

## ORIGINAL ARTICLE

# THE IMPACT OF COVID-19 PANDEMIC ON CHILDHOOD OBESITY: THE REALITY IN A PORTUGUESE HOSPITAL

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### Abstract

**Aim:** The aim of this study was to investigate changes in the prevalence of overweight and obesity in children and adolescents during the first year of COVID-19 pandemic.

**Methods:** This is a cross-sectional study involving children and adolescents aged 2-17 years, followed in a pediatric department of a portuguese hospital. Retrospectively we calculated and compared the body mass index at three different periods: before the first lockdown; after the first lockdown; 1-year after the onset of COVID pandemic.

**Results:** The overall overweight and obesity prevalence significantly increased after the first lockdown and 1-year after the onset of COVID pandemic. The greatest rate change on body mass index percentile was found in the normal-weight group, especially in 10-13 years-old boys. In the overweight and obesity group, girls had a greater mean weight gain during the first lockdown but it was the boys who showed the greatest increase in body mass index during the first year of the pandemic.

**Conclusion:** The childhood overweight and obesity prevalence increased during the first year of COVID-19 pandemic, especially in normal-weight children. Thus, public health measures must be discussed to prevent and fight this increase in childhood obesity prevalence.

### Introduction

Obesity among children and adolescents is currently considered one of the most serious public health challenges. According to the World Health Organization (WHO) the worldwide prevalence of childhood overweight and obesity has rapidly increased over the past two decades, especially in developing countries, having risen significantly from just 4% in 1975 to more than 18% in 2016.<sup>1</sup> WHO estimated that over 340 million children and adolescents aged 5-19 were overweight or obese in 2016 and 38.2 million children under the age of 5 were overweight or obese in 2019.<sup>1</sup>

Coronavirus disease 2019 (COVID-19) was considered by WHO as a pandemic on 11<sup>th</sup> March 2020.<sup>2</sup> Several measures were implemented by national and international authorities, including the closure of schools, parks and playgrounds, lockdown and social distancing.<sup>3,4</sup> In Portugal, schools were shut down on 16<sup>th</sup> March and the first lockdown lasted until May.<sup>5,6</sup> On 18<sup>th</sup> May, face-to-face classes were allowed again in kindergartens and for 11<sup>th</sup> and 12<sup>th</sup> grade high school students. The other students kept online classes at home until the end of the school term in the first week of July.<sup>6</sup> After summer holidays, on 14<sup>th</sup> September,

all schools reopened, but were shut down again on 21<sup>st</sup> January, with a gradual reopening during the months of March and April.<sup>7,8</sup>

Pre-COVID studies reported that children and adolescents tend to gain weight during summer holidays.<sup>9</sup> Hence, like Cuschieri & Grech proposed, if we consider the COVID-19 lockdown period as an "early onset summer holiday", childhood obesity rates might have increased proportionately to the number of months that schools remained closed.<sup>10</sup> At home, children not only tend to eat more unhealthily, but they also have fewer opportunities to engage in physical activities.<sup>10</sup>

The lockdown and school closures during the COVID-19 pandemic caused not only changes in lifestyle and eating behaviors, but decreased the opportunities for physical activity, increasing time spent in sedentary activities, all of which could lead to an increase in obesity rates.<sup>3,11,12,13,14,15,16,17,18</sup>

Several studies have demonstrated the increase in childhood obesity during the first year of COVID-19 pandemic.<sup>3,4,10,11,12,13,14</sup> Pietrobelli et al., reported changes in the lifestyle behaviors of italian obese children and adolescents during the lockdown, such as: increase in potato chip, red meat and sugary drink intake; decrease in time spent in sport activities; and increase in sleep and screen time.<sup>13</sup> In Vogel et al. study, the greatest weight gain was found in the obese subgroup.<sup>14</sup> Cipolla et al. analyzed overweight and obese children and adolescents during the first

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### KEYWORDS

COVID-19, body mass index, childhood obesity.

### ABBREVIATIONS

WHO - World Health Organization; COVID-19 - Coronavirus disease 2019; BMI - Body mass index; P1 - Period 1; P2 - Period 2; P3 - Period 3.

