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Impact of the SARS-CoV-2 pandemic on the body mass index of children seen in the City of Buenos Aires

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ABSTRACT

Introduction. Childhood overweight and obesity are a public health problem. The onset of the COVID-19 pandemic may have contributed to this condition. The body mass index (BMI) Z-score has been accepted as an indicator for overweight and obesity diagnosis and follow-up.

Objective. To assess whether the prevalence of overweight and obesity and the BMI Z-score in children aged 2 to 5 years increased during the pandemic.

Population and methods. Retrospective, cohort study. Patients included were those seen at public health care facilities in the City of Buenos Aires (CABA), who were aged 2 to 5 years, had weight and height values recorded at 2 different visits, before and after the establishment of the preventive and mandatory social isolation policy. Patients' nutritional status (BMI Z-score) and the variation in this indicator between both visits were recorded.

Results. A total of 3866 subjects were assessed; their average age was 3.4 ± 0.8 years; 48.1% were girls. The average interval between both visits was 14.3 ± 2.5 months. The prevalence of overweight/obesity increased from 12.6% (95% CI: 11.6–13.6) to 20.9% (95% CI: 19.6–22.2), $p < 0.001$, and so did the BMI Z-score (0.4 ± 1.1 versus 0.8 ± 1.3, $p < 0.001$).

Conclusion. The prevalence of overweight and obesity and the BMI Z-score in children aged 2 to 5 years increased significantly during the pandemic.

Keywords: *obesity; overweight; COVID-19; pandemic; social isolation.*

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INTRODUCTION

Childhood overweight and obesity are a public health problem with a multifactorial origin that demonstrates an energy imbalance between calorie intake and expenditure.[1] It affects 39 million children younger than 5 years worldwide[2] and its prevalence has been increasing over the past 4 decades.[3]

The measures adopted with the onset of the COVID-19 pandemic resulted in changes in people's lifestyle. Social distancing, school and club closures, and the introduction of several technologies in education routines contributed to a sedentary behavior.[4]

In Argentina, a strict social distancing policy, known as the preventive and mandatory social isolation, was passed on 3-19-2020.[5]

Pietrobelli et al., in Italy, observed that, during the lockdown and the interruption of school activities, children and adolescents ate more meals daily, with an increase in high-calorie and fat-rich foods, more sleep hours, reduced physical activity, and more hours of screen use.[6]

In addition to the changes in habits mentioned before, a reduction of 44% was also reported in the number of health checkups in the Metropolitan Area of Buenos Aires.[7]

The circumstances described here may have increased the prevalence of overweight and obesity in the children of our population as of the onset of the COVID-19 pandemic.

The body mass index (BMI) Z-score is a useful parameter for epidemiological studies.[8] During the period between 2 and 5 years of age, the BMI Z-score remains relatively constant;[2] therefore, a positive variation in the BMI Z-score over time (BMI Z-score/year) evidences a weight gain over height (adiposity rebound),[9] thus increasing the risk for overweight or obesity. Identifying whether the prevalence of overweight and obesity and the BMI Z-score increased during the lockdown would be particularly relevant to design mitigation strategies using evidence-based tools that have already demonstrated their effectiveness.[10]

This study becomes even more relevant if we consider that overweight and obesity in preschoolers have a negative impact that prolongs into adolescence and adulthood, such as adult obesity, arterial hypertension, diabetes, and metabolic syndrome.[11]

OBJECTIVE

To assess whether the prevalence of overweight and obesity and the BMI Z-score in children aged 2 to 5 years increased during the lockdown.

METHODS AND ANALYSIS PLAN

Design: Retrospective, cohort study.

Description of the study setting: The study was carried out at Hospital General de Niños Pedro de Elizalde together with the Subsecretariat of Data Science and the Ministry of Health of the City of Buenos Aires (MoH-CABA). Data were collected from the electronic comprehensive health records used in the outpatient offices of public healthcare facilities under the MoH-CABA.

