Articles

Evaluation of the nutritional condition of adolescents from a Mexican High School

Evaluación de la condición nutricional de los adolescentes de una escuela preparatoria mexicana

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Abstract: One of the main public health concerns worldwide is overweight and obesity resulting from disproportionate energy consumption compared to expenditure. This imbalance can lead to significant damage in the paediatric population (infants, children, and adolescents). The aim of this study was to anthropometrically assess the current health condition and the degree of overweight and obesity in adolescents between 14 and 17 years old from the General High School from the Superior School of Huejutla of the Universidad Autónoma del Estado de Hidalgo. The study was carried out in a sample of adolescents (N = 99), anthropometric measurements such as height, weight, waist and arm circumferences were measured and classified according to the World Health Organization's BMI tables, *such as* low weight (<5 percentile), normal weight (5 <95th percentile), overweight (85 <95th percentile) and obesity (> 95th percentile). Moreover, the systolic and diastolic blood pressures of each of the subjects in the sample were measured in triplicate. The results obtained were subdivided into low weight (6.6%) normal weight (71.71%), overweight (18.18%) and obesity (37.14%) according to the BMI. In this way, they were grouped according to percentiles in normal pressure (82.8%), prehypertension (12.12%) and hypertension (5.05%). According to the results, it is important to maintain the normal weight status in the subjects who participated in the study.

Keywords: Nutritional status, overweight, obesity, cardiovascular damage, metabolic syndrome, adolescents(teenagers).

Resumen: Actualmente, uno de los problemas principales de salud pública a nivel mundial es el sobrepeso y la obesidad; así mismo, este acontecimiento ha desarrollado importantes estragos en la población pediátrica (lactantes, niños y adolescentes), por lo tanto, se sabe que la causa es un desequilibrio energético entre las calorías consumidas y gastadas. El objetivo de este estudio fue evaluar antropométricamente la condición de salud actual y el grado de sobre peso y obesidad en sujetos adolescentes de entre 14 y 17 años de edad provenientes del Bachillerato General de la Escuela Superior de Huejutla, UAEH. El estudio se realizó en una muestra de adolescentes (N= 99), se tomaron mediciones antropométricas convencionales

como: estatura, peso, circunferencia de abdomen, circunferencia de brazo. Se utilizó la medida en percentiles de acuerdo al IMC de Organización Mundial de la Salud como: bajo peso (<5 percentil), normo peso (5 <percentil 95), sobrepeso (85 <percentil 95) y obesidad (> percentil 95). Además, se midió por triplicado la tensión arterial sistólica y diastólica de cada uno de los sujetos de la muestra. Los resultados obtenidos, se subdividieron en bajo peso (6.6 %) normopeso (71.71 %), sobrepeso (18.18 %) y obesidad (37.14 %) según el IMC. De esta manera se agruparon según percentiles en: presión normal (4.4 %), prehipertensión (12.12 %) e hipertensión (5.05 %). De acuerdo a esto, es importante conservar el estado de normopeso en los sujetos que participaron en el estudio..

Palabras clave: Estado nutricional, sobrepeso, obesidad, daño cardiovascular, síndrome metabólico, adolescentes.

INTRODUCTION

Today, in Mexico, it is estimated that the child population occupies the fourth place of global prevalence in obesity .[1] This is approximately 28.1% in males and 29% in females, surpassed by Greece, the United States, and Italy. The joint national prevalence of overweight and obesity in children aged 5 to 11, based on the criteria of the International Obesity Task Force (IOTF) was approximately 26% for both sexes, 26.8% for females and 25.9% for males, representing 4,158,800 schoolchildren who are overweight or obese. It is estimated that, in the adolescent population, one in three males or females are overweight or obese, which represents about 5,757,400 adolescents in the country .[2] It is important that the growth in infantile obesity and the prevalence of overweight and obesity is recognized during the basic (primary) level because when children enter this level (six years of age), the average prevalence of overweight and obesity is 24.3%. However, at 12 years of age, when they are completing primary school, the prevalence increases to 32.5%, reflecting an increase of 12.2 percentage points [3].