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lockdown in Italy and verified that the highest increase in body mass index (BMI) was found in patients who had become more sedentary during the pandemic, but not before. This study also showed a change in eating habits during the lockdown, with an increase of carbohydrates consumption.<sup>15</sup> A cross-sectional online survey among 2680 residents of Denmark, Germany and Slovenia showed that the biggest changes in food habits were found in the increase intake of longer shelf life food such as frozen and canned food, cake and biscuits, with an overall reduction in the consumption of fresh food.<sup>16</sup> Stavridou et al., also found changes in dietary behaviors and unhealthy food choices during COVID-19 pandemic.<sup>17</sup>

Lockdown and closures of schools resulted in the absence of organized physical activity sessions with longer sedentary periods at home. Children living in urban areas or within small apartments are faced with greater difficulties in practicing physical activity due to limited space, being more susceptible to weight gain.<sup>10</sup> In Ventura et al. study, most children and adolescents reported doing less than an hour per day of physical activity when compared to the pre-COVID 19 period. This inadequate frequency of physical activity was greater among boys, especially between 11-16 years.<sup>18</sup>

Another lifestyle change during the pandemic was associated with a higher screen time use as schools shifted to virtual learning, exacerbating sedentary habits.<sup>19</sup> Pietrobelli et al., reported that screen time increased by approximately five hours per day when compared to the pre-COVID-19 period.<sup>13</sup> Katona et al., also reported a significant increase in screen time and decrease in physical activity, with males showing a bigger decrease when it comes to exercise.<sup>20</sup>

In general, overweight and obesity are strongly associated with metabolic changes that increase the risk of non-communicable diseases, such as diabetes and cardiovascular diseases. Furthermore, rapid BMI increases in children are linked to obesity in later life.<sup>21</sup>

The aim of this study was to investigate the impact of COVID-19 lockdown on childhood overweight and obesity prevalence and evaluate if the differences found at the end of the first lockdown remained during the following months.

**Methods & Materials**

We conducted a retrospective cohort analysis of children and adolescents followed in appointments in a portuguese hospital from January 2020 to April 2021.

Data was collected based on nurse and medical record appointment. Height and weight were used to calculate and compare BMI percentile, according to

WHO Child Growth Standards 22, at three different periods: Period 1 (P1) - before the first lockdown (1<sup>st</sup> January to 15<sup>th</sup> March 2020); Period 2 (P2) - after the first lockdown (18<sup>th</sup> May to 31<sup>st</sup> July 2020); Period 3 (P3) - 1-year after the onset of the COVID pandemic (1<sup>st</sup> January to 30<sup>th</sup> April 2021).

Overweight and obesity were defined by WHO’s criteria, as shown in Table 1.<sup>23</sup>

**Table 1.** Classification of nutrition conditions in children and adolescents based on BMI, according to WHO child growth standards.<sup>22,23</sup>

BMI for age	Age	
	2-5 years	5-18 years
< -2 SD *	-	Thinness
-2 SD to 1 SD	Normal-weight	
> +1 SD *	At risk of overweight	Overweight
> +2 SD *	Overweight	Obesity
> +3 SD *	Obesity	Severe obesity

\* The -2SD, +1SD, +2SD and +3SD z-scores approximate **percentiles of 3th, 85th, 97th and 99th** respectively.

Inclusion criteria included the presence in routine appointment in Period 1 and at least one of the other periods, as well as height and weight measurements in all appointments.

Descriptive statistical analysis was performed using the IBM SPSS Statistic, software version 26. Categorical variables were presented in terms of absolute (n) and relative (%) frequencies and percentages. Sex was defined as female and male. Age was divided in four groups: 2-5 years-old; 6-9 years-old; 10-13 years-old; 14-17 years-old. Continuous variables included weight (kilograms), height (centimeters) and BMI percentiles (Table 1) and were characterized by mean and standard deviation (SD). A comparison of the categorical variables was made by the chi-square test. Statistically significant differences in continuous variables between three periods were tested using Paired t-test for paired samples. We evaluated the difference in weight and BMI percentile by age group and sex between the three periods. The minimum significance level used in all statistical test was 5% (p-value < 0.05).

**Results**

This study evaluated 373 children and adolescents aged 2-17 years-old, with 221 (59.2%) males and an average age of 8.3 ± 4.2 years. Table 2 shows the distribution of the sample by sex and age group.

**Table 2.** Distribution of sample by sex and age group.

Age group	2-5 years	6-9 years	10-13 years	14-17 years	Total
Female, n (%)	55 (14.7)	37 (9.9)	44 (11.8)	16 (4.3)	152 (40.8)
Male, n (%)	64 (17,2)	62 (16.6)	62 (16.6)	33 (8.8)	221 (59.2)
Total, n (%)	119 (31.9)	99 (26.5)	106 (28.4)	49 (13.1)	<b>373</b> (100)

Table 3 shows the distribution of the sample by sex and age group in each period of the study.

