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Levels of Anxiety, Depression and Physical Activity of Mexican Children by Sex After COVID-19 Lockdown

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ABSTRACT

Objective: In Mexico, social distancing was implemented to prevent the spread of the COVID-19 virus, and previous studies have reported negative effects on children's mental and physical health during social isolation. Therefore, this study sought to describe levels of anxiety, depression, and physical activity among children in northern Mexico by sex after lockdown conditions, using basic anthropometric measures and stages of sexual maturation as control variables.

Methods and Materials: This study followed a quantitative, non-experimental, cross-sectional descriptive design. No causal inference can be established.

Results: Girls showed higher anxiety scores than boys; depressive symptomatology was slightly more frequent in girls, although the mean difference by sex was not statistically significant. Both groups showed low levels of physical activity, and girls presented more advanced sexual maturation indicators relative to chronological age, alongside BMI values above reference values.

Conclusions: The findings suggest that post-confinement conditions may be associated with changes in psychological and physical health indicators in children in northern Mexico.

Keywords: *COVID-19 lockdown; Children; Anxiety; Depression; Physical activity; Sex differences; Post-pandemic health*

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1. Introduction

Following the World Health Organization's declaration of the COVID-19 pandemic on March 11, 2020 (1), Mexican health authorities published Agreement 02/03/20 in the Official Federal Gazette (DOF), establishing health-security measures to prevent the spread of the virus. These measures included the suspension of classes at different levels of basic education, social isolation, quarantine, and restrictions on leaving home except for essential work activities (2).

Framed by this context, previous studies developed in isolation show that the sudden suspension of classes and prolonged confinement of children caused negative effects on their mental health (3-5). During isolation, children and adolescents were not only physically separated from their classmates and friends, but also from adults who are important to them, generating feelings of loneliness, fear and worry (6). It is worth mentioning that the literature reports the psychological impact caused by the initial phase of the confinement, causing anxiety levels in the moderate to severe category (7), as well as a higher incidence of children with difficulty in regulating their emotions with changes in mood, intolerance to the basic rules of coexistence, setbacks in the degree of independence, difficulty in falling asleep, manifestations associated with anxiety (8), a high prevalence of depressive symptoms in children has also been reported, 41.7% in a sample of 21 330 subjects (9), exposing the vulnerability of this age group to social isolation and confinement measures implemented globally as a strategy to reduce the spread of COVID-19.

Secondly, in addition to the mental health condition of children, other collateral effects of social isolation are recognized, which are related to physical health. Currently, the literature reveals that prevention measures involving social distancing forced children to stay at home, drastically reducing the opportunities for physical activity, including the limitation of being in open spaces and increasing the time spent in sedentary activities associated with overweight and obesity (10, 11). Under COVID-19 confinement, the literature reports a considerable decrease in physical activity levels in several countries (12-14), and it has also been suggested that we are observing an increase in body mass index (BMI) and obesity in children, related to school closure time due to social isolation, which results in a reduction in physical activity (15, 16), a situation that has been associated with modifications in eating behavior that affect nutritional status, lifestyle and socioeconomic status which has generated a condition that the literature calls obesogenic environment (17-19).

Most of the previous studies have reported a detriment of mental health in the variables of anxiety, depression, and physical activity levels in confinement (20). Therefore, the main objective of this article is to describe the levels of anxiety, depression, and physical activity of children from northern Mexico by sex, after the confinement measures caused by COVID-19 in the reincorporation to the activities of the 2022-2023 school year, using as control variables the basic anthropometric measures and the stages of sexual maturation.

2. Methods and Materials

2.1 Study Design

This study followed a quantitative, non-experimental, cross-sectional descriptive design; therefore, causal inferences cannot be established. The results correspond to the initial evaluation of a larger study developed as part of a strategy by the educational authorities of Physical Education Zone No. 14 in Ciudad Juárez, Chihuahua, Mexico, to determine the psychophysiological impact of confinement on children attending the 2022-2023 school year. The study protocol was approved by the Research Ethics Committee (CEI 2022-2-104) of the Universidad Autónoma de Ciudad Juárez (UACJ), and letters of informed consent and assent were obtained from all participants.

2.2 Participants

The sample comprised 240 fifth-grade children from federal public elementary schools in Physical Education Zone No. 14 in northern Mexico. Participants were 10-13 years old (43.8% boys and 56.3% girls), and the mean age of the sample was 10.42 years (SD = 0.56). The sample size was determined according to recommendations by experts in research methodology for the study of typical samples in human populations and regional organizations (21, 22).

Participants were selected according to the following inclusion criteria: belonging to a federal public school in Physical Education Zone No. 14; being duly registered in the Educational Information System of the State of Chihuahua; speaking and reading Spanish; and having signed informed consent and assent forms. The exclusion criteria were a previous diagnosis of a neurological disorder, the presence of intellectual disability, or Down syndrome among students

integrated into the classroom through the Special Education program (USAER).

2.3 Procedure

The protocol was based on a previous study that considered a population and variables similar to those of the present study (23). Initially, the protocol was submitted for review to the CEI of the UACJ; subsequently, permission was requested from the authorities of the Ministry of Public Education in the northern region of Mexico. Once authorization had been obtained from both agencies, meetings were held with the directors of each school to present the protocol and familiarize the research team with the safety measures implemented during the return to the 2022-2023 school year after the end of COVID-19 restrictions. With the corresponding approvals, a pilot test was conducted in a federal elementary school; data from that pilot test were not included in the present publication. Based on the pilot test, the evaluations were organized into three phases (S). For this purpose, fifth-grade students from seven elementary schools belonging to Physical Education Zone No. 14 and their parents were summoned by each educational institution.

2.3.1 Obtaining sociodemographic data

In the first phase (S1), letters of informed consent and assent were obtained during a face-to-face meeting at each educational center at the beginning of the 2022-2023 school year. Sociodemographic data and socioeconomic level were also collected using the questionnaire of the Mexican Association of Market and Opinion Intelligence Agencies (24), along with an eight-item open-ended questionnaire related to social isolation and/or confinement and clinical history.

