Impact of the COVID-19 Pandemic on Weight, Height and BMI Percentiles in Urban School Girls: A Case Study Using US Centers for Disease Control and Prevention Growth Charts

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ABSTRACT

The COVID-19 pandemic affects people worldwide, especially school children. The COVID-19 pandemic has unexpectedly increased the risk of non-communicable diseases due to unhealthy lifestyle choices. Researchers, school authorities, politicians and news outlets have focused on school-based BMI assessment to address childhood obesity. We selected random primary school girls aged 6–10 for this study. The current investigation included demographic, socioeconomic and food habit questionnaires and for the physical test, anthropometric tools were used. We follow CDC 2000 guidelines. Three months after the COVID-19 lockdown began, this study examined the prevalence of height for weight, height for age, weight for age and associated knowledge among government schoolgirls in the Carew & Co (Bangladesh) Ltd. commercial area. Height, weight and BMI measures for surveillance, identifying the percentage of girls at risk for obesity, malnutrition and being too tall for their age and giving parents actionable advice. 8% of the 50 schoolgirls were underweight, 54% were normal, 8% were overweight, and 30% were obese. Height and weight significantly increased in 6-year-old girls compared to 10-year-olds (p<0.0001). Effective health-promoting treatments that emphasize a healthy lifestyle are necessary for underweight teenagers and over tall and obese girls. Schools that use BMI measurement programs should evaluate the program's effects on BMI results and teenager and family weight-related knowledge, nutritional knowledge, pubertal maturation, attitudes and behaviors. They should also take precautions to protect students, provide a safe and supportive environment for all students and use science-based strategies to promote physical activity and healthy eating.

1. INTRODUCTION

COVID-19 has a global impact on human health [1]. The COVID-19 epidemic has also has created the most significant disruption to education systems in history affecting around 38 million students in Bangladesh. Bangladesh closed schools on March 17, 2020 and will continue [2]. Control and prevention measures have led to outdoor activity restrictions, social distance and the shutdown of public services, including public and government schools [3]. The COVID-19 epidemic affects school-aged girls' height, weight, BMI and general nutritional health. School age has an essential impact on physical development [4]. Because of the lockdown, schoolchildren, particularly girls are distracted from their regular routines. They are not moving anywhere especially in Bangladesh for religious reasons but because of the epidemic which is making their lives more difficult [5,6,7].

Height is an indirect measure of a child's nutritional condition. The role of height in school-aged children goes beyond basic physical appearance; it is a critical indicator. Height influences a child's general health development, psychological well-being, academic achievement, long-term health and so on [8]. An optimal height increase is linked to good nutrition, general health and access to essential resources [9]. Children with appropriate development are more likely to have strong immune systems and fewer health problems [10]. Poor nutrition can cause stunted growth, compromising both height and cognitive development [11]. Overweight and obesity rates have risen worldwide, in both developed and developing countries [12].

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Overweight and obesity are becoming increasingly common in developing nations across all economic groups and locations with urban areas being more affected than rural ones [13,14]. Overweight, or obesity is caused by a regular diet, hereditary effects and a lack of physical exercise. Several risky behaviors in the early years of life appear to be highly associated with both underweight and obesity. Both underweight and overweight adolescents exhibited more susceptible risky behaviors such as substance abuse, mental health disorders such as depression and aggressive behavior. Researchers have identified suicide attempts as a major concern for overweight students [15,16]. Optimal nutritional status and health are required to provide not only optimal growth and development outcomes but also enhanced athletic performance in terms of response time, stamina, speed, flexibility and maintenance of a healthy physical state[17]. In reality, nutritional status remains a significant issue among primary school students [18]. Globally, 27% of children under the age of five (171 million) suffer from stunting, while 16% (104 million) suffer from underweight. It is especially alarming that 10.5 million children under the age of five die worldwide each year, with developing nations accounting for 98% of these deaths.

The Body Mass Index (BMI) is a quantitative metric that assesses children's relative weight status depending on their height [19,20]. BMI is a useful tool for measuring the health and well-being of people, especially school-aged children. Muscle intensity and labor demand varied amounts of energy depending on the type of physical exercise. Physical activity and BMI are interconnected factors, as those who engage in more physical activity tend to have lower BMIs. Meanwhile, the lower the level of physical activity the more likely the BMI will drop [21]. Lack of physical activity causes the body to accumulate energy in the form of fat, which can occur on a continuous basis and increase BMI. School-based student BMI assessment has received widespread attention from researchers, school administrators, political leaders and the media as a viable strategy for combating juvenile obesity. Between 1980 and 2004, the percentage of obese kids quadrupled from 7% in children (6–11 years) and 5% in adolescents (12–19 years) to 19% in children and 17% in adolescents [22,23,24].

In Bangladesh, undernutrition is becoming more prevalent. It comprises youngsters who are underweight for their age, too short for their age (stunted), dangerously thin for their height (wasted) and vitamin and mineral deficient (micronutrient malnutrition) [25]. Malnutrition in children under the age of five is an ongoing issue in underdeveloped countries. Bangladeshi's nutritional status is considered to be the poorest among Asian countries, with Bangladesh ranking 57th in relation to children under the age of five. The prevalence of childhood malnutrition in Bangladesh is one of the highest in the world; approximately 43% of under-five-year-olds are stunted, 41% are underweight and approximately 17% are wasting. As a result, the current nutritional situation of the Bangladeshi people is readily comparable to a "silent emergency" [26].

