AN ANTHROPOMETRIC AND PHYSICAL CONDITION ASSESSMENT OF UNIVERSITY STUDENTS ATTENDING A FOOD ASSISTANCE PROGRAM IN COLOMBIA

Carlos Fernando Gómez-Londoño[1]
Clara Helena González-Correa[2]

ABSTRACT

The university life implies significant changes in the food habits and physical activities. The university students usually don't fulfill neither the recommended nutritional requirements nor the physical condition advises. The objective of this study was to evaluate the nutritional state and physical condition in Colombian university students attending to a food assistance program. It was a descriptive cross-sectional study with undergraduate students from the University of Caldas, Colombia. Anthropometric measurements (e.g. height, weight, biceps, triceps, subscapular and suprailiac skinfolds, arm and waist circumferences) were taken. Besides, functional manual pressure tests and the Harvard step test were performed. The correlation between anthropometrical and functional variables was calculated. According to the Body mass index (BMI), 22.4% from 420 students had malnutrition. The weight excess was 3.6 times bigger than undernourishment (17.9 compared to 4.5%). However, when the body fat was measured the situation got worse: the 46.4% of them had fat excess. The women were the most affected. The waist circumference showed a fat distribution with abdominal predominance in 14% of the population. The forearm strength and muscle mass were decreased in almost the 50% of men and 30% of women. The physical condition was inappropriate for the 38.1% of participants with a greater alteration in the men. Contradicting the assumptions, it has found out that around 50% of the public university students and beneficiaries of a food assistance program had body fat excess and an inappropriate physical condition. Efforts to improve the physical activity and food habits must be carried out. At the same time, the impact of the malnutrition in health and academic efficiency must be reduced.

Key words: hand strength, nutrition assessment, physical fitness, college students, food assistance, food insecurity.

[1] Médico. Semillero del Grupo de Investigación en Bioimpedancia Eléctrica, Universidad de Caldas. Manizales, Colombia. E-mail: gomezlondonoc@gmail.com ⓘ ORCID: 0000-0003-3844-5964
[2] PhD. Nutrición. Departamento de Ciencias Básicas para la Salud, Grupo de Nutrición, Metabolismo y Seguridad Alimentaria, Universidad de Caldas. Manizales, Colombia. E-mail: clara.gonzalez@ucaldas.edu.co
ⓘ ORCID:0000-0001-5621-2166

Carlos Fernando Gómez-Londoño, Clara Helena González-Correa

EVALUACIÓN ANTROPOMÉTRICA Y DE LA CONDICIÓN FÍSICA EN ESTUDIANTES UNIVERSITARIOS, BENEFICIARIOS DE UN PROGRAMA DE ASISTENCIA ALIMENTARIA EN COLOMBIA

RESUMEN

La etapa universitaria conlleva cambios significativos en los hábitos de alimentación y en la actividad física. Los estudiantes universitarios usualmente no cumplen los requerimientos nutricionales ni de condición física recomendados. El objetivo del presente estudio fue evaluar el estado nutricional y la condición física de estudiantes de universidad pública, pertenecientes a un programa de asistencia alimentaria. Como método investigativo se empleó un estudio descriptivo de corte transversal en estudiantes de pregrado de la Universidad de Caldas, Colombia. Se realizaron mediciones antropométricas de estatura, peso, pliegue bicipital, tricipital, subescapular y suprailiaco, circunferencia de la cintura y del brazo. Además, se realizaron pruebas funcionales de fuerza de prensión manual y test de banco de Harvard. Se calcularon las correlaciones entre variables antropométricas y funcionales. De acuerdo al índice de masa corporal, de 420 estudiantes, 22,4% presentaban malnutrición. El exceso de peso fue 3,6 veces mayor que la desnutrición (17,9 vs. 4,5%). Sin embargo, al medir la grasa corporal la situación empeoró: el 46,4% de ellos tenían exceso de grasa, siendo las mujeres las más afectadas. La circunferencia de la cintura mostró una distribución de la grasa con un predominio abdominal en el 14% de la población. La fuerza y la masa muscular del antebrazo estuvieron disminuidas en casi el 50% de los hombres y el 30% de las mujeres. La condición física fue inadecuada en el 38,1% de los estudiantes y fue mayor en los hombres. Contrario a lo que podría suponerse en estudiantes de una universidad pública y beneficiarios de un programa de asistencia alimentaria, cerca del 50% presentaron exceso de grasa corporal y una inadecuada condición física. Deben hacerse esfuerzos para mejorar los hábitos de alimentación y actividad física, reduciendo el impacto que tiene la malnutrición en el rendimiento académico y en la salud.

