Research article

Prevalence of hyperlipidemia and its associated factors in university students in Colombia

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A B S T R A C T

The present study aimed to determine the prevalence of hyperlipidemia and its associated factors in the students of the Faculty of Health of Universidad Santiago de Cali in 2017. A descriptive cross-sectional study was performed in a sample of 361 students, with an average age of 21 (16–40) years. A sociodemographic survey was conducted, and blood samples and lipid profiles were obtained. The participants were predominantly female (77%), single (92.5%), and young adults (62.3%) and with an average socioeconomic level (55.1%). The overall prevalence of hyperlipidemia was 33.8%, with the following risk values: triglyceride (TG), 12.8%; hypercholesterolemia, 16.1%; high density lipoprotein cholesterol (cHDL), 15.0%; and low-density lipoprotein cholesterol (cLDL), 42.2%. Using the theory of the logistic regression models and chi-square likelihood ratio tests, the factors that were significantly associated with the risk of hyperlipidemia were male sex and consumption of alcoholic beverages (P-value < 0.05). In the two-way ANOVA, it was observed that the interaction of these two factors for TG was significant (P-value < 0.05), being higher in men who consume intoxicating beverages (Tukey's test, P value <0.05). Regarding cHDL and cLDL, only sex presented a significant effect on their values (P-value < 0.05), while for total cholesterol, none was significant (P-value > 0.05). The results obtained indicate the importance of early detection of blood lipid levels in young people to prevent the early development of noncommunicable diseases.

1. Introduction

According to the latest monitoring of advances in noncommunicable diseases (NCDs) published by the World Health Organization (WHO) after 2017, NCDs are the leading cause of global mortality (70%). NCDs mainly affect the population of adults under 70 years (40%) [1, 2, 3]. The occurrence of these diseases, especially hyperlipidemias, obesity, and high blood pressure (cardio-metabolic diseases), is associated with the risk factors common to unhealthy lifestyles in the population, such as alcohol consumption, smoking, poor diet, and physical inactivity [4].

The WHO statistics indicate that every year, 15 million people aged between 39 and 69 years die from NCDs and more than 80% of these deaths occur in developing countries, disproportionately affecting the poorest population [2]. On the other hand, in Colombia, the mortality between 2011 and 2014 due to NCDs was considered to be 73% of deaths (178,000), with a risk of 15% of premature death [3,5].

NCDs share common risk factors, including biological intermediaries such as hyperlipidemias. These include a set of alterations in blood lipid levels, secondary to genetic factors or lifestyles [6]. Hyperlipidemias are a risk factor for the development of atherogenic disease, of which the prognosis is correlated with the age of the individual, that is, the younger the person, the higher the negative effects on quality of life and life expectancy [7].

Latin America is characterized by ethnic, social, cultural, and economic particularities that distinguish it from other regions of the world and, in conjunction with these factors, during the last decades, Latin America has faced changes in lifestyles that alter the prevalence of NCDs. These changes include the growing trend in the consumption of processed foods with high caloric density, accompanied by a sedentary lifestyle. The combination of these factors has been favoring the incidence of overweight, obesity, and cardio-metabolic diseases such as hyperlipidemias, with significant figures, compared with those recorded in other continents [8].

In addition, the cardiovascular risk factor multiple evaluations in Latin America (CARMELA) study shows a general prevalence of hypercholesterolemia of 12% and a prevalence of dyslipidemia that ranges between 32.8% and 75.5% in the young adult population in seven Latin American cities [9].

The increase in the prevalence of NCDs and their relationship with hyperlipidemias have reached epidemic statistical levels that generate a greater need to monitor their impact on premature mortality, especially in the young adult population [10]. As the study of the global burden of diseases, injuries, and risk factors (GBD) suggests, the years of life lost due to cardiovascular disorders with a metabolic basis, such as coronary ischemic disease and ischemic stroke, increased between 1990 and 2017, moving from the fourth and fifth place to the first cause of death [10,11].

