



# E-Learning During COVID-19 Pandemic: A Surge in Childhood Obesity

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Received: 3 June 2021 / Accepted: 4 July 2021  
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**Abstract** The coronavirus pandemic protracted disruption of in-person schooling, sports and other activities leading to obesity that could have long-lasting impact on children's health. As a result, education has changed dramatically, with the distinctive rise of E-learning. Children are snacking more, exercising less. Their increased screen time, sedentary life style and inadequate sleep anticipated weight gain during Lockdown that could lead to complications. To study the impact of the COVID-19 lockdown on increased weight gain in children. A cross-sectional study was conducted from March to May 2021 at tertiary care hospital, Thandalam among 2000 children between the age of 3–15 years on weight gain during COVID-19 Lockdown. A questionnaire requesting demographic and Anthropometric details was circulated. BMI percentiles were calculated, totalled and compared between pre-school closing and school closing period. Paired t-test was done.  $p$  value  $< 0.05$  was considered statistically significant. Out of 2000 children, 308 were excluded. Male preponderance was noted. Age range was between 3 and 15 years with mean age being 8.5 years. Study revealed significant

differences in variables such as body weight, body mass index before and after lockdown. Post-lockdown, the mean body mass index (BMI) increased among all participants from 17.32 to 17.80 kg/m<sup>2</sup> ( $p < 0.001$ ). Obesity definitely has a proportional impact on the children's Quality of Life (QOL). It is important to address childhood obesity, which if neglected may lead to long-term profound complications of higher eminence than the actual COVID-19 infection. The prevention and management of childhood obesity should be set as a priority at an individual, community and population level during this pandemic.

**Keywords** E-learning · COVID-19 · Lockdown · Obesity · BMI · Quality of life (QOL)

## Introduction

COVID-19 is a highly contagious disease in humans causing significant rates of illness, hospitalization and death. World Health Organization declared COVID-19 a pandemic on March 11, 2020 [1]. On the evening of 24 March 2020, the Government of India ordered a nationwide lockdown for 21 days, limiting movement of the entire 1.38 billion (138 crore) population of India as a preventive measure against the COVID-19 pandemic in India [2]. Pandemic is causing substantial morbidity and mortality, straining health care systems, shutting down economies, and closing school districts [3]. Even with the implementation of major interventions to contain the spread of the disease, COVID-19 has progressed worldwide resulting in significant morbidity and mortality [4–6].

The COVID-19 pandemic has shifted dietary and lifestyle habits of many families. In addition to the lockdown, the major economic turmoil has disrupted livelihood

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activities for millions of people worldwide [7]. There have been attempts at seeing a silver lining as some families have embraced lockdowns as a means to strengthen their family bonds. Whole country went in to complete lockdowns that restricted the family unit to their home, with only allowance to go out for essential shopping and for restricted physical activity. This led to a number of families panic shopping and storing long shelf life foods that are typically ultra-processed and calorie-dense in order to minimize their trips to the supermarket. Many children will experience higher calorie diets during the pandemic response [7].

To control the spread of COVID-19 infection, many restrictions have been imposed to school going children including school closures all across the world. As a result, education has changed dramatically, with the distinctive rise of E-learning, whereby teaching is undertaken remotely and on digital platforms with the help of electronic resources. Children are spending more time indoors using electronic media both for education and recreation. They may also have fewer opportunities to engage in physical activity without school activities, particularly during periods of COVID-19 lock down [8]. Watching tv, playing computer games and using tablets or smartphones increased screen time, intake of high calorie food, decreased physical activity leads to obesity in children during COVID-19 crisis. In this article, we attempted to study other coexisting problems such as childhood obesity, which if uncontrolled may have a long-term profound complications of higher eminence than the actual COVID-19 infection.

Childhood obesity is a complex disease, with multiple influences and varied outcomes. Obesity is identified as an independent risk factor for COVID-19 disease severity [9]. Children with obesity may experience a more severe COVID-19 trajectory, including the need for respiratory support [10].

Social distancing and stay-at-home orders issued by government reduce the opportunities for physical activity among children, particularly for children in urban areas living in small apartments. Screen time is associated with weight gain in childhood, because of the dual issues of sedentary time and the association between screen time and snacking [11]. Children do not have access to safe, accessible outdoor spaces where they can maintain social distance. Parks and playgrounds remain close as it is not possible to keep the playgrounds clean and children will have difficulty maintaining social distance.