Thus, we conducted the study to understand the nutritional status and physical health condition of school-aged children in a specific location in Bangladesh using anthropometric measures. We hypothesized that school-aged children categorized as malnourished and in poor physical condition would display decreased food intake and a BMI deviation from the criteria established by the Centers for Disease Control (CDC) 2000 protocol [27]. This study will serve to evaluate and analyze the nutritional condition of school-aged children aged 6 to 10 years old based on health indicators such as height, weight, and BMI.

2. Litterateur review

Tester et al. (2020) [28] examine how lifestyle changes, physical exercise, and diet during lockdowns affect pediatric obesity during the COVID-19 pandemic. Sidor and Rzymski, on the other hand, investigated how the COVID-19 lockdown in Poland affected food patterns and nutritional consumption. Their findings help explain how pandemic diets may affect schoolgirls weight and BMI [29]. During the COVID-19 pandemic, Tenenbaum studied child growth. Their approach synthesizes studies to explain the pandemic's consequences for child development and health [30]. Martín-Rodríguez conducted a systematic literature review on food habits in children and adolescents before and during the COVID-19 pandemic. There is a strong link between unhealthy items like beer, fast food, and pastries. Comparatively, healthy foods such as beans, meat, fish, grains, pasta, fruit, and vegetables showed a substantial link [31]. Vogel et al. (2022) [32] reviewed weight gain patterns in children and adolescents by age and weight group over 15 years before and during the COVID-19 pandemic.

3. METHODOLOGY

3.1. Study Design and Sample

We selected three government schools for data collection. We conducted the current study among elementary school students in the 1st to 5th grades (ages 6 to 10 years, 50 girls) at the Carew & Co. (Bangladesh) Ltd. commercial area in Bangladesh, selecting them at random as research participants. Before the data collection began, two research assistants who worked at the academy offered a questionnaire to collect demographic information. This study used an anthropometric instrument to measure nutritional status and physical activity. A structured questionnaire containing both closed and open-ended questions was used for the survey and the mothers or guardians of the children were interrogated face-to-face. The survey recorded various important demographic and socio-economic characteristics. To conduct the survey, a suitable number of survey teams each containing 3–4 members were assigned to visit the school students at their households and school with the assistance of their physical education teacher. We described the research procedure to the school's physical education teachers, students, and parents who volunteered to participate.

3.2. Ethical Statement

All primary school children in grades 1 through 5 were excluded as were those who did not fully complete the survey form and whose parents refused. Parents briefed each subject on the research aims and nature of the study before they provided verbal and written consent. The research conducted for this study were carried out in compliance with the protocols approved by Rajshahi University's accredited ethics board (No: 72(22)/320/IAMEBBC/IBSc),Bangladesh.We strictly adhered to the Declaration of Helsinki in conducting this study and all participants provided informed consent.

3.3. Measurement of Height and weight

The subject undergoing assessment stands on the portable stadiometer's (SECA Stadiometer 213, Japan) platform. An excellent stadiometer can read to 0.1 cm (⅛th of an inch), is steady, and has a horizontal headpiece that can come into contact with the most superior area of the head [33]. One specialist individual maintains the measuring system. We assessed individual weights using an Omron HN-289 digital weighing scale (Japan) [34].

We conducted three trials to verify the accuracy of the data. To measure the weight to the nearest 0.1 kilogram, we used a minimum cloth. We used an appropriate height scale to measure the height to the nearest centimeter. To minimize measurement errors, we carefully measured both weight and height.

3.4. Statistical analysis

As stated, data were expressed as mean ± SD (standard deviation) and SEM (standard error of mean). Welch's test and standard one-way ANOVA were used as indicated to determine statistical significance among the experimental groups. Statistical significance was defined as p values less than 0.05. GraphPad Prism 7.05 (GraphPad Software, La Jolla, CA) was used to analyze data and make graphs. Height, weight and BMI status based on anthropometric measurement of the studied children aged 6–10 years were done to evaluate the growth and development of the children. According to the Centers for Disease Control (CDC), 2000 guidelines for field assessment [35], we used it to find out BMI percentile and weight for the status percentile (Fig1, 2). Wasting or thinness (emaciation), stunting (growth retardation), and underweight are defined as BMI for age, height for age and weight for height respectively and classified according to the standard deviation unit (z-scores). The CDC-2000 standards of height, weight and BMI were used to calculate and analyze the nutritional status of children. Center for Disease Control (CDC) standards, 2000 were used to calculate the BMI deviation according to the age and sex difference of the children that were used as samples to understand their growth and nutritional status. Once we calculate the BMI (Table 1) for children, we express it as a percentile using either a graph or a percentile calculator.

Table 1. BMI-for-age, height and weight status categories and the corresponding percentiles were based on expert committee recommendations.

BMI Percentile range	Recommended Classification
<5th Percentile	Underweight
5th -85th Percentile	Normal BMI
≥ 85th Percentile	Overweight
≥95th Percentile	Obesity

These BMI percentiles are obtained by plotting a person's BMI number on the CDC's (Centers for Disease Control) BMI growth chart, taking into account the person's age and gender (CDC-2000

growth charts and American Medical Association Expert Committee Recommendations, 2007).

Figure 1. Center for Disease Control (CDC), 2000 standards of Stature for age and weight for age percentiles for 2-20 year girls.

Figure 2. Center for Disease Control (CDC), 2000 standards of Weight for stature percentiles for 2–20-year Girls.