2.3.2 Basic anthropometric measurements

In the second phase (S2), basic anthropometric measurements of weight, height, waist circumference (WC), and hip circumference (HC) were obtained in the morning and in a controlled environment. These measurements were performed by anthropometrists certified as Level 1 by the International Society for the Advancement of Kinanthropometry (ISAK). Weight and height were measured in a standing position using a TANITA UM-081® scale with an accuracy of 100 g (25) and a SECA 206® stadiometer (0-220 cm; 1-mm accuracy) (26). Waist circumference was measured with the participant standing, feet together, and arms crossed, placing the tape horizontally between the iliac crest and the 10th rib and recording the measurement during exhalation. Hip circumference was measured at the most prominent part of the buttocks at the level of the trochanters. Both circumferences were measured using a Lufkin® EXECUTIVE THINLINE W606PM inextensible metallic tape. After waist and hip measurements were obtained, waist-hip ratio (WHR) was calculated as waist circumference/hip circumference (27, 28), and waist-to-height ratio (WHtR) was calculated as waist circumference/height (29, 30).

Age (years), sex, weight (kg), and height (cm) data were entered into the Excel workbook developed by the scientific community (31) to classify body mass index (BMI; kg/m2) by sex and specific age according to the World Obesity Federation (32), as well as the cut-off points for body mass index (32, 33).

2.3.3 Anxiety

The third phase (S3) involved completion of the self-report instruments, beginning with the Spence Children's Anxiety Scale (SCAS), in the version validated in Spanish for children and adolescents (34). Previous studies in pediatric populations have reported Cronbach's alpha coefficients of 0.89 and 0.82 for the total score of the scale (35, 36), indicating that the SCAS is reliable and valid. Its factorial structure also coincides with the classification proposed by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) of the American Psychiatric Association (37) and its revised version, DSM-IV-TR APA (38), for anxiety disorders in childhood and adolescence.

The SCAS instrument consists of 44 items, six of which are not scored and are included to reduce the impact of the negative bias produced by the list of problems (34). Responses are recorded on a four-point Likert-type scale, where 0 means never and 3 means always. The total score is generated by summing the points obtained for each item (35), thus obtaining the score for the second-order factor of general anxiety (34). The cut-off point for generalized anxiety disorder was considered to be ≥52.2 (39).

2.3.4 Depression

The second S3 instrument evaluated depressive symptomatology by means of the Depression Scale of the Center for Epidemiological Studies in the revised version (CESD-R) of 35 items (40), which extends the time limit to

the last two weeks, to coincide with the DSM-IV criteria (37). The literature reports a Cronbach's Alpha coefficient of 0.93 for this instrument (40).

The cut-off point was calculated using the sample mean plus one standard deviation. While this approach is not equivalent to clinical diagnostic thresholds, it allows for relative classification within the sample and should be interpreted cautiously (41).

2.3.5 Physical Activity

The third instrument used to determine the level of physical activity (LPA) was the Physical Activity Questionnaire for Children (PAQ-C) (42), which has been validated and applied in Mexican children (43), with a Cronbach's alpha coefficient of 0.817.

The instrument consists of 10 items, of which the first nine are used to obtain the total score and estimate LPA, while the last question identifies events that prevented the child from engaging in regular physical activity (42). The categorical classification of the PAQ-C corresponds to five levels: L1-PA represents very low PA; L2-PA represents low PA; L3-PA represents regular or moderate PA; L4-PA represents an active level; and L5-PA represents a very active level (42, 43).

2.3.6 Self-Reported Sexual Maturation

The fourth self-report instrument was a questionnaire with drawings and descriptions representing the five stages of sexual maturation, or Tanner scale (44, 45), for pubic hair development in both sexes and genital development in boys; in girls, mammary gland development was assessed (46). Boys were asked to select the drawing and self-perception description of the developmental stage in which they were at the time of assessment. Girls were also asked to report menarche through a yes/no question, in adherence to the protocol described in the literature (46).

2.4 Statistical Analysis

Given the descriptive aim of the study, the analysis focused on group comparisons rather than modeling relationships between variables. Future studies should incorporate multivariate approaches.

IBM® SPSS® statistical software was used for data analysis v.25 (SPSS Inc., Chicago, IL, USA). First, an exploratory analysis was performed using the Kolmogorov-Smirnov goodness-of-fit test, as well as the determination of the measures of central tendency: mean (M) and standard deviation (SD; ±) for each of the variables. Secondly, frequency distribution analyses were performed, and the Mann-Whitney U test was used to compare by sex.

3. Results

3.1 Sociodemographic characteristics

The sociodemographic characteristics of the 240 fifth-grade children in public elementary schools showed that the average age was 10.42 ± 0.56 years. Regarding socioeconomic level (SES), most children were classified as SES 4 (C-), representing 29.2% (f = 70), followed by SES 3 (C), 28.7% (f = 69); SES 5 (D+), 17.5% (f = 42); SES 2 (C+), 12.9% (f = 31); SES 6 (D), 7.1% (f = 17); SES 1 (A/B), 4.2% (f = 10); and SES 7 (E), 0.4% (f = 1), representing 100% of the sample (n = 240). Thus, there was a predominance of the typical middle class (SES 4), followed by the upper middle class (SES 3) and the lower middle class (SES 5). The family profile of the participants was characterized by parents or guardians with education beyond primary school, living in rented or owned houses or apartments that covered only basic needs for space (bedroom-bathroom) and equipment (computer-basic internet), ensuring minimum practicality and comfort in the home.

Regarding clinical and health characteristics, 100% of the participants reported no chronic noncommunicable diseases. In relation to social isolation caused by COVID-19 prevention measures, 88.3% (f = 212) remained in social isolation without contact with other children outside the nuclear or extended family (i.e., only among siblings, cousins, and direct family members), and only 2.1% (f = 5) reported having had laboratory-confirmed COVID-19.

