Nutr Hosp. 2017; 34(2):357-362 ISSN 0212-1611 - CODEN NUHOEQ S.V.R. 318

Nutrición Hospitalaria

Trabajo Original

Obesidad y síndrome metabólico

Abdominal obesity is strongly associated to blood pressure in young Mexicans

La obesidad abdominal está fuertemente asociada a hipertensión arterial en jóvenes mexicanos

Rene Urquidez-Romero[1], Miguel Murguía-Romero[2,3], Julián Esparza-Romero[4], Beatriz A. Díaz-Torres[1], Alejandra Rodríguez-Tadeo[1], Gabriel Medrano-Donlucas[1], Arnulfo Ramos-Jiménez[1], Abraham Wall-Medrano[1], Itzell A. Gallardo-Ortiz[2], Diana C. Tapia-Pancardo[2], A. René Méndez-Cruz[2,3], J. Rafael Jiménez-Flores[2,3] and Rafael Villalobos-Molina[2,3]

[1]Instituto de Ciencias Biomédicas. Departamento de Ciencias de la Salud. Universidad Autónoma de Ciudad Juárez. Ciudad Juárez, Chihuahua. México. [2]Facultad de Estudios Superiores Iztacala. Tlalnepantla, México. [3]Laboratorio Nacional en Salud: Diagnóstico Molecular y Efecto Ambiental en Enfermedades Crónico-Degenerativas. Universidad Nacional Autónoma de México. Tlalnepantla, México. [4]Unidad de Investigación en Diabetes. Departamento de Nutrición Pública y Salud. Centro de Investigación en Alimentación y Desarrollo, A.C. (CIAD, A. C.). Hermosillo, Sonora. México

Abstract

Objective: The objective of this study was to determine associations between abdominal obesity (AOb) and the other components of metabolic syndrome (MetS) in young Mexicans in a cross-sectional survey completed during a 4 year period.

Methods: This cross-sectional study reports on components and prevalence of MetS by using Alberti et al. (16) criteria, as well as association between AOb and elevated blood pressure (BP) of 2,993 Mexican university students, ages 17 to 25 years (66% women) from central and northern Mexico, over a 4-year survey (2010-2013).

Results: The most prevalent MetS components in the total sample were low HDL-C concentration (43.6%) and AOb (41.1%). MetS prevalence was 11.8%, more men than women were classified with MetS (14.3% *vs.* 10.5%, $p < 0.01$). BP was the MetS component with the lowest prevalence (8.6%). A strong association between AOb and altered BP with in both men and women was found (OR 4.3, IC95% 2.5-7.4).

Conclusions: Even BP was the component with the lowest prevalence, AOb was more strongly associated with it. This fact, could explain the prevalence of hypertension among young Mexican adults.

Key words:

Abdominal obesity.
Blood pressure.
Young adults.

Resumen

Objetivo: el objetivo de este estudio fue determinar la asociación entre la obesidad abdominal (OAb) y los otros componentes del síndrome metabólico (SMet) en jóvenes mexicanos a través de una encuesta transversal completada durante un período de 4 años.

Métodos: este estudio transversal informa sobre los componentes y la prevalencia del SMet usando los criterios de Alberti y cols. (16), así como la asociación entre OAb y la presión arterial (PA) elevada de 2.993 estudiantes universitarios mexicanos, con edades de 17 a 25 años (66% mujeres), procedentes del centro y norte de México, a través de una encuesta de 4 años (2010-2013).

Resultados: los componentes del SMet de mayor prevalencia en la muestra total fueron baja concentración de HDL-C (43,6%) y OAb (41,1%). La prevalencia de SMet fue del 11,8%, mayor en hombres que en mujeres (14,3% *vs.* 10,5%; $p < 0,01$). La PA elevada fue el componente del SMet con la prevalencia más baja (8,6%). Se encontró una fuerte asociación entre OAb y PA elevada, tanto en hombres como en mujeres (OR 4,3; IC 95% 2,5 a 7,4).

