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Descriptive and Correlative Analysis of Anthropometric, Physiological and Nutritional Characteristics in University Students from Morelia, Mexico

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Resumen

Introducción: Las enfermedades no transmisibles (ENT) son la principal causa de mortalidad en el mundo. Entre las variedades de ENT, la obesidad es un problema de salud pública en todo el mundo, pero es especialmente importante en los países pobres o en desarrollo. El objetivo de este estudio es explorar la composición corporal, la actividad física y la diversidad alimentaria en estudiantes universitarios de Morelia, México. **Método:** Se realizó un estudio transversal con 422 estudiantes de nivel universitario. Utilizamos bioimpedancia y antropometría para determinar la composición corporal de los estudiantes. La actividad física se analizó mediante el Cuestionario Internacional de Actividad Física (IPAQ), mientras que la diversidad alimentaria se evaluó mediante las directrices para medir la diversidad dietética familiar e individual de la Organización de las Naciones Unidas para la Agricultura y la Alimentación. **Resultados:** Se redujo una matriz de 16 variables antropométricas a tres componentes principales con un acumulado de varianza de 88.04% para mujeres y 78.9% para hombres. Pudimos separar grupos de mujeres en base a variables antropométricas. En los hombres, el porcentaje de músculo es la variable que más influye en la separación de grupos. La actividad física varía de moderada a alta; en promedio fue 5028.4 y 4449.4 MET-minutos/semana para hombres y mujeres respectivamente. Se encontró una alta diversidad alimentaria y equidad de consumo, el nivel socioeconómico de los estudiantes no permite inferir inseguridad alimentaria. En hombres encontramos más variables asociadas que en mujeres y no encontramos relación con la diversidad dietética. Encontramos relaciones estadísticamente significativas entre la edad cronológica y la edad metabólica en ambos sexos, pero no encontramos relación entre el peso real y el peso ideal. **Conclusión:** En conclusión, se describe la composición corporal, antropometría, actividad física y diversidad alimentaria de universitarios.

Palabras Clave: Antropometría, Composición corporal, Diversidad alimentaria, Actividad física, Estudiantes universitarios

Abstract

Introduction: Non-communicable diseases (NCD) are the leading cause of mortality in the world. Among NCD varieties, obesity is a public health problem around the world, but it is especially important in poor or developing countries. The aim of this study is to explore the body composition, physical activity and food diversity in university students from Morelia, Mexico. **Method:** A cross sectional study was conducted with 422 students of university level. We used bioimpedance and anthropometry to determine the body composition of the students. The physical activity was analyzed by the International Physical Activity Questionnaire (IPAQ), while the food diversity was assessed by the guidelines for measuring household and individual dietary diversity of the Food and Agriculture Organization. **Results:** A matrix of 16 anthropometric variables was reduced to three principal components with a variance accumulate of 88.04% to women and 78.9% to men. We were able to separate groups of women based on anthropometric variables. In men, the percentage of muscle is the variable that most influences the separation of groups. The physical activity ranges from moderate to high; on average it was 5028.4 and 4449.4 MET-minutes/week for men and women respectively. A high food diversity and equitability of consumption was found, the socioeconomic level of the students does not allow inferring food insecurity. In men we found more associated variables than in women and we found no relationship with dietary diversity. We found statistically significant relationships between chronological age and metabolic age in both sexes, but we did not find a relationship between actual weight and ideal weight. **Conclusion:** In conclusion, we describe the body composition, anthropometry, physical activity and food diversity of university students.

Keywords: Anthropometry, Body Composition, Food Diversity, Physical Activity, University Students

Introducción

According to the World Health Organization (WHO) non-communicable diseases (NCD) are the main causes of death around the globe (WHO 2021). Obesity is a serious public health problem because of its association with the risk of developing some of these NCD. Atherogenic dyslipidemia that often accompanies obesity is also associated with metabolic syndrome and cardiovascular diseases. (González et al. 2014). Obesity is connected to other factors such as physical activity and bad nutrition. Changes in diet for the past 30 years have been significant in terms of more fat, more meat, added sugars and bigger portions sizes. “Nutrition transition”, termed as a combination of improved access to food and decreased physical activity level has been identified to be the prime risk factor for the increasing prevalence of overweight and chronic metabolic diseases in the developing countries (Hoffman 2004, Bhurosy and Jeewon 2014)

In university students, bad health habits such as low physical activity or unhealthy food can be a risk factor to develop some NCD in adult life. This is relevant because university students will be soon incorporated into the economically active population. Some studies point out the relationship between economic development and nutritional status of the population (Vargas-Zarate et al. 2008). Therefore, good nutrition is relevant to the future economically active population. By estimating the body composition and anthropometry together with dietary diversity and physical activity, the nutritional and health status of a target population can be inferred, and finally determining health (Haq et al. 2020, Portao et al. 2009, Trujillo-Hernández et al. 2010).

The adverse consequences associated with being physically inactive are numerous and include an increased risk to develop several diseases such as diabetes, breast and colon cancers, stroke, hypertension, and coronary heart disease (Bull and Bauman 2011). It also helps to prevent hypertension, overweight and obesity, and can improve mental health, quality of life and well-being (WHO 2019). Worldwide, 1 in 4 adults do not currently meet the global recommendations for physical activity set by WHO. As countries develop economically, levels of inactivity increase. In some countries, levels of inactivity can be as high as 70%, due to changing patterns of transportation, increased use of technology and urbanization (WHO 2019). The University population is a group of emerging adults known to experience a number of stressors during the transition from high school to college (Arnett 2000). These transitions include a risk for decreased physical activity (PA), increased emotional and psychological stress (Bray and Born 2004, Gall et al. 2000), and the initiation of negative health behaviours (Arria et al. 2008).