Regarding the confinement period, parents reported that 30.4% (f = 73) of the children showed more aggressive behavior during confinement, and 12.5% (f = 30) had setbacks in their degree of independence (e.g., returning to sleep with a family member, mother, father, or siblings).

3.2 Basic anthropometric characteristics

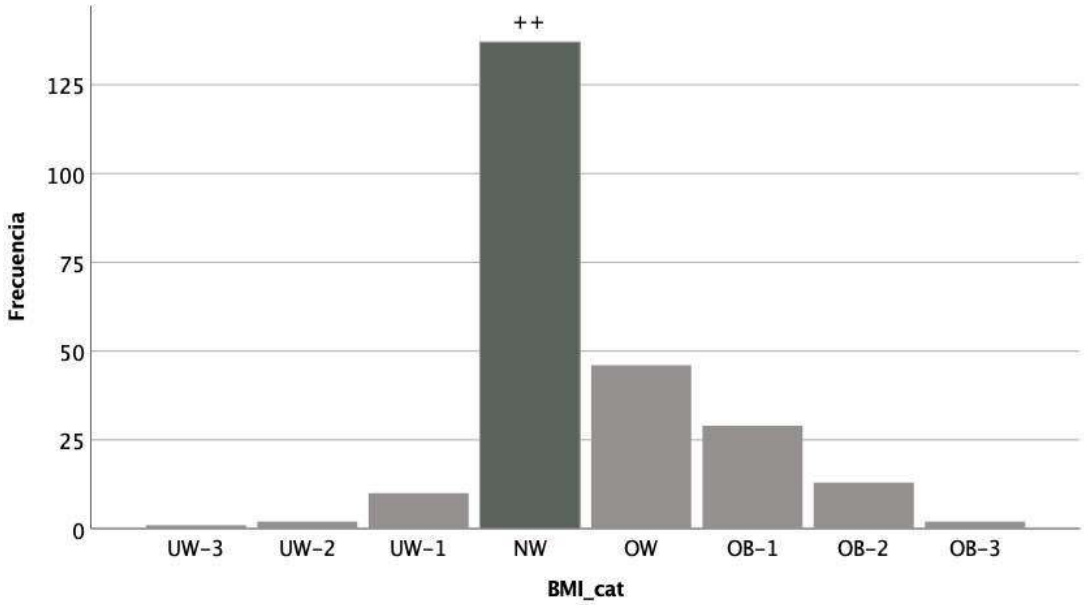
On the other hand, the profile of basic anthropometric measurements is shown in Table 1, highlighting that the majority of the sample (57.1%; f = 137) was in the normal-weight category according to the BMI_cat cut-off points. Likewise, when comparing BMI_cat between boys and girls, the highest percentage in each group was located in the normal-weight category; details are presented in Figure 1.

Table 1. Profile of basic anthropometric measurements of the sample in general and by sex.

Variables	Total n^1	Sex		p value
	M ± SD	n^2 M ± SD	n^3 M ± SD	
Weight (kg)	41.3 ± 11.14	41.7 ± 11.1	40.9 ± 11.1	0.59
Height (cm)	143.4 ± 7.4	142.9 ± 7.1	143.7 ± 6.4	0.38
BMI (kg/m^2)	19.9 ± 4.6	20.24 ± 4.4	19.7 ± 4.7	0.30
BMI_cat	22.1 ± 5.4	22.5 ± 5.2	21.7 ± 5.6	0.11
WC (cm)	65.7 ± 10.2	67.6 ± 10.3	64.2 ± 10	0.006*
HC (cm)	78.1 ± 10.3	77.6 ± 10.2	78.5 ± 10.4	0.71
WHR	0.84 ± 0.05	0.87 ± 0.05	0.81 ± 0.05	0.000*
WHtR	0.45 ± 0.06	0.47 ± 0.06	0.44 ± 0.06	0.001*

Total n1 = 240 children; n2 = 105 boys; n3 = 135 girls; WHR = waist-hip ratio, waist circumference (cm)/hip circumference (cm); WHtR = waist-to-height ratio, waist circumference (cm)/height (cm); M = mean; SD = standard deviation.

*p < .05 statistically significant difference.



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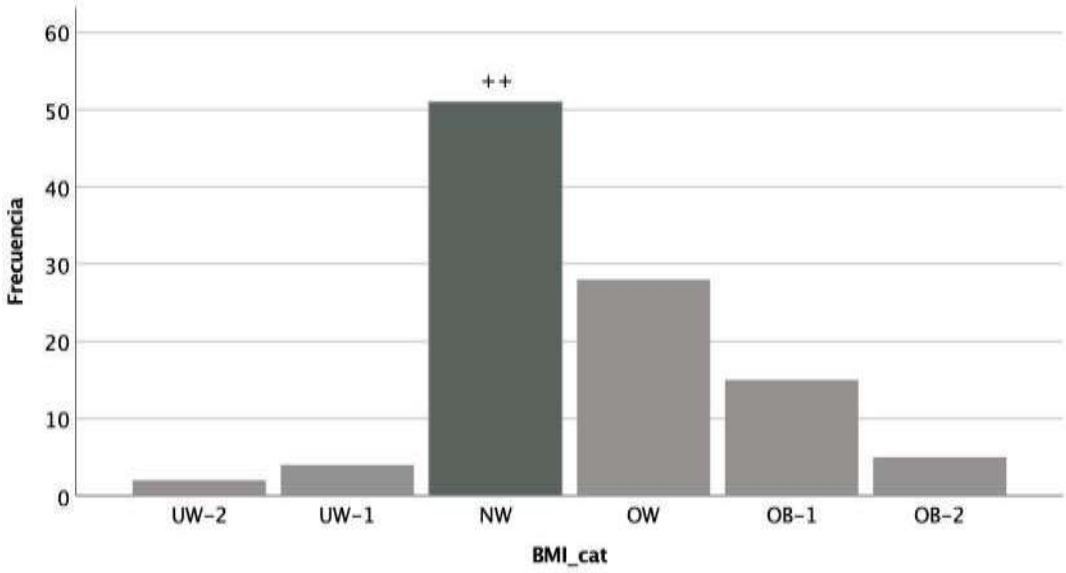