Obesity is a chronic multifactorial disease characterized by increased body fat, it is linked to cardiovascular and metabolic conditions, and has become a notable public health problem since the prevalence of obesity and overweight has increased exponentially in recent decades. Generally, this disease carries important comorbidities, such as high blood pressure, dyslipidaemias, chronic obstructive pulmonary disease (COPD), heart disease, cancer, stress, and anxiety [4]. Excess body weight (fat gain) has been associated with increased aortic stiffness, in addition, the early age at which it appears and the frequency of obesity predict a substantial increase in the incidence of cardiovascular diseases with age [5]. The WHO (World Health Organization) has provided a classification for children and adolescents for Body Mass Index (BMI), using percentile and punctuation Z-score (Table 1), as well as the blood pressure categorization (Table 2) [6].

TABLE 1.
Classification of BMI Characteristic BMI/Percentile Z-score

Table 1. Classification of BMI

Characteristic	BMI/Percentile	Z-score (SD)
Low weight	< 5th	< -2 SD
Normal weight	5th > 85th	0
Overweight	85th > 95th	> +1 SD
Obesity	≥95th	> + 2 SD

(Consultation OMS, 2015, October 1, 2019)

Consultation OMS, 2015, October 1, 2019

Nowadays, the prevalence of overweight and obesity in children and adolescents in Mexico is alarming, since the number of cases has increased by 9.5 percentage points in overweight and obesity according to the national health survey in 2016, the same trend has been observed, but to a lesser extent in Latin American countries, mainly in Argentina, El Salvador, Peru, Bolivia, Nicaragua and Guatemala compared to Mexico [7–9]. A sedentary life coupled with the lack of physical activity, poor eating habits, environmental, social, psychological and genetic factors are the main triggers responsible for this condition, which implies a very important role affecting the health of the Mexican children [10,11]. The WHO defines obesity as a chronic disease, characterized by abnormal or excessive accumulation of fat in the body [6]. Also, the fundamental cause of overweight and obesity is an energy imbalance between calories consumed and spent. This implies that, worldwide, there is a rise in the intake of hypercaloric foods (which are rich in fat, salt, and sugars, but poor in vitamins, minerals, and other micronutrients), and a decrease in physical activity [12]. From the factors mentioned, the first years of life and before 18 years old, obesity leads to detrimental effects for physical and mental health.

According to the above, it is known that adolescents who are obese or overweight, even if they lose weight, have a relative risk of 1.8 mortality from any cause and 2.3 mortality from cardiovascular causes in adulthood compared to the adolescent with a low weight [13]. Obesity is considered an important risk factor for developing noncommunicable diseases, such as cardiovascular, metabolic diseases such as type 2 diabetes mellitus, musculoskeletal disorders and some types of cancer (endometrium, breast, and colon). The risk of contracting these

TABLE 2
Classification of Hypertension in children and adolescents

Table 2. Classification of Hypertension in children and adolescents.

Characteristic	SBP or DBP percentile
Normal	< 90th
Prehypertension	90th to < 95th or if BP exceeds 120/80 mmHg even if below 90th percentile up to >95th percentile
Stage 1 hypertension	85th > 95th to the 99th percentile plus 5 mmHg
Stage 2 hypertension	≥99th percentile plus 5 mmHg

These categories are parallel to the categorization of hypertensionin adults, as seenin JNC 8., in children and adolescents the normal bloodpressure rangedetermined by sex, age and height provides a more accurate classification of blood pressure depending on the size of the body allowing children not to misclassify those who are very high or very low 12.

noncommunicable diseases increases with the highest degree of obesity [14].

Previously, it was thought that obesity and overweight manifested itself in urbanized populations and in adult patients with a sedentary life and with unhealthy eating habits consisting of industrialized and processed foods. However, it is alarming that the current obesity epidemic also occurs in rural populations, which could be improved by obtaining their food directly from the field [15,16]. Thus, the purpose of this study was to anthropometrically assess the percentage or distribution of overweight, obesity, and hypertension in a sample of adolescents between 14 and 17 years old from the General High School – the Universidad Autónoma del Estado de Hidalgo. The sample subjects come from diverse rural places (Huasteca).

Materials and Methods

Population and study design.

