Gac Méd Caracas 2021;129(Supl 1):S56-S65
DOI: 10.47307/GMC.2021.129.s1.8

Sleep disturbances, mobile use and metabolic syndrome in college students

Trastornos del sueño, uso del móvil y síndrome metabólico en estudiantes universitarios

Juan Manuel Guízar Mendoza[1], Norma Amador Licona[2], Leticia Chacón Gutiérrez[3]

SUMMARY

Introduction: *Adolescents and young university students tend to sleep less than adults and children and this could be related to new lifestyles such as greater use of electronic devices and produce greater health risks.*
Objective: *To determine the association between reduction and poor quality of sleep with the use of mobile phones and the presence of metabolic syndrome in university students.*
Methodology: *A total of 331 students were included. The mobile-phone-related experiences (CERM), Pittsburgh sleep quality index (PQI), and chronic reduction of sleep questionnaire (CSRQ) were applied. From this group, 116 students, half of the upper quartile and the lower quartile, were chosen to evaluate the metabolic syndrome (MS).*
Results: *Occasional inappropriate use of mobile was identified in 211 (63.7 %) and regular inappropriate use in 22 (6.6 %). The total CERM score was positively correlated with the PQI total score (r = 0.34; P < 0.0001), and the CSRQ total score (r = 0.38; P<0.0001). Of the 116 students, 14 (12.1 %) showed MS. It was associated with poor sleep quality (OR 4.29; 95 % CI = 1.13 - 16.2), male sex (OR 3.93; 95 % CI= 1.15 - 13.4), and overweight/obesity (OR 6.79; 95 % CI = 2.61 - 17.6);* R^2*=0.48.*
Conclusion: *Regular inappropriate mobile use is associated with poor quality and chronic sleep reduction. Poor sleep quality, male sex, and overweight/obesity explain in 48 % the presence of MS in university students.*

Keywords: *Mobile use, university students, sleep.*

RESUMEN

Introducción: *Los adolescentes y los jóvenes universitarios suelen dormir menos que los adultos y los niños y esto pudiera relacionarse con nuevos estilos de vida como mayor uso de dispositivos electrónicos y generar mayores riesgos a la salud.*
Objetivo: *Determinar la asociación entre la reducción y calidad del sueño con el uso del teléfono móvil y la presencia de síndrome metabólico en estudiantes universitarios.*
Metodología: *Se incluyeron 331 estudiantes a quienes se aplicaron los cuestionarios Experiencias Relacionadas con el Móvil (CERM), índice de calidad*

DOI: https://doi.org/10.47307/GMC.2021.129.s1.8

ORCID: 0000-0002-0044-5099[1]
ORCID: 0000-0003-1470-6883[2]
ORCID: 0000-0002-7268-200X[3]

[1]*Universidad De La Salle Bajío, Facultad de odontología. E-mail: guizarjm@gmail.com*
[2]*Universidad De La Salle Bajío, Facultad de Negocios. E-mail: licoamador@gmail.com*
[3]*Universidad De La Salle Bajío, Centro de Neurociencias. E-mail: lchacon@delasalle.edu.mx*

*Corresponding author: Norma Amador Licona, Facultad de Negocios, Universidad De La Salle Bajío, Avenida Universidad 602, Lomas del Campestre, 37150 León, Gto., México. E-mail: licoamador@gmail.com

Recibido: 23 de noviembre 2020
Aceptado: 13 de febrero 2021

de sueño de Pittsburgh (ICP) y reducción crónica del sueño (CSRQ). De este grupo, se eligieron 116 estudiantes, la mitad del cuartil superior y del cuartil inferior, para medir y comparar los parámetros del síndrome metabólico (SM).
Resultados: *El uso inadecuado ocasional y regular del móvil se identificó en 211 (63,7 %) y en 22 (6,6 %), respectivamente. El puntaje total de CERM se asoció con el puntaje total de ICP (r = 0,34; P <0,0001) y CSRQ (r = 0,38; P < 0,0001). De los 116 estudiantes, 14 (12,1 %) mostró SM. Este se asoció con pobre calidad de sueño (OR 4,29; 95 % CI = 1,13 – 16,2), ser hombres (OR 3,93; 95 % CI= 1,15 – 13,4), y sobrepeso/obesidad (OR 6,79; 95 % CI = 2,61 – 17,6);* R^2*=0,48.*
Conclusión: *El uso inadecuado regular del móvil se asocia con la mala calidad y reducción crónica del sueño. La mala calidad del sueño, ser hombre y presentar Sobrepeso/obesidad explican en 48 % la presencia de SM en estudiantes universitarios.*

Palabras clave: *Uso del móvil, estudiantes universitarios, sueño.*

INTRODUCTION

The World Health Organization (WHO) reported that in 2012 there were 3.7 million deaths attributed to diabetes mellitus, and according to its projections, it will be the seventh leading cause of death in 2030 (1). In México, according to the 2018 National Health and Nutrition Survey, the prevalence of overweight and obesity in people over 20 years of age is 75.2 % and one of its consequences, type 2 diabetes mellitus, has a prevalence in the same group of 10.3 % (2).

