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Brief Cutting-Edge Report

Effects of COVID-19 Lockdown on Lifestyle Behaviors in Children with Obesity Living in Verona, Italy: A Longitudinal Study

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Study Importance

- **What is already known about this subject?**

Children and adolescents gain more weight during summer vacations than during the structured school year, leading to the hypothesis that the COVID-19 lockdown will lead to unfavorable changes in lifestyle behaviors among homebound youths with obesity.

- **What are the new findings in your manuscript?**

Findings from this longitudinal observational study, conducted in Italy, support the hypothesis that unfavorable changes in eating, sleep, and activity behaviors occur in children and adolescents with obesity during a non-school lockdown period.

- **How might your results change the direction of clinical practice?**

Recognizing these adverse collateral effects of the COVID-19 pandemic lockdown is critical in avoiding depreciation of hard-fought weight control efforts among youths afflicted with excess adiposity.

ABSTRACT

Objective: To test the hypothesis that youths with obesity, when removed from structured school activities and confined to their homes during the COVID-19 pandemic, will display unfavorable trends in lifestyle behaviors.

Methods: The sample included 41 children and adolescents with obesity participating in a longitudinal observational study located in Verona, Italy. Lifestyle information including diet, activity, and sleep behaviors were collected at baseline and three weeks into the national lockdown during which home confinement was mandatory. Changes in outcomes over the two study time points were evaluated for significance using paired t-tests.

Results: There were no changes in reported vegetable intake; fruit intake increased ($p=0.055$) during the lockdown. By contrast, potato chip, red meat, and sugary drink intakes increased significantly during the lockdown (p -value range, 0.005 to <0.001). Time spent in sports activities decreased ($X\pm SD$) by 2.30 ± 4.60 hours/week ($p=0.003$) and sleep time increased by 0.65 ± 1.29 hours/day ($p=0.003$). Screen time increased by 4.85 ± 2.40 hours/day ($p<0.001$).

Conclusions: Recognizing these adverse collateral effects of the COVID-19 pandemic lockdown is critical in avoiding depreciation of weight control efforts among youths afflicted with excess adiposity. Depending on duration, these untoward lockdown effects may have a lasting impact on a child's or adolescent's adult adiposity level.

Word and Page Count: Abstract, 200; Text, 1533; Tables, 2; References, 7.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has had far reaching health, social, and economic implications. Among them is the abrupt cessation of school programs for children and adolescents in Italy who by mandate had to remain in their homes during the “lockdown” aimed at containing and mitigating spread of COVID-19. There are reasons to be concerned about housebound children and adolescents who have overweight and obesity: previous studies support the hypothesis these youths will fare worse on weight control lifestyle programs while at home compared to when they are engaged in their usual school curriculum (1).

In support of this hypothesis, a 2007 study by von Hippel et al. reported the effects of school versus non-school environments on overweight in childhood (2). The authors posed the question if non-school environments experienced during summer vacations contribute more to body mass index (BMI) gain in childhood than when school is in session. Von Hippel et al. found that BMI gain was more rapid during summer vacation than during the in-session school year.

In 2014 Franckle et al. reported a systematic review including seven studies examining school-versus summer weight gain in children with an emphasis on racial/ethnic disparities (3). Of the seven studies, six found “accelerated” weight gain during the summer, particularly among black, Hispanic, and overweight children and adolescents. Wang et al. in 2015 (4) found that during summer breaks children consumed less vegetables and more added sugar and watched more television, but they were also more active. The authors did not detect racial differences in these effects.

In 2016 von Hippel and Workman reported observations in a large sample (18,170) of US children attending kindergarten through the second grade (5). The authors found that the prevalence of overweight and obesity increased significantly over two summer vacations but that no increase in adiposity occurred during the three evaluated school years. School environments provide structure and routine around mealtimes, physical activity, and sleep schedule, the three predominant lifestyle factors implicated in obesity risk.

These and other observations led Rundle et al. (1) to recently advance the argument that the COVID-19 pandemic, by restricting children from attending school, will exacerbate the risk factors

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for “weight gain associated with summer recess”. The authors additionally postulated that homes will be stocked during the lockdown with ultra-processed and calorie dense foods, a suggestion now strongly supported by recent observations in real-world settings (6). The aim of this longitudinal clinical study was to test the hypothesis that factors contributing to weight gain among children and adolescents with overweight and obesity are exacerbated during a pandemic-associated lockdown.

