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Assessment of Dietary Intake, Nutritional Status, and Cardiovascular Risk in University Students

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A B S T R A C T

This study assessed the eating habits, nutritional status, and cardiovascular risk in university students. The sample consisted of 295 new students (188 female, 107 male) who attended the induction week at the Autonomous University of Occident and met the inclusion criteria: being adults, enrolled in any undergraduate degree offered by the university, and agreeing to participate through informed consent. The data collection consisted of two parts: an initial survey to collect general characteristics and self-reported height and weight, and the measurement of waist and hip circumferences according to the ISAK protocol. Then, a short version of the FFQ was applied to collect dietary information. Data was captured on MS Excel, and mean, standard deviation, frequencies, and 95 % confidence intervals were reported. Statistical tests were analyzed using SPSS version 26. Results: 38 % of the students are overweight or obese, being higher in men (42 % vs 35.6 % in women). 7.35 % of women and 10.96 % of men presented high WHR, and 33.09 % of women and 35.62 % of men presented high WHRt. Low weekly consumption was found in dairy products (7.13 CI 95 % 6.71 - 7.56), vegetables (5.83 CI95 % 5.33 - 6.34), and fruits (6.92 CI 95 % 6.43 – 7.42). Processed foods and junk food are highly consumed (8.77 CI 95 % 8.10 - 9.45, and 14.20 CI 95 % 13.20 – 15.20, respectively). Significant correlations were found on weekly consumption of processed foods and junk food ($R = 0.765$, $p < 0.001$), processed foods and dairy products ($R = 0.436$, $p<0.001$). The findings indicate a high rate of malnutrition among university students, poor intake of healthy foods, and a high consumption of processed and junk food. These inadequate lifestyle habits could be a risk factor for the development of both cardiovascular diseases and NCDs in the long term. Therefore, it is important to emphasize the need for university-level nutritional interventions.

Keywords: *Dietary intake, Cardiovascular risk, University students, Overweight, Obesity*

1. Introduction

Non-communicable chronic diseases (NCDs) are a consequence of genetic, physiological, and environmental factors that represent 75 % of deaths globally (1) and 71 % of deaths in Mexico (2). In recent years, there has been an increase in mortality rates in diabetes, high blood pressure, and cardiovascular disease, as well as an increase in the prevalence of obesity, dyslipidemia, diabetes, and hypertension in younger populations (3, 4).

The World Health Organization (WHO) (5) recommends prevention and control through early detection, screening, and timely treatment to identify the risk factors in the population. University students are considered a vulnerable population due to the social, emotional, cultural, and physiological factors. Changing schedules, study activities,

stress generated due to the accumulation of tasks, mood swings, beliefs, and customs are common factors associated with an increased risk of adopting unhealthy behaviors that negatively affect dietary patterns and may contribute to the development of NCDs (6).

Diets high in fat and sodium are factors that promote NCDs. Junk food is defined as food high in fat and sodium with low nutritional elements (such as fiber, vitamins, and minerals). Excessive consumption of junk food can contribute to the development of NCDs. In addition, the consumption of high Saturated fats promotes an increase in cholesterol levels, a risk factor for heart diseases (7). A common and reliable method of assessing dietary intake is through the Food Frequency Questionnaire (FFQ) in its short version (8).

Anthropometry is a cornerstone to evaluate the health status of people, being a low-cost, non-invasive, and universally applicable methodology, achieving widely accepted health indicators such as the body mass index (BMI), which has been the gold standard to define the classification of overweight and obesity according to the WHO (9). Additionally, waist-hip ratio (WHR) is a useful indicator that correlates with the distribution of body fat, differentiating accumulation patterns between men and women. Finally, the waist-height ratio (WHRt) is a novel and effective indicator for estimating central adiposity, which has been related to the determination of nutritional status and cardiovascular risk (10, 11). Few studies in Mexico have simultaneously examined BMI, WHR, WHRt, and dietary habits among university students.

The objective of this research is to assess nutritional status, dietary intake patterns, and identify its association with anthropometric indicators of cardiovascular risk in university students.