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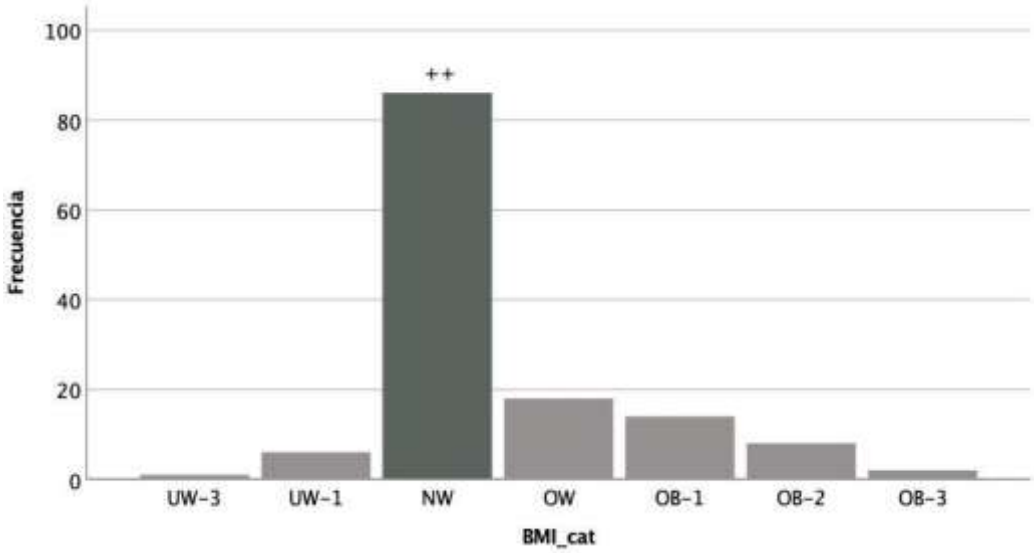


(c)

Figure 1. Distribution of BMI_cat of the sample in general and by sex.

(a) Distribution of overall sample BMI_cat; UW-3 = underweight level 3 (<16 kg/m²); UW-2 = underweight level 2 (16-16.9 kg/m²); UW-1 = underweight level 1 (17-18.49 kg/m²); NW = normal weight (18.5-24.9 kg/m²); OW = overweight (25-29.9 kg/m²); OB-1 = obesity type 1 (30-34.9 kg/m²); OB-2 = obesity type 2 (35-39.9 kg/m²); OB-3 = obesity type 3 (≥40 kg/m²); * indicates the highest percentage within the distribution, 57.1% (f = 137). (b) BMI_cat distribution of boys: UW-2 = underweight level 2; UW-1 = underweight level 1; NW = normal weight; OW = overweight; OB-1 = obesity type 1; OB-2 = obesity type 2; * indicates the highest percentage within the distribution, 48.6% (f = 51). (c) BMI_cat distribution of girls: UW-3 = underweight level 3; UW-1 = underweight level 1; NW = normal weight; OW = overweight; OB-1 = obesity type 1; OB-2 = obesity type 2; OB-3 = obesity type 3; * indicates the highest percentage within the distribution, 63.7% (f = 86).

3.3 Psychological characteristics

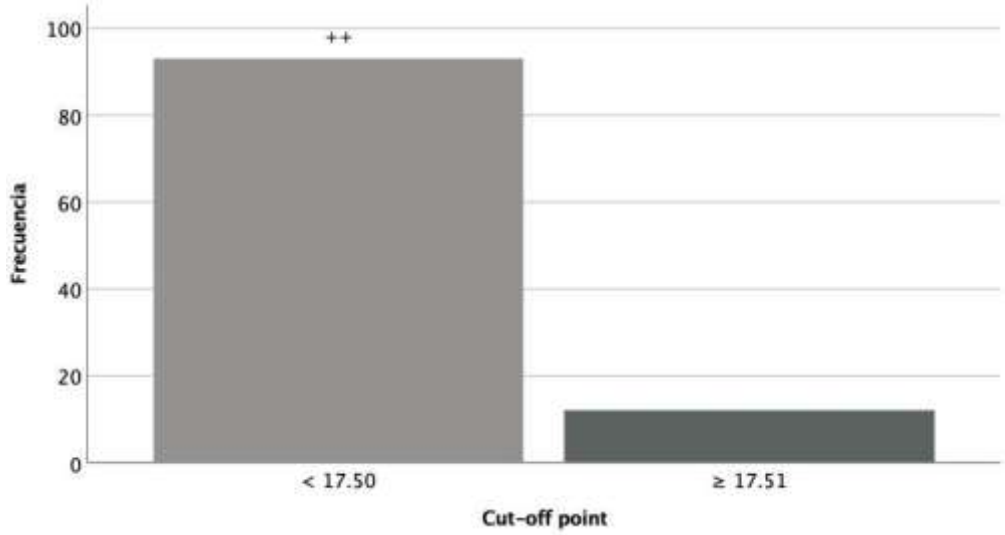
3.3.1 Anxiety

Regarding anxiety, the generalized anxiety disorder factor presented a mean of 12.4 (SD = 3.08) arbitrary units (ua) in the boys' group, whereas the girls' group presented M = 14.03 ± 3.65 ua, showing statistically significant differences by sex (p = .001) for this factor.

On the other hand, when analyzing the global anxiety index through the total score of the instrument, M = 74.48 (SD = 13.86) ua was found in boys and M = 83.07 (SD = 17.82) ua in girls. Therefore, comparison of the values showed statistically significant differences by sex (p < .001).

3.3.2 Depression

The total score of the instrument showed M = 14.08 (SD = 3.43) ua; therefore, the threshold established to determine the presence or absence of depressive symptomatology was ≥17.51 ua. The results by sex showed M = 13.76 (SD = 2.97) ua in boys and M = 14.33 (SD = 3.7) ua in girls, with no significant differences by sex (p = .22). In addition, Figure 2 shows the distribution by sex with respect to the cut-off point.