Palabras clave: fuerza de la mano, evaluación nutricional, aptitud física, estudiantes universitarios, asistencia alimentaria, inseguridad alimentaria.

LIST OF ABBREVIATIONS

%BF: Percentage of body fat.
%HGS: Percentage of handgrip strength adjusted to reference values.
AMA: Arm muscle area.
BMI: Body mass index.
ENSIN: Colombian National Survey of Nutritional Situation in 2010.
HGS: Handgrip strength.
IDF: International Diabetes Federation.
IPAQ: International physical activity questionnaire.
PC: Physical condition.
UC: Universidad de Caldas, Colombia.
WC: Waist circumference.

INTRODUCTION

Despite the preventive efforts made by the local government, Colombia has an epidemiological situation dominated by a growing prevalence of changeable risk factors for cardiovascular diseases in young adults, such as obesity, physical inactivity, alcohol consumption, and smoking habits (1, 2).

This situation has been revealed in the last Colombian National Survey of Nutritional Situation in 2010 (ENSIN, for its initials in Spanish), which showed a raise in obese and overweight people from 45.9% to 51.2% between 2005 and 2010 in those aged between 18 to 64 years, with higher rates in women (55.2% versus 45.6%). Moreover, the highest prevalence of abdominal obesity was seen in men of urban area (52.5%). In addition, an alarming rate of sedentary life style was also found. About this important factor in obesity, it was found that 46.5% of people aged 18-64 years did not meet the 150 minutes per week of regular exercise as recommended (1).

This situation was reported by the Food and Agriculture Organization (FAO) in 2001 for Colombia and by ENSIN in 2010 (1, 3). These reports establish that Colombians consume 20 percent of their energy from sweeteners because a raise in soda drinks consumption from 4% to 15% from 1985 to 1995 (3). Even more, there was a raise in the consumption of saturated fats from 4% to 10% of the population, in the period comprehended between the years of 1964 and 1998. Besides, 71.9% of people do not consume fruits and vegetables daily (1).

University years represent a period of high responsibility in different aspects of life. Food choice and practice of healthy lifestyles acquired in childhood usually change (4). College students have long periods of inactivity and tend to reach unhealthy eating habits such as skipping meals, eating small amounts of vegetables, fruits and fish. Instead of healthy food, they have an increased the intake of energy-dense foods that are high in fat (5), salt and sugars but low in vitamins, minerals and vital micronutrients (6-9).

There are three reasons that influence the food choice in this population: migration to another city with subsequent family uprooting, less available money and time, and the fact that many of them do not have experience choosing, planning and cooking their own food (4, 8).

It is common for university students do not have the intake of many nutrients required (10). Meal and snacking pattern have been shown to give effects on body weight, cognition, cardiovascular outcomes, lipid profiles and carbohydrate tolerance (7), leading to a rise in prevalence of chronic non-transmissible diseases and negative effects in academic performance (11).

Universidad de Caldas (UC), according to state politics, supports the permanence and graduation of vulnerable students by offering them a food subsidy. It consists in giving lunch during weekdays through university restaurants. Students are selected according to their socioeconomic status and afterwards they have an evaluation of their nutritional status.