Until now in young people with metabolic syndrome (MS) it has been described that therapeutic interventions including exercise and different types of diet decrease body weight and normalize or at least diminish metabolic parameters of MS (3,4).

Simultaneously, the prevalence of obesity and metabolic disorders is reported >50 % in the population who sleeps less than 7 hours per night (5). Chronic sleep reduction is associated with an increase in ghrelin levels, but a reduction in leptin levels, which favors appetite and the consumption of a greater amount of calories (6). This supports the hypothesis that sleep disturbances may also contribute to the rapid growth in the prevalence of obesity and MS, characterized by abdominal adiposity, insulin resistance, atherogenic dyslipidemia, and elevated fasting glucose and blood pressure (7).

The mobile phone has become an extension of humans especially for young people, whose use carries a risk of addictive behavior. In adolescents, up to 30 % of mobile abuse has been reported (8), who due to the low level of self-control, may become vulnerable to mobile addiction (9). Addiction adversely affects physical and emotional health, and the term nomophobia has been described as the fear of losing contact with the mobile phone. The quality and duration of sleep, which are crucial for health, can be affected by various factors such as the use of different technological devices. Intensive mobile use is associated with greater anxiety and insomnia, mainly in women (10), it also increases the deterioration in the quality and quantity of sleep, which affects academic performance, and even the growth and development of adolescents (11,12). Furthermore, the intensive use of mobile phones causing poor sleep quality and daytime dysfunction can even lead to anxiety and depression (13). Recently, in medical students, sleep quality, daytime dysfunction, and sleep duration were all affected by the overall use of mobile phones and the inability to control their use (14). So, uncontrolled mobile use seems to be related to many aspects of physiologic development, daily and professional life, all of them linked to human health.

Whereas early identification and treatment of sleep disturbances can improve the metabolic and cardiovascular health of those exposed, the objective of this study was to determine the association of the reduction and quality of sleep with the use of mobile phones and the presence of MS in college students.

MATERIAL AND METHODS

The study consisted of two phases, in the first, a descriptive cross-sectional survey in 331 university Mexican students from 18-29 years old (164 males and 167 females) systematically healthy was carried out. The participants of this study were students from different areas during the 2019–2020 academic year. Students with cardiometabolic or psychiatric diseases, who consumed medications that could affect sleep or had metabolic repercussions, were not included. The survey of mobile-phone-related experiences was used (CERM by its acronym in Spanish). It is a self-administered instrument that assessed conflicts related to mobile abuse in relation to its emotional and communicational use. It consists of 10 items with four-point Likert-type responses - rarely (1), sometimes (2), many times (3), usually (4). It has two factors: conflicts and communicative/emotional use. The score can range from 10 to 40, and the highest score is related to greater "misuse" or "abuse" of the mobile (15).

To evaluate the sleep in this population, two self-administered questionnaires were applied. The Pittsburgh Sleep Quality Index (PSQI) includes 19 items, each are framed in a 4-point Likert scale (0–3), and analyzes seven components including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction over the last month (16). The scores from each component are added to give a global score (range 0–21). Combined, these numerical scores provide the clinician with an efficient overall summary of a patient's quality of sleep and sleep health. The second questionnaire, the Chronic Sleep Reduction Questionnaire (CSRQ) consists of four subscales referring to the previous 2 weeks: a shortage of sleep (six items); irritation (five items); loss of energy (five ítems); and sleepiness (four ítems). Each question has three ordinal response categories ranging from 1 to 3, with higher scores indicating more chronic sleep reduction. The total CSRQ scale consists of the sum of the four subscales, and the range of possible CSRQ scores varies between 20 and 60 (17).

