).

Conclusion Breastfeeding can significantly reduce the prevalence of overweight and obesity among children and adolescents aged 6 to 16. And those who were breastfed for more than 12 months had a lower risk of developing overweight and obesity, especially in boys between the age of 9 to 11.

1. Introduction

In recent decades, obesity in children and adolescents has emerged as a serious health issue worldwide, including in Asian countries (1). From 1990 to 2015, the prevalence of obesity has doubled in more than 70 countries around the world (2, 3). China has the largest number of obese people in the world since 2016 and childhood obesity rate is also rising (4). The first Report on Childhood Obesity in China shows that from 1985 to 2014, the prevalence of overweight among children and adolescents aged 7-18 increased sixfold (2.1–12.2%), while the obesity prevalence increased nearly fifteen times (0.5–7.3%). Without effective intervention, it is estimated that by 2030, the number of overweight and obesity among children and adolescents in China will reach 49.48 million (5). Childhood obesity is caused by the occurrence of many disorders such as lipid disorders, increased glucose levels, abnormal blood pressure, insulin resistance and exercise intolerance. They all lead to the development of many chronic diseases during adulthood, including cardiovascular diseases, hypertension, type 2 diabetes and metabolic syndrome (6, 7, 8).

Various factors are involved in the prevalence of obesity, such as genetic implications, birth weight, parental obesity, physical activity, socioeconomic status, age, gender, etc. (9). A higher protein intake early in life has been linked to body type in later life as it increases the secretion of insulin-like growth factor-1, which may stimulate growth and adiposity (10). The various nutrients contained in breast milk are most suitable for the digestion and absorption in infants, and have the highest bioavailability, which can meet the physiological needs of infants in different development stages and cannot be replaced by any other food (11). Over the previous decade, many studies have indicated an association between breastfeeding and childhood obesity. In a large birth cohort of 42,550 children from Southeast China, Zheng et al. found that longer duration of exclusive breastfeeding (EBF) was associated with lower risk of overweight (12). A meta-analysis of 39 studies published by the World Health Organization (WHO) also shows that prolonging the duration of breastfeeding will reduce the risk of obesity in children (13), while some previous studies showed no significant association between breastfeeding and childhood overweight and obesity in American and European samples (14, 15). The question of whether breastfeeding protects children and adolescents from obesity is still an open debate, despite a large number of related publications. However, there is still a lack of studies on breastfeeding and the prevalence of obesity among children and adolescents in urban areas of China. Therefore, we are more concerned about the current status of breastfeeding in urban areas and its impact on the overweight and obesity in children and adolescents.

As an emerging coastal city, Qingdao is experiencing rapid economic and social development, with a significant increase in the nutrient level of residents and changes in their lifestyles. The aim of the present study was to identify the relationship between breastfeeding and obesity among children and adolescents in Shibei District of Qingdao, China. The purpose is to provide basic data for early intervention of childhood obesity and lay the theoretical basis for promoting breastfeeding.

2. Materials And Method

2.1. Participants

In accordance with the requirements of Qingdao Municipal Center for Disease Control and Prevention [2017] No. 29 document, we had collected data related to this research. In 2017, a total of 39042 students aged 6 to 16 participated in this study, and all of them came from primary and secondary schools (41 schools in total) in Shibei District of Qingdao, China. In total, 11732 participants, including 5860 boys and 5872 girls, were given a survey questionnaire and had their physical measurements taken, and parents of all students signed informed consent forms.

2.2 Measurement

The research team was composed of a professional medical team from Qilu hospital (Qingdao) of Shandong University and personnel from the education bureau personnel division in Shibei District of Qingdao. Only doctors and nurses who have received standardized training are qualified to take physical measurements for students. The physical measurements in this study mainly focused on students' weight and height. Body height (standing height without shoes) was measured to the nearest 0.1 cm using a Harpenden stadiometer (Holtain Ltd., Crymch, UK) and body weight was measured to the nearest 0.1 kg with a calibrated scale (Seca, Hamburg, Germany) with each child wearing only underwear. Participants in total were measured two times and the average of two results were calculated for further studies. Body mass index (BMI) = weight (kg) / height (m)².

2.3 Questionnaire

Personnel from the education bureau personnel division were responsible for gathering information from questionnaires. Questionnaires filled in by students and parents were used to collect demographic information of family members, children's birth conditions, feeding and growth and development conditions, etc. The questionnaire mainly centered upon the following aspects: parents' age, height (cm), ethnicity, parity, birth gestational week, deliver mode and students' age, gender, birth length (cm), birth weight (kg), breastfeeding time (month), supplementary feeding time (month), teething time (month), vision, number of cavities, etc.