Conclusiones: a pesar de que la PA elevada fue el componente con menor prevalencia, la OAb estuvo más fuertemente asociada con esta, hecho que podría explicar la prevalencia de hipertensión entre los adultos jóvenes mexicanos.

Palabras clave:

Obesidad abdominal.
Presión arterial.
Adultos jóvenes.

Received: 01/06/2016
Accepted: 19/09/2016

Urquidez-Romero R, Murguía-Romero M, Esparza-Romero J, Díaz-Torres BA, Rodríguez-Tadeo A, Medrano-Donlucas G, Ramos-Jiménez A, Wall-Medrano A, Gallardo-Ortiz IA, Tapia-Pancardo DC, Méndez-Cruz AR, Jiménez-Flores JR, Villalobos-Molina R. Abdominal obesity is strongly associated to blood pressure in young Mexicans. Nutr Hosp 2017;34:357-362

DOI: http://dx.doi.org/10.20960/nh.171

Correspondence:

René Urquidez-Romero. Instituto de Ciencias Biomédicas. Universidad Autónoma de Ciudad Juárez. Av. Plutarco Elías Calles, 1210. Fovissste Chamizal, Juárez. Chihuahua. México
e-mail: rurquide@uacj.mx

INTRODUCTION

Metabolic syndrome (MetS) is a clustering of symptoms associated with obesity that include abdominal obesity (AOb), increased blood pressure (BP), altered glucose metabolism, and dyslipidaemia. This syndrome strongly predicts the future development of both cardiovascular disease (CVD) and diabetes (1,2).

The MetS and its individual components have been widely studied in adults (3-5), as well as in younger ages (6,7); however, association between AOb measured by waist circumference and elevated BP, has not been examined comprehensively in young university students of Mexico. Our group estimated a national wide prevalence of MetS of 15.8% in young people from Mexico (7). In this regard, young adults entering university are making their own lifestyle behaviors that could impact in their health, even in short-term (8,9). This conversion into adulthood is a good opportunity to adopt healthy lifestyle, since dietary intake and lack of physical activity can affect all MetS components. If poor lifestyle habits are adopted during this stage, young adults will likely carry them through adulthood and progress to negatively impact the individual's health status (9).

Screening young adults, especially first-year university students, regarding MetS components and related risk factors is vital to decrease the risk of future chronic diseases development. First-year university students experience faster weight gain than the average adult, up to 11 times faster (10,11).

In 2012 reports of the Mexican National Health and Nutrition Survey in young adults (20-29 y) found a prevalence of AOb of 53.3% (12), which could represent a high degree of physical inactivity. In relation to diet, a study in college students from northern Mexico reported only 13.2% of fruits and 15.6% of vegetables daily consumption (13). In addition, in 2008 the overall prevalence of risk factors for eating behaviour disorders in a Mexican university of the US-Mexico border was higher in women (8.5%) than men (3.3%) (14). Given these high rates of overweight/obesity and poor diet, young adult populations may be at risk, which is relevant to consider since an increase in body weight augments the probability of developing MetS, and consequently CVD and type 2 diabetes. Thus, risk identification early in life may support healthier and better choices, based upon personalized information during an age when lifestyle changes may be transformed into lifelong behaviours (15).

The present research includes a detailed investigation of first-year students from three universities located in central and northern Mexico.

As it is known that abdominal obesity prevalence in young Mexicans is high (53.3%) (12), and may indicate the beginning of metabolic alterations in young, the objective of this study was to determine the relative association between AOb and the other components of MetS, and the next most probable altered components given that AOb is one of the first metabolic alterations in young.