POPULATION

Inclusion criteria: Users of electronic comprehensive health records who, between 9-19-2019 and 3-19-2020 (prior to the lockdown), were aged 2 to 5 years and had weight and height values recorded (visit 1), and who also had other weight and height values recorded 12 to 15 months after visit 1 at least 6 months after 3-19-2020 (visit 2).

Exclusion criteria: Subjects whose data were incomplete, who had a BMI Z-score > -3 at visit 1 (so as to include healthy subjects only), or who had values that may be considered wrong (subjects with a negative weight difference > 2.5 kg/year or a negative height difference > 5 cm/year between both visits, and who had a positive weight difference > 15 kg/year or a positive height difference > 10 cm/year) were excluded.

Sample size and sampling: All subjects who met the inclusion criteria were included. Similarly, the sample size was calculated to estimate differences in paired samples because it is more exacting. It was observed that 3142 subjects were sufficient to establish a difference of at least 0.1 between related mean values (BMI Z-score for both measurements), with a power of 80% and a confidence level of 95% (Epidat 4.2).

Study variables

Outcome variables

- Nutritional status based on BMI Z-score at both visits, with the following definitions: underweight -3 to < -1, normal weight -1 to < 1, risk for overweight 1 to < 2, overweight 2 to < 3, and obesity ≥ 3.[2]
- BMI Z-score at visit 1 and BMI Z-score at visit 2 (continuous variable).

Secondary outcome variables

- Variation in BMI Z-score/year. To establish the variable, the difference from the BMI Z-score recorded at visit 2 (during the lockdown) minus the BMI Z-score at visit 1 extrapolated to one year (continuous variable) was used.
- Weight, height, and BMI at both visits and annual variation (continuous variables). The BMI Z-score was estimated as per the recommendations of the World Health Organization.[2]

Control variables

- Age (decimal age), sex, type of healthcare facility where the visit took place (hospital/healthcare center/community health center).

Analysis of results

Variables were described using proportions and a 95% confidence interval (CI) for categorical and ordinal variables, and average and standard deviation for continuous variables (all adjusted to normality according to the Kolmogorov-Smirnov test).

The interval between both measurements was variable; for their description and comparison of the variations in weight, height, BMI, and BMI Z-score, they were extrapolated to one year.

The proportion of patients with overweight and obesity between both visits was compared using the χ^2 test. To assess whether there were changes in the mean BMI Z-score between both visits, the t test for related samples was used. To assess the variation in the BMI Z-score/year based on the nutritional status classification of the first visit, an ANOVA test was used.

All results were described with their corresponding 95% CI. A p value < 0.05 was considered acceptable. Data were analyzed and processed using the SPSS 20.0 software.

Ethical considerations

The protocol was developed in accordance with the regulations in force and the Law for Personal Data Protection. The study was approved by the Research Ethics Committee of Hospital General de Niños Pedro de Elizalde. The study was conducted with a fellowship granted by the Sociedad Argentina de Pediatría.

RESULTS

Out of 4776 subjects identified in the database who met the inclusion criteria, 12 were excluded because they had a BMI Z-score > -3 SD at the first control; 756 were excluded due to a weight loss > 2.5 kg/year and/or a height decrease > 5 cm/years between both visits; and 142 were excluded due to a weight gain > 15 kg/year and/or height increase > 10 cm/year between both visits.

Finally, the study population was made up of 3866 subjects; 48.1% were girls; 75.4% lived in the CABA; 57.8% were seen at healthcare centers; 40.9%, at hospital outpatient offices; and 1.3%, at community health centers.

Subjects' average age at the first visit was 3.4 ± 0.8 years, and the interval between both visits was 14.3 ± 2.5 months.

The mean variation between both visits in weight/year was 2.8 ± 1.4 kg; that in height/year was 7.2 ± 1.7 cm; and that in BMI/year was 0.3 ± 1.2 (*Table 1*). The nutritional status at both visits is shown in *Table 2.*

The mean BMI Z-score between both visits increased (0.4 ± 1.1 at visit 1 versus 0.8 ± 1.3 at visit 2, $p < 0.001$). This was accompanied by an increase in the prevalence of overnutrition (overweight and obesity), from 12.6% (95% CI: 11.6–13.6) at visit 1 to 20.9% (95% CI: 19.6-22.2) at visit 2 ($p < 0.001$). Compared to visit 1, 13.9% of subjects were identified to have a reduction in nutritional parameters (BMI Z-score) at visit 2; 55.4% did not show any changes in their nutritional status classification; and 30.6% had an increase in nutritional parameters.