Additionally to NCD and physical activity, food diversity can help to maintain good health. Eating a large diversity of food is an internationally accepted recommendation for a healthy diet, because it is associated with positive health outcomes (Kant et al. 1993, Fernandez et al. 1996, La Vecchia et al. 1997, Michel and Wolk 2002, Jansen et al. 2004, Rahmani et al. 2017). Thereby, the PA and food diversity contribute to diminish the risk of NCD in adult life.

According to the 2018-19 National Health and Nutrition Survey (Acronyms ENSANUT) (INEGI 2018), there is a prevalence of overweight of 39.1 %, for obesity the prevalence is 36.1% and for abdominal fat 81.6% in adults (Barquera et al. 2020). The most commonly used anthropometric method to diagnose obesity is the body mass index (BMI), which fails to detect body fat when individuals have ≤ 30 kg/m^2. Instead of BMI, other techniques such as dual energy X-ray absorptiometry, isotope dilution, hydrostatic weighing, air-displacement plethysmography, and bioelectrical impedance accurately measure body fat (Frankenfield et al. 2001, Okorududu et al. 2010).

The aim of this research project is to present a descriptive analysis of body composition, physical activity and food diversity among students of University level in Mexico to establish institutional plans that allow to contribute to an improvement in the health of students.

Material and Methods

Participants

A longitudinal descriptive pilot study was carried out taking, as a basis, the anthropometric measurements according to the Anthropometric Indicators manual (Aparicio et al. 2004) and the International Questionnaire on

Physical Activity (IPAQ ,2002, Craig et al 2003). Besides validating the measuring instruments, a cross-sectional study was carried out in a sample of undergraduate students from Universidad Latina de America (UNLA). A non-probabilistic sampling by quotas of 422 was formed with volunteers from both genders considering at least one group from each academic level per career, which represents 52.6% of enrolled students during the academic scholar period in spring 2017. Only 390 individuals completed the measurements (243 females and 147 males); their average age was 20.45±1.80 (Table 1). An informed consent letter was signed by each individual. All the study measurements were approved by the Scientific Research Coordination for the protection of Human Subjects.

To find out the socioeconomic level of the alumni we used the socioeconomic level index through the NSE AMAI Questionnaires (Asociación Mexicana de Agencias de Inteligencia de Mercado y Opinión, AMAI, 2018) in an independent sample of all new students, in 2017 and 2018 (Appendix A).

Table 1. General characteristic of study participants (Mean ± standard deviation).

	Age (Years)	Size (centimeters)	Weight (Kg)	BMI	Blood presure (systolic/diastolic)	Sex ratio
Woman (n =262)	20.23±1.63	160.14±5.84	61.15±13.21	23.81±4.70	109.3±11.8/74.7±9.9	0.62
Mens (n =160)	20.79±2.01	174.00±15.90	77.48±16.69	25.42±5.19	127.2±16.6/78.5±11.6	0.38
Total (n= 390)	20.45±1.80	167.07±10.87	69.32±14.95	25.61±4.95	115.9±16.1/75.9±10.7	1.00

Data Collection

Exclusion criteria

- Absence from any of the anthropometric assessment sessions.
- Those people (persons/students?) who present any of the conditions listed below;

Obesity: a disease characterized by excess adipose tissue in the body, which is determined when in adults there is a BMI equal to or greater than 30 kg / m2, and in adults of short stature equal to or greater than 25 kg / m2. The information above was taken from the BMI for age and sex tables of the World Health Organization and (NOM-043-SSA2-2012).

Those individuals who presented a BMI that implies a health risk, were referred to specialized medical care services.

- Students who have followed a weight reduction diet in the last 3 months.
- Students who present any disease that may interfere with the object of study.

Elimination criteria: Those students in which a possible alteration in the measurements or registration errors has been noted.

Anthropometry and Body Composition

Anthropometry and body composition were performed using previously described validated instruments (Appendix 1). Height was measured in cm, using a stadiometer SECA 213 with an error of 1 mm. The corporal weight was evaluated with an electronic scale with a sensibility of 0.1 kg. The diameter of the waist, neck, hip and wrist was measured with anthropometric tape. The weight of fat, protein, abdominal fat, body mass index, ideal weight and metabolic age were obtained through bioimpedance, using a body composition analyser Jawon IOI 353.

Physical Activity and Food Diversity

To assess the physical activity (PA) of all the students, we applied the International Physical Activity Questionnaire (IPAQ, 2002; Craig et al., 2003). Activity counts were converted to metabolic equivalents (METS) and the food diversity was obtained through the Guidelines for Measuring Household and Individual Dietary Diversity of Food and Agriculture Organization (FAO) (Kennedy et al., 2013) with some modifications. The modifications include the next: we considered legumes and nuts and seeds as different items. In the same way, we separated alcohol and beverages from spices and condiments.

Blood pressure (systolic/diastolic) in a sitting position was obtained using a digital upper arm blood pressure monitor (Omron HEM-7130) in all students.

Statistical Analysis

In order to identify groups of students with similar anthropometric, physiological and body composition, we performed a principal component analysis with a matrix of 16 variables (Appendix 2) to identify informative variables (greater eigenvectors) and thus delete noise in the data (Gauch 1982). The multivariate analysis was conducted in PAST, a free software for data analysis (Hammer et al. 2001).

To establish statistical differences in physical activity between men and women at work, during transport, at home, during leisure time and walking, a variance analysis and a Tukey post-hoc test in SPSS (IBM 2016) were made.

