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Prevalence And Risk Factors Associated With Overweight And Obesity Among Under 5 Years' Children In Bangladesh

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Abstract
Childhood obesity is one of the serious public health problems of 21st century. The prevalence has increased at an alarming rate and the problem is gradually affecting many developing countries including Bangladesh. The main objective of this study is to evaluate the prevalence and identify the risk factors of overweight and obesity among under-five year children in Bangladesh. This study obtained data from Bangladesh Demographic and Health Survey conducted in 2017-18. The final dataset of this study consists of 7672 children under the age of 5 years. Risk factors were identified by using quantile regression model. This study found age between 7-23 months, male gender, low birth rank, being Muslim, higher wealth indexes, housewife mother, high maternal BMI and age, father's higher education, living in the rural area and Children from Dhaka division as the risk factors of overweight or obesity.

Key Words: *Prevalence, Overweight, Obesity, Quantile regression, Body Mass Index*

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I. Introduction

Childhood obesity means excess body fat that harmfully affects a child's health (Kopelman et al., 2005). It is one of the serious public health problems of 21st century (Kopelman et al., 2009). The prevalence has increased at an alarming rate (Shahoo et al., 2015). The highest rate of childhood obesity has been detected in developed countries particularly the United States, Canada, Australia and many European countries (Wang & Lobstein (2006)). The problem is gradually affecting many developing countries including Bangladesh, particularly in urban area (Sultana, 2010). Obesity is concerning as overweight and obese children have more possibility to become overweight and obese in adults that can cause a number of life threatening diseases like diabetes, coronary heart disease, hypertension, stroke, certain types of cancer etc (CDC, 2022). This could lead to early death and disability in later life (WHO, 2014). Previous researchers have discovered that obesity impaired the immune system, increase infectious diseases, decreases lung capacity and increases the threat of severe illness from COVID-19 (CDC, 2022). There is also a link between menstrual disorders, diabetes and infertility with obesity in young girls (Lake et al., 1997).

Globally, the prevalence of overweight increased three times between 1975 and 2016 (WHO, 2022). In 2019, 38.2 million children under 5 years of age were overweight or obese. Among them almost half of the children existed in Asia (WHO, 2021). Recent study has reported 3% prevalence of childhood overweight among under 5 Bangladeshi children (Ahmed & Yunus, 2021). Childhood overweight or obesity is rapidly growing for urbanization, economic and demographic changes (Popkin, 2001). Genetic facts, less physical activity, lifestyle behaviors such as too much tv watching or using electric device are related to increase the risk of overweight and obesity (Guo et al., 2013).

Body Mass Index (BMI) Z-score is a screening tool for identifying underweight, overweight, obese or a healthy child (Yirga et al., 2018). According to World Health Organization, BMI Z-score cut-points of $< -2, > 1, > 2, > 3$ are recommended for under 5 years of children for classifying underweight, at risk of overweight, overweight and obese respectively (Onis & Lobstein, 2010). Several studies examine the determinants of overweight or obesity in the developed country but the evidence from developing countries especially in Bangladesh is small. All of those studies carry out their analysis by using linear regression or logistic regression model (Gamal et al., 2020; Mears et al., 2020; Liang et al., 2021). But both models give the estimate of covariates based upon the mean of the dependent variable (BMI Z-score). Also the estimates are influenced by outlier (Hossain, 2017). In addition, covariates are not homogeneous through the distribution of BMI Z-score and their influence can differ across the quantiles of BMI Z-score. Furthermore, Overweight and obese children are at the upper tail of the distribution of BMI Z-score, not in the middle. Quantile regression

model can estimate the effect of covariate at any percentile of the distribution of BMI Z-score (Stifel & Averett, 2009). Therefore, the main objective of this study is to evaluate the prevalence and identify the risk factors of overweight and obesity among under-five year Bangladeshi children by using quantile regression model.

II. Materials And Methods

Data and variables

This study obtained data from Bangladesh Demographic and Health Survey conducted in 2017-18. This survey was carried out by the collaboration between NIPORT, Mitra & Associates, and ICF International whose one of the main objective was to provide up-to-date information on maternal and child health, including nutritional status. The data consists of 7859 children under the age of 5 years. After cleaning the missing values and flagged cases of related variable, the dataset comprises information on 7672 children. To make the country representative sample, the authors use a weighted sample child before starting the analysis.

The body mass index (BMI) Z-score is the dependent variable, and the independent variables are child characteristics such as age, sex, birth order, twin or multiple birth, religion; parental attributes such as mother's current age (Years), mother's age at first birth, mother's BMI, mother currently working, parental educational qualification, and characteristics related to the household and health for instance wealth index, division, residence, household head's sex, had diarrhea recently, had fever in last two weeks.