METHODS

DESIGN AND POPULATION

The study sample consisted of first-year Mexican university students, ages 17 to 25 years. Data were obtained by the Multidisciplinary Group to Investigate Health and Academic Performance (GMISARA), from Facultad de Estudios Superiores Iztacala, Universidad Nacional Autonoma de México (UNAM), Universidad Autonoma de la Ciudad de México (UACM), and Healthy University Program (Medical Services) from Universidad Autonoma de Ciudad Juárez (UACJ). This cross-sectional, observational study reports on MetS prevalence, and relative associations of AOb and the other MetS components of 2.993 (66% women) university students from central (n = 2,387, UNAM and n = 271, UACM from Mexico City) and northern (n = 335, UACJ from Ciudad Juárez, Chihuahua) México, over a 4-year survey (2010-2013). All first year students were invited to participate in the 'Healthy University' program, so that no inclusion neither exclusion criteria were adopted since before the study; participants were voluntary and none of the students reported any illness, and no metabolic disorders were diagnosed by a physician.

In the four surveys conducted at the 3 universities (2010, 2011, 2012 and 2013), trained personnel (physicians, biochemists and anthropometrists) conducted the interviews to assure reliable demographic, socioeconomic, and health related data. After explaining the nature, objectives and risks inherent to the study, all subjects signed an informed consent (when the student was 17 years old, authorization of his (her) parent was obtained). The protocol was approved by the Facultad de Estudios Superiores Iztacala UNAM, and UACJ ethics committees (5).

BIOCHEMISTRY

Healthy University Medical Services (UACJ) and Grupo Diagnóstico Médico PROA, S.A. de C.V. (UNAM/UACM), internationally accredited laboratories, were responsible for sample collection, biochemical analysis and laboratory data handling. Students came to laboratory facilities, either to the UACJ, UNAM or UACM, between 7-10 AM after overnight fasting. Plasma glucose (GLU), triacylglycerol (TAG), and HDL-cholesterol (HDL-C) were assayed by automatized enzymatic-colorimetric methods.

BLOOD PRESSURE AND ANTHROPOMETRICS

BP and anthropometric techniques have been described elsewhere (5). In brief, diastolic and systolic BP values were obtained twice, *i.e.,* after resting quietly in a sitting position for 5 min and determination of the maximum inflation level, then BP readings were obtained with a standard aneroid sphygmomanometer (Model DS44, Welch Allyn).

Anthropometric data were obtained following the Official Mexican Norm (NOM-008-SSA3-2010, Mexican Ministry of Health). All measurements were performed by trained study staff and were obtained using standard procedures: height and waist circumference (WC) were recorded to the nearest 0.1 cm using a wall stadiometer (Seca mod. 208, Mexico City), and a flexible anthropotape (Rosscraft, USA). Body weight was recorded to the nearest 0.1 kg using a digital scale (Seca 700). Body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters. Subjects were classified as obese if BMI was ≥ 30 kg/m^2 and overweight if BMI was ≥ 25 and < 30 kg/m^2. Waist circumference was measured in supine position at the level of the umbilicus. Hip circumference was measured in standing position at the level of the greater trochanters.

METABOLIC SYNDROME CLASSIFICATION

The updated Alberti et al. (16) criteria were used to determine MetS prevalence. The criteria included increased abdominal fat measured by WC (≥ 80 cm for women and ≥ 90 cm for men), elevated TAG (≥ 150 mg/dL), low HDL-C (< 40 mg/dL for men and < 50 mg/dL for women), elevated fasting glucose (≥ 100 mg/dL), and hypertension (≥ 130 mmHg systolic blood pressure [SBP] or ≥ 85 mmHg diastolic blood pressure [DBP]). Subjects bearing 3 or more of the components were classified with MetS (16).

STATISTICAL ANALYSIS

Descriptive data are presented as mean ± SD and percentages. Differences in physical and biochemical characteristics between men and women students were tested by independent Student's *t* test. Fisher's exact Chi-square tests were used to analyse the prevalence of MetS in the total sample by gender and the number of MetS components present by gender. Univariate analysis by using logistic regression was employed to explain association between AOb and MetS components. Data were considered significant when $p < 0.05$. All analyses were performed using STATA software (version 11.0; Stata Corp, College Station, TX, USA).