**Table 3.** Distribution of sample by age groups and sex in each period.

Age group	2-5 years			6-9 years			10-13 years			14-17 years			Total		
	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3
Female, n	55	14	47	37	12	33	44	16	39	16	9	11	152	51	130
Male, n	64	23	54	62	18	52	62	33	46	33	19	27	221	93	179
Total, n	119	37	101	99	30	85	106	49	85	49	28	38	373	144	309

Tables 4 and 5 and Figure 1 show the distribution of the sample according to nutrition conditions, in each period of the study.

**Table 4.** Distribution of 2-5 year-old children according to their nutrition condition, in each period of the study.

Age group	Sex	Nutrition condition*	P1 (%)	P2 (%)	P3 (%)
2-5 years	Female	Normal-weight	29,4	24,3	27,7
		At risk of overweight	11,8	5,4	9,9
		Overweight	1,7	2,7	5
		Obesity	0	0	2
	Male	Normal-weight	34,5	37,8	31,7
		At risk of overweight	14,3	10,8	12,9
		Overweight	1,7	5,4	5,9
		Obesity	1,7	8,1	2
	Total	Normal-weight	63,9	62,2	59,4
		At risk of overweight	26,1	16,2	22,8
		Overweight	3,4	8,1	10,9
		Obesity	1,7	8,1	4

\* Children with BMI < -2SD were excluded from the table.

The overall overweight and obesity prevalence significantly increased across all age and nutrition condition groups after P2 ( $p = 0.003$ ) and P3 ( $p < 0.001$ ). Overweight and obesity prevalence were 5,1%, 16,2% and 14,9% in 2-5 years-old group and 37,1%, 43,4% and 44,9% in 6-17 years-old group, in P1, P2 and P3 periods, respectively (Tables 4 and 5).

In 2-5-year-old age group, there was a significant increase in BMI percentile during the first lockdown ( $p < 0.001$ ). The greatest rate change was observed in males, with 3,4% and 13,5% of overweight/obesity prevalence in P1 and P2, respectively (Table 4 and Figure 1). In P3, overweight/obesity prevalence in males was 7,9%, which corresponds to a reduction in relation to P2, but still higher than in P1.

**Table 5.** Distribution of 6-17 year-old children and adolescents, according to their nutrition condition, in each period of the study.