2. Methods and Materials

2.1. Study design and participants

The study design is descriptive, observational, and cross-sectional. Non-probability convenience sampling was used during the induction week for new students at the Autonomous University of Occident, Guasave Regional Unit. The inclusion criteria were being adults (minimum age of 18), enrolled in any undergraduate degree offered by the university, and agreed to participate through informed consent, after having explained in detail the objective and methodology of the study. The research followed the ethical standards established in the Declaration of Helsinki for research in human subjects (12).

2.2. Anthropometric assessment

In an initial survey, participants were asked about general characteristics, including age, sex, and the educational program in which they were enrolled, and were asked to self-report their height and weight. Next, their waist and hip circumferences were measured according to the International Society for the Advancement of Kinanthropometry (ISAK) protocol, where the waist measurement is the narrowest part of the abdominal area, and the hip measurement is the most prominent part of the buttocks, keeping the feet together and the arms crossed. The measurements were performed by an ISAK Level 2 certified professional, using a Lufkin brand metal tape measure.

2.3. Dietary assessment

To collect dietary information, the short version of the FFQ was used. This method provides information on the usual food, energy, and nutritional intake of the general population. The value was generated by calculating the consumption of different food groups per week. The following food groups were considered: vegetables, fruits, dairy products, processed foods, animal-based foods (ABF), alcohol, and junk food. Its reproducibility and validation were proved by Rodríguez *et al.* (8)

2.4. Nutrition diagnosis criteria

Nutritional status was classified according to conventional recommendations, with the following reference values for BMI (kg/m2): Underweight:<18.5; Normal: 18.5-25; Overweight: 25-30; and Obesity: >30. Malnutrition is categorized when the BMI falls outside the values considered normal (including underweight, overweight, and obesity).

The WHR was calculated as the ratio of waist to hip circumference (cm). It was considered normal when WHR < 0.85 in women and <0.90 in men, and elevated when it was ≥0.85 in women and ≥0.90 in men. The WHRt was generated

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by calculating the ratio of waist to height (cm). It was considered normal when WHRt <0.5, and elevated when WHRt ≥0.5.

2.5. *Data Analysis*

Data was captured using MS Excel and described by comparing means and standard deviations. Statistical tests were analyzed using SPSS version 26 for both capture and analysis, as well as for generating tables and graphs. Descriptive data (mean, standard deviation, and 95 % confidence interval were generated, and data normality was assessed using the Kolmogorov-Smirnov test. Parametric statistics (t-test) were used for data with a normal distribution. Kruskal-Wallis, chi-square (χ^2), and Spearman's Rho correlation were applied for nonparametric data. Effect size was calculated with Cohen's d for two means comparison, and partial eta square was calculated for the Kruskal-Wallis test, as well as the *post hoc* Bonferroni test. A significance level of 0.05 was used to assume statistical differences.

3. Findings and Results

The total number of students evaluated was 295, of which 107 were men, and 188 were women, and they are grouped by academic department in Table 1.

Table 1

Participants by academic department

	Total	Women	Men
Total	295	188	107
Economic	82	48	34
Architecture	20	14	6
Health	104	80	24
Engineering	9	8	1
Social	80	45	35

The overall students and separated by sex evaluated are presented in Table 2. The mean age was 18.53 ± 2.10 years; height in women 162.9 ± 6.09 cm and 175.73 ± 7.14 cm in men, and weight was 63.23 ± 13.19 kg in women and 76.02 ± 15.39 kg in men. All variables presented normality and independent sample t test parametric analysis was implemented.

According to the data, the BMI presented by all female students was 23.82 ± 4.62 kg/m^2 and male students had a BMI of 24.54 ± 4.45 kg/m^2. Age, height, and weight presented significant differences ($p < 0.05$) by sex. Effect sizes were 0.31, 1.93, and 0.89, respectively. BMI, WHR, and WHRt did not present statistical differences between sex.

