



Impact of COVID-19 Lockdown on Children's Health in North Africa

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Abstract

Objectives Lockdown measures have been adopted in many countries around the world to control the spread of COVID-19. These measures induced long confinement period that may have had an unintended negative impact on children's life behaviors and health. This study aimed to investigate the impact of behaviors related to COVID-19 confinement on body weight/BMI changes in children from Constantine, Algeria.

Methods This was a cross-sectional survey based on children aged 5 to 12 years dwelling in any province of Constantine. Parents of children completed an online-distributed questionnaire at two time points (between April and May and another time between 11th July and 10th August 2020). The questionnaire assessed sociodemographic information, anthropometric data, physical activity, dietary, eating habits, and other factors related to children's lifestyle before and during lockdown. Paired before and during lockdown comparison for each lifestyle multiple statistical tests were performed to assess associations among before and during lockdown data.

Results 275 questionnaires were completed (59.7%). Mean self-reported weight and BMI significantly increased by 1.43 kg and 0.84 kg/meter², respectively. Among the examined variables, increased unhealthy food consumption, snacks, number of daily meals taken, low physical activity and increased sedentary behaviors were significantly correlated with higher body weight gain ($P < 0.005$). These behaviors may not only have a significant impact on the development of childhood obesity but also on the deterioration of the mental state of the children surveyed.

Conclusion Restrictive measures during the COVID-19 lockdown, and home confinement, school closure makes children more vulnerable to environmental risks. Results from this study highlight the risk associated with a shift in eating habits, increased dietary intake, decreased physical activity, increased sedentary behaviors, and their impact in exacerbating the gain in body weight and BMI.

Keywords Health · SARS-CoV 2 · Childhood · Lifestyle behaviors

Significance

Apart from the viral infection, the COVID-19 pandemic has a collateral effect on the health and well-being of children. In this health crisis, our study provides useful information on

the impact of COVID-19 related confinement on the behavior, mental health and body weight evolution of children in Algeria. Based on the results of this study, we aim to alert authorities and doctors and attract their attention to the risk of obesity in children and to help in the development of new strategies to be adopted soon to preserve children's health after this pandemic and maybe for future pandemics.

Damien Vitiello and Rouabah Leila have contributed equally to this work.

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Introduction

Since January 30, 2020 to present, humankind has experienced a major pandemic and a death toll of more than 1 095 097 (Worldometers.info 2020). On March 11, 2020, the World Health Organization (WHO) declared the outbreak

of the novel severe acute respiratory syndrome coronavirus-2 or coronavirus disease 19 (SARS-CoV-2 or COVID-19) (World Health Organization, 2020). At the period, the Algerian government implemented a regional lockdown in many mainland cities (Algerian Ministry of Health, 2020). On 22nd March 2020, the city of Constantine declared the first COVID-19 case and consequently schools, companies, non-essential public and private services were closed (Carroll et al., 2020). Unfortunately, due to the long periods of restricted movement, children were more susceptible to unhealthy lifestyle, such as decrease or lack of physical activity, excessive sedentary behaviors, with a negative impact on nutritional habits, as well as on the body composition (Matsungo & Chopera, 2020; Radwan et al., 2020). This was a concerning situation; given that COVID-19 and its related behavioral changes are risk factors for obesity and its related pathologies especially cardiovascular disease (Mattioli et al., 2020).

In this context, we started an online survey that target confined families with children aged between 5- and 12-years old resident in the state of Constantine, Algeria during COVID-19 crisis, to identify changes in nutritional habits, physical activity, sedentary behaviors, sleep and of psychological burden in children. Accordingly, the purpose of the study was to provide a rapid and large-scale assessment of lockdown related factors that may have influence on childhood obesity risk.

Material and Methods

Study Participants

To assess the effects of SARS-CoV 2-induced confinement policies we addressed a survey to girls' and boys' residents of Constantine aged from 5 to 12 years old.