Thus, the objective of this article is to show the evaluation results of the nutritional status and level of physical fitness of college students in a public university, having assistance from a nutritional program.

MATERIALS AND METHODS

Study design and sample

A descriptive cross-sectional study was carried out, enrolling undergraduate students from the UC. Inclusion criteria were: full time registered students attending to the feeding program, without pregnancy or physical limitations. Ethical considerations for health research studies (Declaration of Helsinki of the World Medical

Carlos Fernando Gómez-Londoño, Clara Helena González-Correa

Association) were taken into account. Also, the approval was obtained from the Research Committee of the University.

Data collection

Anthropometric measurements were made according to Lohman et al. (12). Weight was determined using a digital scale PP2000 Icob-Detecto® –±0.1 kg– (A&D Company, Ltd. Japan) and height through a digital Seca 235 Heightronic® stadiometer –±0.1 kg, ±0.01 cm– (SHORR productions U.S.A). For estimation of percentage of body fat (%BF) in biceps, triceps, subscapula and suprailiac skinfolds were measured three times using a Skyndex, System I® caliper –±0.1 mm– (Caldwell, Justiss & Co. Inc., USA). Arm circumference was measured twice at a midpoint between the acromion and olecranon bones (13). Waist Circumference (WC) was also measured twice at midpoint between the lower rib and the iliac crest using a fiberglass tape (1). Handgrip strength (HGS) was obtained using a Baseline® hydraulic dynamometer –±1 kg– (Fabrication Enterprises Inc., USA) according to parameters of American Association of Hand Therapists (14).

Physical condition (PC) was estimated by the Harvard Step Test (HST), using a metronome Yamaha® (Yamaha Corp. Japan) and two chronometers Polar® (CASIO Inc., USA). The height of the bench was 35 cm for females and 40 cm for males (15).

Overall nutritional state was classified using Body Mass Index (BMI) with cut-off points suggested by the World Health Organization (WHO) (16). WC was used to assess body fat distribution (17) Normal WC values recommended for Colombia by ENSIN were < 80 cm for females and < 90 cm for males (1).

%BF was calculated according to Durnin and Womersley method (18) and reference values by Gallagher et al. were used (19). Arm muscle area (AMA) was calculated according the

reference from Frisancho values, considering under nutrition below the 10th percentile (13, 20). Percentage of HGS was obtained by using values from Mathiowetz et al. (21). Normality was considered as superior to 85% adjusted to sex and age (22). Brohua Index obtained from HST was used to estimate PC (15).
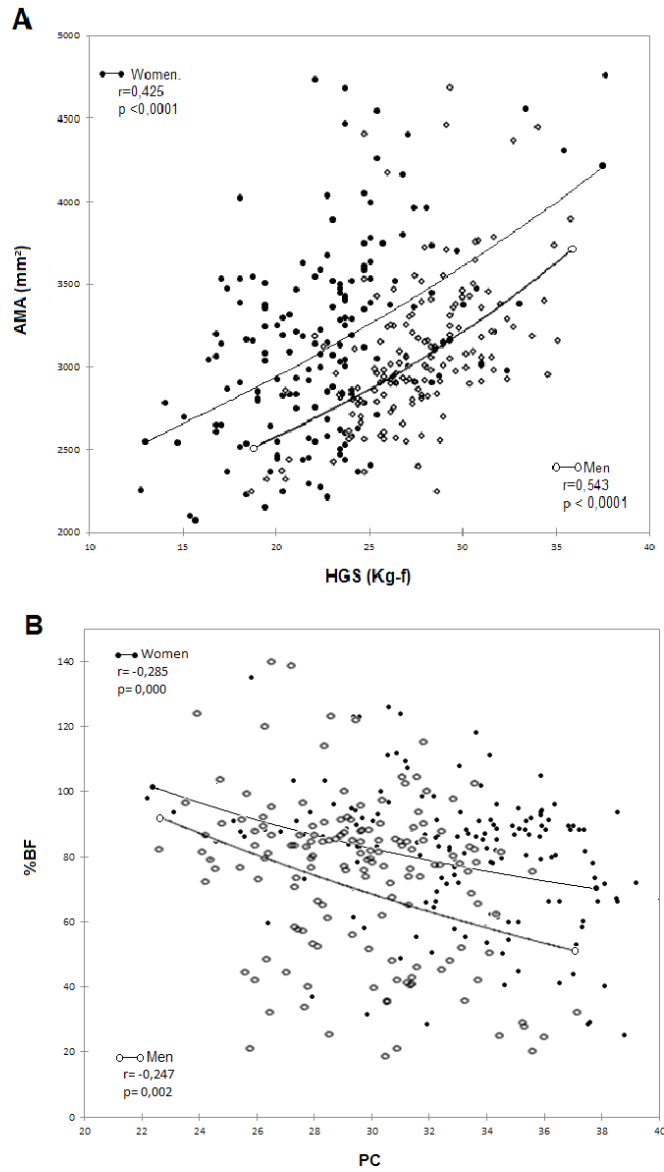
Statistical analysis