Table 2

General and anthropometric characteristics of participants

	Total (n=295) $\bar{x} \pm ds$	Women (n=188) $\bar{x} \pm ds$	Men (n=107) $\bar{x} \pm ds$	p*
Age (y)	18.53 ±2.10	18.27 ± 1.34	18.99 ± 2.96	0.005[1]
Height (cm)	167.56 ± 8.95	162.90 ± 6.09	175.73 ±7.14	<0.001[2]
Weight (kg)	67.87 ± 15.30	63.23 ± 13.19	76.02 ± 15.39	<0.001[3]
BMI (kg/m^2)	24.08 ± 4.56	23.82 ± 4.62	24.54 ± 4.45	0.193
WHR	0.78 ± 0.07	0.76 ± 0.06	0.82 ± 0.67	0.138
WHRt	0.47 ± 0.07	0.47 ± 0.08	0.48 ± 0.07	0.989

Test used: independent samples t-test. Mean ± standard deviation is presented. BMI: Body mass index; WHR: Weight-hip ratio; WHRt: Weight-height ratio. Cohen's d effect size: [1]= 0.31; [2]= 1.93; [3] = 0.89.

Table 3 shows the BMI by sex and classification of underweight (<18.5 kg/m^2), normal weight (18.5 to 25 kg/m^2), overweight (>25 and <30 kg/m^2), and obesity (>30 kg/m^2). 45.8 % of students present malnutrition, and when

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analyzed by sex, the levels were 46.7 % of men and 45.2 % of women. 38 % of the participants presented overweight and obesity, being 35.6 % in women and 42.1 % in men.

Table 3

Nutritional status of participants

	Total	Women	Men
Underweight	23	18	5
Healthy weight	160	103	57
Overweight	79	45	34
Obesity	33	22	11

Table 4 shows percentages of WHR and WHRt according to the cut-offs established as normal values, for the WHR, < 0.85 in women and < 0.90 in men, and for the WHRt, < 0.5 in all students.

Table 4

Percentages of normal and elevated WHR and WHRt of participants

	Women (%)	Men (%)
WHR Normal	92.65	89.04
WHR High	7.35	10.96
WHRt Normal	66.91	64.38
WHRt High	33.09	35.62

WHR = Waist hip ratio; WHRt = Waist-height ratio.

Table 5 shows the frequency of food consumption by the academic department. Date presented non-normal distribution, therefore, mean and 95 % confidence interval (CI) are presented, and the Kruskal-Wallis non-parametric test was implemented. The mean and 95 % CI are presented for the following main food groups: dairy (milk and cheese), vegetables, fruits, animal-based foods (ABF), processed foods, alcohol, and junk food. There is no statistical difference in the consumption of dairy products, vegetables, fruits, alcohol, and junk food by academic department ($p>0.05$). However, there is a statistical difference in the consumption of animal-based and processed foods ($p<0.05$). Regarding the consumption of animal-based foods, the test shows a statistical difference between economics and the engineering department (mean of 17.40 95 % CI 15.70-19.00 vs. 11.80 CI 95 % 8.17-15.50, respectively). Health and social sciences departments showed a statistical difference in the consumption of processed food (8.15 CI 95 % 6.94-9.36 vs. 10.70 CI 9595 % 9.36-12.1, respectively) ($p=0.029$).