Quantile regression

To assess the relationship between BMI Z-score and covariates Quantile Regression (QR) analyses was used. The multiple QR model for each quantile τ is defined as:

$$Q_\tau(y|X) = X\,\beta(\tau) + e$$

where $Q_\tau(y|X)$ is the quantile function of the outcome y for a fixed quantile parameter $\tau\boldsymbol{\varepsilon}(0,1)$, $X_{[n\times m]}$ is the matrix with sample size n and m covariates (assumed), $\beta(\tau)$ are the Quantile Regression parameters at quantile level τ and e is the error term.

The parameters of the Quantile Regression model were estimated by minimizing the weighted absolute sum of deviations (Davino et al., 2013). We used seven quantile parameters, τ{0.074, 0. 25, 0.5, 0.75, 0.905, 0977, 0993}.The four values τ = 0.074, τ = 0.905, τ = 0.977 and τ = 0.993 were chosen because the Z-score was estimated at 7.4%, 90.5%, 97.7% and 99.3% quantiles for underweight, at risk of overweight, overweight and obese respectively corresponding to -2 SD, 1 SD, 2 SD and 3 SD on the reference BMI Z-score distribution.

III. Results

Table 1 shows the summary of child, parental, household and health related characteristics among the study participants with 95% confidence interval for the proportions. The study depicts that 7.4% of the children are at risk of overweight, while 1.8% and 0.7% are overweight and obese respectively. The rate of underweight among under 5 children is 7.3%. Results show that in the study male children are more than half (52.2%), the majorities (73.8%) are from rural areas, around one-quarters (24.7%) are from Dhaka, and about 42.3% are poor. The only 13% of the household's head are women. About 43.5% of mothers have given first birth before 18 years of age. The following Table 1 also exhibits that about 64% mothers have secondary or higher education.

The distributions of the BMI Z-scores are tested by examining descriptive statistics, box plots, density plots, and Kolmogorov-Smirnov tests. Figure 1 and Table 2 show that the BMI Z- score is positively skewed and contains outlier values. Kolmogorov-Smirnov test conforms that the data do not follow normal distribution (Table 3). Therefore, the non-parametric tests and robust regression models are more appropriate for examining the risk factors of childhood overweight in Bangladesh. Hence, to examine bivariate association, the nonparametric Kruskal-Wallis test is used instead of using parametric ANOVA test. The quantile regression model is selected because it provides an unbiased estimate when the data doesn't follow the assumption of normal distribution and also generates robust conditional estimates in the presence of outlier.

Table 4 presents the mean BMI Z-score through different levels of independent variable as well as Kruskal-Wallis test's result. Kruskal-Wallis test shows median BMI Z-scores significantly differ with various levels of child's age, birth order, mother's current age, mother's age at 1st birth, mother's BMI, parent's education, division, residence, wealth index, sex of household head and had fever in last two weeks. The mean BMI Z-score of under 5 children is detected to be highest among 13th to 23th month children. Female children's mean BMI Z-score (-0.426) is smaller compared to male children (-0.404).

Table 1: Background characteristics of study participants, BDHS 2017-18 (n = 7639 (weighted sample)).