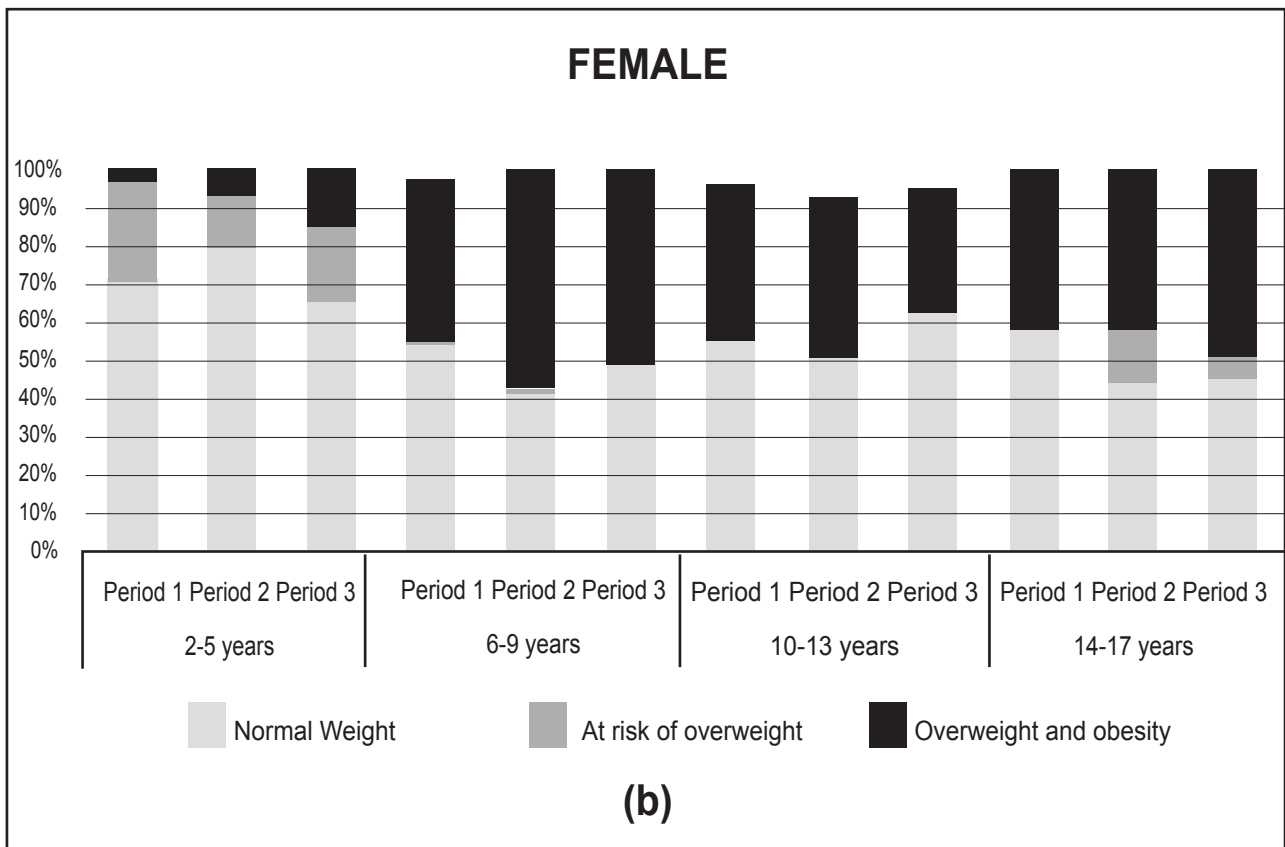
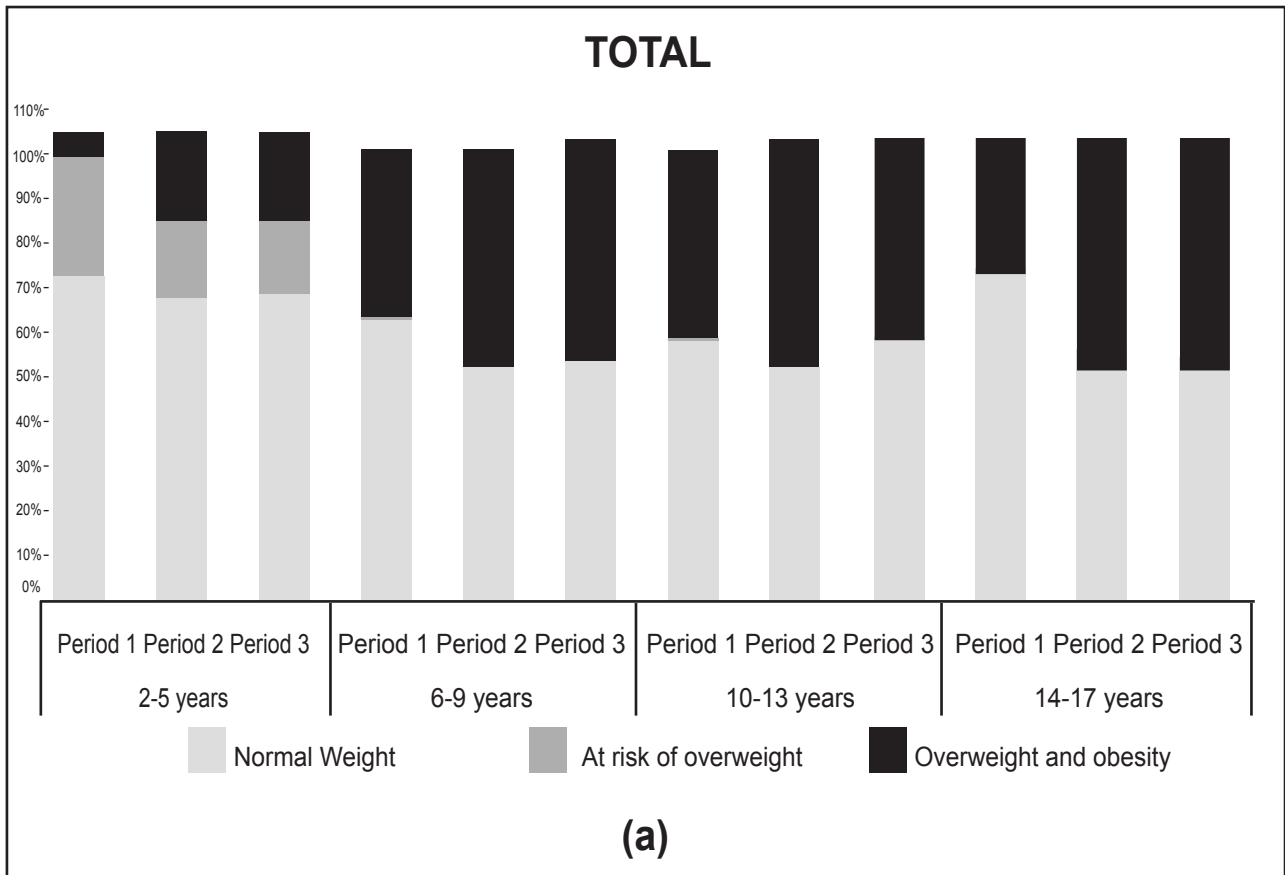
Age group	Sex	Nutrition condition*	P1 (%)	P2 (%)	P3 (%)
6-9 years	Female	Normal-weight	20,2	16,7	18,8
		Overweight	10,1	16,7	18,8
		Obesity	4	10	4,7
		Severe obesity	2	6,7	3,5