The food diversity was analyzed through the Berry-Index (BI), which is similar to the biological Simpson-Index, defined as: $BI = 1 - \sum s_i^2$. Where s_i is the share of product *i* in the total amount of food consumed (Katanoda et al. 2006). For each sample we count the total of the food products consumed). From the relative abundances of food consumed we computed, the Shannon-Wiener index of equitability (J' = H'/H'max) where: $H' = -\sum \quad p_i/logp_1$ and $H'_{max} = log\ log\ S$ (Whittaker 1975). If J' is equal to 0 the consumption of products has the maximum inequality (only 1 product is consumed) and if J'= 1 the consumption of products is maximum (all products are consumed in the same proportion). The food diversity analysis was conducted in PAST (Hammer et al. 2001).)

Multiple correlations of person were made between the anthropometric variables, food diversity and physical activity to explore which are the variables that explain the anthropometric characteristics of the students. Simple regression analyses were performed between chronological age and metabolic age as well as between weight and ideal weight.

Results

Anthropometry, Body Composition and Physiology

We performed a principal component analysis to discriminate possible groups with similar characteristics by sex. After performing a principal component analysis with a matrix of 16 variables that include anthropometric, body composition and physiological characteristics we have found that the percentage of accumulated variance of three first axes for women is 86.256 % while for men is 76.8% (figure 1).

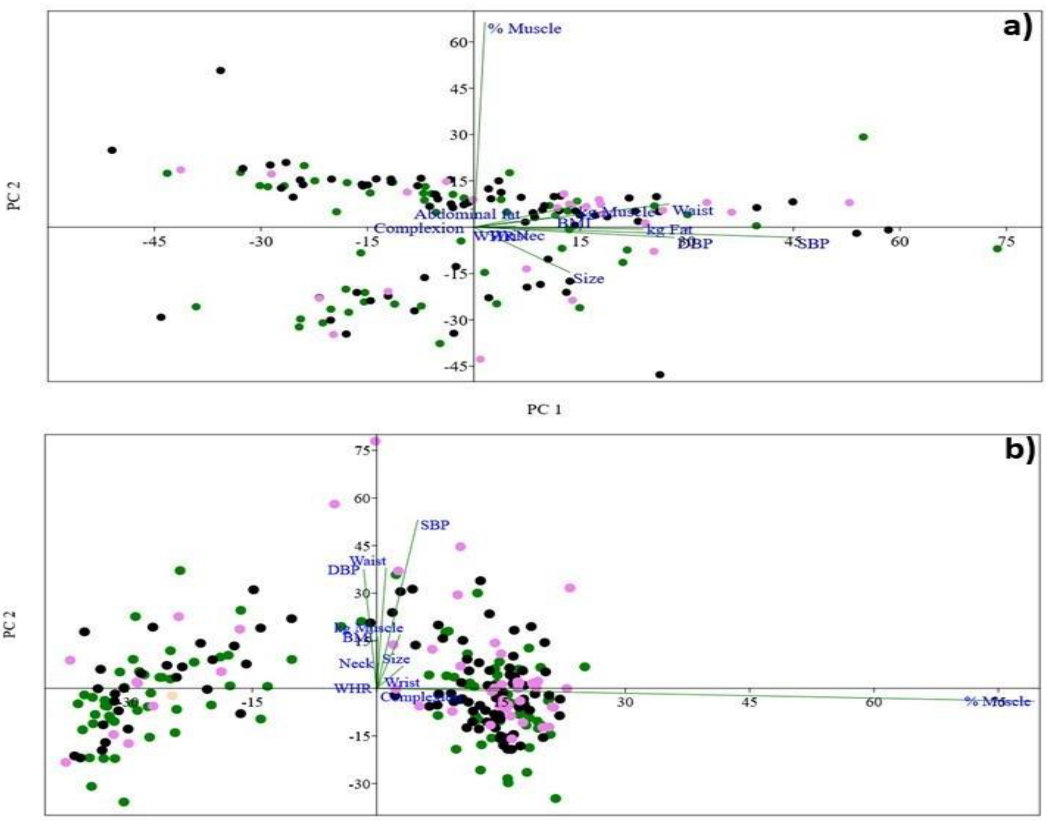
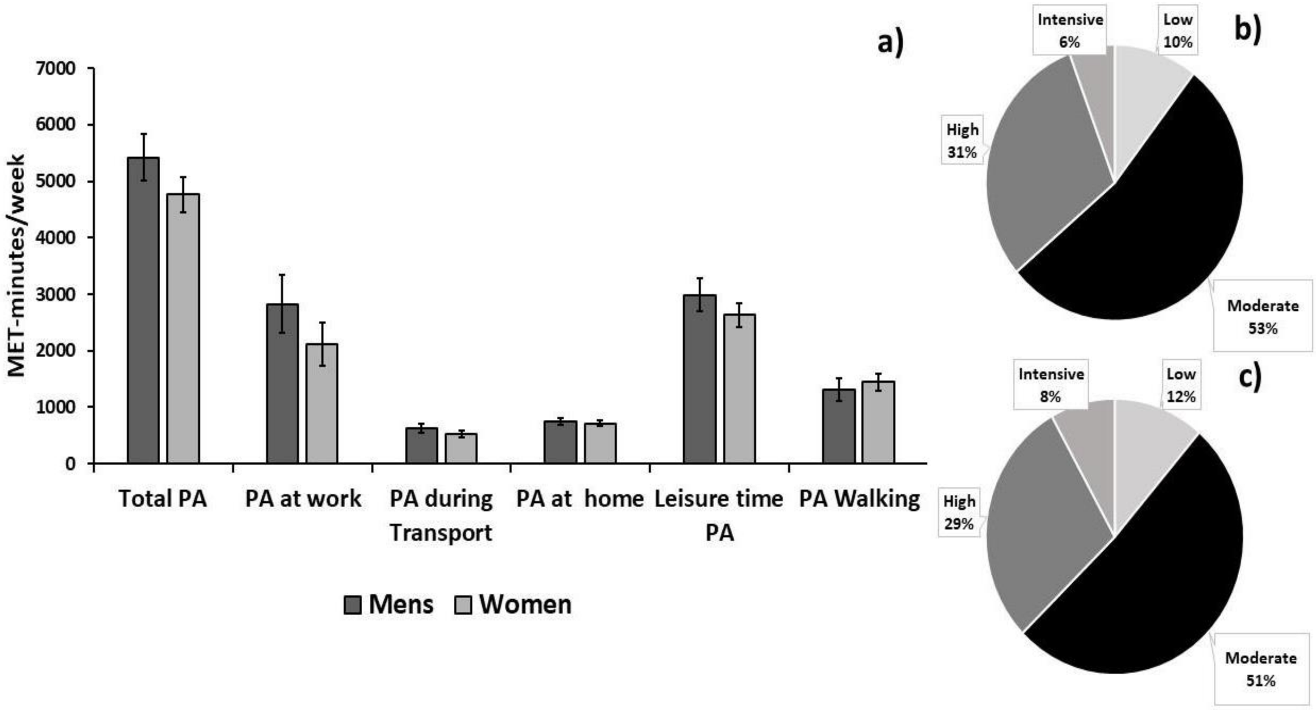