In the second phase of the 331 students initially included, two groups were evaluated, 60 from the lower quartile of the PSQI and CSRQ and 56 from the upper quartile. These 116 students were asked for the number of hours per week of physical activity, and current or past smoking. Each student's weight was measured in kilograms with an electronic scale (Tanita), and the height with a stadiometer (Seca 225), to obtain the body mass index (BMI), as well as the waist circumference. Resting blood pressure was measured after 10 minutes of sitting, the cuff of the sphygmomanometer was placed on the left arm that covered 2/3 of it and with the use of the stethoscope, and the value of systolic and diastolic blood pressure expressed in mmHg was obtained. After a fasting period of at least 8 hours, the quantitative measurement of capillary whole blood glucose, cholesterol, triglycerides, high-density cholesterol (HDL) was done with SD LipidoCare Professional System (SD Biosensor, Inc. Republic of Korea).

Metabolic Syndrome was defined by the criteria proposed by the International Diabetes Federation (IDF) (18). It considers abdominal perimeter >94 cm (for men) or >88 cm (for women) and two or more of the following criteria: fasting glucose between 100 to 125 mg / dL (5.6 a 6.9 mmol/L) or a diagnosis of type 2 diabetes mellitus, systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg, or to be in treatment of hypertension, fasting triglycerides ≥150 mg / dL (1.7 mmol/L); HDL <40 mg/dL (1.0 mmol/L) in men or <50 mg/dL (1.3 mmol/L) in women or to be under treatment for hyperlipidemia.

Statistical Analysis

The numerical variables were summarized in means and standard deviation and the categorical variables in absolute and relative frequencies. The comparison of the quantitative variables between both groups was performed with the Student's t-test for independent samples and the chi-square test for comparison of proportions. We also used multivariable logistic regression models to estimate the effects of different covariates (sex, quality of sleep, and nutritional status) influencing the risk of metabolic syndrome. The data analysis was done with the statistical package SPSS version 21.0 and the level of significance was considered in the case of $P<0.05$.

Ethical considerations

The local Ethical and Research Committee at the De La Salle Bajio University approved the research protocol. Participants who met the selection criteria were explained about the objective of the study, its benefits, and risks, as well as each of the procedures that were carried out, to obtain their authorization. They were informed that their participation would be voluntary, and no economic or academic incentives would be offered. The information was kept confidential, and the results were delivered personally.

RESULTS

We evaluated 331 students, 164 (49.5 %) men and 167 (50.5 %) women with a mean age of 21.3 ± 3.2 years. The mean age for men was 21.5 ± 2.8 and for women 21.1 ± 3.6 (P= 0.39).

For the first phase of the study, women showed a higher CERM total score (17.8 vs. 16.1; P= 0.03) and in the emotional factor (10.3 vs. 9.1; P= 0.01), but not in the conflict factor (7.5 vs. 7.0; P= 0.22), nor in the use of mobile phone (5.3 vs. 4.8 h/day; P= 0.28) than men. The appropriate mobile use was observed in 97 (29.3 %) cases, occasional inappropriate use in 211 (63.7 %), and regular inappropriate use or abuse in 22 (6.6 %). The age of students in the appropriate use category was 22.6 ± 4.6 years, higher than in the category of occasional inappropriate use 20.9 ± 2.2 years (P= 0.005) and then in the category of regular inappropriate use of mobile 20.2 ± 1.9 years (P < 0.0001). No difference in sex was found between the categories of mobile use (P= 0.309).

The hours of daily use of the mobile phone correlated positively with the CERM score (r = 0.28; P= 0.0001); the conflicts factor (r = 0.23; P< 0.0001); and the communicative/emotional use factor (r = 0.26; P= 0.0001). The electronic device with the highest frequency of use before bedtime was the mobile phone, in 315 (95.2 %), followed by the computer 170 (51.4 %), television 73 (23.0 %), tablet 47 (14.2 %) and console games 36 (10.9 %).

Quality and quantity of sleep

Poor sleep quality was identified in 162 (48.9 %) students and chronic reduction in 127 (38.4 %), both characteristics were present in 103 (31.1 %) with a predominance in women 61 (59.2 %).

A trend was found in the increase of the total score of Pittsburgh and in its components of poor quality, latency, interruptions, and sleep dysfunction, being lower in the category of appropriate use and higher for regular inappropriate use. The main statistical differences were identified between the group of appropriate use with that of occasional and regular inappropriate use, but not between the latter two. The proportion of poor quality of sleep was statistically different between the three categories but with the highest proportion in students with regular inappropriate mobile use. There were no statistical differences in the efficiency and duration of sleep between the three categories of mobile use (Table 1).

The total CSRQ score, as well as its components, chronic reduction, irritation, loss of energy, and sleepiness, were higher in the categories with occasional and regular inappropriate use compared to the category of appropriate mobile use (Table 2).