Procedures and Study design

In this descriptive comparative cross-sectional study, the baseline data (Pre-study) was collected using a web-survey (Cognito forms, Columbia, USA) between April and May 2020 from children aged from 5 to 12 years old residing in any province of Constantine. In addition to a longitudinal observation of our previous published (Benmerzoug et al, 2022) study's participants, a new representative sample of children and adolescents living in Constantine was recruited at each follow-up. After 3 months and during the strictest period of confinement (11 July 2020 until 12 August 2020), we asked every child of the pre-study to answer our questionnaire again to track the direct changes in behavior. The

participants were contacted through phone, institutional and private social networks (i.e., WhatsApp, Twitter, and Facebook) and were asked to answer the peri-questions online. The electronic questionnaire took approximately 6 min to be achieved by an adult responsible for the children (Supplementary document).

Ethics

All participants and their parents were informed about the experimental procedures and gave their written consent. The Ethics Committee of the Faculty of life and Nature Sciences of the MENTOURI BROTHERS University approved the protocol with all procedures conducted in accordance with the Declaration of Helsinki (1989) of the World Medical Association.

Survey

The questionnaire consisted of more than 40 questions, based on similar questionnaires reported in the scientific literature (Allabadi et al., 2020; Pellegrini et al., 2020; Pietrobelli et al., 2020; Ruíz-Roso et al., 2020) with slight modifications validated by a group of child growth experts. The questionnaire designed by the authors was divided into two major modules; before and during the lockdown period separated by the following subcategories: sociodemographic characteristics, anthropometric information, sedentary behaviors, physical activity, dietary habits, and life-style practices among children from all the provinces of Constantine.

Variables

The first section requested demographic and household routine regarding the financial and intellectual level of children's parent. The second section added to inquire anthropometric information, including gender, age, height, and weight changes (before: pre-study from the first time point – during: after 3 months of lockdown). The body mass index (BMI) was calculated and interpreted using the international obesity task force graphs to evaluate the body weight change. The third and the fourth sections targeted the effect of the lockdown preventive measures on children's lifestyle behaviors and their impact on weight change. The dietary habits, the frequency of daily consumption patterns for healthy and unhealthy food, the overall frequency and duration of physical activity and sedentary screen time were analyzed before and during the COVID 19 lockdown.

Statistical Analyses

The IBM SPSS version 25 (Armonk, NY: IBM Corp) software was used for analyzing statistical data. Socio-demographic variables collected were categorized as gender (female and male), age (group 1 = [5–7] years; group 2 = [7–9] years; group 3 = [9–12] years) and paternal education level (Illiterate, primary, middle school, high school and university). A list of variables was created quantifying serving of vegetables, fruits, dried vegetables, processed meat and eggs, fried food and sugary food and drinks, intake per week, with four choices (never or rarely, > than one time /week, once to three/week or all the weekdays). To analyze children's meal timing during longer home stays, binary variable (yes/no) were used for assessing whether the SARS-CoV 2 lockdown negatively affected the economic situation of participant's parents. Three variables (sport practice, regular activity, playing time) were added to estimate overall physical activity 45 time and two variables (screen time, laying time (bedtime) to estimate overall sedentary time. We also used the score (Increase, Decrease, No Change) to statically describe changes in independent variables during the lockdown period. Descriptive statistics and frequency analysis were used for the initial characterization of the 275 children during the COVID-19 lockdown versus the previous period (Before). Continuous data were presented as mean \pm standard deviation (SD) while categorical data was presented as frequencies and percentages. Shapiro–Wilk test and Kolmogorov–Smirnov test are used to test the normality of changes in weight and BMI. To evaluate the significance of differences between variables from before to after lockdown, we used paired t-test or McNemar test as necessary. Mann–Whitney (two groups) and Kruskal–Wallis (three groups) tests were used to evaluate the association among weight/BMI changes and other variables. In addition, Pearson's and Spearman correlations tests were used to explore the associations between continuous and categorical variables with anthropometric measures. A significance level of $P < 0.05$ was applied to all statistical analyses.