Adolescents between 14 and 17 years old participated in the study, students with 18 years old and immunosuppressive treatment were excluded through a questionnaire. Being a total of 99 participants attending the General High School – the Universidad Autónoma del Estado del Hidalgo, Huejutla campus. Prior to participation in the study, the parents and/or legal guardians of the students signed an informed consent to participate in the research protocol governed by the bioethics commission, as indicated by the Mexican government (NOM- 012-SSA3- 2012). In addition, the World Medical Association Declaration of Helsinki established ethical principles for medical research involving human subjects. At the same time, the Ethics Committee of the Universidad Autónoma del Estado de Hidalgo approved the descriptive cross-sectional study (Cod. Number 060).

Collection of anthropometric data.

Somatometric data collection was standardized with a pilot test of 35 participants. Subsequently, data were collected from 533 participants, and a final population of 99 confirmed participants from the General High School - Huejutla campus was used to train the staff in questionnaire application, measurement of anthropometric variables and blood pressure.

Body weight was measured with a precision of 0.1 kg and height was measured close to 0.1 m with a mechanical stadiometer (Detecto-439). The BMI was calculated as the weight in kilograms divided by the square of the height in meters. Blood pressure was determined in the left arm in triplicate with a manual sphygmomanometer, after 5 minutes of rest, in a sitting posture. Arm circumference measurements were obtained by measuring with a tape measure the middle part of the arm, taking as a reference the length between the shoulder tip (acromion) and the head of the radius (olecranon). Waist circumference measurements were taken from the midpoint between the last rib and the top of the iliac crest (hip) following exhalation. The average of at least three readings was used in the statistical analyses. Subjects were classified according to body mass index (BMI) in low weight (< 5 percentile), normal weight (5 ≤ 85 percentile), overweight (85 £ 95 percentile) and obese (> 95 percentile).

Statistical analysis

The data were treated as non-parametric statistics. The descriptive analysis showed the median and the range of 25 to 75 percentile of the continuous variables, and the frequencies and the percentage are shown for the categorical variables. Considering that children's BMI values change with age, Z-score was calculated for all age-based variables and universalized data for handling. The analysis was performed using the statistical package STATA 12.0 (StataCorp LP).

Results

The percentages of normal weight, overweight and obesity were assessed based on anthropometric data of 99 subjects of both sexes 62.6% females, 37.3% males, between 14 and 17 years old, representing 17% of the total population of the educational program of the General High School - the Universidad Autónoma del Estado de Hidalgo. Furthermore, the demographic characteristics of the sample are shown in Table 3. The sample was divided into four categories according to the BMI and Z-score: low weight (6.6%), normal weight (71.7%), overweight (18.1%), and obesity (4.4%). In addition, participants are grouped according to blood pressure percentiles having a 12.12% presence in a prehypertension stage (4.4%), 5.05% hypertension

and 4.4% normal pressure. There are no significant data reported by gender in the normal weight category, however, in relation to low weight and obesity, there were 10 observances of obesity compared to overweight. The grouping was determined by extrapolating blood pressure to percentiles, according to age and sex. Another important measurement was the waist circumference (abdominal fat) since it is considered an indicator of risk fordeveloping cardiovascular diseases (Table 4).

Based on estimation from previous work, normal weight in adolescents in this study was higher in comparison with obesity. For the adolescents evaluated, 6% were low weight compared to the category based on their age by z-score. Therefore, the data obtained from the study sample yielded a baseline result for nutritional risk status.

Accordingly, it is essential to monitor these study subjects and identify strategies aimed at the prevention of noncommunicable diseases, such as promotion of food intake with high nutritional content and implementation of physical activity to maintain an optimal state of health according to the state of biological development.