Figure 1. Principal Component Analysis (PCA) based on anthropometric, body composition and physiology of university students. a) Ordination graph to men, the percentage of accumulated variance in the three first axes is 78.9%. b) Ordination graph to women, the percentage of accumulated variance in the three first axes is 88.4%.

We have found two well defined groups of women in the ordination graphic of PC1 vs CP2 and PC2 vs PC3 (Figure1). The main variables that contribute to the total variance for women's in principal component 1 in order are: weight, waist, hip, mass body fat, % fat, muscle mass, BMI and abdominal fat, while in the CP2 the muscle percentage is the most informative variable. The ordering graphic for men identifies two groups along the PC2, the percentage of muscle is the variable that has the main contribution to the variance in this axis. On the axis of the principal component 1 the informative variables are waist, hip, weight, mass body fat, BMI, %f Fat, systolic and diastolic blood pressure. In both men and women, the neck circumference, waist hip ratio, and body frame size are variables that do not allow the separation of groups, in women, height is a variable that does not contribute to the total variance.

Physical Activity

On average, the men spent 5028.4 and the women 4449.4 MET-minutes/week respectively (Fig. 2.) None statistical difference was found on the MET-minutes/week total between men and women ($F = 1.59$, df = 1, $p > 0.5$). We did not either find statistical differences between men and women in the PA at work ($F = 1.2421$, df = 1, $p > 0.5$), PA during transport ($F = 0.92221$, df = 1, $p > 0.5$); PA at home ($F = 0.1386$, df = 1, $p > 0.5$) leisure time PA ($F = 1.0352$, df = 1, $p > 0.5$) or PA walking ($F = 0.2847$, df = 1, $p > 0.5$) MET-minutes/week. Both male and female students consume more energy in leisure and work (figure 2a and b), the walking PA is intermediate and the minor



PA occurs during transport and at home (Figure. 2a).

Figure 2. Physical Activity according to IPAQ. a) Distribution of PA (in MET-minutes/week) according to activity. Percentages of PA in b) men and c) women.

In addition to the aforementioned results, most students have a moderate PA (53 % of men and 51% of women; fig. 2b and c). Besides, 31% of men and 29% of women have high PA. The percentage of students with intensive PA is low in both sexes (6 and 8 percent respectively). Likewise, the low PA was recorded in only 10% of men and 12% of women (Fig 2b and c).

Food Diversity

In general, the diversity of consumption of several food groups was high (table 2). The women consumed between 6 to 19 different items with a mode of 18, while men consumed 7 to 19 items with a mode of 17. According to the Berry index, the total diversity of consumption was high, for men (0.9387), for women (0.9373), or total (0.938). In regards to consumption, a low value of equitability represents that only a few groups of food were consumed, while a high value represents that all food groups of food were consumed in a similar way or equitably. In our study, the equitability was high for both men and women (Table 2).

Table 2. Food Diversity Analysis

	Men's	Woman	Total (n = 390)
Food groups consumed	18 (6-19)	17 (7-19)	18 (6-19)
Berry's Index	0.9373	0.9387	0.938
Equitability of consume (J')	0.903	0.9162	0.9670

The food groups more consumed (Table 3) were cereals (8.8%), oils and fats (8.2%), flesh meat (7.9%), sweets (7.9%) and spices and condiments (7.4%). The food groups with low frequency of consumption were eggs (3.7%), white roots and tubers (3.4%), legumes (3.4%), fish and seafood (2.8%), nuts and seeds (2.6%) and, finally, organ meat (1.4%). However, if we put all types of vegetables together (vitamin A + dark green leafy + other vegetables), their consumption increases to 18.4% and 9.7% for all kinds of fruits (vitamin A + other fruits) and, if we consider the organ meat, flesh meat, fish and seafood the total consumption of meat is 12.1%. Similarly, if we consider the unhealthy food groups as sweets and beverages, their consumption is 12.1%.

Table 3. Percentages of food groups consumed by university students.