RESULTS

Table I shows total and gender differences in anthropometric, clinical and biochemical measures. Approximately 66% of the sample were women. The mean age and BMI of the study population were 19 years and 24.0 kg/m^2, respectively. Average BMI was in the normal range; however 1,059 subjects (35.6%) were either overweight or obese. Comparison by sex showed that men had a significantly greater mean BMI than women (24.3 *vs.* 23.9 kg/m^2, $p \leq 0.01$). Men also had a significantly greater mean elevated BP, elevated TAG, low HDL-C, and elevated GLU.

Table I. Anthropometric, clinical and biochemical characteristics of subjects by sex

Variables	All	Women	Men
	2,993	1,979	1,041
Age (years old)	19.0 ± 1.7	18.9 ± 1.7	19.1 ± 1.8
Weight (kg)	63.7 ± 14.5	59.8 ± 12.3	71.2 ± 15.3
Height (cm)	162.4 ± 8.5	158.1 ± 5.9	170.8 ± 6.4
BMI (kg/m^2)	24.0 ± 4.6	23.9 ± 4.5	24.3 ± 4.7
Waist circumference (cm)	81.3 ± 11.5	79.7 ± 10.8	84.5 ± 12.2
Systolic blood pressure (mmHg)	106.9 ± 12	103.4 ± 10.4	113.7 ± 12.1
Diastolic blood pressure (mmHg)	71.8 ± 8.9	69.8 ± 8.1	75.7 ± 9.1
HDL-cholesterol (mg/dL)	48.1 ± 10.1	49.8 ± 10.1	44.9 ± 9.3
Triacylglycerol (mg/dL)	107.6 ± 58.1	102.2 ± 50.2	118.2 ± 69.8
Glucose (mg/dL)	88.8 ± 9.1	88.2 ± 8.6	8.9 ± 9.8
HOMA-IR	2.3 ± 1.5	2.4 ± 1.6	2.1 ± 1.4
Insulin (mg/dL)	10.4 ± 6.7	10.9 ± 6.9	9.2 ± 6.2
BMI class (%)			
Underweight or normal weight	64.4%	65.6%	62.1%
Overweight	24.9%	25.3%	24.1%
Obese	10.7%	9.1%	13.8%

Differences between averages of women and men were statistically significant ($p \leq 0.01$) for all variables.

METABOLIC SYNDROME PREVALENCE

The overall MetS prevalence was 11.8%. We observed more men than women classified with MetS (14.3% *vs.* 10.5%, respectively, $p < 0.01$). A total of 68.6% of the sample had at least one component for MetS. Although MetS prevalence is higher in men than in women, the percentage of healthy subjects (with none MetS component) is also higher in men than in women (40.7% *vs.* 26.7%, respectively, $p \leq 0.01$; Table II). The most prevalent MetS components in the total sample were low HDL-C concentration (43.6%) and AOb (41.1%). A greater proportion of women had low HDL-C concentration (51.5% *vs.* 28.1%, $p \leq 0.01$), and higher proportion of AOb (47.1% *vs.* 29.3%, $p \leq 0.01$).

Although the percentage of men with elevated TAG concentrations was significantly larger than in women ($p \leq 0.01$), the same was observed with elevated fasting glucose (13.8% *vs.* 8.3%, $p \leq 0.01$) and elevated BP (17.5% *vs.* 4.0%, $p \leq 0.01$).