Parental stress is associated with childhood obesity in some studies, most recently in non-Hispanic Black families [12]. However, high levels of parental stress due to job loss, isolation, and unexpectedly working from home increases the difficulty for parents in providing a

supportive buffering presence for their children. The relationship between stress, mental health, and childhood obesity is complex. Children experiencing obesity have a higher risk for depression because of stigma and isolation and eat in response to stress to a greater degree than normal weight peers. Many centres are housed in the schools and have been impacted by school closure thus, preventing these vulnerable children from accessing healthcare. All these risk factors may lead to impaired metabolic and immune functions of the child increasing susceptibility to obesity and impairs Quality of Life. In this article, we attempted to address the impact of E-learning due to school closure on childhood obesity, how risk factors are exacerbating it and identify interventions to reduce the negative impact.

### Aim

To study the impact of the COVID-19 lockdown on body mass index, obesity, and overweight in children.

### Material and Methods

A cross-sectional study was conducted on 2000 children in and around Chennai, from March to May 2021 between the age of 3–15 years on weight gain during COVID-19 Lockdown. This study was approved by the institutional ethical committee. Customized questionnaire was circulated electronically to parents of children based on their visits to our tertiary care hospital during pre-school closing period. It was assumed that pre-school closing was from march 2019 to February 2020 and school closing was from March 2020 to till date. The parent questionnaire contains following domains: demographic details, Children's and parent's characteristics, Height of child in centimetres (cms), Weight in Kilograms (kgs) before Lockdown and After Lockdown). The parents were requested to fill out the questionnaire with information pertaining only to one child, so that only one child per family is included in the study. In such cases the parents were allowed to select the child to be included in the study. Participation in the study was completely voluntary and the participants were assured of confidentiality. The participants were also assured that there won't be any negative consequences irrespective of their decision to either participate or not participate in the study. 308 children who had not returned the questionnaire were excluded 1692 patients were eligible for analysis finally. The E-learning period during COVID-19 lockdown was approximated to be from March 2020 for ease of data collection and analysis. BMI percentiles between pre-school closing and school closing period were calculated, totalled and compared for all children based on the Centre

for Disease Control and Prevention (CDC). According to CDC, Obesity is defined if the BMI percentile derived from the CDC's sex and age specific growth chart is at or above the 95th percentile. At risk for overweight is defined if the BMI percentile is at or above the 85th percentile, but less than the 95th percentile of BMI. Data tabulation was done using MS Excel. Continuous data was given as mean  $\pm$  standard deviation, categorical data was given as number (percent). Paired t test was computed to assess significant changes in BMI before and after the lockdown period. Statistical evaluation was done using IBM SPSS statistics for Windows v26 (Armonk NY: IBM Corp).  $p$  value  $< 0.05$  was considered statistically significant.

### Inclusion Criteria

1. Parents of children 3–15 years of age.
2. Parents of children who were visiting a general practitioner or paediatrician.
3. Children who visited hospital for well child check, acute pharyngitis, upper respiratory infection, otitis media, and strep throat are included.

### Exclusion Criteria

1. Parents of children who were visiting Specialists
2. Children with chronic illness.

### Results

Sample size was 2000(n). 308 candidates did not respond. Respective data removed from database. Complete data available for  $n = 1692$ .

Demographic data noted (Table 1). Table 1 presents the characteristics of the child participants.  $N = 1692$ , of which 1036 (61.2%) were males and 656 (38.7%) were females. Overall male: female was 1.5:1. Age-wise and gender-wise distribution across groups depicted in Fig. 1. Age range was between 3 and 15 years with mean age 8.5 years.

Figure 2 is a pie chart that represents the distribution of child participants based on their BMI percentile. 78.4% of the study population is between the 5th and 85th percentile which, according to the CDC growth charts, comes under the healthy weight category. The study population with BMI percentile equal to or greater than the 95th percentile (which indicates that they are obese) constituted 5.4%. The "less than the 5th percentile" (underweight) category constitutes approximately 3%, and those who are between 85 and 95th percentile (At risk of being obese) also comprised approximately 13%.