Food group	Percentage (%)
Cereal	8.8
White Roots and tubers	3.4
Vitamin A rich vegetables and tubers	6.7
Dark Green leafy vegetables	5.7
Other Vegetables	6.0
Vitamin A rich fruits	4.8
Other fruits	4.9
Organ meat	1.4
Flesh meat	7.9
Eggs	3.7
Fish and Seafood	2.8
Legumes	3.4
Nuts and Seeds	2.6
Milk and Milk producs	7.7
Oils and Fats	8.2
Sweets	7.9
Spices, Condiments	7.4
Beverages	4.2
Alcohol	2.6
Total	100

Pearson Correlation Coefficient

A multiple correlation analysis was performed to find possible associations among anthropometry, body composition, and physiology with dietary diversity and physical activity in both sexes (Appendix 2). The whole values are found in Appendix 2. In women, we found some expected associations such as body mass index is related to waist circumference (r = 0.7671), hips (r = 0.7206), weight (r = 0.9061), kg fat (r = 0.9601), kg muscle (r = 0.7108) and abdominal fat (r = 0.9024). The waist circumference is also related to weight (r = 0.7466), kilograms of fat (r = 0.7771), and kilograms of muscle (r = 0.6003). Systolic blood pressure was marginally correlated with weight (r = 0.3772), kilograms of muscle (r = 0.3579), and percentage of fat (r = 0.3398). We did not find any association between the anthropometric variables with dietary diversity or with physical activity, whether they are analysed variable by variable or if synthetic variables obtained from the principal component analysis are used.

In men, unlike the associated variables analysed in women, we found a greater number of associated variables, for example the body mass index, is positively related to the waist (r = 0.8144), neck (r = 0.6810), hip (r = 0.8189), wrist (r = 0.6316), body frame size (r = -0.6108), weight(r = 0.8634), mass body fat (r = 0.9617), muscle mass (r = 0.6857), abdominal fat (r = 0.9236) and percentage of fat (r = 0.8899), systolic blood pressure (r = 0.4693), diastolic blood pressure (r = 0.5014). The systolic blood pressure is also related to Waist (r = 0.4390), Neck (r = 0.4205), Hip (0.4146) Wrist (0.4174) weight (0.4337), mass body fat (r = 0.4572) and abdominal fat (0.4291), while systolic blood pressure was positively correlated with waist (r = 0.4323), hip (r = 0.4181), weight (0.5055), and mass body fat (0.5492. The weight was also related to muscle mass, abdominal fat (Appendix), and complexion was inversely correlated with abdominal fat, percentage of fat and BMI (Appendix B).

In men, we also did not find an association between anthropometric variables with dietary diversity and with physical activity, whether they are analyzed in a univariate or multivariate manner.

Relationship Among Age Vs Metabolic Age and Weight Vs Ideal Weight

After performing a simple regression analysis between chronological age and metabolic age in women (Figure. 3b), we found that these variables are positively related (R^2= 0.704, $p \leq 0.01$). In men we also find this relationship with a coefficient of determination of R^2 = 0.852 ($p \leq 0.01$)(Figure. 3b). The magnitude of the relationship between the actual weight and the ideal weight is very weak in both women (R^2 = 0.1445) and men (R^2 = 0.1713) (Figures 3 c and d).

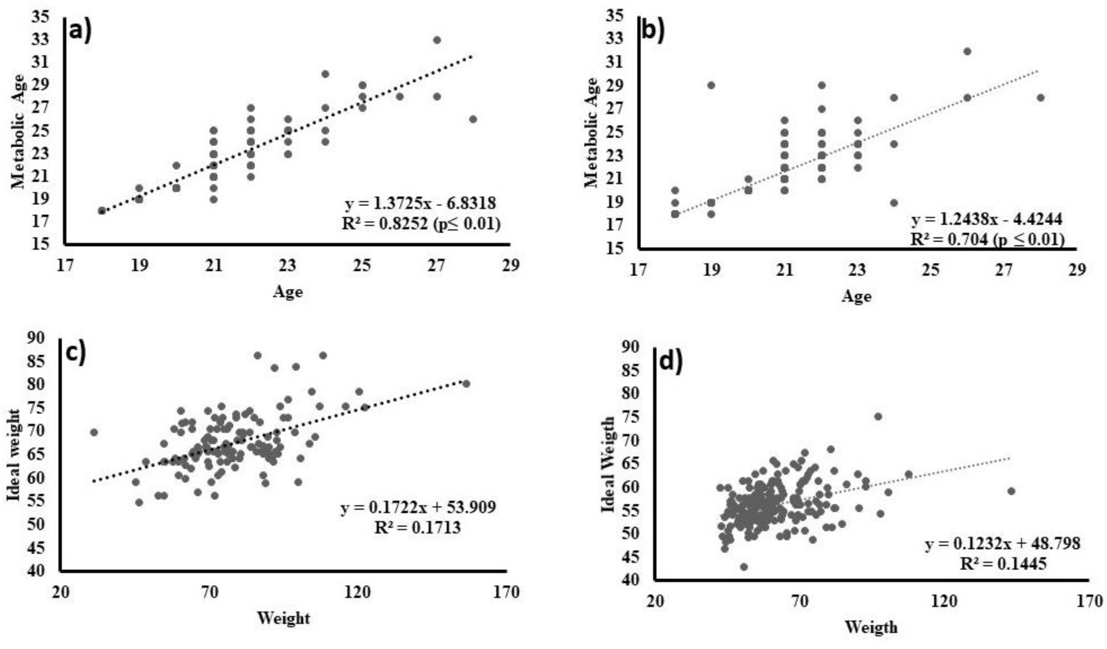


Figure 3. Relationship between age vs metabolic age a) mens, b) and weight and ideal weight for c) men, d) women.