4. RESULTS

4.1. Descriptive characteristics

It displays descriptive statistics (Table 2) for participants' general health indicators as well as height, weight, and BMI in the study sample. This survey included 50 schoolgirls. Six-year-old girls' height (1.10±.25), weight (21.70±4.95) and BMI (19.54±7.45) were measured. At age 9, individuals' weight (38.60 ± 8.71) increased more quickly. At age 10, the girls had a height of 1.44±.11, a weight of 32.30±6.73 and a BMI of 15.32±1.78. The average BMI for 50 girls was 17.66 ± 4.68.

Table 2. Descriptive characteristic of 6-10 school going girls (n=50).

| Age group (year)	Height (m)	Weight (kg)	BMI (kg/m^2)
6 (n=10)	1.10±.25	21.70±4.95	19.54±7.45
7 (n=10)	1.18±.18	24.00±5.68	17.66±4.49
8 (n=10)	1.30±.05	25.70±3.02	15.28±1.40
9 (n=10)	1.37±.07	38.60±8.71	20.52±3.60
10 (n=10)	1.44±.11	32.30±6.73	15.32±1.78
Total 6-10 (n=50)	1.28±0.19	28.46±8.56	17.66±4.68

Results are presented as mean ± SD. BMI was calculated as body weight (kg) divided by body height squared (m^2).

4.2. Anthropometric characters of 6-10 years old school going girls of Carew & Co (Bangladesh) Ltd. Area

During the 2019–2020 academic year, 50 schoolgirls were examined based on their anthropometric factors. The lowest and greatest reported heights ranged from 0.70 to 1.57 meters. In terms of height status, 6 girls were short, 12 were tall and the remaining 32 were normal. In terms of weight, only 7 girls were classified as underweight (u.w) and 6 as overweight among the 50 participants in this research (Table 2). The remaining 37 subjects were listed as having normal. The mean BMI of the 50 individuals was determined to be 17.66 m/s2. The highest and lowest BMIs calculated were 30.9 and 11.5, respectively. In this study, the BMI percentile ranged from 0th to 99.9th. The BMI status of 5 subjects was classified as wasting, 18 as obese, and 27 as normal (Table 3).
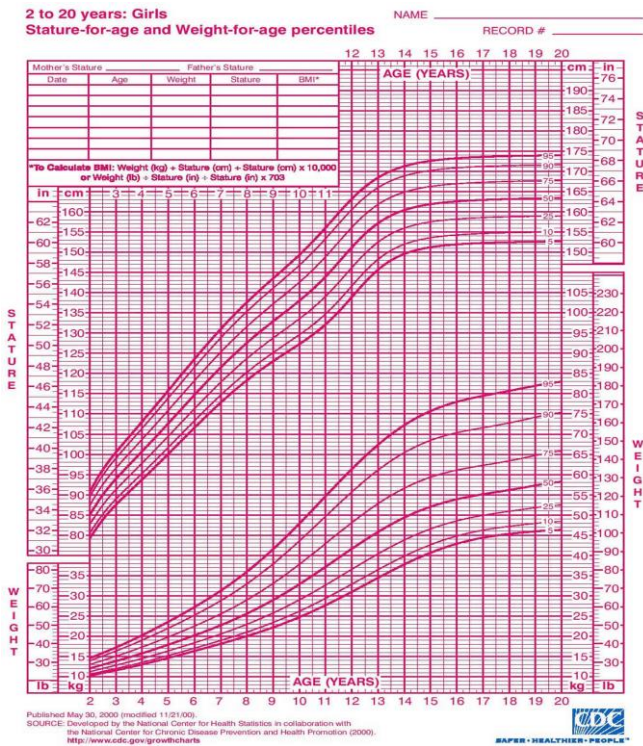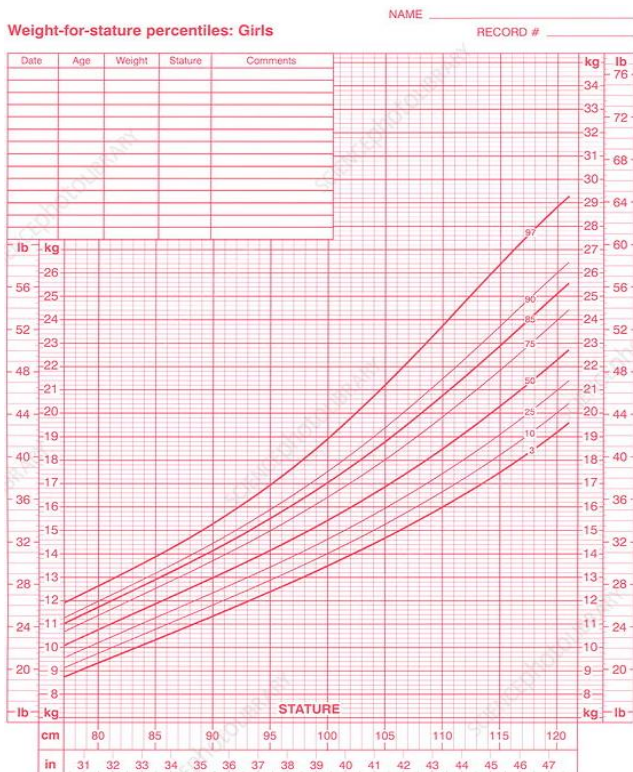
Table. 3. Height, Weight and BMI percentiles status of 6-10 school going girls during.