The variation in the BMI Z-score/year increased 0.4 ± 0.8 in average. The analysis of each nutritional status found a greater average

Table 1. Anthropometric records at each visit and annual variation (n = 3866)

	Visit 1	Visit 2	Variation	Variation/year*	*p*
Weight (kg)	15.2 ± 2.8	18.5 ± 3.7	3.3 ± 1.7	2.8 ± 1.4	< 0.001
Height (cm)	96.7 ± 7.4	105.4 ± 7.2	8.6 ± 2.5	7.2 ± 1.7	< 0.001
BMI	16.2 ± 1.6	16.6 ± 2.1	0.4 ± 1.3	0.3 ± 1.2	< 0.001

BMI: body mass index.

Values are described as mean ± standard deviation.

**Values for variation/year correspond to the difference between visit 2 and visit 1 extrapolated to one year.*

Table 2. Classification of nutritional status by body mass index Z-score at each visit and variation between both visits

		Visit 1			Visit 2			Variation*
BMI Z-score	**Classification**	**n**	**%**	**95% CI**	**n**	**%**	**95% CI**	
-3 to < -1	Underweight	348	9.2	8.1–9.9	259	6.8	5.9–7.5	-2.4
-1 to < 1	Normal weight	2277	58.7	57.1–60.2	2001	51.7	50.1–53.3	-7
1 to < 2	Risk for overweight	755	19.5	18.2–20.7	797	20.6	19.3–21.8	1.1
2 to < 3	Overweight	216	5.6	4.8–6.3	366	9.5	8.6–10.5	3.9
≥ 3	Obesity	270	7	6.2–8.5	443	11.4	10.5–12.5	4.4

**Visit 2 – visit 1.*
BMI: body mass index.

increase in the BMI Z-score/year in underweight subjects ($p < 0.001$, ANOVA test) (*Table 3*).

In relation to control variables, no significant correlation was observed between age at visit 1 and the variation in the BMI Z-score/year (r: 0.1, $p = 0.5$). On the contrary, a difference was observed in the mean variation in the BMI Z-score/year, which was discretely higher in girls compared to boys (0.3 ± 0.7 versus 0.2 ± 0.7, $p < 0.001$). Lastly, no significant differences were observed in the mean variation in the BMI Z-score/year by type of healthcare facility ($p = 0.4$, ANOVA test) (*Table 4*).

DISCUSSION

In this study, we observed an increase in the BMI, the average BMI Z-score, and the prevalence of overweight and obesity during the lockdown in children aged 2 to 5 years seen in public healthcare facilities in the City of Buenos Aires. An increase in mean BMI Z-score was observed, regardless of the subject's nutritional status.

The COVID-19 pandemic and society's response to it triggered unexpected consequences. We focused on the potential weight gain in children, one of the major childhood health problems observed during the pandemic. To this end, we had the opportunity to use electronic records from the health data system implemented in all public healthcare facilities in a city of approximately 3 million inhabitants,[13] which allowed us to identify an adequately

Table 3. Variation in BMI Z-score per year between both visits by classification of nutritional status at the first visit

BMI Z-score visit 1	Classification	n	Variation in BMI Z-score/year* Mean	Standard deviation
-3 to < -1	Underweight	348	1.6	1.5
-1 to < 1	Normal weight	2277	0.2	0.7
1 to < 2	Risk for overweight	755	0.2	0.7
2 to < 3	Overweight	216	0.1	0.7
≥ 3	Obesity	270	0.2	0.8

**ANOVA test p < 0.001.*
BMI: body mass index.

Table 4. Variation in BMI Z-score per year between both visits by type of healthcare facility

Healthcare facility	n	Variation in BMI Z-score/year Mean	Standard deviation
Healthcare center	2234	0.2	0.7
Hospitals	1580	0.3	0.8
Community health center	52	0.3	0.7

BMI: body mass index.

representative population for this study.