Discussion

Anthropometry and Obesity

Obesity is a common condition in many societies and it is a risk factor for several diseases. Abundant scientific evidence supports the association between obesity and various diseases including diabetes mellitus, hypertension, coronary artery disease, cancer and sleep apnea. According to the National Health and Nutrition Survey (ENSANUT) (INEGI, 2018), in Mexico the overweight and obesity in adults went from 71.3%, in 2012, to 75.2% in 2018. In the same way, 76.8 % of women and 73 % of men were both overweight and obesity combined (INEGI, 2018). As a result of the above, there is also a high prevalence of diabetes 10.3% (8.6 millions of people), and hypertension 18.4% (15.2 millions of people). The results found in young adults differ from the above, since in the study population we find in our study, 24% of the students are overweight, 12% are obese, and 5% are underweight % (data not show). Derived from principal component analysis and regression analysis, we identified some male and female students with worrying BMI and blood pressure values. At the extreme, there is a 19-year-old male with a BMI of 42 and 152/117 of blood pressure and a 22-year-old female with a BMI of 52 and a blood pressure of 151/10. Although the frequency of students with these characteristics is low, it highlights the importance of monitoring young adults to correct nutritional problems that will impact the health of young people who will be incorporated into working life in a short time causing pressure on the country's health systems and losses due to man-hours of work that translate into economic losses Some other results have found a high level of overweight or obesity in university students (González et al 2014, Ruano et al. 2015, Haq et al. 2020).

The most common anthropometric method used to diagnose obesity is the body mass index (BMI) which is calculated as an individual weight in kilograms divided by the height in square metres. Body mass index is often used as an index of fatness and significant correlation between BMI and body frame size are found (Henneberg and Ulijaszek 2010). In several studies, high correlation was found between BMI and body fat percent when age and sex and adjusted (Womersley and Durnin 1997). In our study, the BMI almost reaches a perfect positive correlation with the body's fat mass in both men and women and is also associated with abdominal fat and the percentage of fat. Additionally, the body frame size shows moderate positive correlations with the mass body fat, abdominal fat and percentage this association tends to be stronger in men being the BMI a better index for the fatness that the body frame size for people in this age group.

The Commonly used BMI cut-off values to diagnose obesity have high specificity, but low sensitivity to identify half of people with excess percentage of fat body, and their use do not seem always applicable in nutritional assessment (Okorodudu et al. 2010, Mokaddem 2016). An alternative method to measure excessive body fat is Dual-energy X-ray absorptiometry (DXA); however, this clinical method remains expensive nowadays (Verney et al. 2016). Determining anthropometric characteristics by impedance analysis offers a less expensive, faster and easy-to-use way to determine body composition (Kyle et al. 2004). The high correlation found between the BMI and the variables of body fat by electrical bioimpedance allow us to suggest that than in the absence of a body composition analyzer or other more accurate method the measurement of BMI is useful to determine the excess of fat in the age group studied both in men and in women and that even simpler measurements such as weight, waist and hip circumference can be equally useful to assess the nutritional status of young university students. The wrist, ICC and body frame size values do not seem to predict body fat values in college students. The previous assertions need to be validated with a larger sample group.

Several studies have shown a clear association of blood pressure increase with weight gain (Wang et al. 2004). It has been shown that obese subjects have a 3.5-fold increased likelihood of having hypertension and that 60% of hypertension is attributable to increase in adipose stores. Data from NHANES indicate that the prevalence of hypertension among obese individuals with a BMI < 30 kg/m2 is 42.5% compared with 15.3% for lean individuals (Paosuva et al. 2002). Here we found that in women the correlation between morphometric variables (weight BMI, fat mass and fat percentage) and systolic blood pressure is weak (around 0.3), however when it is performed against variables that synthesise the morphometric variation as is the main component 1 the correlation increases to 0.5. In men there are more variables correlated with systolic blood pressure (waist, neck, hip, wrist, weight, mass body fat, and abdominal fat). An important difference between the results found is that in women, body composition was not related to diastolic blood pressure, while in men it was related to waist, neck, hip, weight, mass body fat, abdominal fat, percentage of fat and BMI around 0.4. The above illustrates that the impact of body composition on blood pressure in men is greater than in women. There are two major sex-related differences in human blood pressure. First, orthostatic hypotension and fainting are much more common in young women than in young men (Ganzeboom et al. 2003). Additionally, clinically documented hypotensive disorders of blood pressure regulation are far more common in women than in men (Ali et al. 2000). In contrast to this observation are the age-related increases in blood pressure that occur in both sexes (National Center for Health Statistics 2010). In young women, blood pressure is typically lower than in young men, even in groups of healthy normotensive people. Rates of hypertension are also much lower in young women. In men, blood pressure starts to drift up on a population basis during the third decade of life. In contrast, in women, blood pressure rises with age much more slowly until the fourth or fifth decade in life, i.e. around the time of menopause. It should be noted that these trends are for Western societies marked by low levels of physical activity, high levels of social stress, high levels of salt intake and epidemic levels of overweight and obesity (Hollenberg et al. 1997). The physiological control of blood pressure is different in men and women, in men there is a tight relationship between indices of sympathetic activity and vascular resistance across the age span while that relationship is absent in young women but seen in postmenopausal women These sex and age differences in vascular resistance are largely a result of changes in the balance of vasodilating and vasoconstriction adrenergic receptor tone (Yoyner et al. 2016).