METHODS

Study Design and Rationale

Non-adult participants with obesity ($\text{BMI} > 25 \text{ kg/m}^2$) were enrolled as controls in the ongoing longitudinal observational OBELIX Study in Verona, Italy, where lifestyle changes are the main therapeutic goal and the protocol includes periodic telephone interviews. The study was approved by the hospital Institutional Review Board (Protocol: 5384, 01/29/2019), and parents provided informed consent at the first/baseline evaluation visit which occurred between May 13th and July 30th, 2019. During this period children attended school (May-June) or were involved in structured post-school activities (July) administered weekdays during the morning. Body weight, height, and waist circumference were measured at the baseline visit; BMI was calculated at $\text{weight}/\text{height}^2$. BMI z-scores and BMI %-tiles were computed using US Center for Disease Control 2000 growth chart algorithm (7).

In this pre-peri lockdown observational study, the baseline in-person interviews and later telephone interviews at the second evaluation were conducted with parents and focused on their child's lifestyle behaviors. The lifestyle questionnaire consisted of 12 questions about sports activity participation, screen time, sleep behavior, and eating habits focusing on servings of red meat, pasta, snacks, fruits, and vegetables. A meal was defined as structured non-liquid ingestive events including breakfast, lunch, afternoon snacks, and dinner. Time spent in sports during the lockdown were considered as any physical activity (e.g., jogging, playing in the backyard, etc.) given that it was not possible during the lockdown to participate in organized sports.

Questions related to behaviors observed over the evaluation week. The telephone interviews lasted about ten minutes.

Some educational programs were delivered via internet during the lockdown, but the screen time question related to non-school activities. The interviews were conducted at the baseline visit in May-July 2019 and again three weeks following the mandatory quarantine starting on March 10th, 2020. The same questions collected at baseline were compared to those collected three weeks into the

lockdown confinement. The same person administered the questions at baseline and later by telephone. A structured weight control program was not provided to participants during the shelter-in-place period. Most of the participants had access to courtyards or gardens that provided small open spaces for activities.

Statistical Methods

Descriptive statistics of the participants' baseline characteristics are provided as mean and standard deviation (SD) for continuous variables and frequency and percentages for categorical variables. We used paired t-tests to evaluate the significance of changes from pre-lockdown (baseline, May-July 2019) to lockdown (March-April 2020) in the item responses. Pearson correlation analyses were conducted to assess the associations between diet, activity, and sleep pre-peri behavior changes. In addition, we tested the significance of differences between males and females in response changes using independent two-sample t-tests. The small sample precluded testing race/ethnic differences in outcome variables. All statistical analyses were performed using SAS 9.4 and statistical significance was declared if a two-sided p-value was less than 0.05.

RESULTS

Subjects

Fifty parents were contacted and 41 responded and agreed to be interviewed. The 41 participants included 22 males and 19 females with a mean baseline age of 13.0 ± 3.1 (range, 6-18) years (**Table 1**). Baseline BMI was similar at about 30 kg/m^2 in males and females with mean z-scores between the 97th and 98th percentiles that ranged from the 94.4th to 99.6th percentiles. The participant with the minimum BMI%-tile was the only one whose percentile was less than the 95th percentile. The participant's countries of origin included Italy (35), North Africa (4), and Albania (2). Baseline reported activities included running/soccer (24.4%), swimming (17.1%), jogging (22.0%), volleyball/basketball (9.8%), dancing (9.8%); only 4.9% reported no sports activities.

Questionnaire Observations

The results of lifestyle questionnaire evaluations are presented in **Table 2**. The number of meals eaten per day increased by 1.15 ± 1.56 , a difference that was significant ($p < 0.001$). There were no changes in vegetable intake and fruit intake increased (marginal significance, $p = 0.055$). Potato chips, red meat, and sugary drink intakes all increased significantly ($p = 0.005$ - < 0.001) during the lockdown.

Sleep time increased significantly (0.65 ± 1.29 hours/day, $p = 0.003$) and sports time decreased significantly by 2.30 ± 4.60 hours/week ($p = 0.003$). Screen time increased by 4.85 ± 2.40 hours/day ($p < 0.001$).

There was an inverse correlation between change in sports participation and both a change in number of meals/day ($r = -0.35$, $p = 0.027$) and change in screen time ($r = -0.27$, borderline significant at $p = 0.084$). The only sex difference in lifestyle question responses was between males and females for change in meals/day. The number of meals eaten per day increased significantly more in the males (1.64 ± 1.65) than in females (0.58 ± 1.26 ; $p = 0.028$).