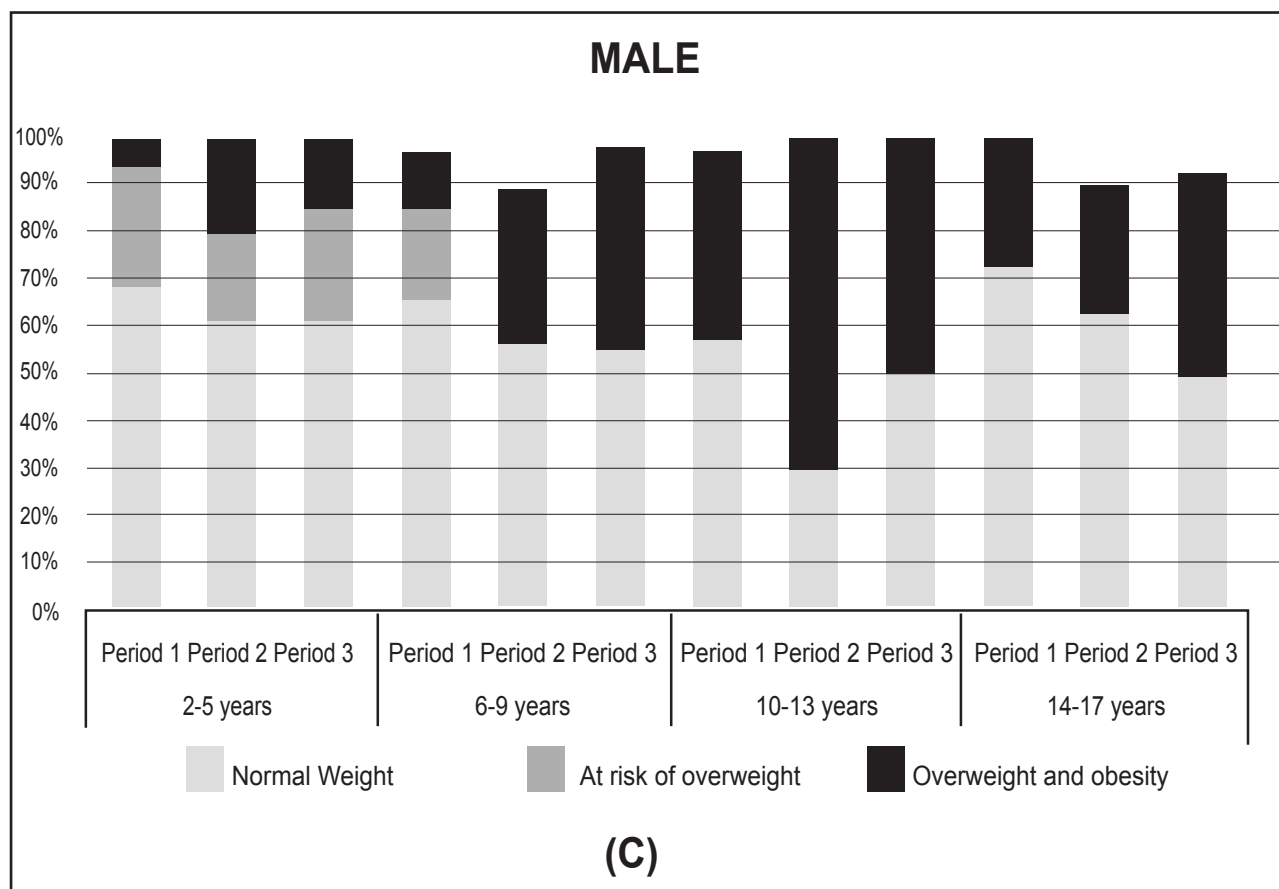
Age group	Sex	Nutrition condition*	P1 (%)	P2 (%)	P3 (%)
6-9 years	Male	Normal-weight	40,4	33,3	32,9
		Overweight	11,1	10	17,6
	Male	Obesity	1	10	7,1
		Severe obesity	8,1	0	2,4
	Total	Normal-weight	60,6	50	51,8
		Overweight	21,2	16,7	29,4
		Obesity	12,1	20	11,8
	Severe obesity	3	6,7	5,9	
10-13 years	Female	Normal-weight	22,6	10,4	28,2
		Overweight	10,4	14,6	9,4
		Obesity	6,6	8,3	5,9
		Severe obesity	0	0	0
	Male	Normal-weight	33	39,6	27,1
		Overweight	3,2	12,5	17,6
		Obesity	7,5	8,3	7,1
		Severe obesity	2,8	4,2	2,4
	Total	Normal-weight	55,7	50	55,3
		Overweight	23,6	27,1	27,1
		Obesity	14,2	16,7	12,9
		Severe obesity	2,8	4,2	2,4
14-17 years	Female	Normal-weight	18,4	14,3	13,5
		Overweight	8,2	10,7	10,8
		Obesity	4,1	0	2,7
		Severe obesity	2	7,1	2,7
	Male	Normal-weight	49	42,9	35,1
		Overweight	10,2	10,7	21,6
		Obesity	6,1	7,1	5,4
		Severe obesity	0	0	0
	Total	Normal-weight	67,3	57,1	48,6
		Overweight	18,4	21,4	32,4
		Obesity	10,2	7,1	8,1
		Severe obesity	2	7,1	5,4