Therefore, the timely identification of NCDs and their monitoring and intervention should be a priority issue in the university contexts and health sector, as NCDs generate years of life lived with disabilities and reduce the maximum potential lifespan of a young individual [12, 13, 14].

In Colombia, the national morbidity rate associated with NCDs of the cardiovascular type is increasing, proposing a significant risk for the young population. Cardio-metabolic risks manifest with the onset of adulthood and are the result of exposure to unhealthy lifestyles for several years. In Colombia, cardiovascular diseases are the leading cause of morbidity in the adult population, the first associated risk factor being sedentary lifestyles, followed by the total cholesterol (cTotal)/HDL ratio >5 and cTotal >200 mg/dL. In the country, there is little recent research on the prevalence of dyslipidemias in the adolescent and young adult population [10,15], which is one of the reasons that makes this study significant. The present study aimed to predict the risk factors for the development of hyperlipidemias in a university population through the evaluation of lifestyles and blood lipid screening. This project is part of the Healthy University model, and it contributes to the strengthening of health promotion and prevention, generates knowledge, and promotes self-care practices for the improvement of lifestyles and behavior modification.

2. Materials and methods

2.1. Individuals and procedures

This study used a descriptive cross-sectional design [11,16], which included a sample of 361 (12% of the population) students of the health school of Universidad Santiago de Cali (USC) in 2017, guaranteeing a level of confidence of 95% and an error average of 5% as it is indicated in equation (1). The selection of the sample was carried out through a simple random sampling [12,17], taking as a sampling frame the list of the students enrolled in the academic programs of the health school, which had current students of the university as a criterion of inclusion.

$$n = \frac{Z^2 * N * p * (1-p)}{e^2 * (N-1) + (Z^2 * p * q)} = \frac{1.96^2 * 3000 * 0.5 * 0.5}{0.05^2 * 2999 + (1.96^2 * 0.5 * 0.5)} = 341 \, students \quad (1)$$

where:

Z: Level of confidence (corresponding to the value Table Z)
e: Maximum accepted estimation error
N: Total of registered students in the health school
P: Percentage of the population with the desired attribute

All participants filled out a structured survey (self-administered) where the sociodemographic aspects were collected: habits, lifestyles, and pathological history. The instrument was validated by expert judgment. Likewise, a lipid control test was carried out, in which a sample of venous blood was extracted without anticoagulant and under fasting conditions for each of the participants, under all biosafety requirements.

Once the blood samples were obtained by professionals and experts, they were processed in a clinic laboratory level IV with high reliability and quality.

The study was approved by the ethics committee of the health school of USC. It followed the international and national ethic normativity for the research related to human beings. All participants over 18 years signed the consent, and those under 18 years signed the informed consent [18, 19, 20, 21].

2.2. Measurements

The sample was stratified according to the age of teenagers (under 20 years) and young adults (between 20 and 40 years), according to the criteria established by the WHO (2019), which define the adolescent as "every person which age ranges between 10 and 19, where systematically occurred physiologic, bio-psychosocial, and cultural changes." [22] The lipid profile was categorized in risk levels according to the NCEP-ATP III guide [13,23,24] for each of the variables as shown in Table 1.

2.3. Statistical analysis

2.3.1. Characterization of individuals

Initially, descriptive data were shown for the sociodemographic (sex, age, socioeconomic level, and marital status) and lipid (cTotal, triglyceride [TG], cholesterol HDL [cHDL], cholesterol LDL [cLDL]) variables, habits, and pathological antecedents. Afterward, the prevalence of individuals with alterations in the lipid profile and its 95% confidence of interval were determined.

2.3.2. Identification of the factors that increased the probability of presenting hyperlipidemia

In the second instance, to identify which factors showed a significant effect in the risk estimation of presenting hyperlipidemia, the logistic regression models were used to predict the behavior of a categorical dichotomous variable or binary (present hyperlipidemia [1] and no present hyperlipidemia [0]) from a set of covariables that can be categorical, discrete, or continuous, being one of their main strengths. These belong to the set of linear generalized models introduced by Nelder and Wedderburn [25] and presented by Dobson and Barnett [26].