Background Characteristics		Frequency (%)	95% C.I.
BMI Z-score category			
Underweight		554 (7.3)	(6.8 - 8)
Normal		6326 (82.8)	(81.8 – 83.5)
risk-of-overweight		564 (7.4)	(6.8 - 8)
Overweight		140 (1.8)	(1.6 – 2.2)
Obese		55 (0.7)	(0.5 – 0.9)
Child Characteristics			
Age(in months)	≤6	1027 (13.4)	(12.7 – 14.3)
	7–12	784 (10.3)	(9.6 – 11)
	13–23	1458 (19.1)	(18 – 19.8)
	24–35	1484 (19.4)	(18.7 – 20.5)
	36–47	1421 (18.6)	(17.9 – 19.6)
	48–59	1465 (19.2)	(18.1 – 19.9)
Sex	Male	3990 (52.2)	(51.3 – 53.6)
	Female	3649 (47.8)	(46.4 – 48.7)
Birth order	1st	2896 (37.9)	(37 – 39.2)
	2nd-3rd	3794 (49.7)	(48.3 – 50.5)
	4th or higher	948 (12.4)	(11.8 – 13.3)
Child is twin	No	7518 (98.4)	(98.1 – 98.7)
	Yes	121 (1.6)	(1.3 – 1.9)
Religion	Muslim	7000 (91.6)	(91.1 – 92.3)
	Non-Muslim	639 (8.4)	(7.7 – 8.9)
Parental Characteristics			
Mother's current age (Years)	≤ 18	653 (7.4)	(6.7 - 7.9)
	19 – 24	3086 (40.4)	(39.7 – 41.9)
	25–34	3424 (44.8)	(43.6 – 45.8)
	35 or more	566 (7.4)	(6.7 – 7.9)
Mother's age at first birth	< 18	3319 (43.5)	(57.2 – 59.4)
	18 or more	4320 (56.5)	(40.6 – 42.8)
Mother's BMI	Underweight (<18.5)	1070 (14)	(13.6 – 15.2)
	Normal (18.5–24.9)	4613 (60.4)	(59.2 – 61.4)
	Overweight (≥ 25)	1955 (25.6)	(24.3 – 26.3)
Mother currently working	No	4573 (59.9)	(59.2 – 61.4)
	yes	3066 (40.1)	(38.6 – 40.8)
Mother's education level	No education	535 (7)	(6.6 – 7.8)
	Primary	2181 (28.5)	(28.2 – 30.2)
	Secondary	3742 (49)	(47.7 – 50)
	Higher	1181 (15.5)	(14 – 15.6)
Father's education level	No education	1140 (14.9)	(14.2 – 15.8)
	Primary	2651 (34.7)	(34.1 – 36.2)
	Secondary	2533 (33.2)	(32.3 – 34.4)
	Higher	1315 (17.2)	(15.7 – 17.4)
Household and Health Characteristics			
Wealth index	Poor	3231 (42.3)	(41.9 – 44.1)
	Middle	1458 (19.1)	(18 – 19.8)
	Rich	2950 (38.6)	(37 – 39.2)
Division	Barisal	430 (5.6)	(6.3 – 7.5)
	Chittagong	1574 (20.6)	(18.9 – 20.7)
	Dhaka	1886 (24.7)	(24.3 – 26.2)
	Khulna	720 (9.4)	(8.5 – 9.8)
	Mymensingh	652 (8.5)	(8.6 – 9.9)
	Rajshahi	895 (11.7)	(9.5 – 10.8)_
	Rangpur	840 (11)	(8.4 – 9.6)
	Sylhet	641 (8.4)	(9.9 – 11.3)
Residence	Urban	2004 (26.2)	(23.6 – 25.5)
	Rural	5635 (73.8)	(74.5 – 76.4)

Household head's sex	Male	6647 (87)	(86.2 – 87.7)
	Female	992 (13)	(12.3 – 13.8)
Had diarrhea recently	No	7260 (95)	(94.6 – 95.6)
	Yes	376 (4.9)	(4.4 – 5.4)
Had fever in last two weeks	No	5061 (66.2)	(64.8 – 67)
	Yes	2578 (33.8)	(33 – 35.2)

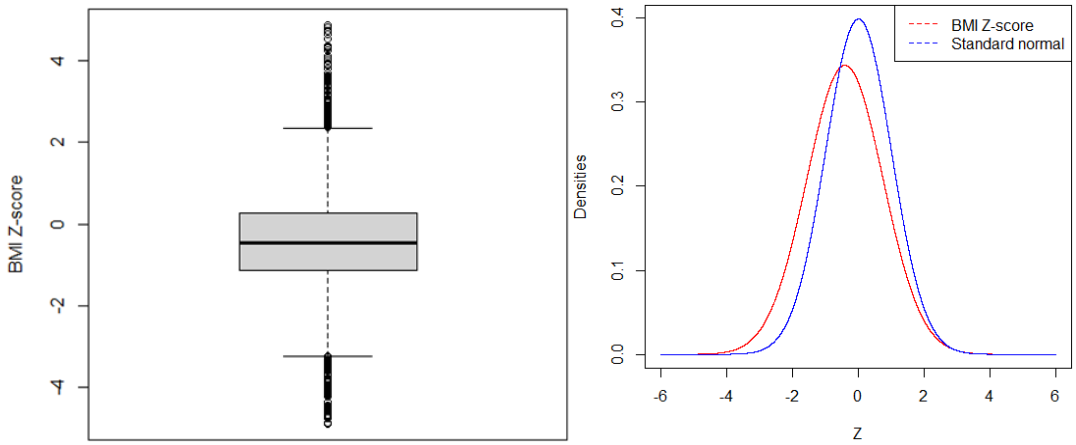


Figure 1: Box-plot and density plot of BMI Z-score

Table 2: Summary statistics of BMI Z-score.

Mean	SD	Min	Max	Skewness	Kurtosis	Percentiles			
						7.4	90.51	97.7	99.36
-0.414	1.156	-4.9	4.88	0.273	1.272	-2	1	2	3

Table 3: Kolmogorov-Smirnov test.