\* Children with BMI < -2SD (Thinness) were excluded from the table.

The greatest rate change in BMI percentile, with statistically significant difference between the three periods ( $p < 0.001$ ), was seen in the normal-weight group, especially in 10-13 year-old boys (Figure 1). In this group, overweight/obesity prevalence were 13,5%, 25% and 27,1%, in P1, P2 and P3, respectively (Table 5).

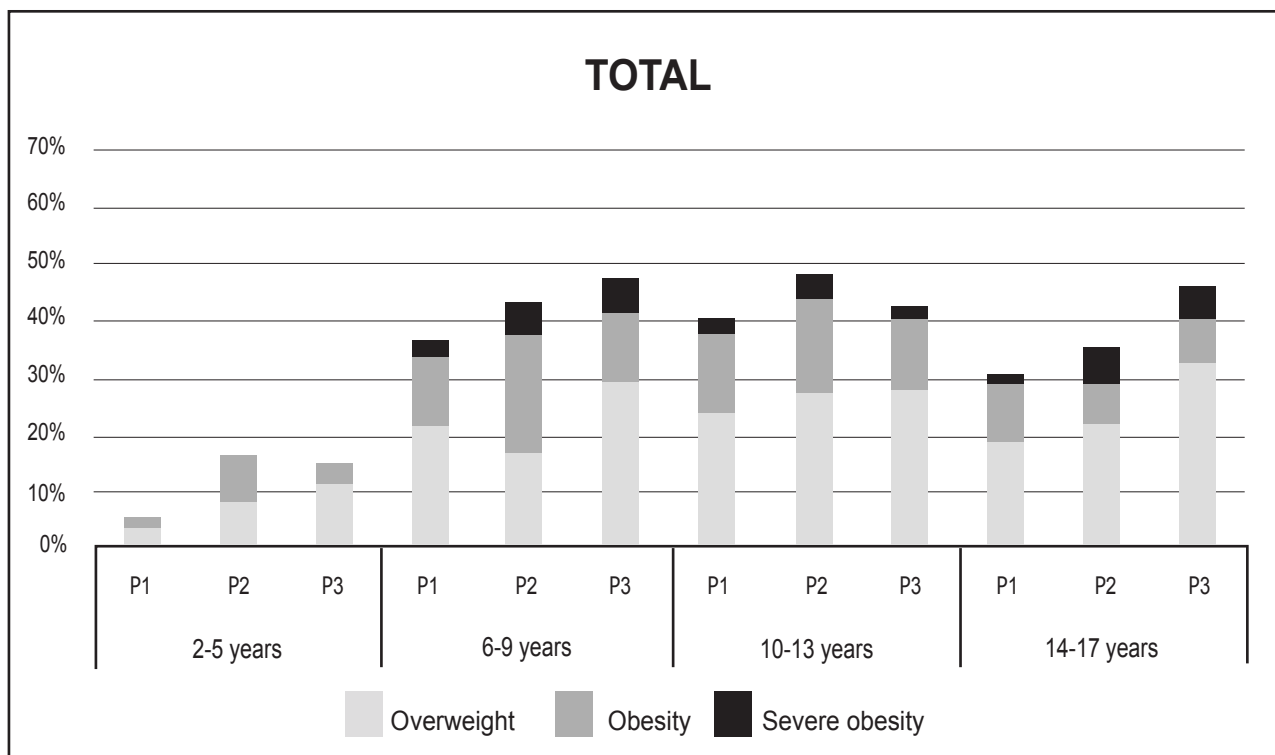
**Figure 1.** Distribution of children and adolescents according to nutrition condition in each period of the study: (a) Distribution of all sample by age group; (b) Distribution of females by age group; (c) Distribution of males by age group. Children with BMI < -2SD were excluded.

