

# Smartphone use associated with overweight and obesity in adolescents in a family medicine unit in Mexico

## Abstract

**Introduction:** The use of smartphones has been increasing globally and in the case of adolescents it represents greater vulnerability and health risks. Clinical research that relates Body Mass Index (BMI) or body weight alterations with Information and Communication Technologies (ICT) demonstrates an association. However, the specific association of problematic smartphone use with overweight or obesity is limited and inconclusive in adolescents.

**General objective:** To associate smartphone use with overweight and obesity in adolescents in a family medicine unit (FMU).

**Material and methods:** A cross-sectional and analytical study was carried out from September 2022 to December 2023 in a first-level medical unit, in adolescents aged 10 to 19 years, in whom the Mobile Phone Problem use Scale (MPPUS-A) was applied and BMI was calculated. A Multiple Binary Logistic Regression (RLM) model was used that included age > 14 years, smartphone use and female sex. Odds Ratio (OR), 95% CI and p.

**Results:** Of 338 subjects, it was found that 39% were overweight or obese and had problematic use of the smartphone. 9.1% of overweight or obese adolescents have an adequate use of the smartphone. In the bivariate analysis, it was found that the inappropriate use of smartphones presented a PMR of 2.68 [95% CI (1.63-4.41)] and  $p < 0.001$ . The multivariate model showed inappropriate smartphone use with an OR of 1.06 [95% CI (1.73-4.87)] with  $p < 0.001$  and age > 14 years an OR of 1.68 [95% CI (2.80-10.25)] and  $p < 0.001$ .

**Conclusion:** Adolescents who have problematic smartphone use and an age > 14 years have a higher risk of being overweight or obese. Longitudinal studies are required to verify the findings shown here.

**Keywords:** smartphone, adolescents, obesity, overweight, body mass index

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## Abbreviations

FMU, family medicine unit; BMI, body mass index; ICT, information and communication technology; ENSANUT, National Health and Nutrition Survey; INEGI, National Institute of Statistics, Geography and Informatics; WHO, World Health Organization; IMSS, Mexican Institute of Social Security; MDs, mobile devices; OR, odds ratio; Internet addiction, AI

## Introduction

Based on data from the World Health Organization (WHO), 55% of people under 18 years of age are overweight or obese worldwide. This prevalence reaches one in five children and adolescents. In Mexico, during the last 30 years, this problem has been increasing in adolescent women between 12 and 19 years of age.<sup>1</sup> Among children and adolescents aged 5 to 19 years, the prevalence of overweight increased dramatically, from 8% in 1990 to 20% in 2022.<sup>2</sup>

Obesity is defined as a chronic, recurrent medical condition that results from an imbalance in energy intake and expenditure, due to a

sedentary lifestyle, excessive calorie intake, or both.<sup>3</sup> This condition is associated with an increased risk of chronic diseases such as type 2 diabetes, cardiovascular problems, and certain types of cancer. It also has important psychological and social repercussions. It variably affects individuals of both sexes, of all socioeconomic strata and age. Its development involves a complex interaction between genetic, social, behavioral, psychological, metabolic, cellular and molecular factors. During the last three decades, there has been a significant increase in the frequency of this condition, both globally and in the specific context of Mexico,<sup>4</sup> where there is a critical situation marked by high rates of systemic hypertension,<sup>5</sup> obesity, type 2 diabetes, and chronic diseases.<sup>6</sup>

Currently, communication technologies (ICTs), the use of the internet and mobile devices (MDs) are part of the daily life of young people, who have adopted them as part of their lifestyle.<sup>7</sup> Globally, there are 5.1 billion mobile phone users and more than 4 billion Internet users, with a usage rate of 58.7%. These figures increased after the COVID-19 pandemic in the world, where mobile phone use went from 52% to 79%.