Data were analyzed using XLSTAT statistical 2015 for Windows, and the SPSS version 12.0 software (Inc., Chicago, IL, USA). Kolmogorov-Smirnov test was used to check the normality of data. Results were presented according to gender as frequencies and percentages for categorical data and means and standard deviations for continuous variables. Mann-Whitney U Test was used to measure differences between genders on different measurements. Spearman coefficient was used to measure correlation between variables. Tests were carried out using a significance value of 0.05.

RESULTS

A total of 420 students from various regions of Colombia were attending a feeding program. They were also evaluated at the UC. Sample was composed of 203 women (48.3%) and 217 men (51.6%) aged 18-30 years. Anthropometric characteristics are shown in Table 1. Table 2 shows the distribution of nutritional markers according to gender. Table 3 presents the distribution of nutritional and fitness markers adjusted to BMI category. Figure 1, shows the correlation between some variables.

Some significant correlations between anthropometric and functional variables were found. BMI had a strong correlation with %BF in women (r = 0.764) and in men (r = 0.695); and with WC in women (r = 0.836) and in men (r = 0.865). The %BF was correlated with WC in women (r = 0.781), and men (r = 0.769). All correlations had a p < 0.001.

A. Correlation between AMA and HGS by sex. **B**. Correlation between %BF and PC.

Figure 1. Correlation between anthropometric variables and BMI categories by sex.

Carlos Fernando Gómez-Londoño, Clara Helena González-Correa

Table 1. Mean (standard deviation) values for sample characteristics by Sex

VARIABLE	Women	Men	Total	*p*
Age (yr)	21.9±2.7	23.0±3.5	22.5±3.2	0.002
Height (m)	1.57±0.1	1.69±0.1	1.64±0.1	< 0.0001
Weight (kg)	55.6±8.1	64.3±9.1	60.1±9.7*	< 0.0001
BMI (kg/m²)	22.6±3.0	22.4±2.8	22.4±2.9	0.709
%BF (%)	32.0±4.4	18.4±4.6	25.0±8.2*	< 0.0001
WC (cm)	74.3±7.1	78.1±6.9	76.3±7.2	< 0.0001
Hip/waist index	0.79±0.05	0.84±0.05	0.82±0.06	< 0.0001
AMA (mm²)	3163.0±564.3	4868.9±1111.8	4001.5±1223.4	< 0.0001
HGS media (kg-f)	22.5±4.0	34.9±6.2	28.9±8.1*	< 0.0001
%HGS (%)	71.1±12.6	66.9±13.1	68.9±13.0	0.0004
PC	80.8±19.8	76.3±22.8	78.7±21.3	0.042

*Normal simple.