Hypothesis	Test Statistic	P-value
H_0: The data follow normal distribution	0.636	<0.001

The mean BMI Z-score is inversely related with child's birth order. Twin or multiple birth children are observed to be lower BMI Z-scores. The mean BMI Z-score of children is detected to be maximum among children of respondents from the Dhaka division (-0.287), whereas it is minimum among those from the Sylhet division (− 0.548). Rural children tend to be lower level of BMI Z-score (-0.427) compared to Urban children (-0.378). Children's BMI Z-score are higher among parent with the highest wealth status and higher level of education. The mean BMI Z-score of the children has a positive relationship with the mother's age at first birth and BMI (Table 4).

Table 4: Mean BMI Z-score and Kruskal-Wallis test results by background characteristics.

Variables		**Mean**	**Chi-square**	**P-value**
Child Characteristics				
Age(in months)	≤6	-.507	198.03	<0.001
	7–12	-.283		
	13–23	-.204		
	24–35	-.325		
	36–47	-.478		
	48–59	-.658		
Sex	Male	-.404	0.176	0.675
	Female	-.426		
Birth order	1st	-.355	17.067	<0.001
	2nd-3rd	-.442		
	4th or higher	-.487		
Child is twin	No	-.411	3.197	0.073
	Yes	-.651		
Religion	Muslim	-.419	0.095	0.758
	Non-Muslim	-.356		
Parental Characteristics				
Mother's current	≤ 18	-.499	16.378	<0.001

age (Years)	19 – 24	-.365		
	25–34	-.423		
	35 or more	-.549		
Mother's age at first birth	< 18	-.473	12.654	<0.001
	18 or more	-.332		
Mother's BMI	Underweight (<18.5)	-.692	101.54	<0.001
	Normal (18.5–24.9)	-.424		
	Overweight (≥ 25)	-.239		
Mother currently working	No	-.398	1.699	0.192
	yes	-.432		
Mother's education level	No education	-0.587	49.315	<0.001
	Primary	-.474		
	Secondary	-.421		
	Higher	-.205		
Father's education level	No education	-.475	34.436	<0.001
	Primary	-.479		
	Secondary	-.404		
	Higher	-.253		
Household and Health Characteristics				
Wealth index	Poor	-.485	30.55	0.001
	Middle	-.432		
	Rich	-.328		
Division	Barisal	-.455	16.605	0.02
	Chittagong	-.405		
	Dhaka	-.287		
	Khulna	-.467		
	Mymensingh	-.475		
	Rajshahi	-.476		
	Rangpur	-.438		
	Sylhet	-.548		
Residence	Urban	-.378	3.887	0.048
	Rural	-.427		
Household head's sex	Male	-.428	5.154	0.023
	Female	-.324		
Had diarrhea recently	No	-.419	3.353	0.0673
	Yes	-.332		
Had fever in last two weeks	No	-.374	27.77	<0.001
	Yes	-.493		

Table 5 illustrates the test results of the significance of running different quantile regression models. Since for all hypotheses considered in this study P − value < 0.05 indicates the test significantly rejects equality of the estimated coefficients for the quantiles in each case at 5% level of significance. That is, different quantile regression model approach is appropriate in this study.

Table 5: Test of equality of slope at different quantile regression models

Hypothesis	**F(36,15308)**	**P-value**
$Q_{7.4} = Q_{25}$	3.049	<0.001
$Q_{7.4} = Q_{50}$	5.276	<0.001
$Q_{7.4} = Q_{75}$	8.302	<0.001
$Q_{7.4} = Q_{90.51}$	6.812	<0.001
$Q_{7.4} = Q_{97.7}$	14.447	<0.001
$Q_{7.4} = Q_{99.36}$	12.809	<0.001
$Q_{25} = Q_{50}$	1.878	<0.001
$Q_{25} = Q_{75}$	3.434	<0.001
$Q_{25} = Q_{90.51}$	3.884	<0.001
$Q_{25} = Q_{97.7}$	11.979	<0.001
$Q_{25} = Q_{99.36}$	11.069	<0.001
$Q_{50} = Q_{75}$	2.291	<0.001
$Q_{50} = Q_{90.51}$	3.009	<0.001
$Q_{50} = Q_{97.7}$	14.592	<0.001
$Q_{50} = Q_{99.36}$	11.121	<0.001
$Q_{75} = Q_{90.51}$	1.756	0.003
$Q_{75} = Q_{97.7}$	10.566	<0.001
$Q_{75} = Q_{99.36}$	8.805	<0.001

$Q_{90.51} = Qq_{97.7}$	7.517	<0.001
$Q_{90.51} = Q_{99.36}$	6.738	<0.001
$Q_{97.7} = Q_{99.36}$	3.175	<0.001

Table 6 represents the QR model results through different quantiles. It was revealed from Table 6 that children aged 7 to 23 months had higher BMI Z-score than those aged 6 months or younger. The coefficient significantly changes from 0.449 to -1.037 for the quantile varies from 7.4th to 99.3th for the children whose age lies between 48–59 months. This implies that overweight and obesity were significantly higher among 7 to 23 months' children but significantly lower among 48 to 59 month children compared to those age 6 months or younger. Sex of a child had a significant effect on the BMI Z-score, except at the 25th and 50th quantile. Female children had lower BMI Z-score at upper quantile but higher score at lower quantile compared to male children. This implies that females have lower tendency to be overweight and obese in Bangladesh.