Equation (2) presents the analytic form in which the probability of presenting hyperlipidemia is related to explanatory variables:

$$\pi = \frac{1}{1 + exp(-Z)} \; where \; Z = \alpha + \beta_1 X_1 + \dots + \beta_k X_k \quad (2)$$

Where π represents the probability of presenting hyperlipidemia (i.e., P(Y = 1)), $\alpha, \beta_1, \dots, \beta_k$ are the model parameters, and *exp* denotes the exponential function. The expression [2] is what is known as the logistic function. The parameters of the linear regression can be transformed with the function of natural logarithm, and they are interpreted as the relations of odds of the dependent variable (answer variable). The odds corresponding to the ratio between the number of events (number of times that takes the value of 1) and that of no events (number of times that takes the value of 0). The generalized linear model does not have theoretic assumptions over the error distribution but assumes that it is disposed of independent variables Y_i, such that all and each follow the same distribution that belongs to the exponential family.

To determine which factors presented a significant contribution in the explanation of the probability of presenting hyperlipidemia for the population of students and achieve to estimate an adequate model, the procedure of selection of variables was performed using the chi-square test of the likelihood ratio (RV) [27], in which the significance of the variable introduced in the model was evaluated. If the variable was meaningful, it was left in the model, and the process continued with the selection of the next variable to be incorporated, adding separately each

Table 1. Risk levels according to the NCEP-ATP III guide.

Category	Range (mg/dL)
Triglycerides (TG)	
Without risk	<150
Moderate risk	150–199
High risk	≥200
Total cholesterol (cTotal)	
Without risk	<200
Moderate risk	200–239
High risk	≥240
Cholesterol LDL (cLDL)	
Without risk	<100
Moderate risk	100–159
High risk	≥160
Cholesterol HDL (cHDL)	
Without risk	≥60
With risk	<40 (men)
	<50 (women)

one of the other variables until the inclusion of one variable was not signified.

2.3.3. Assessments of the factors that increased the probability of presenting hyperlipidemia in the variables of lipid profile

Finally, a two-way ANOVA was carried out to evaluate the risk factors in each of the variables of the lipid profile in relation to the significant

Table 2. Participants' characteristics (N = 361).

Factors	N (%)
Sex	
Female	278 (77.0)
Male	83 (23.0)
Age group	
Adolescent (16–19 years)	136 (37.7)
Young adult (20–40 years)	225 (62.3)
Socioeconomic level	
Low	118 (32.7)
Medium	199 (55.1)
High	44 (12.2)
Marital status	
Single	335 (92.8)
Married/free union	26 (7.2)
Habits and lifestyles	
Do sport or physical activity (yes)	259 (71.7)
Consume alcoholic beverages (yes)	237 (65.7)
Consume cigarettes or tobacco (yes)	22 (6.1)
Use psychoactive substances (yes)	15 (4.2)
Consume hormonal drugs (yes)	81 (22.4)
Consume homemade food (yes)	275 (76.2)
Consume vegetables, fruit and cereals (yes)	341 (94.5)
Consume fried food or with a high content of grease (yes)	320 (88.6)
Consume canned food or cold meats (yes)	250 (69.3)
Consume food rich in carbohydrates and sugar (yes)	342 (94.7)
Pathological history	
Hyperlipidemia diagnosis (yes)	6 (1.7)
Arterial hypertension diagnosis (yes)	1 (0.3)
Thyroid disease diagnoses (yes)	8 (2.2)
History of cardiovascular disease (yes)	25 (6.9)
History of kidney disease (yes)	9 (2.5)
History of liver disease (yes)	6 (1.7)

factors in the estimation of the risk of presenting hyperlipidemia. For the cases in which significant differences were identified, Tukey's test was used to determine among what levels of the factor were the differences about.

In each of the phases described for the data analysis, the statistical software R-3.5.1 was used for the Windows program [28].