Students with impaired sleep quality or chronic reduction showed higher values in the communicative/emotional use factor, conflicts factor, total CERM, and time of mobile users than those without sleep disturbances. There was no difference in the proportion of mobile use before two hours of sleep, but with a > 95 % of its use in the entire group of students (Table 3).

Correlation of sleep quality and quantity scores with mobile phone use

The total CERM score was positively correlated with the Pittsburgh total score (r = 0.34; P< 0.0001) and its following factors: sleep latency (r= 0.28; P< 0.0001); sleep dysfunction (r= 0.34; P< 0.0001); sleep quality (r= 0.24; P< 0.0001), and sleep disturbances (r= 0.26; P< 0.0001). Is also showed a significant correlation with the chronic sleep reduction score (r = 0.38; P< 0.0001) and its following factors: irritation (r= 0.39; P< 0.0001); sleepiness (r= 0.38; P< 0.0001), loss of energy (r= 0.26; P< 0.0001), and shortage of sleep (r= 0.16; P= 0.001).

Table 1

Comparison of sleep quality according to mobile use

	Appropiate mobile use n= 97	Ocassional problems with mobile use n= 211	Regular problems with mobile use n= 22	P	Post hoc
Pittsburg total score	6.14 ± 2.9a	7.59 ± 3.1b	9.09 ± 3.4c	< 0.0001	ab=0.001;ac=0.001
Poor quality	34 (35.1%) a	111 (52.6%) b	17 (77.3%) c	<0.0001	ab=0.003;ac=0.001;bc=0.01
Habitual sleep efficiency	0.16 ± 0.47	0.18 ± 0.45	0.18 ± 0.35	0.85	
Sleep duration	1.32 ± 0.95	1.35 ± 1.03	1.50 ± 1.01	0.75	
Sleep latency	0.95 ± 0.92 a	1.36 ± 0.86 b	1.50 ± 0.80 c	0.0001	ab=0.001; ac= 0.02
Sleep disturbances	0.98 ± 0.54 a	1.22 ± 0.53 b	1.36 ± 0.49 c	0.0001	ab=0.001; ac= 0.007
Subjective sleep quality	1.25 ± 0.76 a	1.65 ± 1.08 b	1.91 ± 0.68 c	0.0001	ab=0.002; ac= 0.01
Daytime dysfunction	1.28 ± 0.77 a	1.69 ± 0.79 b	2.09 ± 0.97 c	0.0001	ab=0.001; ac=0.001

Source: self-made

Table 2

Chronic sleep reduction and mobile use

	Appropiate mobile use n= 97	Ocassional problems with mobile use n= 211	Regular problems with mobile use n= 22	P	Post hoc
Total score	36.7 ± 3.19 a	38.8 ± 4.46 b	41.7 ± 4.3 c	<0.0001	ab=0.001;ac=0.001;bc=0.004
Chronic sleep reduction	22 (22.7%) a	89 (42.2%) b	16 (72.7%) c	<0.0001	ab=0.003;ac=0.001;bc=0.01
Shortage of sleep	12.4 ± 1.84 a	12.6 ± 1.85 b	13.4 ± 1.50 c	0.03	ac= 0.04
Irritation	6.61 ± 1.97 a	7.89 ± 2.62 b	9.82 ± 3.36 c	0.0001	ab=0.001;ac=0.001;bc=0.002
Loss of energy	10.0 ± 1.66 a	10.6 ± 1.53 b	11.2 ± 1.44 c	0.002	ab=0.01;ac=0.003
Sleepiness	6.4 ± 1.63 a	7.59 ± 1.94 b	8.45 ± 1.99 c	0.001	ab=0.0001;ac=0.0001

Source: self-made

Sleep disturbances, mobile phone use, and metabolic syndrome

In the second phase, 116 students were selected, 67 women and 49 men, 60 without sleep disturbances and 56 with sleep disturbances. In 14 (12.1 %) the MS was identified, nine (16.1 %) in the group with alterations in the quality and quantity of sleep and five (8.3 %) without alterations in sleep (P= 0.20). Waist circumference as a criterion for MS was the most frequently observed. No association was identified between the presence of MS with the category of mobile use. MS was identified in 7/61 students with occasional inappropriate use, 2/9 with regular inappropriate use and in 6/49 with appropriate use (Chi^2 = 0.95; P= 0.620). The mobile use (h/day) did not achieve a statistical difference between students with or without MS (6.07 ± 4.3 vs. 5.0 ± 2.5 h; P= 0.18, respectively). Students with MS showed fewer days / week of physical activity 1.0 ± 1.71 vs. 3.55 ± 4.0 (P= 0.02), without difference in the presence or intensity of smoking (P= 0.069).