Serial No	Age (Yr)	Height (m)	Stature	Weight (Kg)	Weight status	BMI (kg/m^2)	BMI status	BMI percentile
1	6	1.24	n	30	o.w	19.5	o	98th
2	6	.90	s	25	n	30.9	o	99th
3	6	.90	s	20	n	24.7	o	99th
4	6	1.32	t	20	n	11.5	o	99th
5	6	.70	s	15	u.w	30.6	o	99th
6	6	1.23	n	20	n	13.2	n	6th
7	6	1.30	t	25	n	14.8	n	38th
8	6	.80	s	15	u.w	23.4	o	99th
9	6	1.29	t	20	n	12.	w	55th
10	6	1.35	t	27	n	14.8	n	38th
11	7	1.00	s	20	n	20.0	o	98th
12	7	1.36	t	25	n	13.5	n	9th
13	7	.75	s	15	u.w	26.7	o	99th
14	7	1.26	n	25	n	15.7	n	56th
15	7	1.27	n	25	n	15.5	n	51th
16	7	1.20	n	20	n	13.9	n	10th
17	7	1.24	n	20	n	13.0	w	4th
18	7	1.25	n	25	n	16.0	n	62th
19	7	1.24	n	35	u.w	22.8	o	99th
20	7	1.24	n	30	n	19.5	o	97th
21	8	1.28	n	30	n	18.3	o	89th
22	8	1.27	n	26	n	16.1	n	58th
23	8	1.30	n	26	n	15.4	n	44th
24	8	1.38	t	30	n	15.8	n	52th
25	8	1.25	n	20	u.w	12.8	w	2th
26	8	1.32	n	26	n	14.9	n	32th
27	8	1.37	n	27	n	14.4	n	16th
28	8	1.25	n	24	n	15.4	n	46th
29	8	1.29	n	25	n	15	n	35th
30	8	1.25	n	23	n	14.7	n	28th
31	9	1.37	n	45	o.w	24	o	99th
32	9	1.28	n	30	n	18.3	n	84th
33	9	1.32	n	35	n	20.1	o	94th
34	9	1.49	t	50	o.w	22.5	o	99th
35	9	1.39	n	25	n	12.9	w	1th
36	9	1.44	t	45	o.w	21.7	o	98th
37	9	1.42	n	47	o.w	23.3	o	99th
38	9	1.30	n	32	n	18.9	o	89th
39	9	1.32	n	32	n	18.4	n	85th
40	9	1.34	n	45	o.w	25.1	o	99th
41	10	1.47	n	35	n	16.2	n	42th
42	10	1.56	t	40	n	16.4	n	46th
43	10	1.57	t	35	n	14.2	n	8th
44	10	1.51	t	42	n	18.4	n	78th
45	10	1.41	n	32	n	16.1	n	40th
45	10	1.32	n	25	u.w	14.3	n	9th
47	10	1.41	n	32	n	16.1	n	40th
48	10	1.57	t	35	n	14.2	n	8th
49	10	1.32	n	27	n	15.5	n	28th
50	10	1.30	n	20	u.w	11.8	w	0th
Total n=50	Mean age=8 Year	Mean heigh= 1.28m		Mean weight =28.46kg		Mean BMI= 17.66m/s^2		

Table 4. Nutritional status and physical health condition of each criterion according to the age group 6 to 10 and weight to stature percentiles of the girls (n=50).

Age group	Normal (n=18) %	L. h. for age (n=6) %	H. h. for age (n=10)%	Underweight (n=5)%	Over weight (n=6)%	Wasted(n=2)%	Mixed (n=3) %
6 (n=10)	10	40	30	0	10	0	10
7 (n=10)	40	20	10	20	0	10	0
8 (n=10)	70	0	10	10	0	0	10
9 (n=10)	20	0	20	0	50	10	0
10 (n=10)	40	0	40	10	0	0	10
Total 6-10 (n=50)	36	12	20	10	12	4	6

n = normal, s = stunted, t = high for high, u = underweight, o = overweight, w = wasted, Body Mass Index (BMI) = BMI was calculated as body weight (kg) divided by body height squared (m2). BMI was categorized into four groups: underweight (< 5th percentile), normal BMI (5th–85th percentile), overweight or obese (≥ 85th percentile) *, and obese (≥ 95th percentile) (CDC's (2000) and AMA (2007)).