3. Results

3.1. Characterization of individuals

The main characteristics of the 361 participants are shown in Table 2. The median ages of the participants were 21.3 ± 3.8 years. Most of the participants were classified as women (77%), young adults (62.3%), medium socioeconomic level individuals (55.1%), and single persons (92.5%). Among the healthy habits, 71.7% of the students "do physical activity," and 76.2% "consume homemade food". However, a contradiction on the eating habits was evidenced, observing similar proportions in the consumption of fruit and vegetables (94.5%) in relation to the food rich in carbohydrates (94.7%) and with high oil content (88.6%). Likewise, high consumption of cold meats and canned food (69.3%) as predisposing factors at a medium-term in the development of NDCs was identified. On the other hand, high consumption of alcoholic beverages was a significant risk factor due to the negative effect that they produced in the liver, which entails an alteration in lipid metabolism. Regarding the pathological antecedents, it is observed that the majority of the students presented a low percentage of morbid preexistence (under 3%).

3.1.1. Prevalence of alteration in the lipid profile

Regarding the lipid profile of participants, the TG level was 100.1 ± 63.6 mg/dL, and the means of cTotal, cHDL, and cLDL were 169.0 ± 32.9, 50.9 ± 11.9, and 97.0 ± 27.6 mg/dL, respectively. Table 3 shows the prevalence (%) of the risk levels for each variable of the lipid profile and its 95% confidence interval. In general, the participants were characterized by having a prevalence of hyperlipidemia of 33.8%, with proportions of risk values in TG, cTotal, and cHDL of 12.8%, 16.1%, and 15%, respectively. Regarding the cLDL, the risk levels were observed with a percentage of 42.2%, which can mean a factor of risk a higher factor for the development of heart disease at a younger age. These levels can be associated with unhealthy lifestyles such as diets rich in grease and sugar.

3.1.2. Identification of the factors that increased the probability of presenting hyperlipidemia

For the construction of the logistic model of the 20 factors presented in Table 2, some factors presented percentages higher than or equal to 5% in their categories (six factors did not meet this condition) and could present an effect over the probability of presenting hyperlipidemia.

Replacing the estimating parameters in Table 4 in equation (2), the probability (risk) of presenting hyperlipidemia in the target population is stated in the following manner:

$$\pi = \frac{1}{1 + exp(-Z)} \tag{3}$$

where. $Z = -0.76 + (0.55 * Sex) + (0.30 * consumption\ of\ alcoholic\ bevarages)$

The Wald test was used to compare the parameters. As can be seen in Table 4, the P values that were associated with the variables sex (male) and consumption of alcoholic beverages (yes) were lower than 0.05. Therefore, the two variables were considered significant. It means that their coefficients were significantly different from 0, their odds ratios (OR) were significantly different from 1, and the confidence intervals for the same ones did not contain 1.

The model parameters were interpreted in terms of quotients of advantage. It is understood that while a specific variable is discussed, the other variables remain fixed.

- *Sex (male)*, presented an *OR of 1.73*, indicating that the risk of hyperlipidemia in men is 1.73 times higher than in women.
- *Consumption of alcoholic beverages (yes)*, presented an *OR of 1.35*, indicating that the risk of hyperlipidemia is 1.35 times higher in students who consume alcoholic beverages than in those who do not.

From these results, two conditions that increased the probability of presenting hyperlipidemia were male sex and the consumption of alcoholic beverages. On the other hand, women and students who did not consume alcoholic beverages were less prone to develop hyperlipidemia.

3.1.3. Assessments of the factors that increased the probability of presenting hyperlipidemia in the variables of lipid profile

When the significant factors (sex and alcoholic beverage consumption) in the risk estimation of presenting hyperlipidemia were identified using the two-way ANOVA (Table 5), it is observed that these factors do not present an effect for cTotal; however, for TG, the interaction between sex and alcoholic beverage consumption was significant (P-value < 0.05, Tukey's multiple comparison test), in which the TG levels were higher in men who consume alcoholic beverages (Table 5); finally, to the cHDL and cLDL, just sex showed a significant effect in its values (Table 5), which can indicate the presence of a protector factor in women for the future development of cardiovascular diseases.