DISCUSSION

The current study strongly supports the hypothesis advanced by Rundle et al. (1) positing that the COVID-19 pandemic will “exacerbate all of the risk factors for weight gain associated with summer recess”. Specifically, our longitudinal study of children and adolescents with obesity affirmed that eating, activity, and sleep behaviors changed in an unfavorable direction three weeks into their confinement during the national lockdown. These observations point to the critical need for implementation of preventive measure during periods of lockdown, particularly when their duration is uncertain. Such measures might include implementation of telemedicine lifestyle programs, practitioners of pediatric and adolescent medicine can offer supplemental guidance encouraging families to maintain healthy lifestyle choices, and facilities can be designed for implementing exercise programs that minimize viral transmission.

Although we do not yet have post-confinement measurements of BMI, based on previous studies we can speculate that excess weight gained during the lockdown may not be easily reversible and might contribute to excess adiposity during adulthood (5).

Our study has several limitations, including that our data was acquired in a small sample from parent reports and that no quantitative measures of weight, height, and activity levels were available. The possibility exists that parent’s sense of their child’s behavior was heightened during the lockdown, potentially inadvertently biasing their responses. We were aware of this possibility in our study and tried to the extent possible to avoid leading questions during the lockdown interviews. Our baseline evaluation was at the start of the study and not at the beginning of the lockdown, an event that was largely unpredictable. These limitations are understandable given the exigencies operating during course of this study.

In sum, the tragic COVID-19 pandemic has collateral effects extending beyond those of direct viral infection. Children and adolescents struggling with obesity are placed in an unfortunate position of isolation that appears to create an unfavorable environment for maintaining healthy lifestyle behaviors. Recognition of the lockdown phenomenon is the first step in taking preventive measures. Additionally, government officials and policy makers may want to consider the deleterious lifestyle effects of the lockdown on youths with obesity when making decisions regarding when and how to loosen restrictions.

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Table 1. Participant Baseline Characteristics.[†]

Characteristics	Males (N=22)		Females (N=19)		Total (n=41)	
	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
Age (years)	13.3±3.0	(6.0, 17.0)	12.7±3.2	(7.0, 18.0)	13.0±3.1	(6.0, 18.0)
Height (cm)	161.5±17.9	(124.0, 194.0)	154.9±12.0	(126.0, 170.0)	158.4±15.6	(124.0, 194.0)
Weight (kg)	81.8±25.6	(40.0, 141.0)	72.2±15.7	(40.0, 99.5)	77.4±21.9	(40.0, 141.0)
Z-score	2.24±0.29	(1.68, 2.70)	2.11±0.31	(1.68, 2.60)	2.18±0.30	(1.58, 2.70)
BMI%-tile	98.4±1.2	(95.3, 99.6)	97.8±1.6	(94.3, 99.5)	98.2±1.4	(94.3, 99.6)
BMI (kg/m ²)	30.5±4.3	(23.1, 39.1)	29.7±3.8	(24.0, 39.9)	30.2±4.1	(23.1, 39.9)
WC (cm)	92.8±12.7	(71.0, 121.0)	87.4±9.8	(68.5, 110.0)	90.3±11.6	(68.5, 121.0)

[†]BMI, body mass index; WC, waist circumference.

Table 2. Results of the Questionnaire Survey.[†]

Variable	Baseline	Lockdown	Δ	95% CI	t	p-value
Meals (#/day)	4.17±0.95	5.32±1.29	1.15±1.56	0.65/1.64	4.71	<0.001
Vegetable intake*	1.34±0.74	1.27±0.69	-0.07±0.60	-0.26/0.12	-0.78	0.438
Fruit intake*	1.16±0.74	1.39±0.70	0.23±0.75	-0.01/0.47	1.98	0.055
Potato chips*	0.07±0.24	0.61±0.83	0.54±0.86	0.26/0.81	3.99	<0.001
Red meat*	1.80±1.53	3.46±2.45	1.66±2.10	1.00/2.32	5.05	<0.001
Sugary drinks (#/day)	0.40±0.90	0.90±1.16	0.50±1.08	0.16/0.84	2.97	0.005
Screen time (hrs/day)	2.76±1.64	7.61±2.13	4.85±2.40	4.10/5.61	12.94	<0.001
Sleep time (hrs/day)	8.46±0.85	9.11±1.10	0.65±1.29	0.24/1.05	3.22	0.003
Sports (hrs/week)	3.60±4.25	1.29±1.44	-2.30±4.60	-3.76/-0.85	-3.21	0.003

[†]N=41, X±SD. *, units are serving per day. Δ = lockdown – baseline value.