4.3. BMI and health status of all the participants

Figure 1 depicts the overall BMI category (Fig. 3) based on its reference value. We observed that 8% of subjects were underweight, 5% were healthy weight, 8% were overweight and 30% were obese. The Centers for Disease Control (CDC) standard determined the nutritional status and physical health condition of each criterion for girls aged 6–10 years. Regarding the relationship between height and age, Table 3 revealed that 40% of girls at the age of 6 had below-average height for their age, while 30% had above-average height. Table 3 data revealed that 40% of girls at the age of 6 had below-average height for their age, while 30% had above-average height. Among the 7-year-old and 8-year-old females, 40% and 70% respectively were classified as normal. By the age of 9, the majority of children are overweight, accounting for 50% and wasting 10% (Table 4). The prevalence of normal weight for age is 40% among 10-year-olds, whereas the prevalence of height for age is 40%. 10% of the population is underweight, and another 10% is a combination of underweight and mixed.
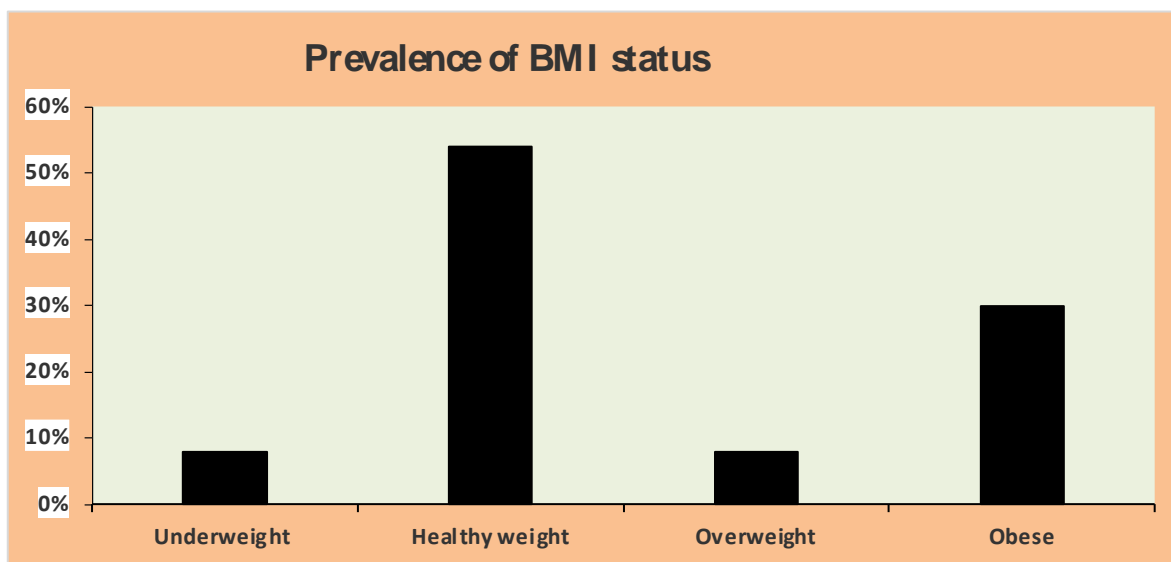
4.4. Comparisons of height, weight and BMI within participant's age group

Comparisons of girl's height, weight and BMI within their own age group. Between the ages of 6 and 10 the height of girls tends to develop steadily. Our findings indicate that there was a substantial increase in height between the ages of 6 vs 8 (p<0.05), 6 vs 9 (p<0.01), 6 vs 10 (p<0.0001) and 7 vs 10 (p<0.01) respectively.

Weight gain in 9-year-old girls was significant. Regarding weight gain across different age groups there was a significant increase in the following comparisons: 6 vs 9 (p<0.01), 6 vs 10 (p<0.0001) and 7 vs 10 (p<0.5).There was no statistically significant difference in BMI levels among various age groups. Children aged 6 and 9 have a BMI within the healthy range, whereas children aged 8 and 10 have a BMI below the standard value (Fig. 4)
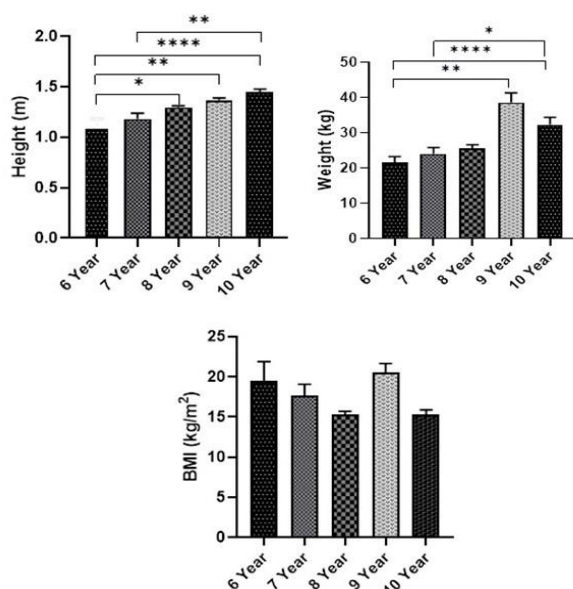
*Significant difference between groups at *P*<0.05,
**Significant difference between groups at *P*<0.01,
****Significant difference between groups at *P* < 0.0001
Figure 4. Comparative analysis of height, weight and BMI among participants age group.

5. DISCUSSION

To the best of our knowledge, this is the study on the height, weight and BMI changes during the COVID-19 lockdown among school going girls aged 6 to 10 years at the Carew & Co. (Bangladesh) Ltd. commercial area in Bangladesh, which includes their dietary habits, nutritional knowledge, and socio-economic condition in lockdown. In this case study, it was shown that 8% of the subjects were underweight, 54% were healthy weight, 8% were overweight, and 30% were obese respectively. Healthy participants were conscious of a healthy lifestyle, they were influenced by the teacher during online classes. Local government authorities and mainstream media also contributed to the dissemination of health-related knowledge. Basically, their parents were educated, so their lifestyle was healthy. But some parents were educated, but they thought overweight was bad for their health so they concentrated only on food and not on daily exercise so obesity rose. On the other hand, their educational institute was not opened, so they have no chance to join daily physical exercise classes taught by physical education teachers. Jarnig also found a large increase in the prevalence of overweight or obesity among children from September 2019 to March 2021 in our analysis, which is highly likely to be linked to the recurrent shutdowns of schools and athletic facilities [36]. At the start of COVID-19 most of the girls had a healthy BMI and after that sequence most of them

were obese. The COVID-19 pandemic has had a significant impact on childhood obesity with several studies reporting an increase in BMI and obesity prevalence among school-going children. A previous study found a significant increase in BMI and obesity rates in Korean and Swedish preschool children, particularly in lower socioeconomic areas during the pandemic [37,38]. According to CDC 2000, 20% of participants' heights were higher than the normal range, while 12% were lower than the usual range [39].