Table 2. Number (Percentage) for variables distribution

Variable	Category	Women	Men	Total
BMI	Underweight	10 (4.9)	9 (4.1)	19 (4.5)
	Normal	150 (73.9)	176 (81.1)	326 (77.6)
	Overweight	39 (19.2)	29 (13.4)	68 (16.2)
	Obesity	4 (2)	3 (1.4)	7 (1.7)
%BF	Underfat	2 (1)	1 (0.5)	3 (0.7)
	Healthy	108 (53.2)	114 (52.5)	222 (52.9)
	Overweight	89 (43.8)	85 (39.2)	174 (41.4)
	Obese	4 (2.0)	17 (7.8)	21 (5.0)
WC	Acceptable	156 (76.8)	205 (94.5)	361 (86)
	Unacceptable	47 (23.2)	12 (5.5)	59 (14)
HGS	Normal	180 (88.7)	20 (9.2)	200 (47.6)
	Deficient	23 (11.3)	197 (90.8)	220 (52.4)
AMA	Normal	137 (76.1)	88 (50.6)	225 (63.6)
	Malnutrition	43 (23.9)	86 (49.4)	129 (36.4)
PC	Good + excellent.	117 (69.2)	83 (53.9)	200 (61.9)
	Regular, + bad, + very bad	52 (30.8)	71 (46.1)	123 (38.1)

Table 3. Number (Percentage), %BF, WC, %HGS, AMA and PC according to BMI and gender

Variable	Category by BMI	Underweight		Normal		Overweight		Obese	
		Women	Men	Women	Men	Women	Men	Women	Men
%BF	Underfat	1 (10)	0 (0)	1 (0.7)	1 (0.6)	0 (0)	0 (0)	0 (0)	0 (0)
	Healthy	9 (90)	9 (100)	95 (63.3)	102 (57.9)	4 (10.3)	2 (6.9)	0 (0)	1 (33.3)
	Overweight	0 (0)	0 (0)	54 (36.0)	69 (39.2)	32 (82.0)	15 (53.7)	3 (75)	1 (33.3)
	Obese	0 (0)	0 (0)	0 (0)	4 (2.3)	3 (7.7)	12 (41.4)	1 (25)	1 (33.3)
WC	Acceptable	10 (100)	9 (100)	135 (90.0)	176 (100)	11 (28.2)	1 (3.4)	0 (0)	2 (66.7)
	Unacceptable	0 (0)	0 (0)	15 (10.0)	0 (0)	28 (71.8)	28 (96.6)	4 (100)	1 (33.3)
%HGS	Normal	1 (10)	0 (0)	14 (9.3)	16 (9.1)	7 (17.9)	4 (13.8)	1 (25)	0 (0)
	Deficient	9 (90)	9 (100)	136 (90.7)	160 (90.9)	32 (82.1)	25 (86.2)	3 (75)	3 (100)
AMA	Normal	4 (44.4)	0 (0)	91 (70.5)	66 (46.8)	38 (100)	21 (84.0)	4 (100)	1 (100)
	Malnutrition	5 (55.6)	9 (100)	38 (29.5)	75 (53.2)	0 (0)	4 (16.0)	0 (0.0)	0 (0.0)
PC	Normal	7 (77.8)	3 (50)	92 (74.8)	70 (55.6)	17 (51.5)	9 (42.9)	1 (25)	1 (100)
	Low	2 (22.2)	3 (50)	31 (25.2)	56 (44.4)	16 (48.5)	12 (57.1)	3 (75)	0 (0)