2.4 Overweight and Obesity

In this study, obesity and overweight in different age groups and in both genders were defined according to the standards for obesity in the Screening for overweight and obesity among school-age children and adolescents released in 2018 by the National Health and Family Planning Commission, People's Republic of China.

2.5 Covariates

The following sociodemographic and exposure factors studied derived from the questionnaire: age, sex, ethnicity, parity, birth method, birth gestational week, birth weight (kg), birth height (cm).

2.6 Statistical Analysis

The data entries and analysis were computed utilizing the Statistical Package for the EpiData 3.0 and SPSS 26. T-test and chi-square test were used to compare mean levels of continuous variables and percentage of categorical variables among children and adolescents with different feeding mode status. Multiple linear regression model was used to analyze the relationship between duration of breastfeeding (as a continuous variable) and BMI. And generalized linear model was used to analyze the relevance between duration of breastfeeding (as a categorical variable) and BMI. The relationship between duration of breastfeeding (as a continuous variable and categorical variable) and the prevalence of overweight and obesity was analyzed by Logistic regression analysis. The criterion for statistical significance was P value < 0.05.

3. Results

3.1 General Characteristics

A total of 11732 children and adolescents participated in this study, including 5860 boys (49.95%) and 5872 girls (50.05%). This study aimed to explore the relationship between duration of breastfeeding and overweight and obesity in children and adolescents. Therefore, after excluding underweight children (979), 10754 children and adolescents were finally included in the statistical analysis. Descriptive statistics of sociodemographic variables are shown in Table 1.

Table 1
The relationship between characteristics of the participants between breastfeeding duration in children and adolescents (aged 6 to 16) from Shibe District of Qingdao, China.

Shibei District of Qingdao, China.					
Duration of breastfeeding (months)					
	<12months (n 4573)		≥12months (n 6180)		
Characteristics	Mean or n	SD or %	Mean or n	SD or %	P value
Age ^a	9.45	2.27	9.24	2.22	<0.001
Sex ^b					
Male	2196	40.89	3174	59.11	0.001
Female	2377	44.16	3006	55.84	
Ethnicity ^b					
Han	4495	42.49	6084	57.51	0.536
Others	78	44.83	96	55.17	
Parity ^b					
First	4047	43.89	5174	56.11	<0.001
Others	526	34.33	1006	65.67	
Birth method ^b					
Vaginal delivery	1996	39.00	3122	61.00	<0.001
Cesarean delivery	2577	45.73	3058	54.27	
Gestational age at birth ^b					
Preterm birth	272	54.51	227	45.49	<0.001
Full-term birth	4100	41.77	5715	58.23	
Postterm birth	201	45.79	238	54.21	
Birth weight (kg) ^a	3.49	0.54	3.52	0.54	0.001
Birth height (cm) ^a	50.89	1.91	50.97	1.83	0.264
BMI (kg/m2) ^a	18.47	4.17	17.91	3.83	0.001
Body type ^b					
Normal	2762	41.71	3860	58.29	0.030
Overweight	795	43.85	1018	56.15	
Obesity	1016	43.83	1302	56.17	
Note: ^a , Student's t-test was XXXsed, the number indicate mean and SD; ^b , Chi-square(χ2) test was used, the number indicate percentage value.					

3.2 Relationship between duration of breastfeeding and BMI

The study found that after adjusting covariates, there was a significant negative correlation between the breastfeeding duration and BMI ($\beta=-0.025$, 95% CI: -0.033, -0.005, $P<0.01$). But this association was not found in overweight students. After classifying subjects into two groups according to their gender, it was also discovered that the negative correlation still existed between boys ($\beta=-0.040$, 95%CI: -0.052, -0.012, $P < 0.01$) and obese girls ($\beta=-0.105$, 95% CI: -0.141, -0.034, $P<0.01$). The BMI of all subjects who have been breastfed for more than 12 months is significantly lower than that who have less than 12 months after adjustment for covariates ($\beta=-0.274$, 95%CI: -0.422, -0.127, $P<0.01$), similarly the negative relationship also could be found in boys ($\beta=-0.440$, 95%CI -0.655,-0.224, $P<0.01$) (Table 2).

Table 2
Association of breastfeeding and in children and adolescents (6 to 16 years) BMI (kg/m²) from ShiBei District of Qingdao, China.