**Table 1** Demographic details

Variables		Value (% , n)
Age range (years)		3–15
<i>Mean age (years)</i>		8.5
3–7 years	752	44.4
8–12 years	680	40.1
13–15 years	260	15.3
Male	1036	61.2
Female	656	38.7
Male: female		1.5:1
<i>Birth weight</i>		
< 2500 g	112	6.6
$\geq$ 2500 g	1580	93.3
<i>Gestational age</i>		
Pre term < 37 weeks	104	6.1
Term 38–42	640	37.8
Post term > 42	948	56

Changes in BMI, obesity and overweight before and after the COVID-19 lockdown period is shown in Table 2.

Post-lockdown, the mean body mass index (BMI) increased among all participants from 17.32 to 17.80 kg/m<sup>2</sup> ( $p < 0.001$ ). The overall obesity (5.4–7.8%,  $p < 0.001$ ) and overweight (13–17.8%,  $p < 0.001$ ) burdens significantly increased after the lockdown period.

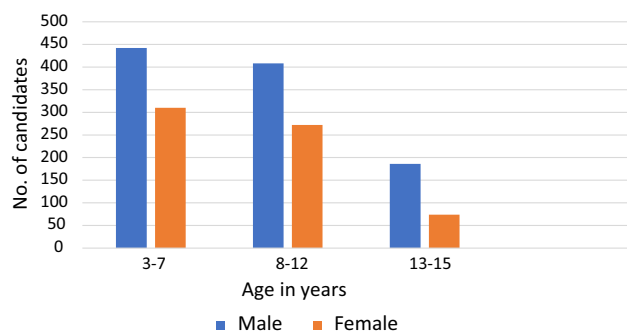
The eldest age group (13–15 years) had the greatest increase in obesity after the lockdown period (14–27%,  $p < 0.001$ ), compared to those aged 3–7 (9.4%) and 8–12 (11.9%) years.

### Discussion

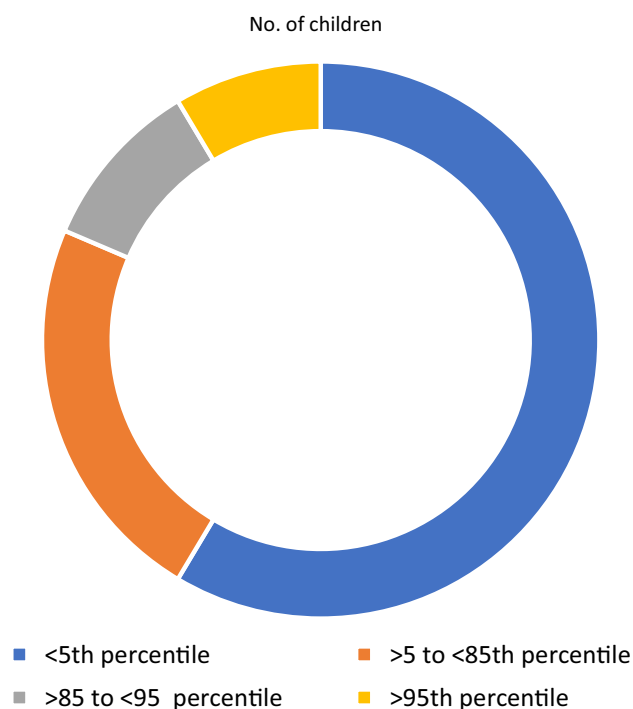
The coronavirus disease 2019 (COVID-19) pandemic is causing substantial morbidity and mortality, straining health care systems, shutting down economies, and closing school districts. While it is a priority to mitigate its immediate impact, we want to call attention to the pandemic's longer-term effect on children's health; COVID-19, via these school closures, may exacerbate the epidemic of childhood obesity and increase disparities in obesity risk.

we found that, after the COVID-19 lockdown, the children's weight status has increased; the frequencies of their physical activities have reduced, and their sedentary, sleeping, and screen time have all increased.

Weight assessment of a child with obesity is accomplished by considering both the age of the child and the severity of the obesity. For infants up to the age of 2, BMI is not assessed. Instead, the infants' weight percentile is



**Fig. 1** Age and gender wise distribution of children



**Fig. 2** Distribution of child participants based on their BMI percentile

compared to length percentile. Body mass index charts are used for children between the ages of 2–20 years according to Centre for Disease Control (CDC). These CDC charts were developed in the year 2000 and are colour coded by BMI percentile: < 5th percentile (red), 5th – 85th percentile (green), 85th – 95th percentile (yellow), and > 95th percentile (red). The chart extends to a BMI of 35 kg/m<sup>2</sup>.