Table II. Prevalence of individual components of MetS among subjects by sex

MetS component	All	Women	Men
*Low HDL-cholesterol (%)	43.6	51.5	28.1
*Abdominal obesity (%)	41.1	47.1	29.3
*Elevated triacylglycerol (%)	15.7	12.7	21.4
*Elevated fasting glucose (%)	10.2	8.3	13.8
*Elevated blood pressure (%)	8.6	4.0	17.5
*Elevated systolic blood pressure (%)	4.8	1.5	11.2
*Elevated diastolic blood pressure (%)	6.3	3.4	11.9
No. of MetS components			
*None (%)	31.4	26.7	40.7
*1 (%)	33.3	35.9	28.3
*2 (%)	23.4	26.9	16.7
*3 or more (%) (MetS prevalence)	11.8	10.5	14.3

$p < 0.001$ when comparing women and men using χ^2 test.

ABDOMINAL OBESITY ASSOCIATIONS WITH METS COMPONENTS

The magnitude of associations between AOb and the other MetS components in men and women was explored. In both, men and women AOb was significantly associated with all of the MetS components ($p \leq 0.01$); the observed association followed the magnitude order BP > TAG > HDL-C > GLU ($p \leq 0.01$) (Table III).

When examining MetS components by AOb in both men and women, we observed significant greater mean values in SBP and DBP in obese men than in non-obese (120.2 *vs.* 111.0 mm/Hg, $p \leq 0.01$ and 79.9 *vs.* 74.0 mm/Hg, $p \leq 0.01$, respectively). As expected, a lower mean value in HDL-C concentration was found in obese men when compared with non-obese (40.7 *vs.* 46.6 mg dL, $p \leq 0.01$). Mean values for glucose were grater in obese than in non-obese (92.2 *vs.* 89.0 mg/dL, $p \leq 0.01$), as well as TAG (158.7 *vs.* 101.4 mg/dL, $p \leq 0.01$) (Table IV).

The same was observed in women, SBP and DBP mean values were significantly greater in obese compared to those in non-obese (106.3 *vs.* 100.8 mm/Hg, $p \leq 0.01$ and 72.2 *vs.* 67.8 mm Hg, $p \leq 0.01$, respectively). With respect to HDL-C, lower value was observed in obese (47.4 mg/dL) than in non-obese (52.0 mg/dL, $p \leq 0.01$). Regarding glucose concentration we found significantly lower values in non-obese (87.5 mg/dL) than in obese (88.9 mg/dL, $p \leq 0.01$). Even TAG concentration was considered normal in both, obese and non-obese, these values were higher in obese.

DISCUSSION

The main findings from this study is that a great number of Mexican university students presented unhealthy HDL-C levels and AOb, and a relatively high association of AOb with elevated BP, which could be at risk for developing chronic diseases, including type 2 diabetes and CVD (1,2,8,9). On the other hand, men have higher prevalence of MetS than women; however, the percentage of healthy men (with no MetS components) is also higher in men than in women.

According to the National Health and Nutrition Survey (ENSANUT 2012), the prevalence of overweight and obesity was 71.3%

Table III. Relative associations of AOb with MetS components in men and women

MetS Component	Women			Men		
	AOb (%)	No-AOb (%)	OR (IC 95%)	AOb (%)	No-AOb (%)	OR (IC 95%)
Elevated BP	78.5	21.5	4.3 (2.5-7.4)	62.2	37.9	5.7 (4.0-8.1)
Elevated TAG	69.1	31.0	2.9 (2.1-3.8)	57.1	42.9	4.8 (3.5-6.6)
Low HDL-C	56.2	43.8	2.2 (1.8-2.6)	47.4	52.6	3.2 (2.4-4.2)
Elevated GLU	54.6	45.5	1.4 (1.0-1.9)	43.6	56.4	2.1 (1.4-3.0)

AOb: abdominal obesity; BP: blood pressure; TAG: triacylglycerol; HDL-C: HDL-cholesterol; GLU: glucose. All odd ratios (OR) values were statistically significant ($p < 0.01$).