In all participants, 4% were wasted in girls, while 6% were mixed, which implies they were short, tall, underweight and obese. They eat enough food, yet it does not provide adequate nourishment and energy for their bodies. In this case, their diet does not contain all of the nutrients like dietary variety and their parents did not follow any diet plan for their growth due to a lack of information about child nutritional food and their unconsciousness. Parenting has an impact on a child's eating habits, and there is a substantial amount of correlational evidence suggesting that a child's eating habits and weight can also influence parenting. Parents compelled their children to consume a diverse range of nutritious meals in order to facilitate optimum growth and development. Parents must have sufficient knowledge of their children's nutritional needs in order to prepare appropriate dietary meals for them [40].

Our study revealed significant variations in height between girls attending schools for 8, 9, and 10 years, compared to those attending schools for 6 years. The weight of 9 and 10-year-old females was significantly higher compared to 6-year-old girls. Furthermore, 10-year-old girls exhibit a significant rise in both height and weight when compared to 7-year-old girls. Pubertal maturation occurs more frequently in girls aged 9–10 than in girls aged 6 years. Weight and height often rise with pubertal development. During puberty, hormonal changes cause growth spurts in teenagers, resulting in increases in skeletal growth (height), muscular mass and body fat (weight). Research indicates that various factors influence pubertal development. These include gender, genetics, nutrition, endocrine regulation, physical activity and ethnicity [41]. At 9.3, 9.8, and 9.5 years of age, respectively, girls started to experience their pubertal development spurts in height, facial size, and mandibular length [42]. The height growth patterns showed a consistent increase in annual height gain for girls starting at age 7.5 years, reaching its highest point between ages 9.5 and 11.5 years. In contrast, male height gains initially experienced a minor fall and then

reached their peak between ages 11.5 and 12.5 year[43].

There was a marked increase in the prevalence of height and weight across age groups in this study of school-aged girls' changes in body mass index (BMI) as well as their overall nutritional status, during the COVID-19 lockdown, Even though the majority of the children and their parents ate healthily and had good nutrition knowledge but participants risk trend was obesity. All of these things, plus the fact that the same individual measured height and weight before and shortly after the lockdown, under the same circumstances, which improves the accuracy of the nutritional status data, might be seen as positives of the study. With these numbers, the scientific community has a better idea of how children's health changed in the commercial area of Carew & Co. (Bangladesh) Ltd. during the COVID-19 lockdown. It is important to continue monitoring these changes in the future.

6. Conclusion

In summary, data from this survey revealed an increase in height, weight, and BMI variations among Bangladesh schoolgirls in a specific commercial area during the COVID-19 lockdown period. The COVID-19 pandemic and associated lockdowns have had a substantial impact on childhood obesity rates, as indicated by a noticeable increase in BMI and obesity prevalence among school-aged children during the lockdown era. Children from better educated and health-conscious families were more likely to maintain a healthy weight during the lockdown. Parents' understanding of dietary requirements, as well as their capacity to serve variety and healthy meals have a significant impact on children's eating patterns and weight status. A lack of parental awareness regarding healthy child nutrition may lead to children's substandard growth and development. Pubertal maturation has a substantial impact on height and weight growth patterns in teenage girls. Hormonal changes during puberty cause growth spurts, resulting in increased skeletal growth, muscle mass, and body fat. Understanding these developmental patterns is critical to determining nutritional status and overall health in teenagers. The study emphasizes the significance of continuous monitoring of children's health and nutritional status, especially during times of disruption like the COVID-19 epidemic. Continued research and intervention efforts are required to address the increased prevalence of childhood obesity and promote healthy lifestyle habits among children and their families. Overall, the study highlights the complex interplay of socioeconomic, parental, and biological factors in shaping children's growth and nutritional status, as well as the importance of targeted interventions to address the COVID-19 pandemic's impact on childhood obesity and overall health.

7. Limitation and future of Study

The purpose of this study was to assess the nutritional status and physical health conditions of school-going (6–10 year-old) children. Only 50 children from three locations in Chuadanga participated in the current study, which took place during the COVID-19 pandemic lockdown. We did not have that opportunity to get enough samples of school going children and did not get proper data by collecting the anthropometric test. Given that the guardians of the subjects were upset in a few cases, we need to gather information with urgency.

A larger and more varied sample of school-age children should be the focus of future research in order to give a more thorough evaluation of their physical and nutritional health. In order to assure accuracy and dependability, future research should also think about using more reliable data collection techniques, pre-plan questionnaries and longer time periods. Including qualitative information from educators and parents could help provide more in-depth understanding of the variables impacting children health. By addressing these issues, the findings will be more valid and applicable, which will improve health interventions and policies for school-age children in the long run.

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Author Contributions

Study Design, AA, JH ; Data Collection, AA, JM; Statistical Analysis, AA, KHH; Data Interpretation, AA,JTL; Manuscript Preparation, AA, JH,JM; Literature Search, AA, JTL,KHH, . All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

No conflict of interest is declared by tehe authors. In addition, no financial support was received.