A statistically significant inverse relationship between the BMI Z-score and the child's birth order was found for the 4th or higher birth order at the 99.3th quantile as well as for the 2nd and 3rd births order at the 75th, 90.5th and 99th quantiles. This reveals that increased birth order, was significantly associated with the decrease risk of overweight and obesity. It can also be seen that twin or multiple children have a negative effect on the conditional distribution of BMI Z-score. For twin or multiple children, the effect on BMI Z-score firstly increases but gradually decreases after the 50th quantile. Results also show that non-Muslim children had significantly lower BMI Z-score than their counterparts at 99.3th quantile only. This means that obesity is significantly lower among non-Muslim children compared to Muslim children.

The effect of mother's current age was positively significant only at the 99.3th quantile levels of the BMI Z-score distribution which indicates that obesity is associated with higher current age of mother. Working mother's children have significantly lower BMI Z-score than their counterpart at the 97.7th and 99.3th quantile point. This would mean that children whose mother are working tend to be less overweight and obese than children whose mother are housewife. Furthermore, parental education had a significant effect on the conditional BMI Z-score distribution. Compared to children of illiterate parents, the higher educated mother's children show a significantly higher BMI Z-score in the 25th, 50th and 75th quantile which indicate that mother with higher levels of education have healthy children. This happens because higher educated mothers are more aware of the dangers of overweight or obesity. In contrast, Children of fathers with higher education illustrates significant positive coefficient in the 97.7th quantile only.

Moreover, mother's BMI exhibit significant positive coefficients through all quantiles, signifying that higher maternal BMI are related with higher BMI Z-scores of their children. That is, childhood overweight or obesity was connected to maternal obesity. Additionally, the wealth index was significantly related with the BMI Z-score in the upper quartile of the distribution. Children from the richest families were 0.126 and 0.305 points higher BMI Z-score than those from the poorest families at 90.5th and 99.3th quantile respectively. This is an expected result because people can spend more on various unhealthy foods for their children if their income is high. Also, outside of the Dhaka division's children shows significant negative coefficients from 75th quartile to upper quartile suggesting lower BMI Z-score compared to the Dhaka division children.

It is also observed from Table 6 that children living in rural area were .255 points lower BMI Z-score than their urban counterparts at the 99.3th quantile. That is, greater prevalence of obesity amongst urban area's children compared to those from rural area. At 50th quantile, female-headed household's children reveals positive coefficient indicating a higher BMI Z-score in median compared to male-headed household's children. A Children's BMI Z-score is also connected with his or her current health status, as a child who has fever in last two weeks have significantly lower BMI Z-score than a healthy child except at the 97.7th and 99.3th quantiles.