Table 5

Frequency of food consumption by academic department

	Total (n=295) $\bar{x}$ (CI 95 %)	Architecture (n=20) $\bar{x}$ (CI 95 %)	Economic (n=82) $\bar{x}$ (CI 95 %)	Engineering (n=9) $\bar{x}$ (CI 95 %)	Health (n=104) $\bar{x}$ (CI 95 %)	Social (n=80) $\bar{x}$ (CI 95 %)	p+
Dairy	7.13 (6.71-7.56)	6.43 (4.55-8.32)	6.94 (6.17-7.71)	5.41 (3.22-7.61)	7.08 (6.32-7.83)	7.78 (6.96-8.60)	0.139
Vegetables	5.83 (5.33-6.34)	5.08 (3.46-6.71)	6.49 (5.51-7.47)	3.83 (1.87-5.79)	5.05 (4.33-5.77)	6.59 (5.41-7.76)	0.102
Fruit	6.92 (6.43-7.42)	6.40 (4.40-8.39)	6.50 (5.59-7.40)	7.00 (4.20-9.79)	6.56 (5.77-7.34)	7.97 (6.87-9.07)	0.204
ABF*	15.90 (15.00-16.70)	14.70 (11.40-17.90) [ab]	17.40 (15.70-19.00) [a]	11.80 (8.17-15.50) [b]	14.70 (13.30-16.10) [ab]	16.70 (14.90-18.50) [ab]	*0.029*[1]
Proceed	8.77 (8.10-9.45)	9.53 (7.39-11.60) [ab]	7.50 (6.49-8.50) [a]	8.19 (3.18-13.20) [ab]	8.15 (6.94-9.36) [a]	10.70 (9.36-12.10) [b]	*0.002*[2]
Alcohol	1.28 (0.97-1.58)	0.46 (0.13-0.78)	1.55 (0.83-2.28)	0.44 (-0.50-1.46)	0.86 (0.51-1.21)	1.84 (1.14-2.53)	0.054
Junk	14.20 (13.20-15.20)	13.00 (10.70-15.30)	13.50 (11.90-15.20)	10.00(3.36-16.80)	13.30 (11.70-14.90)	16.80 (14.30-19.20)	0.177

* ABF=Animal-based food. Data is presented as means and 95 % confidence intervals. + Kruskal-Wallis test is used to compare means, and the Bonferroni *post hoc* test was performed. Partial eta square: [1] =0.034; [2]=0.05.

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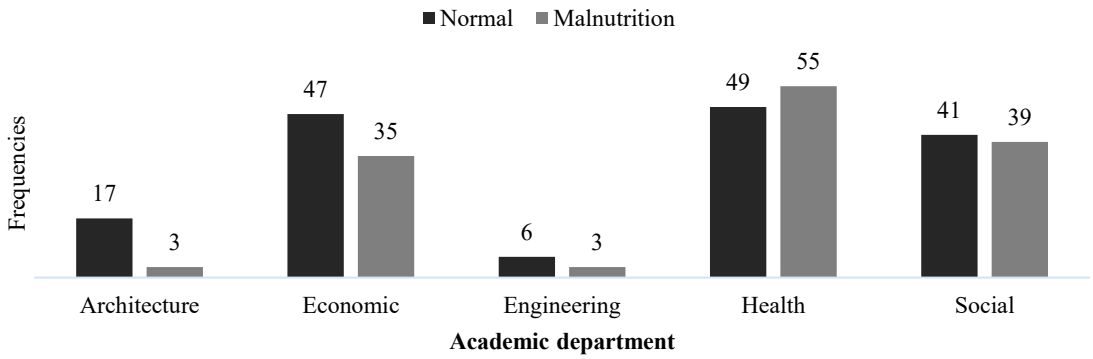
Figure 1 shows the frequency of participants by nutritional status and academic department. The results reflect the presence of underweight, overweight, and obesity in all academic departments evaluated. The architecture department had the lowest rate of malnutrition, with 3 out of 20 individuals (15 %); economics had 35 out of 82 students with malnutrition (42.7 %); engineering had 3 out of 9 individuals (33.3 %); social sciences had 39 out of 80 individuals with malnutrition (48.8 %); and, finally, health had the highest number of people with malnutrition, with 55 out of 104 individuals (52.9 %), noticing having the highest rate. χ^2 statistical test showed a dependency between nutritional status and academic department ($\chi^2 = 10.912$, p = 0.028).