DISCUSSION

Nutritional status

It was aimed to determine the nutritional status and physical fitness in Colombian ethnically diverse university students, attending to a feeding program at UC. The results showed a population who endures malnutrition problems in 22.4% of the cases according to BMI. Excess weight exceeded 3.6 times the problems of under nutrition. In comparison to another study among university students in Colombia, where the prevalence of overweight and obesity was 3.6 and 0.9% (23), the levels of malnutrition in UC are alarming. Moreover, when assessing the %BF, the real health problem was revealed since 46.4% of evaluated subjects had excess of body fat. These numbers are similar to those found by Diniz Araújo (24) in college students in Brazil. In this study, BMI identified only 1 in 2.5 students presenting body fat excess. This is how, once again, it was demonstrated that BMI underestimates health problems associated with body weight. Different studies have shown that BMI does not discriminate the various components of body composition and tends to underestimate rates of obesity and overweight (25, 26). As the general trend in the country, women had higher weight for height than men, (55.1 vs, 45%) (1). These results are similar to other two studies (7, 27), but differ from most research in which men were more affected by overweight and obesity than women (9, 24, 27-30). However, in Chile another research (31) did not find differences by sex.

Regarding the abdominal obesity, this study showed that one of each 6.6 students had abdominal obesity. This fact was predominantly in women. Another study reported predominance in women with a prevalence of 23% (2). However, some authors found this kind of fat distribution predominantly in men (5, 23, 27). In 2010, Martins et al. reported no difference according to sex (29). Nevertheless our results are based on IDF cut-off values made on Asian population rates that are lower than a recent Colombian study (32) in which authors determined values of 91 cm for men and 89 cm for women with a sensitivity of 89% and 78.9% respectively.

Functional indicators

The use of HGS for evaluation of nutritional and functional states has progressively increased. However, despite its low cost and accuracy, it is rarely used in clinical settings in Colombia, even when it has been recognized as a good instrument to find signs of malnutrition (32). In this study, HGS was particularly decreased in men. In addition, some of them had reduced AMA. It was not found recent reports to compare these issues in university students.

30.8% of women and 46.1% of men were classified as having inadequate physical condition. In other studies, all using questionnaires as the International Physical Activity Questionnaire (IPAQ) were found similar percentages, but mainly in females (23, 24, 29, 31). This may reflect the reports of a sedentary lifestyle in about 79.5% in Colombia (23) and 86-94% in Chile (5, 31).

These findings and available evidence suggest that college life makes college students vulnerable to cardio-metabolic health risks since they engage in eating and physical activity behaviors that which places them in a situation of food insecurity and may adversely affect their body composition, physical condition and academic achievement (25). This problem has been recognized as a major public health situation. Whether or not these effects are attributable to variations in several factors such as stress, body image perturbation, anxiety and drive for thinness, are still controversial (33-37).

From thirteen recent studies reviewed and performed in college students, only four (30.8%) evaluated the %BF and eight (61.5%) measured the WC, two (15.38%) evaluated level of physical activity based on subjective tests. None assessed HGS or AMA. Thus, the present study may inform, with greater confidence, nutritional states, body composition and some functional aspects of college students.

Despite these facts explained above, the study has limitations: it was performed with a population chosen for its poor socioeconomic status. The reference values used in this research were made originally for other populations.

CONCLUSIONS

As BMI may underestimate the number of subjects with body fat excess, it is necessary to use different and accessible tools such as %BF and HGS to have an exhaustive assessment. The fact that students were from low socioeconomic levels did not imply that thinness predominated. In fact, alarming levels of obesity and overweight were found in this population. Having the purpose of supply daily-recommended nutritional intakes, without exceed the total amount of calories; feeding assistance programs in universities should be focused on food quality more than on quantity. These programs should also be evaluated for their impact on university students.

RECOMMENDATIONS

Some low-cost, precise, reliable and broadly applicable screening tools are necessary to make a comprehensive nutritional assessment in population field studies and in clinical practice (such as %BF by skin folds, AMA and HGS). Results emphasize the need for healthy nutrition and physical activity courses or programs, either compulsory or optional for first year university students.

ACKNOWLEDGEMENTS

INTEREST CONFLICT

The authors declare have neither conflict of interests nor any financial relationships with corporations or with non–profit organizations.