Table IV. Averages of individual components of MetS by AOb in women and men

	Women		Men	
	Obese	**Non-obese**	**Obese**	**Non-obese**
n (subjects)	932	1,047	297	717
Systolic blood pressure (mmHg)	106.3 ± 10.3	100.8 ± 9.7	120.2 ± 11.9	111.0 ± 11.1
Diastolic blood pressure (mmHg)	72.2 ± 8.1	67.8 ± 7.6	79.9 ± 9.5	74.0 ± 8.3
Triacylglycerol (mg/dL)	114.6 ± 59.4	91.2 ± 36.9	158.7 ± 84.9	101.4 ± 54.3
HDL-cholesterol (mg/dL)	47.4 ± 9.7	52.0 ± 10.0	40.7 ± 8.8	46.6 ± 8.9
Glucose (mg/dL)	88.9 ± 8.4	87.5 ± 8.8	92.2 ± 10.0	89.0 ± 9.5

Data (mean ± SD) analyzed using independent samples t test to determine differences by sex. All parameters show differences ($p < 0.01$) between abdominal obese and non-obese, in women and men.

(overweight 38.8% and obesity 32.4%) in Mexican adults, and the prevalence of abdominal adiposity was 74.0%, being higher in women (82.8%) than in men (64.5%) (12). In our study, the prevalence of overweight and obesity in young adults was 35.6%, being slightly higher in men. Total prevalence of AOb in this sample was lower compared with that found in a nationwide Mexican young adults 20-29 y (41.1% *vs.* 53.3%, respectively) (12), which is alarming since these elements are closely related to the MetS. Assuming the MetS as a multifactorial process, it is a progress between "healthy" and "not healthy" status, early events of that process might predict progression to future chronic disease (17). Screening and identifying young adults, especially men, with conditions such as AOb, dyslipidaemia and the MetS are crucial steps in establishing effective educational and intervention strategies to reduce the incidence and burden of chronic diseases.

MetS prevalence was higher in men than in women, but the percentage of healthy men (with no MetS components) is higher than healthy women, similar to what has been reported (18).

From the five MetS components, three of them, TAG, fasting GLU and BP, showed a higher prevalence in men than in women; while two, HDL-C and WC, showed higher prevalence in women when compared with men. Abdominal obesity and low HDL-C were 1.6 and 1.8 times higher, respectively, in females. Our results suggest that dyslipidemia presence in women is favored by the central body fat distribution.

In our study, MetS prevalence was 11.8% using criteria from Alberti et al. (16) (14.3% in men and 10.5% in women), these values are higher than those found in college students from Latin America countries, including Ecuador, Chile and Argentina where the reported prevalence was 7.5%, 4.9% and 4.1%, respectively (19-21). The prevalence of MetS in our study is higher, even compared with that found in college students from developed countries like United States where MetS was identified in 10% of men and 3% of women (22), and 4.7% (men) 1.6% (women) in first-year college students between 18 and 24 years (23).

It is worth to mention that the prevalence of abdominal obesity in young adults of Mexico was 53.3%, in Ecuador 43.2% and in Argentina 12%, using as reference the IDF criteria; while in Chile it was 6.0% using the ATPIII-2002 criteria. The difference in the prevalence of MetS between Mexico, Ecuador and Argentina, could be explained due to higher differences in the prevalence of abdominal obesity in the studied populations; whereas the differences with Chile are related to a lack of comparability because of the different diagnostic criteria used.

Mean values in all of the related components of the metabolic syndrome through AOb were significantly higher in obese young adults, compared to non-obese ($p \leq 0.01$). Among those students who are non-obese, only 1% has the MetS. A similar trend was observed by DuBose et al., in elementary school children, as well as other studies observed a higher prevalence for each component of the MetS (24,25).

It is important to notice that the chronological development of AOb increases the cardiovascular risk, which is at the core of metabolic syndrome. In young adults, moderate obesity generally is well tolerated; however, with advancing years, there is a common progressive weight gain, a gradual loss of muscle mass, stiffening of the arterial tree, decline in secretory capacity of pancreatic β-cells, mitochondrial dysfunction, and increased inflammatory changes in adipose tissue as well as other age-related alterations (22). The syndrome often culminates in type 2 diabetes in which risk for vascular disease is markedly raised (1).