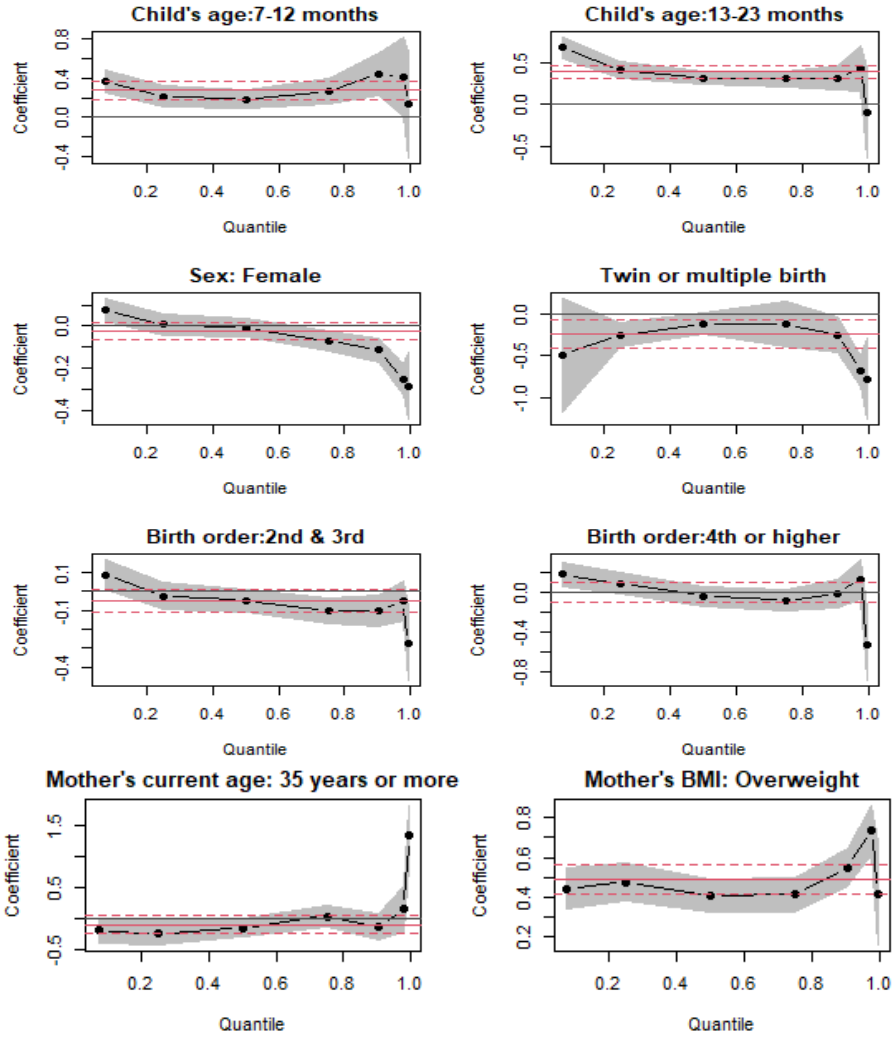
Table 6: Results of Quantile regression model of BMI Z-score for under-5 Bangladeshi children.

Variable		**Quantile regression analysis**						
		$Q_{7.4}$ Estimate (se)	**Q_{25} Estimate (se)**	**Q_{50} Estimate (se)**	**Q_{75} Estimate (se)**	**$Q_{90.5}$ Estimate (se)**	**$Q_{97.7}$ Estimate (se)**	**$Q_{99.3}$ Estimate (se)**
Intercept		-2.808*** (0.159)	-1.550*** 0.157	-0.604*** 0.110	0.042 0.119	0.921*** 0.168	2.065*** 0.273	3.112*** 0.507
Child Characteristics								
Age (in months)	≤6 (Ref)							
	7–12	0.369*** 0.072	0.213*** 0.064	0.184*** 0.055	0.268*** 0.076	0.439*** 0.129	0.417 0.247	0.129 0.334
	13–23	0.672*** 0.080	0.406*** 0.059	0.316*** 0.047	0.300*** 0.055	0.314*** 0.084	0.424** 0.162	-0.103 0.330
	24–35	0.547*** 0.074	0.262*** 0.061	0.154*** 0.048	0.107* 0.050	0.071 0.085	0.079 0.165	-0.098 0.408
	36–47	0.498*** 0.072	0.146* 0.063	-0.037 0.045	-0.165** 0.053	-0.212* 0.092	-0.187 0.166	-0.529 0.337