Table 3

Comparison of mobile use according to the quality and quantity of sleep

	Students without quality sleep disturbance n= 169	**Students with quality sleep disturbance n= 162**	**P**
Factor conflicts	6.70 ± 1.57	8.24 ± 2.32	< 0.0001
Factor communicative/emotional use	9.98 ± 2.47	10.73 ± 2.47	0.006
Total CERM score	16.6 ± 3.4	18.9 ± 4.15	0.001
Mobile use h/day	5.43 ± 2.76	6.56 ± 3.69	0.001
Mobile use 2 h before going to bed n (%)	165 (97.6)	159 (98.1)	0.56
	Students without chronic sleep reduction n= 204	**Students with chronic sleep reduction n= 127**	**P**
Factor conflicts	6.9 ± 1.7	8.3 ± 2.43	<0.0001
Factor communicative/emotional use	9.8 ± 2.3	11.2 ± 2.6	<0.0001
Total CERM score	16.8 ± 3.3	19.5 ± 4.3	<0.0001
Mobile use h/day	5.41 ± 2.9	6.44 ± 3.7	0.01
Mobile use 2 h before going to bed n (%)	199 (97.5)	125 (98.4)	0.79

Source: self-made

The multiple logistic regression analysis in which the dependent variable was MS, showed that poor sleep quality Odds ratio [(OR) 4.29, 95 % confidence interval (CI) = 1.13 - 16.2, P= 0.03], overweight/obesity (OR 6.79, 95 % CI 2.61 - 17.6, P<.0001), and the male sex (OR 3.93, 95 % CI 1.15 - 13.4, P= .02) explain the presence of metabolic syndrome with an $R^2 = 0.48$.

DISCUSSION

Women reported a higher total CERM score and emotional factor, despite a similar time use of the mobile phone than men. This could be related to the report that self-criticism tends to be more common in females than in male youths (19). Women are also more vulnerable to develop internalizing disorders such as depression and anxiety, and men more likely to engage in risky behaviors and substance use (20), which can also be related to the higher proportion of affection in quality and quantity of sleep in women than in men. It has also been reported a different sensation seeking and impulsivity traits by sex (21), explained by developmental imbalances between the prefrontal cortex, amygdala, and striatum especially during adolescence (22). Furthermore, recently, Zhang et al. (23) reported gender differences in both brain structure and brain function. Therefore, it seems that there are sex differences in adolescent vulnerability, behavior, and development, even without considering social contexts.

The students in the occasional or regular inappropriate mobile use were younger than students in the appropriate use. It is in accordance with a recent study to identify the mobile phone use in Australia where 18–24-year-old participants reported the highest problematic use (24).

Poor sleep quality was identified in near of half of all the students, chronic reduction in 38 %, and both in 31 %. Previous research indicates that sleep disturbances may vary across racial/ethnic groups (25), age, and sex (26). Sleep changes in women across the life span are related to steroid sex hormones, the aging process, and comorbid diseases (26). In a big sample of college students in the United States, between 40 and 65 % meet cutoff criteria for poor sleep with also a higher incidence in women (64 %) than in men (57 %) (27).

Both in the group with altered sleep quality and those with chronic sleep reduction, a higher total CERM score was observed as in each of its factors, along with a long time of mobile phone use than in those without sleep disturbances. The literature indicates that its use close to bedtime alters sleep by mechanisms such as the effect of the electromagnetic field on melatonin; a hormone produced by the pineal gland that influences the circadian cycle, such as sleep, metabolism, and even reproduction (28). Furthermore, about 99 % of the students reported its use 2 h before bedtime, which makes it a much-generalized behavior in this population regardless of sex. A recent systematic review identified that the use of late-night media such as text messages, social media, games, etc., correlates with poor quality and quantity of sleep (29). For many years, it has been considered that problematic phone use is associated with depression, anxiety, and sleep disturbance (30). However; recently a bidirectional relationship has been identified among mobile phone addiction behaviors with mental and sleeps problems (31), supporting that those with psychological distress seem to be more likely to be trapped into problematic media use.