With the purpose to establish future interventions aimed to reducing risk factors for MetS development, it is important to know the prevalence of its components. According to the results of this study, low HDL-C was the most frequent, followed by AOb. In 2012, our research group suggested that the binomium HDL/WC is the main prevalence factor and the main predictor of MetS occurrence, since low HDL-C is very frequent in this population (17). However, to increase the effectiveness of these interventions and as a goal of this report, we consider that is more important to know the degree of association of each of these elements on its development. In this study, AOb was selected as one of the most important components of the MetS due to its high prevalence, and other studies have shown that AOb is a factor of high importance for its development (19,26). The degree of association of AOb with the other components of MetS was established and we found that elevated BP was more strongly associated in both men and women. This finding is important because in our university population, high BP is the lowest frequent individual component of MetS, but the importance on its development could

be greater than biochemical components, including low HDL-C, despite being the most frequent component in this population.

Our results could be very important to public health authorities for the design and implementation of focused preventive policies to reduce MetS and CVD in college students.

As it is known, cross-sectional design limits causal inferences; however, this design allows researchers to obtain the current health status of the desired population at one point in time. Some studies define young adults as 18 to 24 (8,18), others from 20 to 39 (23), as in this study was from 17 to 25 years old, we think a single operational definition for young adults would be beneficial for future data comparisons. Our reported prevalence of MetS in students could not be generalized to all Mexican university students; even, our sample was derived from two universities from central (UNAM and UACM) and one from northern (UACJ) locations, more universities need to be sampled. Yet, to our knowledge no other study of this sample size has examined MetS in young Mexicans.

CONCLUSIONS

Central obesity and low HDL-C are the most prevalent components of MetS, while elevated BP shows the lowest prevalence. Nevertheless, the degree of association between AOb and the other components of MetS was established, and we found that elevated BP is more strongly associated in both men and women. This finding is important because in our Mexican university population, elevated BP is the lowest frequent individual component of MetS, but the importance on its development could be greater than biochemical components, including low HDL-C, the most frequent component in this population.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge to subjects of the study and the support of this study to Universidad Saludable Program at UACJ and Grupo Diagnóstico Médico PROA, S.A. de C.V. This study was funded by FESI-DIP-PAPCA-2014-53, and is part of the Collaboration agreement UACJ/AG/CV-22/2015 and Reg. No. UNAM: 41079-789-7-IV-15.