Population	Breastfeeding		All weight types		Overweight		Obesity	
			Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
			β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)
All	Continuous ^a		0.025	-0.025	-0.033	-0.038	-0.088	-0.091
			(-0.034, -0.006)**	(-0.033, -0.005)**	(-0.035, 0.006)	(-0.037, 0.004)	(-0.097, -0.035)**	(-0.100, -0.038)**
	Categorical ^b	<12months	ref	ref	ref	ref	ref	ref
		≥ 12 months	-0.284	-0.274	-0.172	-0.200	-0.419	-0.435
			(-0.432, -0.137)**	(-0.422, -0.127)**	(-0.380, 0.035)	(-0.409, 0.008)	(-0.740, -0.099)**	(-0.757, -0.114)**
In boys	Continuous ^a		-0.040	-0.040	-0.076	-0.084	-0.081	-0.082
			(-0.052, -0.012)**	(-0.052, -0.012)**	(-0.057, -0.006)**	(-0.061, -0.009)**	(-0.092, -0.020)*	(-0.094, -0.020)*
	Categorical ^b	<12months	ref	ref	ref	ref	ref	ref
		≥ 12 months	-0.441	-0.440	-0.372	-0.415	-0.445	-0.451
			(-0.657, -0.225)**	(-0.655, -0.224)**	(-0.639, -0.104)**	(-0.684, -0.146)**	(-0.830, -0.061)*	(-0.836, -0.066)*
In girls	Continuous ^a		-0.017	-0.017	0.014	0.010	-0.098	-0.105
			(-0.032, 0.007)	(-0.032, 0.007)	(-0.026, 0.040)	(-0.028, 0.038)	(-0.136, -0.029)**	(-0.141, -0.034)**
	Categorical ^b	<12months	ref	ref	ref	ref	ref	ref
		≥ 12 months	-0.196	-0.181	0.030	0.020	-0.402	-0.426
			(-0.394, 0.001)	(-0.379, 0.018)	(-0.294, 0.354)	(-0.304, 0.345)	(-0.953, 0.149)	(-0.981, 0.130)
Note: BMI, Body Mass Index; CI: confidence interval; ^a , Multiple liner regression was used to analyze the relationship between breastfeeding duration (as a continuous variable)								
and BMI; ^b , Generalized liner model was used to analyze the relationship between breastfeeding duration (as a categorical variable) and prevalence of overweight and obesity; All the models were adjusted for age, sex, ethnicity, parity, birth method, gestational age at birth, birth weight (kg), birth height (cm); *P<0.05, **P<0.01.								

3.3. Relationship between duration of breastfeeding and the prevalence of overweight/obesity

Among boys, the longer the breastfeeding duration was, the lower the prevalence of obesity would be (OR = 0.987, 95% CI: 0.974, 0.999, $P < 0.05$) in our study, after making adjustments to covariates. And the prevalence of obesity among participants whose breastfeeding durations were more than 12 months was significantly lower than participants who were breastfed for less than 12 months (OR = 0.853, 95% CI: 0.748, 0.974, $P < 0.05$) (Table 3). Among boys aged 9 to 11, a significant negative relationship between the duration of breastfeeding and the prevalence of obesity could be found (OR = 0.978, 95% CI: 0.958, 0.999, $P < 0.05$), and the prevalence of obesity was lower in participants who were breastfed for more than 12 months (OR = 0.787, 95% CI: 0.653, 0.975, $P < 0.05$). However, this association was not found in boys aged 6 to 8 and boys older than 12 (Table 4).

Table 3. Association of breastfeeding and the prevalence of overweight/obesity of children and adolescents (6 to 16 years) from Shibei District of Qingdao, China.

Population	Breast-feeding		Prevalence of overweight			Prevalence of obesity		
			n	Crude OR (95%CI)	Adjusted OR (95%CI)	n	Crude OR (95%CI)	Adjusted OR (95%CI)
All	Continuous		8365	0.996(0.986,1.006)	0.996(0.986,1.006)	8940	0.995(0.986,1.005)	0.998(0.988,1.007)
	Continuous	<12months	3487	ref	ref	3778	ref	ref
		≥12momths	4878	0.916(0.825,1.018)	0.918(0.826,1.021)	5162	0.917(0.834,1.009)	0.923(0.838,1.018)
In boys	Continuous		3990	0.992(0.978,1.006)	0.992(0.978,1.006)	4340	0.986(0.974,0.998)*	0.987(0.974,0.999)*
	Continuous	<12months	1599	ref	ref	1766	ref	ref
		≥12momths	2391	0.911(0.789,1.052)	0.932(0.805,1.078)	2574	0.856(0.752,0.974)*	0.853(0.748,0.974)*

Note: CI, confidence interval; OR, odds ratio; Logistic regression analysis was used to analyze the relationship between breastfeeding and prevalence of overweight and obesity. Adjusted for age, sex, ethnicity, parity, birth method, gestational age at birth, birth weight (kg), birth height (cm); *P<0.05.