In the present study, the MS was identified in 14 students (12.1 %), a frequency that is in the expected range for young adults between 18 and 24 years of age, ranging from 0.6 % to 14 % (32). Those with MS showed one more hour per day of mobile use than students without MS, although without statistical difference. It has been reported that, in adolescents and young adults, the probability of developing MS increases proportionally to the combined time spent using different screens, including television, computers, and video games, regardless of physical activity (33). One of the mechanisms considered is that excessive time in front of a screen is associated with sedentary behavior, consumption of food with high energy density, and fewer fruits and vegetables (34). In the present study, students with MS reported fewer days of physical activity.

Multiple logistic regression analysis showed that poor sleep quality, overweight/obesity, and male sex explain the presence of MS in 48 %. At a young age in other populations, also a trend of male sex has been reported associated with this syndrome, in a study of 80 adolescents, the prevalence of MS was 13.6 %, and 66.7 % of them were males. Although no statistical difference was found; the authors consider it was secondary to the small sample size (35). Also, it has been reported that shortening the duration of sleep in 6 or fewer hours is significantly associated with the presence of MS, type 2 DM, and comorbidities such as arterial hypertension, coronary heart disease, and increased mortality (36). Specifically, the risk for developing type 2 diabetes mellitus could increase 2 % for each year that people report insufficient sleep (37) or in case of subjects with insomnia and reduction in sleep duration (≤ 6h per night), have almost 3 times more risk (OR 2.95, 95 % CI 1.2-7.0) to develop type 2 DM (38). Sleep and the circadian cycle modulate the metabolic function and daily energy expenditure through the regulation of hormones involved in energy metabolism such as leptin, ghrelin, insulin, glucocorticoids, etc. (39). Leptin is the satiety hormone and ghrelin is the hormone that stimulates appetite. During sleep restriction, there is less leptin release and increased ghrelin, leading to increased hunger and appetite, which specifically induces higher consumption of foods with high carbohydrate density (6). Also, in experimental studies with healthy participants, sleep restriction was associated with an increase in IL-6, tumor necrosis factor-alpha (TNF alpha), and cortisol, which may partially explain insulin resistance, a crucial factor in the development of MS (40).

In the present study, MS was identified in 16.1 % of the students with alterations in the quality and quantity of sleep compared to 8.3 % in the group without sleep problems. The higher score in the adverse perception of sleep quality increased the probability of MS. Shortening in sleep duration is significantly associated with waist circumference and the presence of metabolic syndrome, each hour of sleep reduction corresponds to an increase of 0.06 in the odds ratio for having metabolic syndrome (36). Also, the reduction in the period of slow waves of sleep and alterations in REM sleep have been associated with changes in the secretion of cortisol and growth hormone affecting insulin sensitivity and favoring weight gain (41). In young students in whom the significant use of electronic devices motivated by academic, professional, and entertainment demands, makes them more vulnerable to presenting poor quality and shortened sleep time (42). Therefore, it is conceivable that seeking environments before and during the sleeping period, how to avoid noise and light, improve the quality and quantity of sleep, one of the risk factors for diabetes that can be treated from an early age can be modified.

In the sample studied, multivariate analysis showed that overweight and obesity was the factor that most increased the probability of MS, also, abdominal obesity was the component most frequently observed in students with metabolic syndrome. Central fat accumulation is associated with the development of insulin resistance and increases the risk of MS (43).

In the present study, a higher frequency of MS was identified in men, as previously reported in the population under 50 years of age, mainly associated with hyperandrogenism, hyperinsulinemia, insulin resistance, abdominal obesity, and some social factors such as economic and educational level (44).

The current results are the product of a cross-sectional survey, which does not allow supporting causality between the quantity and quality of sleep or the use of mobile phones with the metabolic conditions of the young people studied. We consider it is necessary to carry out future longitudinal studies with a bigger sample size adjusting the differentiated use of the mobile phone to variables such as different periods of the school year and parameters such as anxiety, depression, or even other addictive behaviors, etc. Also, to evaluate the effect of formal programs of mobile use in students of different academic degrees on their academic performance and the maladaptive pattern of their use.

CONCLUSIONS

Regular inappropriate mobile use is associated with poor quality and chronic reduction of sleep. Poor sleep quality, male sex, and being overweight/obese increase the probability of developing metabolic syndrome in college students. Physical health such as MS stands to be affected by poor sleep quality and chronic reduction of sleep must thus awareness that practice of sleep hygiene is essential in budding future competent professionals. It is thus important to create educational programs focus on sleep health and to increase awareness regarding the disadvantage and benefits of controlled mobile phone usage.