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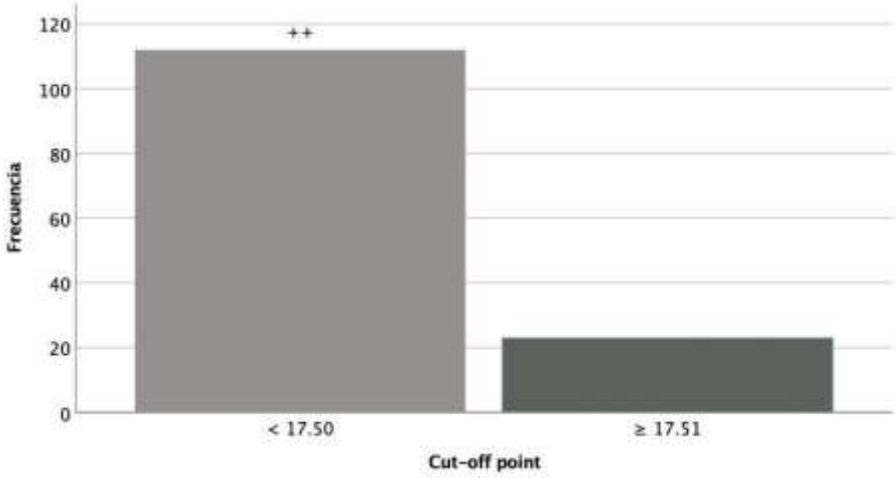


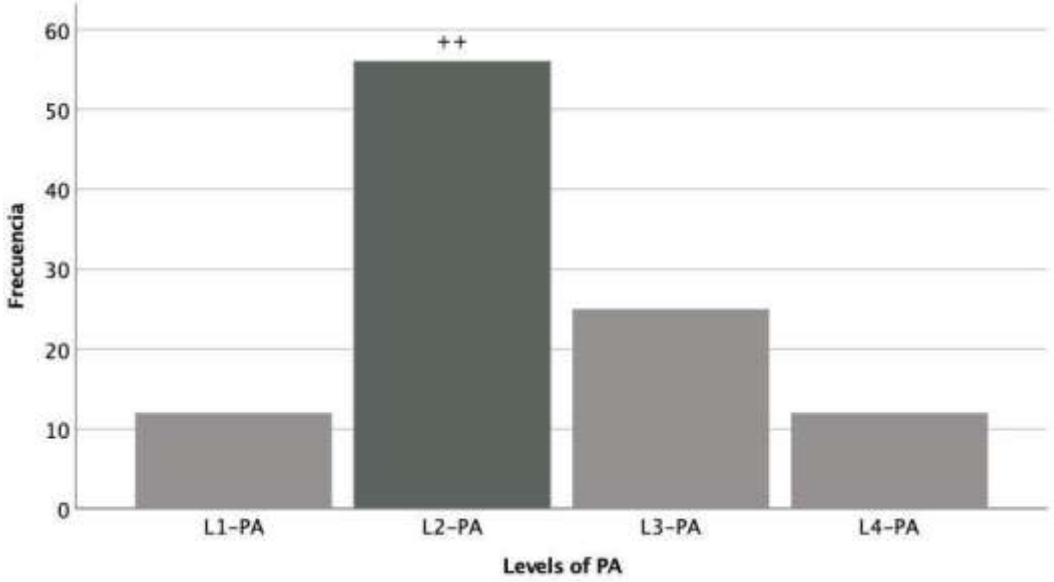
(b)

Figure 2. Distribution by sex with respect to the cut-off point.

(a) Boys (n = 105, 100%): 11.4% (f = 12) scored above the threshold for depressive symptomatology, while 88.6% (f = 93) scored below it. (b) Girls (n = 135, 100%): 17.0% (f = 23) scored above the cut-off point, while 83.0% (f = 112) scored below it.

3.4 Physical Activity

The results showed M = 2.8 (SD = 0.79) ua in boys and M = 2.53 (SD = 0.67) ua in girls. When comparing the groups, significant differences were found (p = .01). Figure 3 shows the frequency distribution by sex with respect to the categorical classifications of the PAQ-C.



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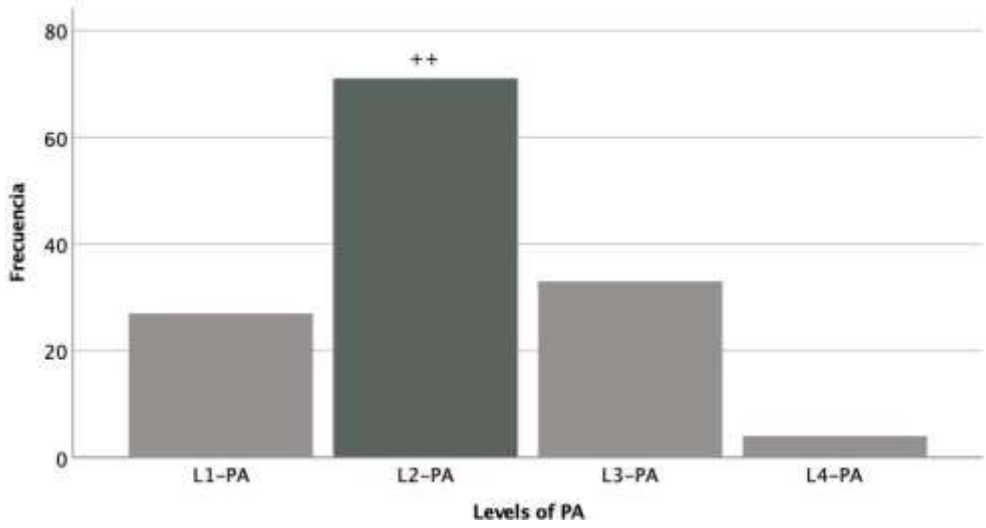