4. Discussion

This research showed that 33.8% of the population presented any of the forms of hyperlipidemias, being more frequent in men (50.6%) than in women (28.8%). These figures are in line with those in the CARMELA study, which reported the prevalence rates of dyslipidemia of 70% and 47.7% in men and women, respectively, in a young adult Colombian population [9].

The obtained results of hyperlipidemias (33.8%) match with investigations developed in South American countries between 2013 and 2017, the general prevalence of which are found related to hyperlipidemias in the young adult population, with maximum values of 87.7% and a minimum of 13.4%, media between (32.0% and 43.5%) [29, 30, 31, 32, 33, 34, 35, 36], and with national studies, the prevalence was from 36.6% to 74.7% [1,10,15,37]. This shows that in the vast majority of low and medium-income countries, the young adult population is potentially vulnerable to the future development of multiple ENTs at an early age.

Regarding specific hyperlipidemias, the prevalence of hypertriglyceridemia was 12.8%, with a higher manifestation in men than in women [29,30,35,38]. To a national level, some studies found prevalence rates of hypertriglyceridemia from 13.8% to 41.8% [1,37], suggesting that the increase in the level of plasmatic lipoproteins rich in TG (LPRTG) and atherogenic particles is the main risk metabolic factor for the development of atherogenic dyslipidemia, states of insulin-resistance, and atherosclerotic disease [8]. Considering these factors as triggers of the main cardiovascular disorders that are increasing in the young adult population, inadequate lifestyles need to be intervened, such as alcoholic beverage consumption that is related to the increase in serum TG levels [8,29].

On the other hand, the increase of cTotal showed a prevalence of 16.1%, which is consistent with the findings of other studies carried out in countries like Mexico, Peru, and Argentina in which high numbers are also shown in this population with high prevalence in the two last countries [29, 30, 31]. They can be associated with the variation of lifestyles, geographic distribution, and use of different criteria in the lipid diagnostic techniques. Hypercholesterolemia is the main cause of arteriosclerosis, hence its early inquiry in the young population is required [8].

Regarding the disorders associated with low cHDL and high cLDL levels, different investigations in young adults in Latin America [29, 30, 31, 32, 33, 34, 35, 36] reported high levels of these lipids, evidencing differences by gender, with a higher percentage of cHDL and cLDL in men than in women. In Colombia, a decrease in the cHDL level between 40.4% and 53.7% and an increase in the cLDL level between 41% and 67.5% were described [7]. This study showed a prevalence of 15% to the cHDL of the students, 37.3% in men, and 8.3% in women. Regarding the cLDL it was observed a prevalence of 42.4% (similar to the figures reported in the country), 33.7% in men, and 45.0% in women, which indicated an early alarm signal for the development against other associated diseases. Studies of prospective cohort show that increases in the cLDL levels at an early age are associated with episodes of ischemic heart disease and signs of subclinical coronary atherosclerosis at an elderly age [39]. Allowing to establish that among the main criteria for the appearance of atherogenic dyslipidemia are included the metabolic disorders of the lipoproteins such as the high concentration of lipoproteins rich in TG (LPRTG), the high serum values of cLDL and the diminished

Table 3. Prevalence of alterations in the lipid profile (N = 361).