Figure 1

Dependence between nutritional status and academic department. No parametric χ2 test = 10.912, p=0.028



χ2 = 10.912, p = 0.028

Finally, a correlation test was performed (Table 6) considering all participants. Since the data presented non normal distribution, Spearman's Rho test was run. Significative correlations were found in Weight (kg) and BMI (kg/m^2) (R = 0.857, p < 0.001), consumption of processed foods and junk food (R = 0.765, p < 0.001), dairy and processed foods consumption (R = 0.436, p < 0.001), dairy and fruit consumption (R = 0.324, p < 0.001), dairy and animal foods (R = 0.349, p < 0.001), dairy and junk food (R = 0.344, p < 0.001), vegetables with fruits (R = 0.314, p < 0.001), vegetables with animal-based foods (R = 0.318, p < 0.001), processed foods and animal-based foods (R = 0.317, p < 0.001), and animal-based foods and junk food (R = 0.341, p < 0.001).

Table 6

Correlations between weight, BMI, and frequency of food consumption

	Weight (kg)	BMI (kg/m^2)	Dairy	Vegetables	Fruit	ABF*	Processed	Alcohol	Junk food
Weight (kg)	--	0.86*	-0.05	0.02	-0.13*	0.03	-0.03	0.09	-0.03
BMI (kg/m^2)	0.86*	--	-0.07	0.02	-0.12*	-0.01	-0.10	0.02	-0.11
Dairy	-0.05	-0.07	--	0.18*	0.32*	0.35*	**0.44***	0.08	0.34*
Vegetables	0.02	0.02	0.18*	--	0.31*	0.32*	0.14*	0.10	0.15*
Fruit	-0.13*	-0.12*	0.32*	0.31*	--	0.28*	0.26*	0.03	0.22*
ABF*	0.03	-0.01	0.35*	0.32*	0.28*	--	0.32*	0.15*	0.34*
Processed	-0.03	-0.11	**0.44***	0.14*	0.26*	0.32*	--	0.27*	***0.77****
Alcohol	0.09	0.02	0.08	0.10	0.03	0.15*	0.27*	--	0.28*
Junk food	-0.03	-0.11	0.34*	0.15*	0.22*	0.34*	***0.77****	0.28*	--

1 0 -1

*BMI: Body mass index; ABF: Animal-based foods. Spearman's Rho test is used. * p <0.05.*

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4. Discussion

University life presents conditions associated with student's habits capable of negatively affecting and influencing lifestyle changes, as well as increasing chances for cardiovascular risk factors (6).

Anthropometric measurements provide objective information on the nutritional status of individuals. Thus, although overall students BMI are normal, 38 % are overweight or obese, results like those found by Yaguachi-Alarcón *et al*. (7) and the Chilean students studied by Moral *et al*. (13), in addition to the values found being higher in men than in women, also coinciding with the study by Gamarra *et al*. (14) showing a consistency in Latin-American students nutritional status and highlighting the promotion of nutritional programs to prevent NCDs.

WHR and WHRt values show the distribution of abdominal fat, which allows the estimation of visceral fat accumulation. Women tend to accumulate higher fat in the hips, buttocks, and thighs, which leads to a lower WHR than men. In this way, WHR values in women of this study were like those found by Zurita *et al*. (11) in their study, where they calculated WHR and WHRt to evaluate fat distribution in students. On the other hand, Guzmán-Muñoz *et al*. (10) investigated the relationship between the perception of physical condition and anthropometric measurements in a student population, obtaining slightly higher values in both WHR and WHRt than those found in our study. The difference may lie in the fact that their data were entirely self-reported.

The eating habits of university students found in this study show poor nutritional practices. Although statistical differences were found in two groups (animal-based food and processed foods) between academic departments, all groups had a deficient consumption of healthy foods belonging to the dairy, vegetable, and fruit groups, and, in turn, a high consumption of junk food and processed foods. This unhealthy habit is common in the general Mexican population. Gaona-Pineda *et al*. (15) reported the consumption of different food groups by the Mexican population, reflecting a high fraction of the Mexican population that consumes sugary beverages and, on the other hand, a very low fraction in the consumption of healthy foods. Cortez-Belmares *et al*. (16) reported in their study of 354 university students that only 13.8 % of the participants maintained a good eating habit index, while 73.5 % showed a regular index and 12.7 % a poor index. This behavior is constant in different regions according to several studies (17-20).