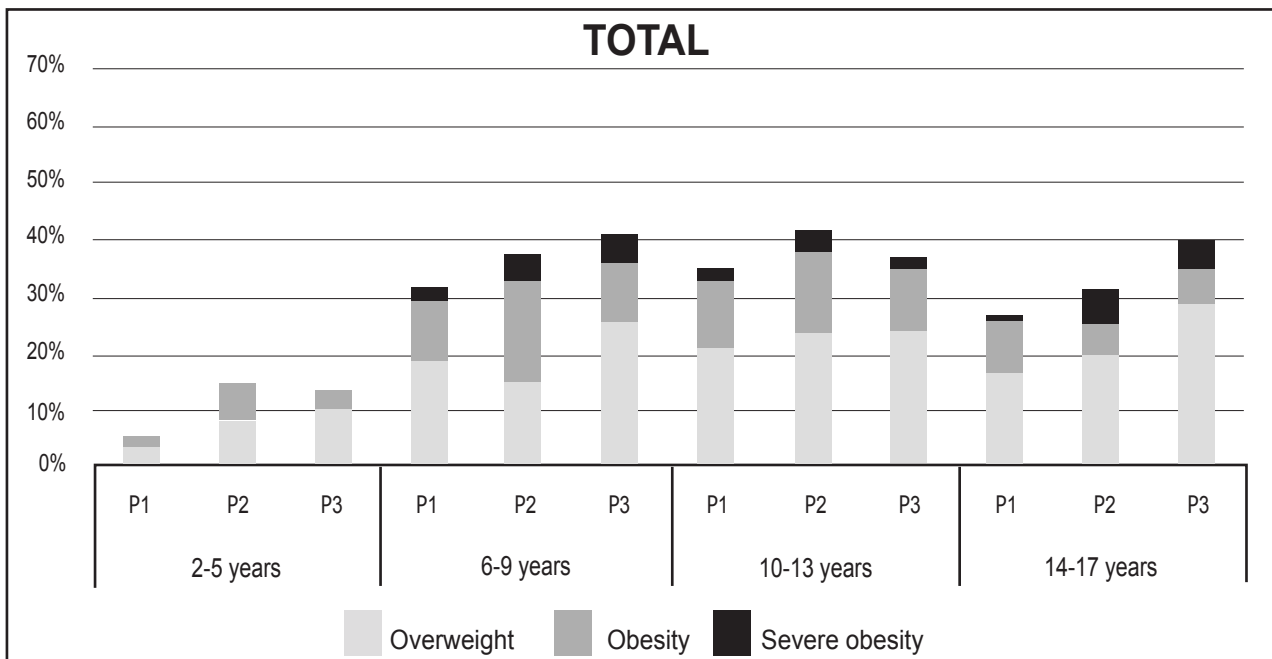




In the overweight/obese population, the greatest rate increase in BMI during the 1st year of the pandemic was in 6-9 and 14-17 age groups (Figure 2). As shown on Table 5, overweight and obesity prevalence were 36% and 47,1% in 6-9 years-old group and 30,6% and 45% in 14-17 years-old group in P1 and P3, respectively.

**Figure 2.** Distribution of overweight/obese sample according to nutrition condition, in each period of the study, by age group.



**Figure 3.** Distribution of overweight/obese sample according to nutrition condition, in each period of the study, by sex.

As shown in Figure 3, girls with overweight/obesity had a greater mean weight gain during the first lockdown compared to boys. However, there wasn't a statistically significant difference between girls' BMI percentile in P1 and P2 ( $p=0.07$ ). It was the boys that showed the greatest increase in BMI during the first year of COVID-19 pandemic, with a statistically significant difference between BMI percentile in P1 and P3 ( $p < 0.001$ ).