DISCUSSION

The objective of this study was to determine the percentage or distribution of overweight, obesity, and hypertension in a sample of adolescents from a rural environment to evaluate the risk of health complications in this population. This information has a great impact since adolescence is the stage of development and growth with a hormonal intervention that causes a temporary energy imbalance necessary to reach adulthood. Anthropometry is essential, since it allows evaluation of changes during this period of increased nutritional need. Several cross-sectional studies that have been developed in some parts of the world such as; United States, China, Spain and India have shown that the prevalence of obesity and overweight in children and adolescents between 6 to 18 years of age has increased in rural zones [17–19]. Especially women in rural areas of Mexico in a period from 2010 to 2016 increased 9.5 percentage points in overweight and obesity [20]. There is a tendency of percentage increase in the prevalence of overweight and obesity and it is also observed but to a lesser extent in other Latin American countries, such as El Salvador, Honduras, Argentina, Nicaragua, Bolivia, Guatemala and Peru [21,22]. The food intake data of participants in the present study are not yet available, however, it is known that the diet is rich in carbohydrates and saturated fats due to the culture and the low socioeconomic level of the population in the Huasteca.

According to the above, it is known that the causes of this disease are developed by an unbalanced caloric intake, and little or no physical activity, leading to a sedentary lifestyle. Gender differences exist such as male patients having an excess of 15- 20% body fat in total body fat. In females it is between 25% and 30%. In this way, it is easier to diagnose the condition of obesity presented by the patient [23]. Additionally, it is known that changes in weight reduction are accompanied by a 24-hour change in blood pressure (BP) and, since ambulatory BP is the most accurate measurement, it is

TABLE 3.
Demographic characteristics of the population

Table 3. Demographic characteristics of the population	
Characteristic	**Sample (n=99) median (25th, 75th percentile)**
Age (year)	15 (15 – 17)
Height (z-score)	-0.74 (-2.75 -1.4)
Weight (z-score)	-0.125 (-2.6 - -2.54)
BMI (z-score)	0.545 (-3.58- 2.44)
Abdominal Circumference (cm)	76.5 (58- 130)
Arm Circumference (cm)	25 (19 - 40)
SBP (z-score)	-0.46 (-2.86 – 2.52)
DBP (z-score)	0.265 (-11.21 – 1.82)
	% (n)
Gender	
Male	37.37 (37)
Female	62.62 (62)
Body mass index	Z- score
Low weight	6.6 (6)
Normal weight	71.71 (71)
Overweight	18.18 (18)
Obesity	4.4 (4)
Blood pressure (percentile)	Percentile
Normal	82.82 (82)
Pre-Hypertension	12.12 (12)
Hypertension	5.05 (5)

Weight insufficiency Registered data: Height, Weight, BMI,
Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were recorded in Z-Score by the development status of the sample.

TABLE 4.
Statistical analysis of nutritional status in adolescents

Table 4. Statistical analysis of nutritional status in adolescents

Parameter	Overall (99)	Low weight (6)	Normal weight (71)	Overweight (18)	Obesity (4)
	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)
Age (year)	15 (15 – 17)	15.1 (15 - 16)	15.6 (15 - 17)	15.3 (15 – 17)	15 .5(15 – 16)
BMI (Kg/m^2 Z-score)	0.545 (-3.58- 2.44)	16.6(14.7 – 17.8)	21.3 (18.5 - 24.9)	26.9 (25.3 – 29.3)	32.3 (32 – 35.1)
Abdominal circumference (cm)	76.5 (58- 130)	64.4(58- 70)	75.1 (61 – 90.)	85.6(74 - 96)	110 (101 - 130.)
Arm circumference (cm)	25 (19 - 40)	20.9 (19 - 22.5)	24.6 (21 – 30.)	27 (23 - 34)	32.5 (27 - 40)
SBP (mmHg, z-score)	-0.46 (-2.86 – 2.52)	-1.33 (-2.11 – 0.58)	-0.39(-1.96 – 1.51)	-.097 (-.89 – 1.48)	1.41 (.42 – 2.52)
DBP (mmHg, z-score)	0.265 (-11.21 – 1.82)	-0.18 (-0.85 – 0.61)	.124(-11.21 – 1.81)	.409 (-.89 – 1.48)	1.58 (1.3 – 1.82)

IQR: Interquartile Range. BMI: Body mass index. SBP: Systolic Blood Pressure. DBP: Diastolic Blood Pressure
The population studied is predominantly 15 years old in all categories of nutritional status, the parameters evaluated show that the minimum weight prevails in a high number of observations in adolescents, waist and arm circumference data in one diameter greater than the corresponding age and nutritional status were 1% the remaining population was within the healthy range.

recommended that 24 hr ambulatory BP measurements are taken in children and adolescents [24].