REFERENCES

1. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 2006;3(11):e442.
2. Romero-Martínez M, Shamah-Levy T, Vielma-Orozco E, Heredia-Hernández O, Mojica Cuevas J, Cuevas-Nasu L, et al. Encuesta Nacional de Salud y Nutrición (Ensanut 2018): metodología y perspectivas [National Health and Nutrition Survey 2018-19: methodology and perspectives]. Salud Pública Méx. 2019;61(6):917-923.
3. Villalobos-Rodríguez I. Prevención del síndrome metabólico en adolescentes. Gac Méd Caracas. 2009;117(2):145-150.
4. Luna-Ruiz MA, Rangel-Vázquez D, Guízar-Mendoza JM, Amador-Licona N. Modificación de factores de riesgo para desarrollar diabetes mellitus tipo 2 en escolares obesos. Rev Méd IMSS. 2007;45(1):53-62.
5. Swanson LM, Arnedt JT, Rosekind MR, Belenky G, Balkin TJ, Drake C. Sleep disorders and work performance: findings from the 2008 National Sleep Foundation Sleep in America poll. J Sleep Res. 2011;20(3):487-494.
6. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. PLoS Med. 2004;1(3):e62.
7. Xi B, He D, Zhang M, Xue J, Zhou D. Short sleep duration predicts risk of metabolic syndrome: A systematic review and meta-analysis. Sleep Med Rev. 2014;18(4):293-297.
8. Jeong SH, Kim H, Yum JY, Hwang Y. What type of content are smartphone users addicted to?: SNS vs. games. Computers in Human Behavior. 2016;54:10-17.
9. Gogtay N, Giedd JN, Lusk L, Hayashi KM, Greenstein D, Vaituzis AC, et al. Dynamic mapping of human cortical development during childhood

through early adulthood. Proc Natl Acad Sci U S A. 2004;101(21):8174-8179.

10. Jenaro C, Flores N, Gómez-Vela M, González-Gil F, Caballo C. Problematic internet and cell-phone use: Psychological, behavioral, and health correlates. Addict Res Theory. 2007;15(3):309-320.
11. Punamäki RL, Wallenius M, Nygård CH, Saarni L, Rimpelä A. Use of information and communication technology (ICT) and perceived health in adolescence: The role of sleeping habits and waking-time tiredness. J Adolesc. 2007;30(4):569-585.
12. Sahin S, Ozdemir K, Unsal A, Temiz N. Evaluation of mobile phone addiction level and sleep quality in university students. Pak J Med Sci. 2013;29 4):913-918.
13. Demirci K, Akgönül M, Akpinar A. Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. J Behav Addict. 2015;4(2):85-92.
14. Dash S, Ganesh-Kamath M, Sharma KAP, Hui LW, Ponusamy TAL, Pathmaseelan K, et al. Problematic Mobile Phone Use Among Undergraduate Medical Students and Its Impact on Sleep Quality and Sleep Pattern. Mal J Med Health Sci. 2020;16 (4):132-137.
15. Beranuy Fargues M, Chamarro Lusar A, Graner Jordania C, Carbonell Sánchez X. Validación de dos escalas breves para evaluar la adicción a Internet y el abuso de móvil [Validation of two brief scales for Internet addiction and mobile phone problem use]. Psicothema. 2009;21(3):480-485.
16. de la Vega R, Tomé-Pires C, Solé E, Racine M, Castarlenas E, Jensen MP, et al. The Pittsburgh Sleep Quality Index: Validity and factor structure in young people. Psychol Assess. 2015;27(4):e22- e27.
17. Dewald JF, Short MA, Gradisar M, Oort FJ, Meijer AM. The Chronic Sleep Reduction Questionnaire (CSRQ): A cross-cultural comparison and validation in Dutch and Australian adolescents. J Sleep Res. 2012;21(5):584-594.
18. Alberti KG, Zimmet P, Shaw J, IDF Epidemiology Task Force Consensus Group. The metabolic syndrome-a new worldwide definition. Lancet. 2005;366(9491):1059-1062.
19. Calvete E, Cardeñoso O. Gender differences in cognitive vulnerability to depression and behavior problems in adolescents. J Abnorm Child Psychol. 2005;33(2):179-192.
20. Bangasser DA, Valentino RJ. Sex differences in stress-related psychiatric disorders: Neurobiological perspectives. Front Neuroendocrinol. 2014;35(3):303-319.
21. Hammerslag LR, Gulley JM. Sex differences in behavior and neural development and their role in adolescent vulnerability to substance use. Behav Brain Res. 2016;298(Pt A):15-26.
22. Ernst M, Romeo RD, Andersen SL. Neurobiology of the development of motivated behaviors in adolescence: A window into a neural systems model. Pharmacol Biochem Behav. 2009;93(3):199-211.
23. Zhang X, Liang M, Qin W, Wan B, Yu C, Ming D. Gender differences are encoded differently in the structure and function of the human brain revealed by multimodal MRI. Front Hum Neurosci. 2020;14:244.
24. Oviedo-Trespalacios O, Nandavar S, Newton JDA, Demant D, Phillips JG. Problematic use of mobile phones in Australia Is It Getting Worse? Front Psychiatry. 2019;10:105.
25. Ralls FM, Grigg-Damberger M. Roles of gender, age, race/ethnicity, and residential socioeconomics in obstructive sleep apnea syndromes. Curr Opin Pulm Med. 2012;18(6):568-573.
26. Pengo MF, Won CH, Bourjeily G. Sleep in women across the life span. Chest. 2018;154(1):196-206.
27. Becker SP, Jarrett MA, Luebbe AM, Garner AA, Burns GL, Kofler MJ. Sleep in a large, multi-university sample of college students: Sleep problem prevalence, sex differences, and mental health correlate. Sleep Health. 2018;4(2):174-181.
28. Lewczuk B, Redlarski G, Zak A, Ziółkowska N, Przybylska-Gornowicz B, Krawczuk M. Influence of electric, magnetic, and electromagnetic fields on the circadian system: current stage of knowledge. Biomed Res Int. 2014:169459.
29. Chandra MF, Kartika A, Hendra WM, Putri ZI, Puteri ES, Armazura DK, et al. The effect of duration of mobile phone usage with sleep quality in adolescents: A Systematic Review. Int J Res Review. 2019;6(12):390-396.
30. Lissak G. Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. Environ Res. 2018;164:149-157.
31. Kang Y, Liu S, Yang L, Xu B, Lin L, Xie L, et al. Testing the bidirectional associations of mobile phone addiction behaviors with mental distress, sleep disturbances and sleep patterns: A One-Year Prospective Study Among Chinese College Students. Front Psychiatry. 2020;11:634.
32. Huang TT, Kempf AM, Strother ML, Li C, Lee RE, Harris KJ, et al. Overweight and components of the metabolic syndrome in college students. Diabetes Care. 2004;27(12):3000-3001.
33. Mark AE, Janssen I. Relationship between screen time and metabolic syndrome in adolescents. J Public Health (Oxf). 2008;30(2):153-160.
34. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L. Television viewing behaviour and associations with food habits in different countries. Public Health Nutr.