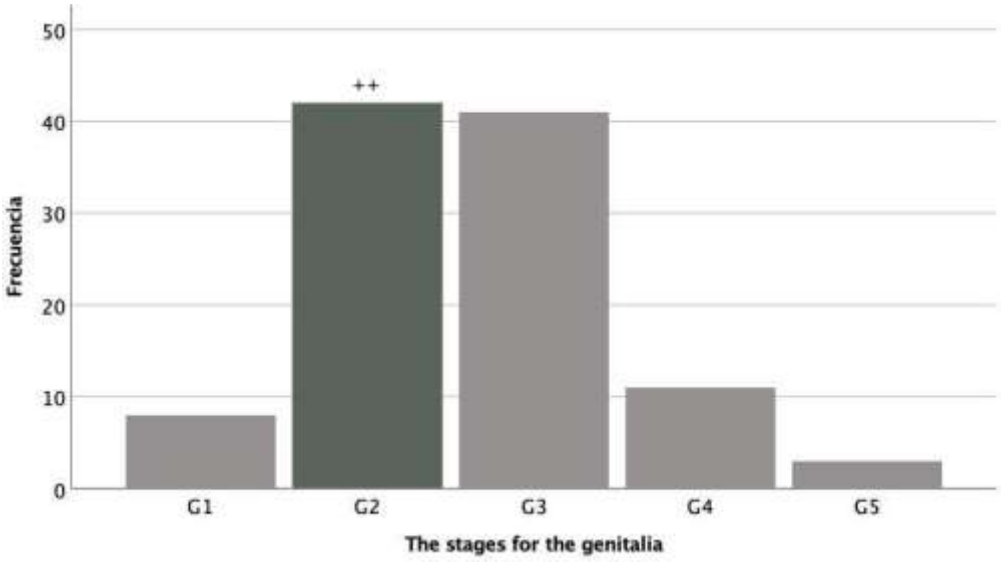
(b)

Figure 3. Distribution of frequencies by sex with respect to the categorical classifications of the level of physical activity.

In boys (n = 105, 100%), the majority, 53.3% (f = 56), were located in L2-PA, indicating low PA levels, followed by L3-PA with 23.8% (f = 25), indicating regular or moderate PA levels. Finally, L1-PA and L4-PA presented the same values, 11.4% (f = 12), where L1-PA represents very low PA and L4-PA represents an active level. In girls (n = 135, 100%), the majority, 52.6% (f = 71), were located in L2-PA, indicating low PA levels, followed by L3-PA with 24.4% (f = 33), indicating a regular or moderate PA level; then L1-PA with 20.0% (f = 27), equivalent to very low PA levels; and finally L4-PA with 3.0% (f = 4), indicating an active level.

3.5 Self-Reported Sexual Maturation

In the boys' group, most participants (40%; f = 42) were located in stage two (G2) of the Tanner scale for genital development, indicating infantile/pre-adolescent characteristics; the complete distribution is shown in Figure 4(a). Regarding pubic hair (PH) development in boys, the majority (48.6%; f = 51) reported being in stage two (PH2), indicating infantile/prepubescent characteristics; the distribution is shown in Figure 4(b).



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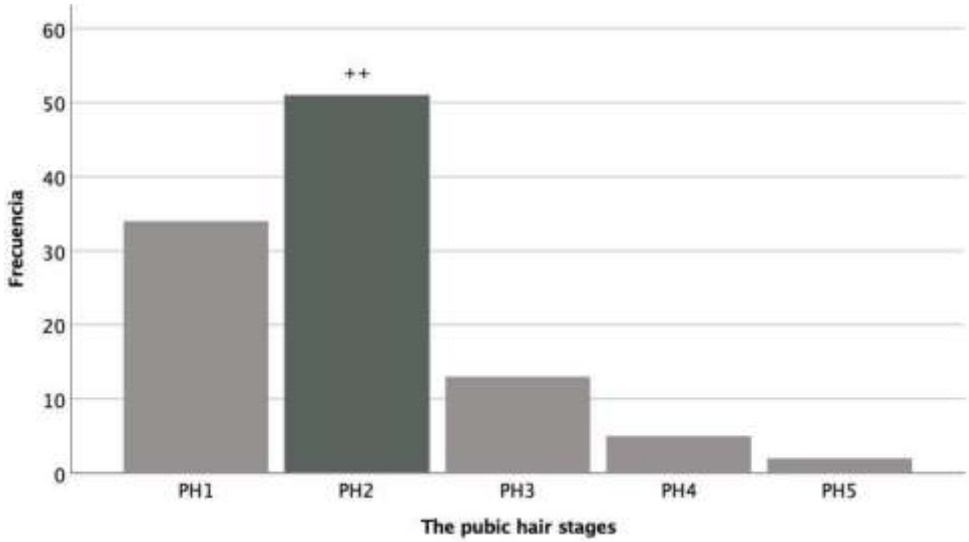


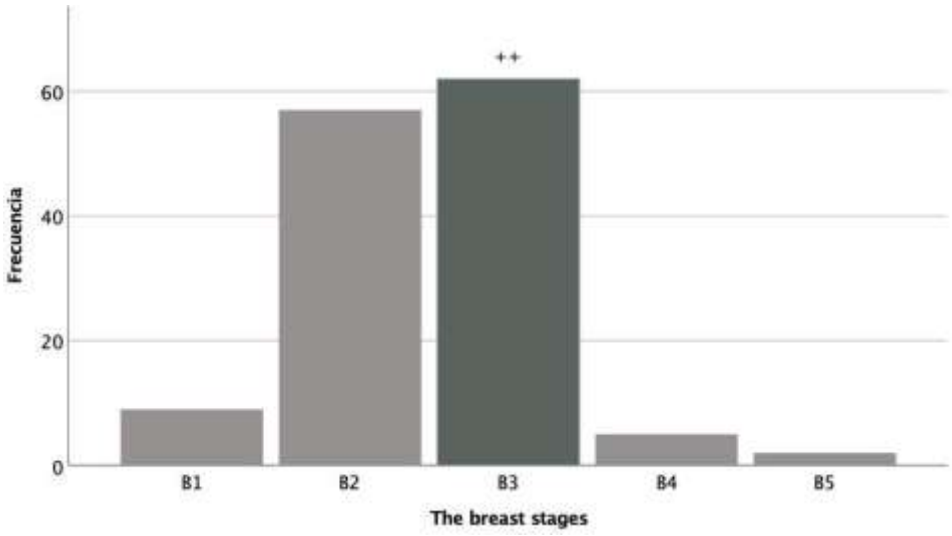
(b)

Figure 4. Distribution of the group of children with respect to genital development and pubic hair.