The new mobile technology has given way to virtual spaces for socialization and has displaced face-to-face ones. This has generated behavioral changes in individuals, especially in today's young people.<sup>9</sup> In previous studies, it has been shown that problematic mobile phone use has been associated with various diseases, including attention deficit hyperactivity disorder, stress, depressive disorders and eating disorders. Among them is the study by Tamura et al., which concluded that using mobile phones for 2 hours a day for social media services and online chats is associated with an increased risk of depression.<sup>10</sup> On the other hand, Tabares et al. concluded that due to the COVID-19 pandemic, there has been an increase in the problematic or excessive use of mobile phones during quarantine, especially among young men and adolescents.<sup>11</sup> This, in turn, changes eating habits, as people use their phones even while eating, which affects the regulation of intake.

Various clinical studies have found that excessive time on the smartphone conditions a sedentary lifestyle and alteration of eating habits. This leads to an imbalance between the supply and use of nutrients, resulting in alterations in nutritional status, affecting the quality of life of those with problematic use of mobile phones due to an increase in the risk of the appearance of chronic non-communicable diseases. The scientific evidence is inconclusive regarding the association of smartphone use and nutritional status in Mexico. Therefore, the objective of this research is to associate smartphone use with overweight and obesity in Mexican adolescents.

## Material and methods

### Type of study and objective

An observational, analytical, and cross-sectional study was carried out from September 2022 to December 2023. The main objective was to associate problematic smartphone use with overweight or obesity in adolescents from the Family Medicine Unit No. 64 Tequesquahuac of the Mexican Institute of Social Security.

### Subject

A sample size was calculated using a Sealed Envelope Ltd. calculator.<sup>12-25</sup> to estimate a difference of two proportions, in relation to the expected outcome, with an alpha of 0.05% and 1 - B of 20%. A prevalence of 23.8% (obese or overweight subjects with normal ICT use) and 12% (obese or overweight subjects with problematic ICT use) was considered, obtaining an n=338 subjects. A 1:1 exposed/unexposed ratio was considered. The sampling technique was non-probabilistic for convenience.

Adolescents between 10 and 19 years of age, male and female, with normal weight, overweight and grade I obesity were included. Subjects with blindness/visual impairment and those whose visual impairment does not allow the use of a smartphone were excluded; subjects with an endocrinological disease (thyroid gland disorders, diabetes mellitus, other disorders of glucose regulation and internal secretion of the pancreas, disorders of other endocrine glands) that caused endogenous weight gain. Likewise, subjects with a psychiatric pathology (anxiety disorders, bipolar disorder, obsessive-compulsive disorder), which conditions problematic use or addiction to the smartphone and malnutrition, were excluded.

### Ethical issues and consent

This research work was approved by the Research Ethics Committee 14088 and Local Health Research Committee 1408, obtaining the registration number R-2023-1408-002. Participants were taken as subjects who came to the Family Medicine Unit No. 64 "Tequesquahuac" spontaneously, by their own appointment or that of a family member. Previously, the subjects and their parents or legal guardians were informed about the details of the study, the main objective, risks and benefits obtained, the procedure and the questionnaires used. Consent was requested from the parents or guardians of the minors and informed assent from the research subjects under 18 years of age.

A scale was applied to identify problematic mobile phone use MPPUS-A Scale, with internal consistency showed a Cronbach's alpha of 0.97, indicating high reliability in the adolescent population.<sup>26</sup> The interviewer performed the measurement of weight and height (Anderson method) on standardized scales of the first-level medical unit for later analysis of the same. BMI was calculated using weight/height and was classified as: normal 18.5-24.9, overweight 25-29.9, obesity I 30-34.9, obesity II 35-39.9, obesity III >40.<sup>2</sup>

### Statistical analysis

The statistical analysis was performed with the SPSS version 27 (Statistical Package for the Social Sciences) program. For qualitative variables (nutritional status, smartphone use, sex, and schooling), frequencies and percentages were obtained. For the quantitative variables (age), their type of distribution was determined using asymmetry criteria (-0.05-0.05), kurtosis criteria (-0.02-0.02) and statistical test criteria (Kolmogorov-Smirnov, considering a  $p > 0.05$ ) as a Gaussian distribution.