Results

Participant Characteristics

The socio-demographic characteristics of the study population are summarized in the Table 1. Out of 461 questionnaires returned, 275 (or 59.7%) were completed twice (before and after 3 months of COVID-19 lockdown). Among our participants, 7.6% were underweight, 59.6% normal weight, 16.7% overweight and 16% obese. The

distribution of participants' weight has changed during the lockdown period to 4.7% under-weight, 50.2% normal weight, 25.1% overweight and 20% obese.

Changes in Lifestyle During the Lockdown Period

A significant change in the daily food consumption was reported (Supplementary Table A) where the distribution intake frequencies show a significant increase ($P = 0.0001$) in the number of children who consume ultra-processed foods, (from 9.1% and 9.8% before to 19.3% and 15.3% during COVID-19 lockdown).

In addition, 13.1% of children reported that they consumed a high calorie content at each meal taken per day (Supplementary Table B), before lockdown (at first time point) and 24% during this period (after 3 months) ($P < 0.001$). On the one hand, 6.2% of parents declared that their children missed their breakfast meal during the COVID-19 lockdown ($p = 0.001$). On the other hand, a significant increase of snacks consumption was noted among our participants ($P < 0.001$), the shift in eating habit was also proved through the results which show that watching television during mealtimes (lunch and breakfast) was significantly increased ($P < 0.005$).

Finally, sport practice decreased to 30.2% and the screen time raised (i.e., more than 2 h/day) to 5.5% during the lockdown compared to 52.4% and 3.3% respectively before this period ($P < 0.005$) (Supplementary Table C).

Influencing Factors on Changes in Body Weight

Changes in weight status among our target population according to the quality of lifestyle during the lockdown period are described in Table 2. The change in daily children's behaviors by BMI category was not significantly different either for girls or boys as well as for age categories. Our results showed that there was a statistically significant difference in weight status classes between the different daily meals intake variations ($P < 0.05$) with a significant positive association to body weight change. Similarly, the amount of food consumed per meal was significantly correlated to weight change and to the difference in weight status. In addition, there was a moderate negative correlation ($P < 0.05$, $R = -0.581$) between weight change and food consumed whilst controlling for healthy meals.

However, unhealthy food showed a significant impact of fat, saturated fat and refined foods intake consumption on body weight change. We also found a significant positive association of children's regular activity ($P = 0.002$) and screen times ($P < 0.005$) with the body weight change and weight status among children.

Table 1 Characteristics of the study population before and during the COVID-19 lockdown period

	Before the pandemic Means \pm SD or %	During the pandemic	Change in values
Weight (Kilogram)	30.15 \pm 9.80	31.58 \pm 10.37	1.43 \pm 2.71
BMI (Kilogram / meter ²)	18.77 \pm 7.78	19.61 \pm 7.61	0.84 \pm 1.65
Situation of thinness (%)	7.6	4.7	-2.9
Normal weight (%)	59.6	50.2	-9
Overweight (%)	16.7	25.1	+8.4
Obesity (%)	16	20	+4
		Means \pm SD or %	
Age (N=275)		8.62 \pm 2.28	
[5–7] (%)		36	
[7–9] (%)		23.3	
[9–12] (%)		40.7	
Sex (N=275)			
Girls (%)		48.4	
Boys (%)		51.6	
Residence area (N=275)			
Urban (%)		92.7	
Rural (%)		7.3	
Education Level attended by the father (N=275)			
Illiterate (%)		3.3	
Primary (%)		2.9	
Middle School (%)		10.5	
High school (%)		24.4	
University (%)		26.9	
Education Level attended by the mother (N=275)			
Illiterate (%)		2.2	
Primary (%)		4	
Middle School (%)		10.5	
High school (%)		30.2	
University (%)		53.1	
Economic situation (does the COVID-19 lockdown affected your Economic situation?)			
Yes (%)		36.4	
No (%)		63.6	