(a) Boys (n = 105, 100%) by genital development: G1 7.6% (f = 8), G2 40.0% (f = 42), G3 39.0% (f = 41), G4 10.5% (f = 11), and G5 2.9% (f = 3). (b) Boys by pubic hair development: PH1 32.4% (f = 34), PH2 48.6% (f = 51), PH3 12.4% (f = 13), PH4 4.8% (f = 5), and PH5 1.9% (f = 2).

Among girls, most participants (45.9%; f = 62) were located in stage B3 for mammary gland development, considered a pubertal stage; the remaining information is presented in Figure 5(a). Regarding PH development, most girls were located in PH2, represented by 45.9% (f = 62), indicating that the majority of girls were in an early pubertal

stage; Figure 5(b) complements the information with the distribution by stage.



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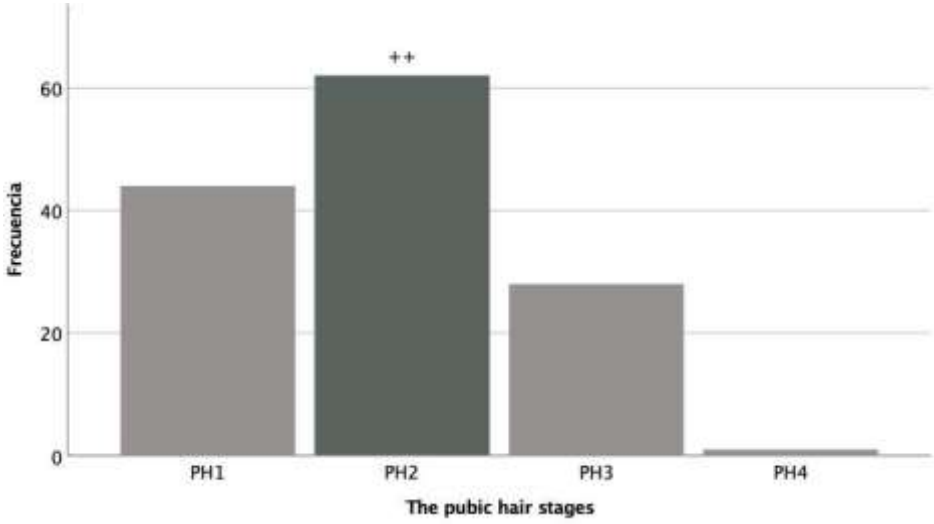

(b)

Figure 5. Distribution of the group of girls with respect to the development of mammary glands and pubic hair.

(a) Girls (n = 135, 100%) by mammary gland development: B1 6.7% (f = 9), B2 42.2% (f = 57), B3 45.9% (f = 62), B4 3.7% (f = 5), and B5 1.5% (f = 2). (b) Girls by pubic hair development: PH1 32.6% (f = 44), PH2 45.9% (f = 62), PH3 20.7% (f = 28), PH4 0.7% (f = 1), and no participants in PH5.

4. Discussion

The present findings should be interpreted within a multifactorial post-pandemic context. Unmeasured factors

such as parental mental health, family stress, and school reintegration processes may partially explain the observed results. Moreover, some studies have reported heterogeneous or non-significant differences in mental health outcomes by sex following the COVID-19 pandemic, suggesting that contextual, cultural, and family-related factors may play an important role.

The present study aimed to describe the levels of anxiety, depression, and physical activity of children in northern Mexico by sex after lockdown conditions. The study reveals three main results. First, elevated anxiety symptoms were observed among children from Physical Education Zone No. 14 in northern Mexico; these findings may be associated with post-confinement conditions. However, no causal relationships can be inferred due to the study design. Alternative explanations such as family stress, school reintegration, and environmental factors should also be considered.

Second, a higher proportion of girls exceeded the cut-off point for depressive symptomatology, although the mean depression score did not differ significantly by sex. Finally, the physical activity levels of the overall sample were low even after the return to school activities in the 2022-2023 school year.

4.1 Anxiety levels

The present study suggests that anxiety levels were elevated in the post-confinement period among children, which is consistent with literature describing the collateral effects of social isolation caused by the COVID-19 pandemic on psychological health in this population (18, 47-49). Anxiety levels in this age group are also consistent with previous studies conducted during confinement (35, 50).

Possible explanations for increased anxiety related to social isolation or confinement are associated with age, since the literature reports that anxiety disorders and depression are more common among younger people than among adults and older adults in the COVID-19 pandemic context. In addition, symptoms of anxiety and depression have been related to difficulties within family relationships and restrictions caused by the pandemic, such as reduced outdoor activities (51).

Another factor associated with increased anxiety is the information that children and adolescents receive regarding COVID-19. The literature reports that, among 745 children, 37.4% (f = 279) were affected by such information, and the main concern was associated with the possible health problems that the virus could cause, a situation reported by 58.1% (f = 433) of children (48). It should also be noted that, compared to adults, children in this age group have different cognitive capacities for understanding and interpreting information (52).

One aspect to consider regarding increased post-confinement anxiety is that children's reactions and responses to a traumatic event do not necessarily manifest immediately; rather, they may appear weeks or months after the traumatic event. This delayed response has been observed in other epidemics, such as the Ebola virus epidemic (53).