Metabolic age vs Chronological Age

Aging is a natural process, which we broadly define as the time-dependent functional decline that affects most living organisms. Chronological age is one of the most important risk factors for adverse clinical outcomes. Still two individuals at the same chronological age could have different biological ageing states leading to different individual risk profiles (Hertel 2015). The above was evidenced here based on the relationship between chronological and metabolic age, approximately 17.5% of men and 30% of women do not have a correspondence between their chronological age and their metabolic age, the prevalence of age- related disabilities can be challenging the health systems, national economies and societies (Ferrucci et al. 2008) especially in developing countries with poor health systems like Mexico. On the other hand, for the first time in history, most people can aspire to live beyond age 60. This has profound consequences for health and systems health, your staff and your budget (WHO, 2015.). Although life expectancy in old age has increased on average throughout the world, in developing countries the key factor influencing the increase in life expectancy is the decrease in mortality in the early stages of life more than the increase in life expectancy in adults. Although our study does not have a large sample to extrapolate the data to the entire population, it is worrying that 30 percent of women do not have a match between chronological age and metabolic age.

The loss of capacity associated with ageing is loosely related to chronological age and the fact that there is no typical older person. Some 80-year-olds have levels of both physical and mental ability similar to many 20-year-olds, but many people also have a significant decline in their abilities at much younger ages (Petters et al. 2019). Other models point to old age as a period of vulnerability and disconnection (Hutton 2008) between these two extremes, the discussions and public policies focus on the health, retirement and social services systems. The focal point is healthy ageing. Taking into account the above, it is important to have a healthy age and an important component to consider is that there is a close relationship between chronological age and metabolic age.

Food Diversity

Diet is one of the main risk factors for chronic non-communicable diseases (Rodriguez-Ramirez et al. 2020). In the case of our study, a high diversity of food consumption was found in both men and women; this was estimated by the dietary diversity indices. However, the variability in food consumption is large (6-19), which means that some students have a poor diet while others incorporate a high diversity of foods. Studies documenting beneficial effects of dietary diversity on health have yielded contrasting results, some of them documenting an inverse relationship between obesity and dietary diversity indices (Azadbakht et al. 2012, Jayawardera et al. 2013, Rhamani et al. 2017), others finding positive associations (Azadbakht et al. 2012, Oldewege-Theron et al. 2014) and some failed to find this link (Kimura 2009, Hasan-Ghomi et al. 2012). Salehi-Aborgouei et al (2016) when conducting a meta-analysis between dietary diversity and obesity concluded that there are no associations between these two variables, but the field of research remains open in the search for better indices and adequate study design.

Despite the conclusion above, the dietary recommenda

.tions include at least a variety of foods considered healthy. Healthy diets must have an appropriate caloric intake consisting of a diversity of plant-based food, low amounts of animal source foods, unsaturated rather than saturated fats, and small amounts of refined grains, highly processed foods and added sugars (Willet et al. 2019). However, healthy dietary patterns must be flexible according to age, body size and physical activity. The high equitability found in our study means that students include in their diet both healthy foods and those considered unhealthy, such as sweets, drinks, alcohol and fats. Our study does not allow us to know if they consume saturated or unsaturated fats.

Mexico is a biologically megadiverse country, this biodiversity does not significantly impact access to food, rather, eating patterns vary enormously from place to place and tend to be homogeneous in cities (Melendez and

Aboites 2015); food diversity also allows estimating the access that households have to a variety of foods (Kennedy et al. 2013) and therefore serves as a sensitive indicator of food insecurity, since it is linked to socioeconomic conditions and access to food (Thorne-Lyman et al. 2010). It is important to consider that having sufficient financial resources is not a reference to a good diet. It has been documented, for example, that the diversity of food consumption in university students decreases as obesity increases (Yeon et al. 2012). Differences have also been found in food consumption if students are residents or foreigners. In the case of our study, we can observe that diversity is a clear indication of the socioeconomic level of most of the students, who on an average of two years 41.3% belong to class A / B, followed by class C + 32.8% and, finally, class C 11.6% (Appendix A). According to the AMAI (2019), Level A / B is represented by the highest class in Mexico, class C + represents upper middle-class families, while class C represents the middle class (AMAI 2019). In our study, we did not observe a reduction in the consumption of foods of animal origin, or lack of consumption of foods such as legumes, fruits and vegetables, which are indicative of food insecurity (Morales-Ruán et al. 2017), but the low consumption of seeds, in addition to the consumption of foods considered unhealthy such as sugary drinks and alcohol; it is necessary to make students aware of the decrease in the consumption of these items, to improve their health in their adult life. It should be noted that this research is a by-product of the institutional strategy undertaken in 2016, to know the health characteristics of university students in order to generate localised educational strategies and to improve the food options offered on campus. In addition, the results of the health diagnosis were shared with each of the participants in a space where they could clarify their doubts and receive diet guidance.

Physical activity

The importance of physical activity in disease prevention has been widely studied and it is generally well accepted (Chomistek et al. 2012). The benefits of physical activity include: lower rates of mortality caused by coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome, colon and breast cancer, and depression. Other benefits of physical activity are: less risk of hip or vertebral fracture, higher cardiorespiratory level, muscular fitness, weight maintenance, and a healthier body mass composition. The recommendations by WHO (2021) include at least 150 to 300 minutes of physical activity per week in adults. Likewise, the physical activity guidelines for the Americans (Piercy et al. 2018) indicate that adults should do at least 150-300 minutes a week of moderate-intensity, or 75-150 minutes a week of vigorous-intensity aerobic activity. Our results show that 84 % of men and 80% of women have moderate to intensive physical activity. Results of ENSANUT (INEGI 2018) show that 17.3 % of the adult population (men plus women) are inactive (less than 150 minutes per week of physical activity). The percentage of young adults (20-29 years old) who are moderate or active is 85.4%. These results are consistent with our results. It is important for local health authorities to discuss the fact that physical activity is high; however, overweight and obesity are also high. As our results indicate, the physical activity of both men and women varies between moderate to high; however, the BMI average plus standard deviation is above 25, which is considered overweight by the WHO. This overweight may probably be related to the consumption of foods with high energy content such as sugary drinks. Subsequent correlative analyses are needed to demonstrate this claim.