Table 4. Association of breastfeeding duration and the prevalence of overweight and obesity of children and adolescents (6 to 16 years) in boys from Shibei District of Qingdao, China.

Age	Breast-feeding		Prevalence of overweight			Prevalence of obesity		
			n	Crude OR (95%CI)	Adjusted OR (95%CI)	n	Crude OR (95%CI)	Adjusted OR (95%CI)
6-8 years	Continuous		419	0.991(0.971,1.012)	0.990(0.970,1.011)	675	0.991(0.973,1.008)	0.989(0.971,1.007)
	<12months		160	ref	ref	263	ref	ref
	≥12momths		259	0.953(0.761,1.194)	0.948(0.756,1.189)	412	0.923(0.764,1.114)	0.896(0.740,1.085)
9-11 years	Continuous		398	0.991(0.969,1.014)	0.993(0.970,1.016)	525	0.974(0.954,0.994)*	0.978(0.958,0.999)*
	<12months		172	ref	ref	248	ref	ref
	≥12momths		226	0.868(0.688,1.095)	0.875(0.691,1.108)	277	0.738(0.598,0.910)*	0.787(0.653,0.975)*
≥12 years	Continuous		213	1.007(0.973,1.041)	1.009(0.974,1.044)	180	0.997(0.962,1.033)	0.999(0.964,1.035)
	<12months		98	ref	ref	86	ref	ref
	≥12momths		115	1.006(0.727,1.392)	1.009(0.727,1.400)	94	0.937(0.664,1.322)	0.921(0.650,1.306)

Note: CI, confidence interval; OR, odds ratio; Logistic regression analysis was used to analyze the relationship between breastfeeding duration and prevalence of overweight and obesity. Adjusted for age, sex, ethnicity, parity, birth method, gestational age at birth, birth weight (kg), birth height (cm); *P<0.05.

4. Discussion

WHO and United Nations International Children's Emergency Fund (UNICEF) recommend that breastfeeding be initiated within one hour of birth, that it continue with no other foods or liquids for the first six months of life, and be continued with complementary feeding until at least 24 months of age. Globally, the overall rate of EBF for infants under six months old is 40% in 2017 (16). But in China only 29.2% of the infants under 6 months were breastfed exclusively in 2017 (17). The problem of low breastfeeding rates is even more serious in the United States. For example, in 2015, the mean prevalence of women EBF their children by the age of six months was 24.9% in the United States (18). Currently, for 89.8% of children and adolescents in Shibei District of Qingdao, the breastfeeding duration is more than 6 months and 57.5% of children and adolescents' breastfeeding durations were more than 12 months, which is significantly higher than the overall level of the world. This decision of how long breastfeeding lasts is strongly influenced by economic, environmental, social, and political factors, such as inadequate healthcare support, marketing of baby foods, and workplace support for women (16). In addition, our study indicated that infants who are non-first birth or vaginal delivery are more likely to breastfeed for more than 12 months. A similar conclusion was reached in Du Li et al.'s study (19). This may have to do with the fact that infants delivered normally are more likely to stimulate breast milk secretion, and that mothers with two or multiple children are more aware of the advantages of breastfeeding.

Up to now, most studies have confirmed that prolonging the time of breastfeeding in infancy can reduce the prevalence of overweight and obesity in children and adolescents. For example, studies conducted in Hong Kong (20) and Spain (21) suggested that the BMI of formula-fed infants increased faster than breastfed infants. And Spain's birth cohort study also found that babies in the region who have never been breastfed will have a 7.8% increased risk of childhood obesity and overweight, and that every week of breastfeeding will reduce their childhood BMI by 3.5% (21). Our study proved that the longer breastfeeding duration was during infancy, the lower the BMI would be in childhood and adolescent years. But in a cohort study involving 5 years old Swedish children, Huus et al. found no relationship between EBF and the risk of overweight including obesity (OR = 1.22; 95%CI: 0.81-1.83) (22).