All participants had 2 visits with an average interval of 14 months between them, which allowed to conduct an objective observation of potential changes in nutritional status during the study period. We observed that the average weight and height increase was consistent with the growth considered normal for this age group. However, while the observed variation in height (7 cm/year) was equivalent to the 50th percentile of height growth for girls and boys, the variation in weight (2.8 kg/year) was at the upper limit of what is expected (the 50th percentile corresponds to 2 kg/year).[14] This difference in the pattern of weight and height increase probably accounts for the observed increase in BMI.

At this stage of life (2 to 5 years), the increase in weight and height is physiological; however, the BMI Z-score should be consistent or may decrease slightly.[15] In our study, we verified a significant increase in the average BMI Z-score between both visits, which changed from 0.4 to 0.8. This is consistent with the observations by Wessely et al., who found an average increase in the BMI Z-score from 0.4 to 0.6 during the period of strict lockdown in Germany.[16]

In our population, the increase in the BMI Z-score observed at the second visit led some subjects classified as normal weight or overweight at the first visit to be reclassified as overweight or obese at the second visit. An increase in the prevalence of overweight and obesity of slightly more than 8% was observed in the study period (approximately a year), which was consistent with the stricter lockdown period. These results may be similar to those described by Surekha et al. in India, in subjects aged 3 to 15 years, who showed an increase in obesity from 5.4% to 7.8% during the COVID-19 pandemic.[17]

When analyzing the variation in the BMI Z-score extrapolated to one year (BMI Z-score/year), it was observed that all groups showed an increase in the average Z-score, which was higher among underweight patients. It was observed that, in the second visit, most of overweight and obese patients remained in the same category and that the increased prevalence observed in our sample may be explained by the weight gain of the lower weight groups (risk for overweight, normal weight, and underweight). The greater weight gain observed in underweight patients is similar to that described by Weng et al. in relation to risk factors for the development of overweight and obesity.[18]

The evidence indicates that an excessive weight gain during childhood is associated with an increased risk for obesity in adulthood.[19,20] In addition, it has been estimated that 30–50% of children with obesity remain obese in adulthood,[21] so it is important to identify situations that may lead to this clinical outcome for a timely and effective intervention.

Regarding the cause of weight gain during the lockdown, most likely it has a multifactorial origin. On the one side, a significant reduction was verified in the level of physical activity among children and adolescents during the COVID-19 pandemic.[22] On the other side, important changes in household dynamics may have occurred, which are difficult to verify and quantify and may have had an impact on a higher calorie intake.[6]

Another point to consider is the length of the lockdown policy in our country and the magnitude of the mentioned behavioral changes. In our sample, all the records from the second visit corresponded to both the preventive and mandatory social isolation period and the preventive and mandatory social distancing period established in our country, which implemented similar restrictions (no in-person school activities, greater screen use, etc.).[23]

This study has potential weaknesses that should be taken into consideration. Given that this was a retrospective cohort, it was not possible to standardize measurements. However, these children were aged 2 to 5 years in whom small estimation errors may not be so relevant considering their weight and height, unlike what would occur with infants. There is the possibility of a selection bias in relation to a more thorough recording of anthropometric control in children who appeared overweight or obese that may have overestimated the actual prevalence of this condition in our population. However, an anthropometric control is a common practice in pediatrics and, in addition, the prevalence of overweight and obesity observed in the first visit is consistent with local data.[24]

A strength of our study is that it corresponded to a retrospective cohort that included a sample of patients aged 2 to 5 years seen across all public healthcare facilities under the MoH-CABA, identified using a methodology that has already been tested in other studies and that demonstrated an adequate sensitivity;[25] therefore, we believe that it is sufficiently representative and with little possibility of bias in terms of subject selection.

CONCLUSIONS

During the mandatory lockdown due to the COVID-19 pandemic, an increase has been observed in the prevalence of overweight and obesity and in the BMI Z-score in children aged 2 to 5 years in the City of Buenos Aires. ■

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