A study by conducted by Williams et al. (1992), on 3,320 children in the age-group of 5–18 years classified children as fat if their percentage of body fat was at least 25% for males and 30% for females, respectively [13]. The Centre for Disease Control and Prevention defined overweight as at or above the 95th percentile of body mass

index (BMI) for age and “at risk for overweight” as between 85 to 95th percentile of BMI for age [14, 15]. European researchers classified overweight as at or above 85th percentile and obesity as at or above 95th percentile of BMI [16]. An Indian research study has defined overweight (between ≥ 85th and < 95th percentile) and obesity (≥ 95th percentile) [17]. Another study has followed World Health Organization 2007 growth reference for defining overweight and obesity [18].

The ecological model, as described by Davison et al., suggests that child risk factors for obesity include dietary intake, physical activity, and sedentary behaviour [19]. The impact of such risk factors is moderated by factors such as age, gender. Family characteristics parenting style, parents’ lifestyles also play a role. Eating out or watching TV while eating is associated with a higher intake of fat. Parental feeding style is also significant.

Another factor that has been studied as a possible contributing factor of childhood obesity is the consumption of snack foods. Snack foods include foods such as chips, baked goods, and candy. Many studies have been conducted to examine whether these foods have contributed to the increase in childhood obesity. While snacking has been shown to increase overall caloric intake, no studies have been able to find a link between snacking and overweight [20].

One of the factors that is most significantly linked to obesity is a sedentary lifestyle. Each additional hour of television per day increased the prevalence of obesity by 2% [20]. Television viewing among young children and adolescents has increased dramatically in recent years [20, 21]. The increased amount of time spent in sedentary behaviours has decreased the amount of time spent in physical activity. Research which indicates the number of hours children spend watching TV correlates with their consumption of the most advertised goods, including sweetened cereals, sweets, sweetened beverages, and salty snacks [22].

It was reported in one study in Copenhagen that online platforms were extensively used by the young generation to communicate with others, to play video games and to access social media prior to COVID-19 pandemic also [23]. But the pandemic increased screen time for children as schools shifted to E-learning. Although this was beneficial for educational purposes, the increase in screen time can further exacerbate sedentary habits as well as increase the risks for anxiety, depression and inattention [24].

A study had shown association between increased body mass index (BMI) and body fat percentage as screen time increased [25]. Another study had shown association between screen time and increase in snacking and a consequent increase in weight [11].

**Table 2** Changes in BMI, obesity and overweight before and after the COVID-19 pandemic lockdown among participants

Variables	Under weight (< 5th percentile) n (%)		Normal weight (> 5th to < 85th percentile) n (%)		Overweight (> 85th to < 95th percentile) n (%)		Obese ( $\geq$ 95th percentile) n (%)		BMI kg/m <sup>2</sup>	
	Before	After	Before	After	Before	After	Before	After	Before	After
All children	51 (3)	23 (1.3)	1328 (78.4)	1234 (72.9)	221 (13)	302 (17.8)	92 (5.4)	133 (7.8)	17.32	17.80
<i>Gender</i>										
Male	28 (1.6)	14 (0.8)	826 (48.8)	791 (46.7)	130 (7.6)	167 (9.8)	52 (3)	64 (3.7)	17.26	17.63
Female	23 (1.3)	9 (0.5)	502 (29.6)	443 (26.1)	91 (5.3)	135 (7.9)	40 (2.3)	69 (4)	17.43	18.06
<i>Age groups</i>										
3–7	27 (1.5)	13 (0.7)	567 (33.5)	517 (30.5)	117 (6.9)	163 (9.6)	41 (2.4)	55 (3.2)	15.81	16.23
8–12	19 (1.1)	9 (0.5)	555 (32.8)	529 (31.2)	69 (4)	95 (5.6)	37 (2.1)	51 (3)	17.73	18.17
13–15	5 (0.2)	1 (0.05)	206 (12.1)	188 (11.1)	35 (2)	44 (2.6)	14 (0.8)	27 (1.5)	20.62	21.43

Studies reported that children had higher tendencies to experience weight gain during the summer holidays. Such weight gain is difficult to shed and actually accumulates from one summer to another [26, 27]. Hence, if one considers the COVID-19 lockdown period as an ‘early onset summer holiday’, it could be anticipated that the childhood obesity rate will rise proportionately to the number of months the schools remain closed.