REFERENCES

1. Baloch, S., Baloch, M. A., Zheng, T., & Pei, X. (2020). The coronavirus disease 2019 (COVID-19) pandemic. *Tohoku J Exp Med*, 250(4), 271-278. [PubMed]
2. Rahman, T., & Sharma, U. (2021). A Simulation of COVID-19 School Closure Impact on Student Learning in Bangladesh. World Bank. [CrossRef]
3. Kenđel Jovanović, G., Dragaš Zubalj, N., Klobučar Majanović, S., Rahelić, D., Rahelić, V., Vučak Lončar, J., & Pavičić Žeželj, S. (2021). The outcome of COVID-19 lockdown on changes in body mass index and lifestyle among Croatian schoolchildren: a cross-sectional study. Nutrients, 13(11), 3788. [PubMed]
4. Karatzi, K., Poulia, K. A., Papakonstantinou, E., & Zampelas, A. (2021). The impact of nutritional and lifestyle changes on body weight, body composition and cardiometabolic risk factors in children and adolescents during the pandemic of COVID-19: a systematic review. Children, 8(12), 1130. [PubMed]
5. Banyard, K. (2010). The equality illusion: The truth about women and men today. Faber & Faber.
6. Matuk, C., Martin, R., Vasudevan, V., Burgas, K., Chaloner, K., Davidesco, I. ... & Dikker, S. (2021). Students learning about science by investigating an unfolding pandemic. Aera Open,7, 23328584211054850. [CrossRef]
7. Raha, S. A., Rana, M. S., Mamun, S. A., Anik, M. H., Roy, P., Alam, F., & Sultan, M. (2021). Revisiting the impact of covid-19 on adolescents in urban slums in Dhaka, Bangladesh: Round 2. Policy brief.
8. Scholder, S. V. H. K., Smith, G. D., Lawlor, D. A., Propper, C., & Windmeijer, F. (2013). Child height, health and human capital: evidence using genetic markers. Eur Econ Rev, 57, 1-22. [PubMed]
9. World Health Organization. (2013). Essential nutrition actions: improving maternal, newborn, infant and young child health and nutrition. [PubMed]
10. Schneider, E. B. (2017). Children's growth in an adaptive framework: explaining the growth patterns of American slaves and other historical populations. Econ Hist Rev; 70(1), 3-29. [CrossRef]
11. Perkins, J. M., Kim, R., Krishna, A., McGovern, M., Aguayo, V. M., & Subramanian, S. V. (2017). Understanding the association between stunting and child development in low-and middle-income countries: Next steps for research and intervention. Soc Sci Med, 193, 101-109. [PubMed]
12. Rawal, T., Willeboordse, M., Arora, M., Sharma, N., Nazar, G. P., Tandon, N., & van Schayck, C. P. (2021). Prevalence of excessive weight and underweight and its associated knowledge and lifestyle behaviors among urban private school-going adolescents in New Delhi. Nutrients, 13(9), 3296. [PubMed]
13. Watkins, D., Hale, J., Hutchinson, B., Kataria, I., Kontis, V., & Nugent, R. (2019). Investing in non-communicable disease risk factor control among adolescents worldwide: a modelling study. BMJ Glob Health, 4(2). [PubMed]
14. Arora, M., Mathur, C., Rawal, T., Bassi, S., Lakshmy, R., Nazar, G. P. ... & Kinra, S. (2018). Socioeconomic differences in prevalence of biochemical, physiological, and metabolic risk factors for non-communicable diseases among urban youth in Delhi, India. Prev Med Rep, 12, 33-39. [PubMed]
15. Mistry, S. K., & Puthussery, S. (2015). Risk factors of overweight and obesity in childhood and adolescence in South Asian countries: a systematic review of the evidence. Public health, 129(3), 200-209. [PubMed]
16. Yen, Y., Shi, Y., Soeung, B., Seng, R., Dy, C., Suy, R., & Ngin, K. (2018). The associated risk factors for underweight and overweight high school students in Cambodia. Diabetes & Metabolic Syndrome: Clin Res Rev, 12(5), 737-742. [PubMed]
17. Hossain, J., Azim, A., & Author, M. H. (2024). Kinetics and kinematic analysis of different phases in 100m sprints. International Journal of Physical Education, Sports and Health, 11(3), 183–190. https://doi.org/10.22271/kheljournal.2024.v11.i3c.3341.[CrossRef]
18. Akubuilo, U. C., Iloh, K. K., Onu, J. U., Iloh, O. N., Ubesie, A. C., & Ikefuna, A. N. (2020). Nutritional status of primary school children: Association with intelligence quotient and academic performance Clin Nutr ESPEN, 40, 208-213. [PubMed]
19. Chung, S. (2015). Body mass index and body composition scaling to height in children and adolescent. Ann Pediatr Endocrinol Metab, 20(3), 125. [PubMed]
20. Doak, C. M., Hoffman, D. J., Norris, S. A., Ponce, M. C., Polman, K., & Griffiths, P. L. (2013). Is body mass index an appropriate proxy for body fat in children? Glob Food Sec, 2(2), 65-71. [CrossRef]
21. Suryana, S., & Fitri, Y. (2017). Hubungan aktivitas fisik dengan IMT dan komposisi lemak tubuh. Aceh Nutri J, 2(2), 114-119. [CrossRef]
22. Hedley, A. A., Ogden, C. L., Johnson, C. L., Carroll, M. D., Curtin, L. R., & Flegal, K. M. (2004). Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. Jama, 291(23), 2847-2850. [PubMed]
23. Ogden, C. L., Flegal, K. M., Carroll, M. D., & Johnson, C. L. (2002). Prevalence and trends in overweight among US children and adolescents, 1999-2000. Jama, 288(14), 1728-1732. [PubMed]
24. Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. Jama, 295(13), 1549-1555. [PubMed]
25. Awino, S. (2017). Factors associated with under nutrition in Children under five years in Bangaladesh Parish, Namasalesub-County, Amolatar District. http://hdl.handle.net/20.500.12306/4500