The evaluation of the variable smartphone use was transformed into a dichotomous variable: problematic and non-problematic, for the purposes of bivariate and multivariate statistical treatments. In the bivariate analysis phase, for the association of qualitative variables (nutritional status, smartphone use, sex and schooling) the non-parametric statistical Pearson's Chi-square test or Linear Trend Test was used, according to the corresponding mathematical assumption and was considered as statistically significant with a  $p < 0.05$  as and dependence on the factors.

A multiple binary logistic regression model was constructed, for which confounding factors with statistical significance, statistical risk tendency ( $p > 0.05$  and  $< 1.0$ ), biological plausibility, avoiding colliders, intermediate links of effect and collinearity (variance inflation factor  $< 10$ ) that impact overweight or obesity (smartphone use, age over 14 years and female). To assess clinical relevance, simple and adjusted PMRs, B exponentials, standardized errors, 95% CI, and p were calculated. The results were represented by a forest graph using GraphPad Software, LLC, 2365 Northside Dr., Suite 560, San Diego, CA 92108, USA.

## Results

### Descriptive results

Of 338 subjects, 61.5% were female. The median age was 16 years. 58.5% had a high school education. 71% had problematic smartphone use. 38.8% were overweight and 10% obese. 51.2% were of normal weight (Table 1).

**Table 1** General characteristics of teenagers with smartphone use

Variable general	n (%) =338
Sex	
Female	208 (61.5)
Male	130 (38.5)
Age, Median IQR (25.75), years	16 (15,17)
Schooling	
Primary	35 (10.4)
High school	105(31.1)
High school	198(58.5)
Using your smartphone	
Problematic	240(71)
Non-problematic	98(29)
Nutritional status	
Normal weight	173(51.2)
Overweight	131(38.8)
Obesity	34(10)

N, Frequency; %, Percentage; RIC, interquartile ranges

### Bivariate results

Of the adolescents who had problematic smartphone use, 63% were female, with a median age of 16 years, and 62.5% were in high school (Table 2).

**Table 2** Characteristics of teenagers with smartphone use

General variable	Problematic smartphone use n=240 (%)	Non-problematic use of smartphone n=98 (%)	p
Sex			
Female	152 (63.3)	56(57.1)	0.28(2)
Male	88(36.7)	42(42.9)	
Age, median, IQR (25.75), years	16(14,18)	16 (14,18)	<0.05(1)
Schooling			
Primary	25(10.5)	10(10.2)	0.17(3)
High school	65(27)	40(40.8)	
High school	150 (62.5)	48(49)	

N, Frequency; (%), Percentage; IQR, interquartile ranges; <sup>(1)</sup> Mann-Whitney U; <sup>(2)</sup> Pearson's Chi-Square; <sup>(3)</sup> Linear Trend Test

Among the adolescents who were overweight or obese, 57.9% were female, the median was 16 years old, and 75.1% were in high school (Table 3).

**Table 3** Characteristics of adolescents with smartphone use and overweight or obesity

General variable	Overweight or obese n=164(%)	Normal weight n=174(%)	p
Sex			
Female	95(57.9)	113(64.9)	0.185(2)
Male	69(42.1)	61(35.1)	
Age, median, IQR (25.75), years	16(13,17)	16 (13,17)	<0.05(1)
Schooling			
Primary	7(4.2)	28(16.1)	0.17(3)
High school	34(20.7)	71(40.8)	
High school	123 (75.1)	75(43.1)	

N, Frequency; (%), Percentage; RIC, interquartile ranges; <sup>(1)</sup> Mann-Whitney U; <sup>(2)</sup> Pearson's Chi-Square; <sup>(3)</sup> Linear Trend Test

It was found that 81.8% of adolescents with problematic smartphone use were overweight or obese with an OR of 2.68 [95% CI (1.53-4.41)] (Table 4).