BMI Body Mass Index, Δ difference between values during lockdown and before the lockdown, (-): empty cell

Lifestyle Modulation Impact on Body Weight and BMI Changes

The findings revealed a statistically significant increase in weight gain 2.08 ± 1.21 kg and BMI 1.21 ± 1.54 Kilogram/meter², among individuals who increased their unhealthy food consumption ($P=0.00$), snacks ($P<0.05$) and those who reported that they increased their daily meals intake either alone ($P<0.05$) or shared with family ($P<0.014$) (Table 3). In addition, the increase in number of meals consumed in front of TV and sedentary behavior based on screen time, were significantly associated with increased weight gain during the lockdown period compared to the period before by a mean of 2.00 ± 3.16 , 1.55 ± 3.67 kg, respectively).

Only the decrease in physical activity and healthy food consuming in comparison to the pre-lockdown period were independently and significantly correlated with increased body weight ($P<0.005$).

Impact of Lockdown Period on Children's Mental Health

Data in Table 4 show that the proportion of stressed and very nervous children increased from 2.7% to 30.2% and from 8% to 20.7% during lockdown respectively. In addition, our findings revealed that children who exhibited stress symptoms had significantly changed their snacks intake ($P<0.0001$), sleeping time ($P<0.0001$), body weight and BMI ($P<0.0001$).

Table 2 Correlation analysis between selected variables and weight and BMI changes during the lockdown period

Variables	Body weight change P value	BMI change P value
Age	0.583 ^k	0.91 ^k
Sex	0.10 ^m	0.09 ^m
Food quality		
Healthy food	< 0.00 ^k	0.093 ^k
Unhealthy food	< 0.01 ^k	0.000 ^k
Dietary habits		
Meals taken / day		
Breakfast	0.047 ^k	0.088 ^k
Snack at 10 a.m	0.031 ^k	0.061 ^k
Lunch	0.001 ^k	0.001 ^k
Afternoon's snack	0.028 ^k	0.028 ^k
Having dinner	0.149 ^k	0.152 ^k
Meals taken in front of TV	0.077 ^k	0.913 ^k
Meals shared with family	0.023 ^k	0.827 ^k
Snacks	0.001 ^k	0.002 ^k
Amount of food at each meal	0.00 ^k	0.00 ^k
Ask more food	0.000 ^k	0.001 ^k
Physical activity (self-declaration)		
Practice sport	0.741 ^m	0.534 ^m
Physical activity assessment	0.000 ^m	0.235 ^m
TV Screen time	0.029 ^m	0.241 ^m
Smart phones screen time	0.047 ^m	0.883 ^m
Bedtime	0.051 ^m	0.008 ^m
Sleeping time	0.069 ^k	0.048 ^k

Bold values indicate statistical significant difference

^kKruskal–Wallis (three groups)

^mMann–Whitney (two groups)

P < 0.05

Discussion

Algeria was among the first countries to be severely affected by the current COVID-19 pandemic, and the changes induced by the restrictive national measures. To our knowledge, the present survey is one of the first studies in North Africa to highlight the impact of this pandemic on the daily lives of young citizens and health-related behavior.

Our study revealed a significant increase in weight gain and BMI by an average of 1.4 kg and 0.84 kg/m². Hence, we showed a greater risk of childhood obesity prevalence in Constantine, which supports a longitudinal study that showed an average of 1.5 kg in the first month of lockdown (Pellegrini et al., 2020). The current study revealed that 20.7% of investigated children who showed a significant increase in both body weight and BMI during this period were those who significantly decreased their dairy products, eggs, and meat consumption.

According to an Italian study, it was predicted that the reduction in fresh food consumption rich in anti-inflammatory and antioxidants properties during the lockdown crisis led to a deficiency in fiber and vitamin intake (Karuc et al., 2020). Deficiency of these micronutrients is associated with both obesity and altered immune function, making children at this young age more vulnerable to viral infections (Karuc et al., 2020). However, during the lockdown, families in Constantine placed more emphasis on Mediterranean food especially in legumes and dried vegetables. Consequently, we did not find a significant change in fiber and vitamin intake between the pre and post lockdown period.