REFERENCES

1. Dragsbaek K, Neergaard JS, Laursen JM, et al. Metabolic syndrome and subsequent risk of type 2 diabetes and cardiovascular disease in elderly women: Challenging the current definition. Medicine 2016;95(36):e4806.
2. Gómez-Ambrosi J, Catalán V, Rodríguez A, et al. Increased cardiometabolic risk factors and inflammation in adipose tissue in obese subjects classified as metabolically healthy. Diabetes Care 2014;37:2813-21.
3. Salas R, Bibiloni MM, Ramos E, et al. Metabolic syndrome prevalence among northern Mexican adult population. PLoS ONE 2014;9(8):e105581.
4. Goodman D, Fraga MA, Brodine S, et al. Prevalence of diabetes and metabolic syndrome in a migrant Mixtec population, Baja California, Mexico. J Immigr Minor Health 2013;15:93-100.
5. Misra R, Misra A, Kamalamma N, et al. Difference in prevalence of diabetes, obesity, metabolic syndrome and associated cardiovascular risk factors in a rural area of Tamil Nadu and an urban area of Delhi. Int J Diabetes Dev Ctries 2011;31:82-90.
6. Villalobos-Molina R, Wall-Medrano A, Rodríguez-Tadeo A, et al. Hypertriglyceridemic-Waist (HTGW) phenotype in university students from two regions of México. Acta Med Mediterr 2015;31:173-7.
7. Murguía-Romero M, Jiménez-Flores R, Villalobos-Molina R, et al. Estimating the geographical distribution of the prevalence of the metabolic syndrome in young Mexicans. Geospat Health 2012;6:43-50.
8. Topè AM, Rogers PF. Metabolic syndrome among students attending a historically black college: prevalence and gender differences. Diabetol Metab Synd 2013;5(2):1-8.
9. Irazusta A, Hoyos I, Irazusta J, et al. Increased cardiovascular risk associated with poor nutritional habits in first-year university students. Nutr Res 2007;27:387-94.
10. Holm-Denoma JM, Joiner Jr TE, Vohs KD, et al. The "freshman fifteen" (the "freshman five" actually): predictors and possible explanations. Health Psychol 2008;27:S3-S9.
11. Levitsky DA, Halbmaier CA, Mrdjenovic G. The freshman weight gain: a model for the study of the epidemic of obesity. Int J Obes 2004;28:1435-42.
12. Barquera S, Campos-Nonato I, Hernández-Barrera L, et al. Prevalencia de obesidad en adultos mexicanos, ENSANUT 2012. Salud Publica Mex 2013;55(Suppl 2):S151-S160.
13. Rodríguez-Tadeo A, Urquidez R. Hábitos alimenticios poco saludables en estudiantes Universitarios Fronterizos. AVANCES 2007;147:1-13.
14. Rodríguez-Tadeo A, Urquidez-Romero R, Wall-Medrano A, et al. Trastornos de la conducta alimentaria (TCA) en población universitaria: hallazgos del programa universidad saludable. AVANCES 2008;226:1-16.
15. Freire de Freitas RW Jr, Moura de Araújo MF, Soares Lima AC, et al. Study of Lipid profile in a population of university students. Rev Latino-Am Enfermagem 2013;21(5):1151-8.
16. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009;120:1640-5.
17. Jiménez-Flores JR, Murguía-Romero M, Mendoza-Ramos MI, et al. Metabolic syndrome occurrence in university students from México City: The binomium HDL/waist circumference is the major prevalence factor. Open J Prev Med 2012;2:177.
18. Murguía-Romero M, Jiménez-Flores JR, Sigrist-Flores SC, et al. Use of the plasma concentration ratio of triglyceride/high-density lipoprotein cholesterol to identify cardio-metabolic risk in young men and women. J Lipid Res 2013;54:2795-9.
19. Ruano NC, Melo PJ, Mogrovejo FL, et al. Prevalence of metabolic syndrome and associated risk factors in ecuadorian university students. Nutr Hosp 2015;31(4):1574-81.
20. Martínez SM, Leiva OA, Sotomayor C, et al. Cardiovascular risk factors among university students. Rev Med Chile 2012;140:426-35.
21. Gotthelf SJ. Prevalencia de síndrome Metabólico según definición de la International Diabetes Federation (IDF) en adolescentes escolarizados de la provincia de Salta, Argentina. Rev Fed Arg Cardiol 2013;42:119-26.
22. Morrell JS, Lofgren IE, Burke JD, et al. Metabolic syndrome, obesity, and related risk factors among college men and women. J Am Coll Health 2012;60:82-9.
23. Fernández J, Lofgren IE. Prevalence of metabolic syndrome and individual criteria in college students. J Am Coll Health 2011;59:313-21.
24. Dubose KD, Stewart EE, Charbonneau SR, et al. Prevalence of the metabolic syndrome in elementary school children. Acta Paediatr 2006;95:1005-11.
25. Liu W, Lin R, Liu A, et al. Prevalence and association between obesity and metabolic syndrome among Chinese elementary school children: a school-based survey. BMC Public Health 2010;10:1471-2458.
26. Freire de Freitas RW Jr., Wagner R, de Araújo M, et al. Prevalence of the metabolic syndrome and its individual components in Brazilian college students. J Clin Nurs 2013;22:1291-8.