### Discussion

The results of the present study show that childhood overweight and obesity prevalence increased during the first year of COVID-19 pandemic. As previous studies have showed, this is probably not only associated with changes in eating and sleeping habits but also with longer time spent at home with increase in sedentary activities, such as watching TV, playing video-games and the use of mobile devices.<sup>11,12,13,14,15,16,17,18,19</sup> The lockdown and pandemic effects promote the risk factors for weight gain and may have a lasting impact on childhood adiposity level, leading to an increase of metabolic and cardiovascular diseases in later life.<sup>13</sup> In other words, this rapid increase in BMI is particularly alarming because it increases the risk of obesity in later life.<sup>21</sup>

One of the possible explanations for overall BMI increase, particularly during the first lockdown, is that families may have bought more long-shelf-life and processed food, such as snacks, chips, canned and frozen food, in order to minimize their trips to the supermarket.<sup>10,13,15,16,17</sup> This would result in higher sugar and high-calorie dense foods consumption, increasing susceptibility to weight gain. Another possibility may be related to less opportunities for physical activity, particularly for children and adolescents who live in small apartments, increasing time spent with sedentary/screen activities.<sup>3,11,12,13,19,20</sup>

The significant weight gain in 2-5 year-old children, especially during the first lockdown, is particularly worrying, as we know that the sooner the child adopts unhealthy eating and lifestyle sedentary habits, the more difficult it is to change them during life and so fight childhood obesity and its future health consequences.

In our study, normal-weight children were the group with the most significant increase in weight and BMI percentile, especially in 10-13 year-old boys and particularly during the first lockdown. This may be explained by the greater impact in children and adolescents who were more physical active and had healthier eating habits before the COVID-19 lockdown. This hypothesis is in agreement with findings of Cipolla et al. study, which verified that the most increase in BMI during the lockdown was found in patients who were more sedentary during the pandemic, but not before.<sup>15</sup> On the other hand, school age boys tend to be at a greater risk of inadequate practice of physical activity, which can explain the greater impact in 10-13 year-old boys presented in this study.<sup>18,20</sup> However, the results are not consistent in literature. In Vogel et al. study, it was the obese children and adolescents that showed the greatest weight gain during the COVID-19 pandemic.<sup>14</sup>

In the overweight/obese group, girls of all age groups showed a greater weight gain during the first lockdown. This might be related to the fact that girls usually spend more time on cooking activities than boys, causing higher and more frequent consumption of caloric food, like homemade cakes and desserts, as shown in Cipolla et al. study.<sup>15</sup> However, it was the overweight/obese boys that showed the greatest increase in BMI percentile during the first year of pandemic. This result may be due to the fact that boys were more physically active than girls before the pandemic and therefore with greater impact on weight gain when enclosure.<sup>15,18,20</sup>

Our study has several limitations. It is a cross-sectional study and our data was acquired in a small sample that may not be representative of pediatric portuguese population. On the other hand, we have a reduced sample in P2, explained by the few number of face-to-face medical appointments during the first months of the pandemic. The anthropometric measurements (weight and height) were taken and registered by different health professional (nurse and doctors), which can be associated with greater measurement error. However, we emphasize that the measurement instruments (digital scale and stadiometer) were the same for all children. Finally, other environmental factors that probably influenced BMI increased, such as family's socioeconomic status, were not analyzed.

### Conclusion

The results of the present study suggest an increase in childhood overweight and obesity prevalence during the first year of the COVID-19 pandemic, probably associated with an increase in sedentary activities and changing dietary habits, due to longer time spent at home.

One of the purpose of this study was to draw attention to the pandemic's short and long-term effect on children and adolescents' health. Schools, parks and playground closures have disrupted the everyday routine of children and adolescents, leading to changes in physical activity, eating and sleeping behaviors, which have exacerbated the epidemic of childhood obesity. As already known, childhood obesity is a major predictor of adult obesity such as other chronic conditions. Hence, efforts to prevent obesity should begin in younger ages.

In this context, given the impact of lockdown and other public health measures taken during the COVID-19 pandemic on childhood overweight and obesity rates, it is crucial that health professionals are aware of and approach this problem in their clinical practice. Thus, it is urgent to discuss and implement weight control programs to counteract the impact of the COVID-19 lockdown on rapid and unhealthy weight gain in children and adolescents. Parental figures, schools, hospitals and the community should all be involved in these programs, in order to increase its effectiveness and raise public awareness of the severity of overweight and obesity in future health.

Further studies are needed to assess the real impact of the COVID pandemic on childhood health.

### Compliance with Ethical Standards

Funding: None

Conflict of Interest: None

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