	48–59	0.449*** 0.058	-0.011 0.062	-0.219*** 0.046	- 0.402** * 0.046	-0.412*** 0.086	-0.459** 0.166	-1.037** 0.343
Sex	Male (Ref)							
	Female	0.078* 0.033	0.006 0.030	-0.008 0.026	-0.070* 0.028	-0.115*** 0.034	- 0.257** * 0.045	-0.286** 0.096
Birth order	1st (Ref)							
	2nd-3rd	0.088 0.049	-0.025 0.043	-0.048 0.037	-0.104* 0.041	-0.103* 0.050	-0.049 0.065	-0.277* 0.118
	4th or higher	0.182* 0.077	0.09313 0.068	-0.035 0.061	-0.077 0.063	-0.012 0.091	0.137 0.123	-0.531* 0.223
Child is twin	No (Ref)							
	Yes	-0.489 0.417	-0.252** 0.088	-0.111 0.079	-0.120 0.169	-0.249* 0.127	- 0.679** * 0.113	-0.777** 0.299
Religion	Muslim (Ref)							
	Non-Muslim	0.069 0.047	0.032 0.051	0.036 0.049	0.003 0.059	0.038 0.041	-0.194* 0.08	-0.451** 0.165
Parental Characteristics								
Mother's current age (Years)	≤ 18 (Ref)							
	19 – 24	0.117 0.091	0.019 0.089	0.006 0.055	0.128 0.066	0.021 0.088	0.132 0.089	0.578** 0.211
	25–34	-0.048 0.104	-0.110 0.098	-0.045 0.067	0.134 0.079	-0.019 0.099	0.086 0.128	1.043** * 0.256
	35 or more	-0.193 0.125	-0.236 0.120	-0.149 0.085	0.038 0.102	-0.133 0.125	0.148 0.224	1.338** * 0.299
Mother's age at first birth	≤ 18 (Ref)							
	19 or more	0.069 0.042	0.026 0.0362	0.024 0.032	-0.001 0.0356	0.056 0.043	0.093 0.064	0.109 0.127
Mother's BMI	Underweight (<18.5) (Ref)							
	Normal (18.5–24.9)	0.303*** 0.058	0.312*** 0.048	0.263*** 0.044	0.227** * 0.041	0.280*** 0.046	0.157** 0.061	-0.004 0.143
	Overweight (≥ 25)	0.444*** 0.063	0.476*** 0.056	0.412*** 0.049	0.415** * 0.052	0.550*** 0.058	0.737** * 0.076	0.419** 0.157
Mother currently working	No (Ref)							
	Yes	0.039 0.038	0.012 0.034	0.030 0.029	0.059 0.031	-0.003 0.038	- 0.239** * 0.050	- 0.421** * 0.096
Mother's education level	No education (Ref)							
	Primary	0.041 0.054	0.016 0.061	0.098* 0.047	0.176** 0.057	0.112 0.069	0.282 0.183	-0.114 0.1896
	Secondary	0.018 0.064	0.048 0.062	0.058 0.049	0.105 0.059	0.004 0.070	0.129 0.189	0.062 0.205
	Higher	0.119 0.078	0.157* 0.079	0.134* 0.066	0.236** 0.077	0.159 0.086	-0.006 0.197	-0.184 0.232
Father's education level	No education (Ref)							
	Primary	-0.023 0.053	-0.009 0.051	-0.100* 0.04	-0.081 0.043	-0.099 0.059	-0.023 0.072	-0.231 0.256
	Secondary	-0.037 0.051	-0.037 0.056	-0.099* 0.044	-0.044 0.049	-0.079 0.066	0.157** 0.060	-0.019 0.271
	Higher	0.088 0.076	-0.004 0.068	-0.050 0.058	0.008 0.064	0.041 0.085	0.558** * 0.092	0.044 0.309
Household and Health Characteristics								
Wealth index	Poor (Ref)							
	Middle	0.018 0.052	-0.013 0.041	-0.009 0.036	-0.020 0.036	-0.051 0.049	-0.194* 0.081	-0.287 0.150
	Rich	-0.060 0.052	-0.022 0.045	0.045 0.039	0.053 0.043	0.126* 0.054	-0.009 0.072	0.305* 0.134
Division	Dhaka (Ref)							
	Barisal	-0.070 0.077	0.008 0.070	-0.042 0.053	-0.148* 0.058	-0.165 0.104	- 0.436** * 0.085	- 0.688** * 0.2
	Chittagong	0.022 0.066	-0.064 0.062	-0.062 0.051	-0.159** 0.052	-0.202* 0.094	- 0.488** * 0.142	- 0.646** * 0.165
	Khulna	-0.009 0.061	-0.092 0.067	0.012 0.057	-0.117* 0.059	-0.199* 0.100	- 0.655**	-0.517** 0.191

							* 0.104	
	Mymensinh	-0.068 0.080	-0.078 0.069	0.006 0.056	-0.102 0.059	-0.239* 0.104	- 0.595** * 0.089	- 0.679** * 0.206
	Rajshahi	-0.019 0.065	-0.084 0.071	-0.046 0.05	-0.196** 0.059	-0.304** 0.101	- 0.907** * 0.079	- 0.886** * 0.182
	Rangpur	0.043 0.067	0.004 0.063	-0.005 0.053	-0.160** 0.056	-0.307*** 0.090	- 0.860** * 0.099	- 0.995** * 0.165
	Sylhet	-0.140 0.087	-0.089 0.066	-0.075 0.054	-0.132* 0.059	-0.261*** 0.088	- 0.829** * 0.066	- 1.126** * 0.171
Residence	Urban (Ref)							
	Rural	0.043 0.039	0.022 0.038	0.011 0.030	-0.026 0.033	0.039 0.041	-0.062 0.062	-0.255* 0.110
Household head's sex	Male (Ref)							
	Female	0.085 0.044	0.082 0.042	0.083*** 0.037	0.092 0.055	0.043 0.035	0.028 0.070	-0.187 0.167
Had diarrhea recently	No (Ref)							
	Yes	-0.015 0.098	0.041 0.093	-0.085 0.067	-0.012 0.068	-0.034 0.066	0.055 0.091	0.072 0.119
Had fever in last two weeks	No (Ref)							
	Yes	-0.191*** 0.037	-0.189*** 0.034	-0.180*** 0.027	- 0.131** * 0.031	-0.089* 0.040	-0.072 0.046	0.053 0.090

Notes: Ref.: Reference category; ***refers p-value <0.001; ** refers p-value <0.01 and; * refers p-value <0.05.