Ideal Weight vs. Real Weight

Additional findings of this study indicate that there is a very low relationship between real weight and ideal weight in both men ($R^2 = 0.1713$) and women ($R^2 = 0.1445$). Ideal body weight (IBM) was considered as healthy weight and was defined according to its association with lowest mortality; it has also been interpreted to represent a fat-free weight and thus was used as a surrogate for lean body weight (LBW). Ideal body weight (IBW) equations and body mass index (BMI) ranges have both been used to delineate healthy or normal weight ranges although these 2 different approaches are at odds with each other (Peterson et al. 2016). Considering the results of physical activity and those of dietary diversity, we conclude that reaching the ideal weight in people aged between 19-22 years old with physical activity moderate on average and with a diverse food consumption is a difficult condition to achieve.

Conclusion

Our results have a descriptive scope and show that we can separate groups of students based on their morphometric characteristics in a multivariate manner, the differentiating characteristics of the groups are dependent on sex. The students have a varied diet related to the socioeconomic position of the family they belong to, where food insecurity is zero. Above 80% of the students studied have a physical activity considered healthy;

however, they incorporate some foods with high energy content that impact their body mass index and, thus, that group of students can be considered overweight.

According to the epidemiological context of adults in Mexico, we consider that it is necessary to continue and extend research in graduates to detect which are the main factors that determine changes in habits that impact the health status of adults, to establish institutional strategies aimed at a culture of prevention in young university. The results of this study may also be useful to compare the anthropometric characteristics, physical activity and dietary diversity of university students aged 19-22 years before and after the pandemic related to the COVID19 disease.

Appendix 1.

	Size	*Waist*	*Neck*	*Hip*	*Wrist*	*WHR*
Size	1					
Waist	0.0753543	1				
Neck	0.25151614	0.68636351	1			
Hip	0.06293389	0.85014421	0.699355583	1		
Wrist	0.20122082	0.62651438	0.705851805	0.698914002	1	
WHR	0.06147964	0.74569348	0.365253172	0.290740195	0.271060457	1

	Complexion	*Weight*	*Mass body fat*	*Muscle mass*	*Muscle %*	*Abdominal fat*
Complexion	1					
Weight	-0.34740253	1				
Mass body fat	-0.5189483	0.873024	1			
Muscle mass	-0.24008483	0.86367354	0.70735264	1		
Muscle %	0.03767098	0.08650661	0.1239213	0.09874474	1	
Abdominal fat	-0.58191055	0.72013264	0.91580142	0.48476211	0.15395233	1

	Fat %	*BMI*	*SBP*	*DBP*	*Taxa_S*	*Simpson_1-D*
Fat %	1					
BMI	0.88999054	1				
SBP	0.35149011	0.46931985	1			
DBP	0.42682563	0.50148301	0.68113727	1		
Taxa_S	-0.11277884	-0.0585026	0.03197139	-0.07275042	1	
Simpson_1-D	-0.04791084	-0.00715686	0.06280431	-0.0747935	0.92386434	1

METs Totales	*METs Trabajo*	*METs Transporte*	*METs T Doméstico*	*METs Esparcimiento*
1				
0.73196233	1			
0.16788106	-0.04951735	1		
0.26077732	0.22899097	-0.092079559	1	
0.57716999	-0.0798954	0.036835646	-0.084228904	1

	METs Transporte	*METs T Doméstico*	*METs Esparcimiento*
METs Transporte	1		
METs T Doméstico	-0.092079559	1	

METs Esparcimiento	0.036835646	-0.084228904	1

	METs Caminata	METs Moderada	METs Vigorosa	Promedio	PC 1
METs Caminata	1				
METs Moderada	0.084717725	1			
METs Vigorosa	-0.007373608	0.094844505	1		
Promedio	0.49788577	0.627884342	0.687335003	1	
PC 1	-0.062087077	-0.044716234	-0.037613503	-0.0761471	1

	PC 2	PC 3	Kcal Caminata	Kcal Moderada	Kcal Vigorosa	Prom/D
PC 2	1					
PC 3	-2.56222E-07	1				
Kcal Caminata	-0.063341653	0.250246638	1			
Kcal Moderada	-0.045337677	0.100693952	0.214413322	1		
Kcal Vigorosa	-0.04320747	0.199589569	0.284995623	0.248372041	1	
Prom/D	-0.067575287	0.242047493	0.580782494	0.730238816	0.779705239	1

Appendix 2 Socioeconomic level of the students of the Latin American University. The interpretation of the categories is found in http://nse.amai.org/niveles-socio-economicos/

NSE	2017 (n = 205)	2018 (n = 216)	Total (n = 421)
They did not answer	0 (0%)	13 (6%)	13 (3.1 %)
A/B	118 (58%)	56 (26 %)	174 (41.3%)
C	11(5%)	38 (18%)	49 (11.6%)
C-	7 (3) %	20 (9%)	27 (6.4%)
C+	61 (30%)	77 (36%)	138 (32.8%)
D	3 (1%)	3 (1%)	6 (1.4%)
D+	5 (2%)	9 (4%)	14 (3.3%)

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