26. Roy, R. K., Matubbar, M. S., Kamruzzaman, M., & Ud-Daula, A. (2015). Determination of nutritional status of under-five year children employing multiple interrelated contributing factors in southern part of Bangladesh. Int J Nutr Food Sci, 4(3), 264-272. [CrossRef]
27. Flegal, K. M., Wei, R., & Ogden, C. (2002). Weight-for-stature compared with body mass index–for-age growth charts for the United States from the Centers for Disease Control and Prevention. Am J Clin Nutr, 75(4), 761-766. [PubMed]
28. Tester, J. M., Rosas, L. G., & Leung, C. W. (2020). Food insecurity and pediatric obesity: a double whammy in the era of COVID-19. Curr Obes Rep, 9, 442-450. [PubMed]
29. Sidor, A., & Rzymski, P. (2020). Dietary choices and habits during COVID-19 lockdown: experience from Poland. Nutrients, 12(6), 1657. [PubMed]
30. Tenenbaum, A., Shefer-Averbuch, N., Lazar, L., Yakobovitch-Gavan, M., Phillip, M., & Oron, T. (2021). Growth assessment of children during the COVID-19 pandemic—Can we rely on parental measurements?. Acta Paediatr, 110(11), 3040-3045. [PubMed]
31. Martín-Rodríguez, A., Tornero-Aguilera, J. F., López-Pérez, P. J., & Clemente-Suárez, V. J. (2022). Dietary patterns of adolescent students during the COVID-19 pandemic lockdown. Physiol Behav, 249, 113764. [PubMed]
32. Vogel, M., Geserick, M., Gausche, R., Beger, C., Poulain, T., Meigen, C. ... & Pfäffle, R. (2022). Age- and weight group-specific weight gain patterns in children and adolescents during the 15 years before and during the COVID-19 pandemic.Int J Obes (Lond), 46(1), 144-152. [PubMed]
33. Baharudin, A., Ahmad, M. H., Naidu, B. M., Hamzah, N. R., Zaki, N. A. M., Zainuddin, A. A., & Nor, N. S. M. (2017). Reliability, Technical Error of Measurement and Validity of Height Measurement Using Portable Stadiometer. Pertanika J Sci Technol,25(3).
34. Kwakye, S. K., Mostert, K., Garnett, D., & Masenge, A. (2023). Risk factors associated with football injury among male players from a specific academy in Ghana: a pilot study. Sci Rep, 13(1), 8070. [PubMed]
35. Kuczmarski, R. J. (2000). CDC growth charts: United States (No. 314). US Department of Health and Human Services, Centers for Disease Control and Prevention, Natl Health Stat Report.
36. Jarnig, G., Jaunig, J., Kerbl, R., Strenger, V., Haeusler, G., & van Poppel, M. N. (2022). Acceleration in BMI gain following COVID-19 restrictions. A longitudinal study with 7-to 10-year-old primary school children. Pediatr Obes, 17(6), e12890. [PubMed]
37. Gwag, S. H., Oh, Y. R., Ha, J. W., Kang, E., Nam, H. K., Lee, Y. ... & Lee, K. H. (2022). Weight changes of children in 1 year during COVID-19 pandemic. J Pediatr Endocrinol Metab, 35(3), 297-302. [PubMed]
38. Fäldt, A., Nejat, S., Edvinsson Sollander, S., Durbeej, N., & Holmgren, A. (2023). Increased incidence of overweight and obesity among preschool Swedish children during the COVID-19 pandemic. Eur J Public Health, 33(1), 127-131. [PubMed]
39. Centers for Disease Control and Prevention (CDC. (2006). National Center for Health Statistics (NCHS). National Health and Nutrition Examination Survey Questionnaire (or Examination Protocol, or Laboratory Protocol). http://www. cdc. gov/nchs/nhanes. htm.
40. Ventura, A. K., & Birch, L. L. (2008). Does parenting affect children's eating and weight status? Int J Behav Nutr Phys Act, 5(1), 1-12. [PubMed]
41. Soliman, A., De Sanctis, V., Elalaily, R., & Bedair, S. (2014). Advances in pubertal growth and factors influencing it: Can we increase pubertal growth? Indian J Endocrinol Metab, 18(Suppl 1), S53. [PubMed]
42. Mellion, Z. J., Behrents, R. G., & Johnston Jr, L. E. (2013). The pattern of facial skeletal growth and its relationship to various common indexes of maturation. Am J Orthod Dentofacial Orthop, 143(6), 845-854. [PubMed]
43. Zheng, W., Suzuki, K., Yokomichi, H., Sato, M., & Yamagata, Z. (2013). Multilevel longitudinal analysis of sex differences in height gain and growth rate changes in Japanese school-aged children. J Epidemiol, 23(4), 275-279. [PubMed]