**Table 4** Adolescent smartphone use associated with overweight or obesity. Bivariate analysis

Using your smartphone	Body weight		P	OR with 95% CI
	Overweight or obese n=164 (%)	Normal weight n=174 (%)		
Problematic n=240 (%)	134 (81.8)	106 (61)	<0.05a	2.68 (1.53-4.41)
Non-problematic n=298 (%)	30(18.2)	68 (39)		

<sup>a</sup>Pearson's Chi square; OR, odds ratio; CI, confidence interval; n, frequency; %, percentage

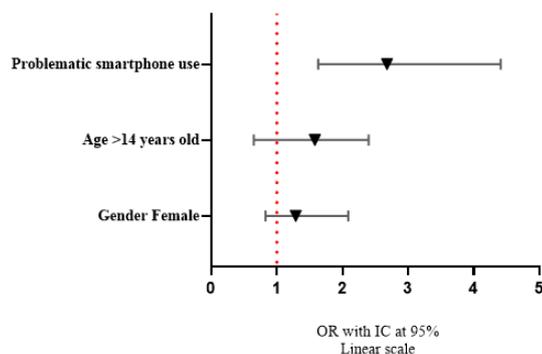
### Multivariate results

Problematic smartphone use was found to have an OR of 1.06 [95% CI (1.73-4.87)] and an EE of 0.26 and age >14 years had an OR of 1.68 [95% CI (2.80-10.25)] and an EE of 0.33 (Table 5 and Figure 1).

**Table 5** Risk factors for overweight or obesity in adolescents. Multivariate analysis

Variable	OR <sup>a</sup>	95% CI	p	USA
Age >14 years	1.68	2.80-10.25	<0.001	0.33
Female	0.41	0.93-2.47	0.91	0.24
Problematic smartphone use	1.06	1.73-4.87	<0.001	0.26

<sup>a</sup> Multivariate logistic regression; Overall percentage of the model = 66.3%; Nagelkerke's r<sup>2</sup> = 0.18%; USA= standardized error; CI, confidence interval



**Figure 1** Factors associated with overweight and obesity in Mexican adolescents. Multiple logistic regression.

OR, odds ratio; IC, confidence interval

### Discussions

Regarding the sociodemographic findings of the present research, a predominance of females was found in adolescents. This is explained based on the census carried out by INEGI where the population of 12-17 years old are adolescents and there is a predominance of females.<sup>20</sup> Finding similarity of this research with the study carried out by Ashut in which they examined the relationship between screen time, Internet addiction and other styles with obesity where the female sex predominated.<sup>13</sup>

Regarding age, a median of 16 years was found. Based on data from INEGI, where the population under 18 years of age is divided into three groups, the 12-17 age group found the highest percentage of adolescents in the Mexican population.<sup>20</sup> This differs from the study by Lit et al., where the median was 15 years, where adolescents between 12 and 18 years of age were studied with the aim of examining the longitudinal associations between anxiety, depression and internet addiction.<sup>14</sup>

The present study showed that most of the adolescents were in high school. This is consistent with the relationship with international

education systems, specifically in Latin America. In countries such as Mexico, Argentina and Colombia, students start high school at 15 or 16 years old and finish it at 17 or 18 years old. This corresponds to our age prevalence in adolescents studied in this study.<sup>21</sup> Contrary to our research is the study by Shamah, which studied the probability of being overweight and obese with prolonged time watching on the television screen in adolescents and schoolchildren, most of its population attended primary school.<sup>17</sup>

The highest frequency of the subjects of this research is in normal weight. It is worth mentioning that Mexico ranks first in childhood obesity,<sup>24</sup> however, the finding shows coincides with the studies carried out by ENSANUT where the highest frequency of the population between 12-19 years of age is in normal weight (58.9%).<sup>17</sup> This is a point of convergence with the research carried out by Asut where an association was sought between screen time, internet addiction and other lifestyle behaviors with obesity, finding that 68% had normal weight.<sup>13</sup>