The COVID-19 epidemic had collateral effects extending beyond those of direct viral infection (Pietrobelli et al., 2020). Urban areas appear the most affected by this specific sanitary crisis (Di Renzo et al., 2020). Children were placed in a position of isolation, creating unfavorable environment for maintaining healthy lifestyles (Di Renzo et al., 2020; Petrakis et al., 2020). Consequently,

Table 3 Impact of lifestyle modulation on body weight and BMI changes during the COVID-19 lockdown

Variables		N	Body weight change		BMI change	
			Mean ± SD	P Value	Mean ± SD	P Value
Healthy food consumed	Decreased	57	2.55 ± 3.34	0.012^k	1.49 ± 2.00	0.004^k
	No Change	152	1.11 ± 2.48		0.66 ± 1.53	
	Increased	66	1.19 ± 2.40		0.67 ± 1.49	
Unhealthy food consumed	Decreased	115	2.08 ± 2.72	0.00^k	1.21 ± 1.54	0.00^k
	No Change	111	0.7 ± 2.09		0.39 ± 1.34	
	Increased	49	1.48 ± 3.51		0.98 ± 2.26	
Number of Meal taken per day	Decreased	52	1.59 ± 3.15	0.02^k	0.95 ± 1.73	0.01^k
	No Change	195	1.20 ± 2.50		0.69 ± 1.59	
	Increased	28	2.71 ± 2.97		1.65 ± 1.76	
Number meals intake in front of the television	Decreased	24	1.59 ± 2.44	0.06 ^k	1.06 ± 1.77	0.07 ^k
	No Change	186	1.21 ± 2.56		0.68 ± 1.49	
	Increased	65	2.00 ± 3.16		1.20 ± 2.00	
Number of meals shared with the family	Decreased	37	0.77 ± 2.73	0.014^k	0.54 ± 1.35	0.018^k
	No Change	184	1.36 ± 2.69		0.76 ± 1.70	
	Increased	54	2.10 ± 2.69		1.29 ± 1.62	
Sport practice	Decreased	79	2.04 ± 3.00	0.028^k	1.08 ± 1.87	0.063 ^k
	No Change	178	1.23 ± 2.49		0.77 ± 1.56	
	Increased	18	0.63 ± 3.17		0.44 ± 1.50	
Regular Activity	Decreased	146	1.47 ± 2.71	0.448 ^k	0.98 ± 1.16	0.882 ^k
	No Change	99	1.21 ± 2.49		0.81 ± 1.73	
	Increased	30	1.91 ± 2.26		0.98 ± 1.16	
Sedentary behavior (Screen time)	Decreased	5	0.40 ± 2.07	0.01^k	0.32 ± 1.37	0.08 ^k
	No Change	88	1.21 ± 2.47		0.81 ± 1.62	
	Increased	57	1.50 ± 2.39		0.77 ± 1.63	
Bedtime	Decreased	7	2.00 ± 2.16	0.733 ^k	1.14 ± 1.26	0.537 ^k
	No Change	247	1.39 ± 2.73		0.80 ± 1.67	
	Increased	21	1.69 ± 2.70		1.10 ± 1.65	
Snacks	Decreased	57	1.53 ± 2.56	0.045^k	0.81 ± 1.87	0.039^k
	No Change	151	0.97 ± 2.64		0.58 ± 1.52	
	Increased	67	2.38 ± 2.77		1.44 ± 1.62	

Bold values indicate statistical significant difference

^kKruskal–Wallis (three groups), ($P < 0.05$)

the lockdown itself can exacerbate changes in the consumption of poor-quality foods, such as fried and ultra-processed foods (Ruíz-Roso et al., 2020). This result was in line with our results demonstrating a significant rise in unhealthy food consumption, and an impact on both body weight change and weight status or BMI respectively.