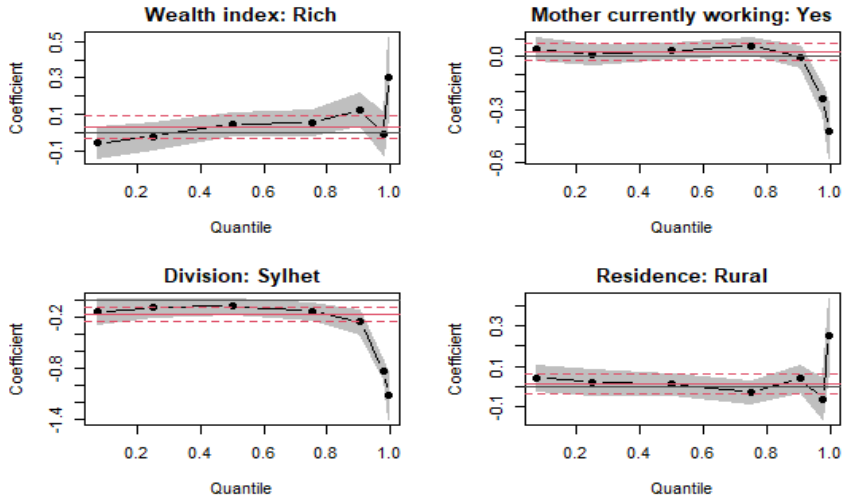


Figure 2: Coefficient plot of significant covariates obtained from quantile regression models

Figure 2 presents the coefficients of some selected significant covariates for overweight and obesity obtained by using 7.4th, 25th, 50th, 75th, 90.5th, 97.7th and 99.3th quantile regression models of BMI Z-score. The figure also reveals that the coefficients vary through quantiles.

IV. Discussion

This study was carried out to estimate the prevalence of overweight or obesity among under-five children in Bangladesh and determine potential risk factors of overweight or obesity in this population by using quantile regression model which study the impact of covariates on different quantiles of the response variable (BMI Z-score). Result shows that 2.5% of the under 5 children in Bangladesh were obese or overweight. Overweight and obesity were significantly higher among 7 to 23 months' children compared to those age 6 months or younger. Findings demonstrated that females have lower tendency to be overweight and obese in Bangladesh. These findings are in accordance with some previous study reported obesity was higher among the males compared to females (Gamal et al., 2020, Hong et al., 2016, Bjelanovic et al., 2017). Present study shows that being a single child was a risk factor of overweight and obesity which is consistent with previous study (Liang et al., 2021).

A previous study conducted in the Greek island indicated that maternal obesity and maternal occupation were risk factors of childhood obesity (Athanasopoulos et al., 2011). A study published in the USA stated that childhood obesity was linked to parental obesity (Bouchard, 2009). The present study also found that childhood obesity was associated with maternal obesity and maternal occupation which supporting previous reports.

In the current study, mother's education was not a significant predictor of overweight or obesity in the studied children. These finding is supported by previous studies (Martorell et al., 2000; Bhuiyan et al., 2013). A positive relationship between overweight or obesity with higher wealth index as well as urban residence have been reported in this study. This results are in line with previous developing countries studies that found the similar risk factors (Gupta et al., 2012; Kelishadi, 2007).

Furthermore, religion, mother's current age, father's education, and division were also found significantly associated with childhood overweight or obesity in the present study, while other variables like mother's age at first birth, sex of household head, and current health status were not significant.

Finally, this study used a nationally representative sample with data weighted for accounting the unequal probability sampling in different strata, so the results are generalizable for all under 5 Bangladeshi children. Previous study shows less physical activity, lifestyle behaviors, nutritional characteristics such as dietary habits are related to increase the risk of overweight and obesity but these can't be considered in this present study for absenting these covariates in the dataset.

V. Conclusions

This study measured the prevalence and identified the risk factors associated with overweight or obesity in children under the age of 5 years in Bangladesh. To combat early death and life threatening diseases as a consequence of underweight and overweight, we need to find out the risk factors of overweight and obesity in Bangladesh in order to take appropriate measures by the government and other stakeholders. The present study shows risk factors of overweight or obesity are aged between 7-23 months, male gender, low birth rank,

being Muslim, higher wealth indexes, housewife mother, high maternal BMI and age, father's higher education, living in the rural area and Dhaka division.

We recommend that policy makers should consider timely interventions based on important child, parental, household and health factors in Bangladesh as reported in this paper.

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