REFERENCES

1. Instituto Colombiano de Bienestar Familiar –ICBF–. Encuesta Nacional de Salud y Nutrición ENSIN [Internet]; 2010. Available in: http://www.icbf.gov.co/portal/page/portal/PortalICBF/Bienestar/ENSIN1/ENSIN2010/LibroENSIN2010.pdf

2. Alvarado C, Molina DI, Zárate A, Toro E. EPRAS Study: population-based study of cardiovascular risk in a Colombian population. Rev. Colomb. Cardiol. 2014;21(5):284-293.

3. United Nations for Food and Agriculture. Nutrition profiles by country - Colombia [Internet]. FAO; 2001. ESNA, Fajardo LF. Available in: ftp://ftp.fao.org/es/esn/nutrition/ncp/col.pdf

4. Karlen G, Masino MV, Fortino MA, Martinelli M. Breakfast consumption among university students: habit, nutritional quality and relationship with body mass index. Diaeta. 2011;29(137):23-30.

5. Durán-Agüero S, Bazaez-Díaz G, Figueroa-Velásquez K, Berlanga-Zúñiga MR, Encina-Vega C, Rodríguez-Noel MP. Comparison between the quality of life and nutritional status of nutrition students and those of other university careers at the Santo Thomas University in Chile. Nutr Hosp. 2012;27(3):739-746.

6. Durán-Agüero S, Reyes-García S, Gaete MC. Vitamin and minerals consumed food group by Chilean university students. Nutr Hosp. 2013;28(3):830-838.

7. Abdull-Hakim NH, Muniandy ND, Danish A. Nutritional status and eating practices among University students in selected universities in Selangor, Malaysia. Asian J. Clin. Nutr. 2012;4(3):77-87.

8. Rodríguez F, Palma X, Romo A, Escobar D, Aragú B, Espinoza L, et al. Eating habits, physical activity and socioeconomic level in university students of Chile. Nutr Hosp. 2013;28(2):447-455.

9. Zaccagni L, Masotti S, Donati R, Mazzoni G, Gualdi-Russo E. Body image and weight perceptions in relation to actual measurements by means of a new index and level of physical activity in Italian university students. J Transl Med. 2014;12:42.

10. Vargas-Zárate M, Becerra-Bulla F, Prieto-Suárez E. Evaluating university students' dietary intake in Bogotá, Colombia. Rev. salud pública. 2010;12(1):116-25.

11. Córdoba LG, Luengo LM, García V. Analysis of knowledge about healthy breakfast and its relation to life style habits and academic performance in compulsory secondary students. Endocrinol Nutr. 2014;61(5):242-51.

12. Lohman TG, Roche AF, Martorell R. Anthropometric standardization reference manual. Abridged; 1991.

13. Frisancho AR. New norms of upper limb fat and muscle areas for assessment of nutritional status. Am J Clin Nutr. 1981;34(11):2540-5.

14. Tyler H, Adams J, Ellis B. What can handgrip strength tell the therapist about hand function? J Hand Ther. 2005;10(1):4-9.

15. McArdle WD, Match VI. Essentials of Exercise Physiology. 3rd Ed. Lippincott Williams & Wilkins Publ; 2006. Available in: https://books.google.com.co/books?id=L4aZIDbmV3oC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

16. WHO. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. WHO Technical Report Series 894. Geneva: World Health Organization; 2000.

17. Waist Circumference and Waist–Hip Ratio Report of a WHO Expert Consultation, Geneva, 8-11 December 2008.

18. Durnin JV, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br J Nutr. 1974;32(1):77-97.

19. Gallagher D, Heymsfield SB, Heo M, Jebb SA, Murgatroyd PR, Sakamoto Y. Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index. Am J Clin Nutr. 2000;72(3):694-701.

20. Corvos-Hidalgo CA. Anthropometric assessment of nutritional status using the circumference of the arm in university students. Nutr. Clin. diet. hosp. 2011;31(3):22-27.

21. Mathiowetz V, Kashman N, Volland G, Webber K, Dowe M, Rogers S. Grip and Pinch Strength: Normative Data for Adults. Arch Phys Med Rehabil. 1985;66(2):69-74.