Based on epidemiological studies, a series of factors related to overweight and obesity were found, which are: demographics (age, female gender, race), sociocultural (educational level, economic income), biological (parity), food intake, smoking, alcohol intake, and sedentary lifestyle [25–27]. It has been reported that obese patients have an independent increase in vascular stiffness (central and peripheral arterial), which plays an important role in the development of cardiovascular diseases. These factors help us to diagnose with certainty a patient with obesity, thus preventing one of the main consequences and direct effects for cardiovascular diseases, such as arterial stiffness [28,29]. In addition, the measure of central adiposity, WHtR (Waist circumference - height ratio) has the strongest association with aortic stiffness beyond BMI, therefore, the results suggest that WHtR may be the best anthropometric measure of excess of adiposity in the population [30].

It is appropriate to mention the benefits of physical exercise when used preventively, since multiple studies have been published that describe the beneficial effects of it, as part of programs used in the prevention of cardiovascular complications to maintain and improve the quality of a patient's life, the benefits can be achieved with low, moderate or high intensity, regardless of the activity [31,32]. It is known that in non-obese and mild hypertensive individuals, aerobic exercises decrease arterial stiffness. Low-intensity aerobic exercises are the most suitable for the reduction of vascular stiffness since high- intensity exercises show an increase in oxidative stress [33,34]. It is important to comply with the essential parameters of physical training and the intensity of the exercises to achieve good results in the prevention and/or reversal of the disease.

It is important to recognize that children with obesity who regain their normal weight before adulthood have a cardiovascular risk similar to those who were never obese. Therefore, early treatment and prevention of childhood obesity are crucial to prevent irreversible damage to the cardiovascular system[35].

García Rodríguez J and Fonseca Hernández C (2012), developed a comparative analysis of physical activity in Mexican youth, resulting in a high rate of sedentary lifestyle and a higher percentage of physical inactive 0020CNBity in the female gender. Sometimes with infrastructure to carry out the physical condition but it does not have the specialized staff in the physical orientation. Other cases, without infrastructure and specialized staff, emphasizing that the interference of companies of food products with high caloric content are indispensable within educational institutions, generating greater damage to their students [36]. Hidalgo-Rassmusen *et al.,* (2013) through an analytical cross-sectional observational study aimed at students from 17 to 19 years old to evaluate the time and days they dedicate an exercise as a result of men, enhance greater physical activity and in time, recommended duration and again the female gender obtained less participation [21]. Another study determined the physical activity based on the national health and nutrition survey, the author recommends adding weight, height and BMI, as well as the kind of sport practiced by the interviewees, since the physical activity in students compared to eastern countries and especially in women [37].

Global and national studies are focused on the reduction and prevention of obesity in children and adolescents, since overweight and obesity increase the probability of suffering from diseases such as metabolic syndrome, diabetes mellitus, hypertension, cardiovascular diseases, and orthopaedic problems, among others. In another study, it was found that in Mexican children there is the presence of SNP (single nucleotide polymorphism) in genes such as MC4R, FTO, and ADRB1, associated with obesity and that PON1-192 polymorphism increases the risk of insulin resistance. Regardless, the ADIPOR2 gene variant (rs11061971) protects Mexican children against obesity, while a larger number of copies of the AMY gene was found in children with normal weight [3,37.]

On the other hand, depressive, anxious disorders, dissatisfaction with their body image and low self-esteem in obese children have been repeatedly identified in case studies. This frequency is higher in girls than in boys and increases with age [38]. Obesity and overweight are a public health problem in Mexico, since several factors are involved and combined, such as genetics, food, physical activity and current eating patterns that are acquired through habits and customs of parents to children. These factors may continue until adulthood and directly impact the state of overweight and obesity from an early age to later in life.

CONCLUSION

The results obtained in our study determined that the population sample showed discrete values in their condition of risk related to overweight and obesity. Finally, as future lines of research, this cohort of students will be monitored over time to observe the evolution of their anthropometric parameters and the pertinent information of their eating habits and the frequency of participation in physical activity. Thus, the relationship of anthropometric parameters can be assessed with the intake and expenditure of energy that this population presents and the risk of developing metabolic syndrome.

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