During the lockdown, we found a doubling in food intake amount. Consequently, a change in eating habits including the increase in snacks consumption among children led to a significant impact on body weight gain and BMI. These results were in accordance with other studies, which found an increase of the amount of food intake and of unhealthy eating habits in children and adolescents compared to the school days' period (Allabadi et al., 2020; Di Renzo et al., 2020; He et al., 2020).

In addition, children and adolescents gained more weight during summer vacation than during the structured school year, leading to the hypothesis that lockdown due to the COVID-19, may likely lead to unfavorable changes in the physical activity status of children confined at home (Allabadi et al., 2020; Pietrobelli et al., 2020; Von Hippel et al., 2007). The increase in the amount of food intake might also be the result of neurohormonal modulation favoring the development of obesity in children (Yeung & Tadi, 2021).

Based on self-reported assessments of the regularity of children's physical activity (i.e., sport frequency and duration) and screen time during the lockdown period compared to normal days, our results demonstrated that children in Constantine were more active before confinement through participation in regular sport. Participants

Table 4 Mental health change according to body weight, BMI and lifestyle behaviors changes before and during the lockdown

Variables	Before lockdown			During lockdown				
	Very nervous	nervous	Stressed	Very nervous	nervous	nervous	Very nervous	nervous
N (%)	22 (8)	60(21.8)	35(12.7)	158(57.5)	57(20.7)	54(19.6)	83(30.2)	81(29.5)
<i>P</i> Δ	0.000*							
Snack change	0.001**							
Amount of food	0.757**							
Sleeping time	0.010**							
BMI change	0.000**							
Body weight change	0.000**							

Bold values indicate statistical significant difference

BMI Body Mass Index, *P* Δ difference between values before lockdown and during the lockdown

**Spearman

*Homogeneity test, ($P < 0.05$)

who reported a decrease in physical activity and an increase in screen time during the lockdown were those who gained body weight by an average of 0.77 ± 1.63 kg.

The results of the present study were similar to those found in a study conducted in Verona, Italy, where children and adolescents exhibited a significant body weight gain associated with an increase in screen time and sleeping hours and a decrease in physical activity during this period (Di Renzo et al., 2020). The high rates of physical inactivity and rise in sedentary behaviors in children with excess weight were particularly alarming in our study, which is consistent with results of another study in China (He et al., 2020). Reduced physical activity and increased sedentary behaviors may negatively affect physical and mental health of children and adolescents. These results strongly support previous studies which found that body size of children and adolescents increased significantly during lockdown (Allabadi et al., 2020). The results also confirm that many people were physically inactive and adopted a number of unhealthy habits during this period (Pombo et al., 2021). Increased body weight at an early age may increase susceptibility to viral infection and adulthood obesity. These factors may be considered as two pandemic-related components that threaten public health (Von Hippel et al., 2007).

Conclusion

Three months of restrictive measures during the COVID-19 lockdown, home confinement and school closure have made children more vulnerable to environmental risks. The negative impact on children's health was illustrated by a shift in eating habits, an increased dietary intake, decreased physical activity, increased sedentary behavior, increased screen time, and a gain in body weight and BMI. These

factors may increase the prevalence of childhood obesity in Algeria.

Limitations

The main limitations of this study are the small sample size and the uncertainty of the data collected via the online survey. However, the online survey remained the safest and best way of investigation regarding the lockdown restrictive measures. Similarly, in many recent studies based on self-reported questionnaires, body weight was not measured, but rather self-reported at two time points during the pandemic.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10995-022-03441-2>.

Author Contributions All authors contributed equally to this work.

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Data availability Online survey in the supplementary material.

Code availability Not applicable.

Declarations

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All the inquired read the purpose of our study (in the first page) and gave their consent by clicking to proceed (submit) on the last page of the survey questionnaire. The study protocol was approved and reviewed by the Helsinki ethics committee of research of the University of Constantine

Consent to participate Not applicable

Consent for publication Not applicable.

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