In relation to sex and BMI, a higher frequency of female adolescents with a high body mass index was found. This is explained by differences in fat distribution between men and women, as well as hormonal influences, which affect both weight gain differently.<sup>22</sup> This finding coincides with other studies in adolescents in different settings, such as the study conducted by Yépez et al.<sup>22</sup> that found a prevalence of overweight and obesity of 21.5% in Ecuadorian adolescent women.<sup>23</sup> However, it differs from the study conducted by García et al.,<sup>17</sup> where it was observed that the prevalence of overweight in men of 19.9% was higher than in women with 17%. Similarly, obesity in men was 6.2%, compared to women with 3.7%.<sup>18</sup>

In the present research, it was observed that most adolescents with problematic use are attending high school. This is because most teens are in late adolescence, which exposes them and makes them vulnerable to social and technological standards that promote an unhealthy lifestyle. In the study carried out by Fisher et al., where the impact of problematic smartphone use on quality of life was studied, the age between 15 and 17 years old found the highest prevalence of adolescents with problematic smartphone use, which is similar to this study.<sup>19</sup> This can be attributed to certain cultural customs shared between the U.S. and Mexican populations due to Mexican migration to that country.

With respect to the main objective, problematic smartphone use represents a risk factor for overweight and obesity, in the simple and adjusted analysis. Scientific studies have shown that spending too much time in front of the smartphone encourages a sedentary lifestyle and poor eating habits, resulting in an imbalance between nutrient intake and expenditure, leading to overweight and obesity.<sup>12</sup> Similar to Eliacik et al.,<sup>15</sup> who conducted a case-control study to determine the associations between internet addiction and obesity-related problems in Turkish adolescents, finding a positive association between prolonged use of electronic devices and the risk of obesity.<sup>16</sup> Likewise, the result obtained is convergent with the study carried out by Bozkurt et al., who concluded that internet addiction (AI) in children and adolescents is linked to an increase in body mass index (BMI).<sup>15</sup> In contrast, Li et al., who conducted a cross-sectional study in Chinese adolescents between 12 and 18 years of age with the aim of examining the longitudinal associations between anxiety, depression, and internet addiction (AI), considering sex and obesity, argue that prolonged use of electronic devices is not directly related to overweight and obesity.<sup>14</sup>

Within the limitations of this work, it is recognized that, as it is a cross-sectional study, it does not allow to reliably establish the causal thread between smartphone use and overweight or obesity. It is also recognized that as it is a single-center study, the sample representativeness may be low. The strengths of the research are the inclusion of multivariate models, which allow a better approach to the variables that can influence obesity and overweight, in addition to the smartphone. Measures of clinical relevance are also considered, which give a better probability of the risk of smartphone use or other variables towards overweight or obesity. In the same way, additional precision parameters to the 95% confidence interval were obtained, such as standardized error. Longitudinal studies are required, which can verify the findings shown here. The results of this research can be extrapolated to Mexican adolescents with characteristics similar to those included in this study, in the context of Mexico and the IMSS.

Finally, it is essential to develop strategies to reduce problematic smartphone use in adolescents. A feasible alternative is the use of the smartphone through parenteral control applications, which allows the reduction of hours of use. An additional measure is the generation of health education strategies, focused on adolescents, parents or guardians, that emphasize the short, medium and long-term negative effects of problematic smartphone use. Likewise, the promotion of recreational activities, workshops, occupational therapies, aerobic and anaerobic exercise inside and outside schools. Within the family nucleus, clear limits must be established between the parental subsystem and the child subsystem; with a shared parental hierarchy, which establishes precise and reasonable times for the use of smartphones or the use of other digital technologies for adolescents.

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## Conflicts of interest

The authors declare that they have no conflict of interest.

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