2006;9(2):244-250.

35. Lozada M, Machado S, Manrique M, Martinez D, Suarez O, Guevara H. Factores de riesgo asociados al sindrome metabólico en adolescentes. Gac Méd Caracas. 2008;116(4):323-329.
36. Iftikhar IH, Donley MA, Mindel J, Pleister A, Soriano S, Magalang UJ. Sleep Duration and Metabolic Syndrome. An Updated Dose-Risk Metaanalysis. Ann Am Thorac Soc. 2015;12(9):1364-1372.
37. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. Sleep. 2010;33(5):585-592.
38. Vgontzas AN, Liao D, Pejovic S, Calhoun S, Karataraki M, Bixler EO. Insomnia with objective short sleep duration is associated with type 2 diabetes: A population-based study. Diabetes Care. 2009;32(11):1980-1985.
39. Van Cauter E, Polonsky KS, Scheen AJ. Roles of circadian rhythmicity and sleep in human glucose regulation. Endocr Rev. 1997;18(5):716-738.
40. Vgontzas AN, Zoumakis E, Bixler EO, Lin HM, Follett H, Kales A, et al. Adverse effects of modest sleep restriction on sleepiness, performance, and inflammatory cytokines. J Clin Endocrinol Metab. 2004;89(5):2119-2126.
41. Fatima Y, Doi SA, Mamun AA. Sleep quality and obesity in young subjects: a meta-analysis. Obes Rev. 2016;17(11):1154-1166.
42. Leger D, Beck F, Richard JB, Godeau E. Total sleep time severely drops during adolescence. PLoS One. 2012;7(10):1-6.
43. Engin A. The Definition and Prevalence of Obesity and Metabolic Syndrome. Adv Exp Med Biol. 2017;960:1-17.
44. Pucci G, Alcidi R, Tap L, Battista F, Mattace-Raso F, Schillaci G. Sex- and gender-related prevalence, cardiovascular risk and therapeutic approach in metabolic syndrome: A review of the literature. Pharmacol Res. 2017;120:34-42.