22. Bragagnolo R, Caporossi FS, Dock-Nascimento DB, Eduardo de Aguilar-Nascimento J. Handgrip strength and adductor pollicis muscle thickness as predictors of postoperative complications after major operations of the gastrointestinal tract. E-SPEN. 2011;6(1):e21-e26.

23. García-Gulfo MH, García-Zea JA. Cardiovascular risk factor prevalence in university students. Rev Salud Pública. 2012;14(5):822-30.

24. Diniz Araújo ML, Coelho Cabral P, Kruze Grande de Arruda I, Siqueira Tavares Falcão AP, Silva Diniz A. Body fat assessment by bioelectrical impedance and its correlation with anthropometric indicators. Nutr Hosp. 2012;27(6):1999-2005.

25. Webb JB, Hardin AS. A preliminary evaluation of BMI status in moderating changes in body composition and eating behavior in ethnically-diverse first-year college women. Eat Behav. 2012;13(4):402-5.

26. Pasco JA, Holloway KL, Dobbins AG, Kotowicz MA, Williams LJ, Brennan SL. Body mass index and measures of body fat for defining obesity and underweight: a cross-sectional, population-based study. BMC Obes. 2014;1:9.

27. Ledo-Varela M.T, de Luis-Román DA, González-Sagrado M, Izaola-Jauregui O, Conde-Vicente R, Aller de la Fuente R. Nutritional characteristics and lifestyle in university students. Nutr Hosp. 2011;26(4):814-18.

28. Ratner R, Hernández P, Martel J, Atalah E. Food quality and nutritional status in university students of eleven Chilean regions. Rev Med Chile. 2012;140(12):1571-79.

29. Martins Mdo C, Ricarte IF, Rocha CH, Maia RB, Silva VB, Veras AB, Filho MD. Blood pressure, excess weight and level of physical activity in students of a public university. Arq Bras Cardiol. 2010;95(2):192-9.

30. Huda N, Ahmad R. Preliminary Survey on Nutritional Status among University Students at Malaysia. Pak. J. Nutr. 2010;9(2):125-27.

31. Martínez MA, Leiva AM, Sotomayor C, Victoriano T, Von-Chrismar AM, Pineda S. Cardiovascular risk factors among university students. Rev Med Chile. 2012;140(4):426-35.

32. Buendía R, Zambrano M, Díaz A, Reino A, Ramírez J, Espinosa E. Waist circumference cut-off points for the diagnosis of abdominal obesity in Colombian population by means of bioimpedance as a reference standard. Rev. Colomb. Cardiol. 2016;23(1):19-25.

33. Flood A, Chung A, Parker H, Kearns V, O'Sullivan TA. The use of hand grip strength as a predictor of nutrition status in hospital patients. Clin Nutr. 2014;33(1):106-14.

34. Bruening M, Brennhofer S, van Woerden I, Todd M, Laska M. Factors related to the high rates of food insecurity among diverse, urban college freshmen. J Acad Nutr Diet. 2016. doi: 10.1016/j.jand.2016.04.004.

35. Payne-Sturges DC, Tjaden A, Caldeira KM, Vincent KB, Arria AM. Student Hunger on Campus: Food Insecurity Among College Students and Implications for Academic Institutions. Am J Health Promot. 2017. doi: 10.1177/0890117117719620.

36. Wilson CK, Matthews JI, Seabrook JA, Dworatzek PD. Self-reported food skills of university students. Appetite. 2016;108:270-276. doi: 10.1016/j.appet.2016.10.011.

37. Farahbakhsh J, Hanbazaza M, Ball GDC, Farmer AP1, Maximova K, Willows ND. Food insecure student clients of a university-based food bank have compromised health, dietary intake and academic quality. Nutr Diet. 2017;74(1):67-73. doi: 10.1111/1747-0080.12307.