Durmus et al. also reported similar findings (OR = 1.20; 95%CI: 0.98-1.47) in Dutch children at the age of 3 (14). These inconsistency in the results of different studies may be attributed to children's age, parental country of birth, parental age, parental smoking, education and cultural differences (22). The related biological mechanism of obesity in children may be closely related to protein intake and energy metabolism. First, the hormones in breast milk, such as leptin, ghrelin, and adiponectin, were identified to be involved in energy balance regulation and to protect children from obesity (23). Second, infant formula generally has a higher protein content than breastmilk, and protein intakes in excess of metabolic needs in early life may stimulate the secretion of insulin and insulin like growth factor type one, which in turn, promotes weight gain in infancy (24). Finally, breastfed infants are more likely to accept low-calorie complementary foods such as vegetables, and tend to form a low-calorie diet in later stages, thus reducing the total dietary calorie intake of children and adolescents (25).

In recently published articles, consensus has not been reached about the time at which breastfeeding significantly reduces the incidence of overweight and obesity in children. For example, Fallahzadeh et al. found that breastfeeding for more than 24 months was a protective factor for children overweight (26). Australian researchers conducted a survey on 2868 infants and found that children breastfed for less than 4 months had a significantly increased risk of childhood weight exceeding the 95th percentile of children of the same age and sex (27). The research in Croatia indicated that breastfeeding for more than 6 months is a protective factor for overweight and obesity in children aged 6 to 11 (28). But our study considered infants who were breastfed for more than 12 months were significantly less likely to be overweight and obese in childhood and adolescent years. At present, the reasons for the differences in the optimal timing of breastfeeding in different studies are still unclear.

In addition, we discovered that prolonged breastfeeding could reduce the prevalence of childhood obesity, especially among boys aged 9 to 11. A longitudinal study with 1,037 children, Poulton and Williams also pointed out that the protective effects of breastfeeding on childhood overweight were relatively weak up to the age of 7 years and then strengthened in the late childhood (at the age of 9 to 11) (29). Meanwhile, from German logistic regression analyses which classified subjects into age groups, also indicated that the protective effects of breastfeeding is the most significant at the age of 7 to 10 (30). The reason why this correlation is more obviously in boys may be due to girls' intrinsically high insulin resistance. Girls have been found to have higher levels of triglycerides and lower concentrations of high density lipoprotein than boys of the same age, which indicates that metabolic disturbances are more advanced in girls than in boys (31).

Surely, there are some limitations in the present study. First, the participants in this study is only from Shibei district of Qingdao, which may have selection bias and the questionnaire response rate is 38%. However, the sample size of this study is large, and it is still representative to a certain extent. Second, part of the data in this study were collected through questionnaires, which is prone to recall bias. We excluded the data with missing variables, which reduced the recall bias to a certain extent. Third, due to the lack of data of the weight of parents, BMI of parents was not included in the multivariate statistical analysis, but other confounding factors such as maternal pregnancy and birth history were included in the analysis, and a variety of stratified analysis was conducted on the data, and the results of the study were stable and reliable.

5. Conclusions

In this study, 1.5% of participants had never been breastfed, 89.8% for more than 6 months and 57.5% for more than 12 months. So it suggested that the current status of breastfeeding in Shibei District of Qingdao is significantly higher than other regions. And it also indicated that children and adolescents who were breastfed for more than a year had a lower risk of developing overweight and obesity, especially in boys between the age of 9 to 11. Therefore, enhancing the awareness of breastfeeding and prolonging breastfeeding duration for more than one year in the current social background is of great significance to public health in China for the prevention and control of obesity in children and adolescents.

List Of Abbreviations

BMI
body mass index
EBF
exclusive breastfeeding
WHO
World Health Organization
UNICEF
United Nations International Children's Emergency Fund.

Declarations

Informed Consent: The study has obtained the informed consent of all subjects and their legal guardians.

Acknowledgments and Consent for Publication: No need any administrative permissions were required in order to access and use the medical records described in their retrospective study.

Guidelines: In accordance with the requirements of Qingdao Municipal Center for Disease Control and Prevention [2017] No. 29 document, we had collected data related to this research.

Approval of ethics committee and consent: This study is a retrospective research and based on the requirements of Qingdao Municipal Center for Disease Control and Prevention [2017] No. 29 document. So we has not been granted ethics committee approval prior to commencing.

Availability of data and materials: All data generated and analyzed during this study are included in this published article.

Conflicts of Interest: The author has no conflicts of interest to declare.

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Authors' contributions: FEL, DL and WCH designed this research and analyzed and interpreted the data and were major contributor in writing the manuscript. LMW, XYF, ZRJ and WDL participated in the collection and assembly of data and revised the manuscript. All authors read and approved the final manuscript.

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