4.2 Depression

Regarding depression, the findings of the present study showed that a higher proportion of girls exceeded the cut-off point for depressive symptomatology, although the mean difference by sex was not statistically significant. This finding is partially consistent with previous studies indicating that girls may be more vulnerable to depressive symptoms in contexts of social isolation or traumatic events (53, 54). A higher incidence of depressive symptomatology in girls has also been observed in epidemiological studies of normative samples. In Mexico, one out of four girls has been reported to show significant symptoms of depression (40), and another epidemiological study with a sample of 57,403 subjects found that female adolescents were more vulnerable to depressive symptomatology than boys (55).

In an attempt to explain this trend, the literature reports several adverse childhood situations associated with psychopathological disorders, such as family economic adversity related to the inability to meet basic needs and confinement-related reductions in social and physical contact, which can lead to frustration and feelings of loneliness (56). In addition, cultural context may influence symptom expression. From a gender perspective, understood as the social role associated with behaviors, attitudes, and stereotypes that define masculinity and femininity, boys may mask symptomatology to avoid contradicting the socialized role of masculinity (57).

The literature also reports that depressive symptomatology in minors can be associated with family migration, especially maternal migration, because children and adolescents may face different belief systems, values, stressors, and lower social support in a new community (23). Given that the present study was conducted in Ciudad Juárez, a border city with a strong migration dynamic (58),

migration-related stress may be a relevant contextual factor. However, migration was not directly measured in this study and should therefore be interpreted cautiously.

4.3 Physical Activity

Concerning the physical activity levels observed in the L2-PA category, the findings are consistent with expert warnings that social-isolation measures used to contain the spread of COVID-19 would considerably reduce opportunities for PA among children, especially those living in urban areas (11). The results are also consistent with studies reporting reduced physical activity among children of similar ages during COVID-19 confinement (12, 59, 60, 65). Specialists estimate that PA levels decreased substantially due to behavioral and lifestyle modifications during the COVID-19 context (62).

These similarities may be explained by the fact that many governments employed comparable social restrictions to contain COVID-19. As a result, the lack of opportunities to be in open spaces - such as parks and school playgrounds - together with housing conditions and parental work characteristics, may have affected children's PA levels (16). Socioeconomic status can also modify PA patterns; lower socioeconomic levels have been associated with lower PA levels (63).

4.4 Tanner Stages

On the other hand, when the maturation stages of the present sample are compared with the reference data for the Mexican population proposed by Chavarro et al. (46), the boys' group shows similar tendencies in genital development, with both samples classified under the infantile/pre-adolescent stage G2. In contrast, the girls' group in the present study differs from the reference values for B3 and PH2 reported by Chavarro et al. (46).

These differences can be attributed to what the scientific literature calls biological age, which refers to physiological maturation processes that may be accelerated or delayed and do not necessarily correspond to chronological age (64). In the girls' group in the present protocol, biological maturation may have occurred earlier relative to chronological age, with menarche occurring at earlier ages compared to the reference study (46). If so, post-menarche physical and physiological changes may accelerate, allowing physical changes related to mammary gland and pubic hair development to be observed within intervals of up to six months (44). However, this interpretation should be treated cautiously given the self-reported nature of Tanner staging.

4.5 Anthropometric characteristics

The basic anthropometric characteristics of the present sample in the BMI variable for both sexes differed from previous cohorts of children of similar ages, which reported lower values than those found in the present study (66). Compared with normative values for the Mexican pediatric population, the sample also presented values above the expected range (67). Similar differences remained when compared with studies of samples with comparable sociodemographic characteristics from northern Mexico (43, 68).

Regarding WHR indices, both groups presented a mean above the 50th percentile developed from a sample of Mexican-American children (68). Likewise, the values found for the waist-to-height ratio (WHtR) were higher than those of a previous study that analyzed body composition in the same region of northern Mexico (69).

In light of the literature, this situation was expected, since COVID-19 restrictions were anticipated to contribute to changes in children's weight and nutrition-related profiles (61). Another possible reason why participants presented values higher than the means reported in previous studies may be related to what the literature calls the reaction norm, in which genetic expression may be potentiated or limited depending on the environment. Biological age status may also be relevant; as mentioned above, development in the girls' group seems to be accelerated compared to parallel groups (64). It should also be noted that anthropometric characteristics or profiles are influenced by racial, ethnic, and population groups (68), as well as by environmental and sociocultural factors (67), which may explain why the values differ from previous studies.

4.6 Limitations and strengths

This study has several limitations. First, its cross-sectional and descriptive design does not allow causal inference. Second, the sample was limited to a specific region, which restricts generalizability. Third, Tanner stages were self-reported, which may introduce measurement bias. Finally, the absence of pre-pandemic data limits the ability to attribute the findings directly to confinement.

A strength of the present study is that the sample size was adequate for regional organizational studies. In addition, the protocol was conducted face-to-face using pencil-and-paper

instruments, differing from the predominant tendency in pandemic-related research to use digital media, which may introduce specific biases. Another strength is the inclusion of basic anthropometric characteristics and sexual maturation stages, which previous studies had not considered.

Future research should consider a longitudinal panel design that allows the natural development of the observed phenomenon to be studied, including assessment not only of children but also of parents or guardians.

5. Conclusion

These findings suggest that post-confinement conditions may be associated with changes in psychological and physical health indicators in children in northern Mexico; however, causal relationships cannot be established.

Authors' Contributions

R.M.C.C. and G.H.C. designed and directed the project; H.H.P., J.Q.C., B.R.C., and J.H.R. conceived and planned the experiments; H.H.P., J.Q.C., and J.H.R. carried out the experiments; Z.N.A.R., R.M.C.C., G.H.C., and B.R.C. contributed to sample preparation; G.H.C., H.H.P., J.Q.C., J.H.R., R.M.C.C., and Z.N.A.R. analyzed the data; H.H.P., J.Q.C., J.H.R., Z.N.A.R., G.H.C., and R.M.C.C. contributed to interpreting the results; and H.H.P., R.M.C.C., J.H.R., and J.Q.C. took the lead in writing the manuscript with input from all authors. All authors discussed the results and commented on the manuscript.

Declaration

None.

Transparency Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board/Ethics Committee of Universidad Autónoma de Ciudad Juárez (protocol code CEI-2022-2-104).

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