Healthy eating habits in college students are key to maintaining health during adulthood. Good eating habits that include a high consumption of fruits and vegetables, accompanied by a low consumption of processed foods or foods high in saturated fat and simple sugars, promote better health. The effect of poor eating habits on NCDs such as obesity, type 2 diabetes, and cardiovascular disease is well known (9). Likewise, a good diet allows better academic performance due, in part, to better concentration and alertness during academic activities, as well as better control of academic stress and mental health found in college students (21). However, despite the awareness of such problems in university study, poor eating habits continue to prevail, so action is needed at different levels (family, social, and political). Strategies such as tax implementation on sugary drinks (22), warning labels on foods high in sugars, saturated fat, and energy (23), as well as the prohibition of junk foods in school environments, are promising strategies that could be reinforced or adapted in university environments. Some of these strategies are suggested by the WHO on its "WHO acceleration plan to stop obesity" as well as promote evidence-based approaches to reduce obesity on a public health basis (24). Organizations such as the OECD highlight different options to promote groups and stakeholders to reduce obesity with strategies as well as school-based and workplace-based interventions, interventions in the sport sector, healthcare setting, among other urban and information policies (25).

The consumption of different food groups showed correlations between them. Strong correlations were found between weekly consumption of dairy products and processed foods, as well as consumption of processed foods and junk foods. On the other hand, significant correlations were found between weight and BMI with fruit consumption, but at a very low level. The strong positive correlation between the consumption of processed foods and junk foods can be explained by the convenience of eating. Processed and junk foods are relatively inexpensive and practical for students, who may have little time to prepare

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their meals. Cortez-Belmares *et al*. (16) reported that almost a third of university students (28.5 %) eat fewer than three meals a day.

Previous studies have identified correlations between anthropometric, lifestyle, and body composition indicators (26). However, according to our literature review, there is a lack of studies available on the correlation between dietary intake and anthropometric variables in Mexican university students. O'Leary *et al.* (27) demonstrated that nutritional knowledge is related to dietary intake. This suggests that it is important to assess nutritional knowledge to promote healthy habits and foster nutritional education strategies.

This study considers non-probabilistic sampling, which is considered a limitation. However, it relies on an important sample size that provides reliable insight into the situation of university students at the Autonomous University of Occident. Information from various academic departments is available, allowing for the identification of the nutritional status of the different areas. This study allows the corresponding departments to understand the situation of their students and focus on the potential impact (academic performance, mental state, physical health, academic retention, etc.). Additionally, the student status presented in this study could reflect the general student population in Sinaloa. It is important to note that further studies are needed to understand the effect that poor eating habits and nutritional status could have on these and other variables of interest (socioeconomic level, food availability, food culture) to university students and the institution. The university stage is key to developing healthy habits, as it is where, as adults, students will continue their professional lives. Another study limitations are identified in this research: anthropometric self-reported data, which reduces accuracy; the cross-sectional design, where more than one measure could contribute to assessing the changes in habits; the absence of biomedical markers, because they could support the obtained data with other instruments; and the non-random sampling, because cases that could be relevant may have been omitted.

5. Conclusion

In conclusion, the rate of malnutrition among university students is high and is related to the academic department under study. The eating habits of young university students are characterized by a poor intake of healthy foods and a high consumption of processed and junk food. Overall, correlations between some food groups consumption exist, being strong on junk and processed food. The students' inadequate lifestyle habits could be a risk factor for the development of both cardiovascular diseases and NCDs in the long term. Therefore, it is recommended that educational institutions establish programs to promote balanced diets among university students.

Authors' Contributions

All authors contributed to the study equitably. Material preparation, data collection, and analysis were performed collaboratively. The first draft of the manuscript was written jointly, and all authors critically revised subsequent drafts and translations.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The research followed the ethical standards established in the Declaration of Helsinki for research in human subjects. Written informed consent was obtained from all participants.

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