Parents that shifted to telework had more time with their children. Needless to say, these faced new challenges in trying to balance taking care of their children, home-schooling them while at the same time tele-working. Nonetheless stronger family bonds are expected to have been developed as more family events under one roof had to be catered for [28].

In our study, the mean body mass index (BMI) increased among all participants from 17.32 to 17.80 kg/m<sup>2</sup> ( $p < 0.001$ ). The overall obesity (5.4–7.8%,  $p < 0.001$ ) and overweight (13–17.8%,  $p < 0.001$ ) burdens significantly increased after the lockdown period. This is similar to study subjects of Jia et al. [29] where the youths showed a significant increase in BMI on average (21.8 to 22.1 kg/m<sup>2</sup>,  $p < 0.001$ ), which was also observed in all education subgroups after lockdown. Similarly, increases in the prevalence of overweight (21.4% to 24.6%,  $p < 0.001$ ) and obesity (10.5% to 12.6%,  $p < 0.001$ ) were also observed in all education subgroups.

This is similar to the Pellegrini et al. [30], where on average, during the lockdown period, self-reported weight and BMI significantly increased by 1.51 kg ( $p < 0.001$  by t-test for paired samples) and 0.58 kg/m<sup>2</sup> ( $p < 0.001$ ), respectively.

Similar results are seen in study reports of Kim et al. [31], where mean body mass index (BMI) increased among all participants from 26.7 to 27.7 kg/m<sup>2</sup> ( $p < 0.001$ ).

COVID-19 restrictions, for the good of all, have reduced many healthy food and physical activity options for

children. Clinicians, families and communities must create and prioritize alternate, safe options. The many effects of the COVID19 pandemic on childhood obesity must be considered in creating effective health policy going forward. However virtual platforms have been used by some schools to organise physical activity classes for children to easily follow at home [32]. Such initiatives should continue and be more readily implemented during these COVID-19 times.

## Limitations

The first limitation of this study was the comparatively small sample size. Also, as food choices, culture, food availability, beliefs vary across different ethnicities this restricts the extrapolation of these findings to other ethnic and racial groups. The study should be conducted on a larger sample comprising more ethnically and socioeconomically diversified populations to better understand the influences of different ethnic and racial groups and socioeconomic status on child obesity. Because of the small sample size, the study may not have enough power to detect an association between a factor of interest and the child BMI percentile.

The second limitation of this study was that the data were obtained using a self-reported questionnaire. Parents might have tended to choose desirable answers. Self-reported body weight, may be subject to recall bias. Also, it is questionable whether parents were accurate reporters of their habits. Finally, this being a cross-sectional study, the direction of a relationship cannot be established between children’s BMI percentile and a parental or family factor even if the relationship is significant. To better understand the association of the parental and family factors with child’s BMI percentile, a longitudinal research design needs to be undertaken in future studies.

## Conclusion

COVID-19 places children at increased risk for physical and psychosocial sequelae. For schools that have the capacity to stream online classes, physical education teachers could stream exercise classes and few exercise programs could be adapted into at-home lesson plans to engage children in physical activity. A supportive relationship with adults can help “buffer” a stressful experience and support the child’s adaptation. Ensuring the health of children, especially those with the chronic condition of childhood obesity, requires ongoing monitoring by healthcare specialists. Healthcare and educational systems should engage in an adequate supporting and managing system to deal with childhood obesity. Educating the parents on food availability, convenience and how to choose food wisely even if on a budget, is an issue that needs to be tackled. Advocacy for physical activity while maintaining social distancing is a must. BMI, obesity and overweight increased among children during the COVID-19 lockdown, disproportionately affecting disadvantaged subpopulations. Strategies are needed to counteract the impact of the COVID-19 lockdown on unhealthy weight gain and childhood obesity.

**Author Contributions** Dr. BC Surekha made substantial contributions to the design of the work, data collection and analysis. Dr. KK agreed to be accountable for all aspects of the work in ensuring that integrity of any part of the work are appropriately investigated and resolved. Dr. KV and Dr. BC Sreelekha made substantial contributions to the acquisition and analysis of data. Dr. VDK contributed to the interpretation of data for the work statistical analysis.

**Funding** No external funding.

**Code Availability** Microsoft Excel was used. Computed with IBM SPSS v26.

**Declarations**

**Conflict of interest** The authors declare that they have no conflicts of interests.

**Ethical Clearance** Obtained.

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