Variables	Prevalence (%)	95% confidence interval for prevalence (%)		Sex		Consume alcoholic beverages	
		Lower bound	Upper bound	Female (N = 278)	Male (N = 83)	Yes (N = 237)	No (N = 124)
Hyperlipidemia (yes)	33.8	25.4	42.2	28.8	50.6	38.0	25.8
Triglycerides							
Without risk (<150 mg/dL)	87.3	83.6	90.9	88.8	81.9	84.8	91.9
Moderate risk (150–199 mg/dL)	7.5	0.0	17.4	7.6	7.2	8.0	6.5
High risk (≥200 mg/dL)	5.3	0.0	15.3	3.6	10.8	7.2	1.6
Total cholesterol							
Without risk (<200 mg/dL)	83.9	79.8	88.1	83.8	84.3	81.0	89.5
Moderate risk (200–239 mg/dL)	12.5	2.8	22.1	12.6	12.0	14.8	8.1
High risk (≥240 mg/dL)	3.6	0.0	13.7	3.6	3.6	4.2	2.4
Cholesterol LDL							
Without risk (<100 mg/dL)	57.6	50.9	64.3	55.0	66.3	40.9	37.1
Moderate risk (100–159 mg/dL)	39.6	31.6	47.6	42.1	31.3	56.1	60.5
High risk (160 mg/dL)	2.8	0.0	12.9	2.9	2.4	3.0	2.4
Cholesterol HDL							
Without risk (≥60 mg/dL)	19.1	9.8	28.4	23.7	3.6	18.6	20.2
Of risk (<40 mg/dL)	15.0	5.4	24.5	8.3	37.3	16.9	11.3
Between 40 to 60 mg/dL	65.9	59.9	71.9	68.0	59.0	64.6	68.5

Table 4. Parameter estimation for the probability of presenting hyperlipidemia.

Explanatory variable	Coefficient	Error standard	Wald	P value	OR	95% confidence interval for EXP(B)	
						Lower bound	Upper bound
Intercept	-0.76	0.13	-5.96	0.000**	0.47	-	-
Sex (male)	0.55	0.16	3.41	0.000**	1.73	1.26	2.36
Average of alcoholic consumption (yes)	0.30	0.15	2.02	0.044*	1.35	1.01	1.81

*P value < 0.05; **P value < 0.01.

Table 5. Two-way ANOVA: Comparison of means of lipid parameters regarding sex and alcoholic beverage consumption.

Lipid parameters	Sex				Alcoholic beverage consumption				Interaction (sex*alcoholic beverage consumption)	
	Mean		F	P value	Mean		F	P value	F	P value
	Female	Male			Yes	No				
Total cholesterol	170.8	163.0	3.63	0.057	170.6	165.8	0.131	0.131	0.791	0.374
Triglycerides	92.9	124.0	16.24	0.000**	105.5	87.7	5.49	0.019*	5.22	0.023*
cHDL	53.0	43.8	42.63	0.000**	50.4	52.0	0.32	0.573	0.12	0.725
cLDL	99.0	90.3	6.53	0.011*	97.5	96.1	0.54	0.462	0.33	0.564

*P value < 0.05; **P value < 0.01.

plasmatic concentration of cHDL, joined to the non-healthy lifestyles [8, 40].

Regarding the risk factors, the results indicated a significant effect between the figures of hypertriglyceridemia and alcoholic beverage consumption, which have incidence in the development of ENTs, especially, cardiovascular. Alcoholic beverage consumption is a social and cultural practice worldwide, with a multifactorial connotation, considered by the WHO as an issue for public health, that increasingly affects the young adult population [41,42]. The factors that favor this habit in young university students included the own behaviors of this vital cycle, low self-esteem, social pressure, and a deficit of control of the authorities over the distribution of these substances in places near the universities, mainly in teenagers, which place them in a vulnerable condition. Hence, this risk factor denotes importance and should be studied as a potential agent that causes early development of cardiovascular and kidney diseases [41,42] besides its negative influence in some other aspects that affect the physical and emotional health of an individual.

Latin America presents the higher prevalence of alcohol consumption in the young adult population (95.8%), in countries like Ecuador (88.7%), Peru (87.5%), and Bolivia (77.1%) [41]. In Colombia, some studies conducted in young university students showed a tendency to the raise the consumption of alcoholic beverages (88.6% and 96.1%), with a pattern of harmful consumption of 20.5% and dependency risk of 14.9% [15]. On the other hand, investigations carried out in Asian university students showed a significant relationship between alcohol consumption and hyperlipidemias [43,44], which is in accordance with the findings in this study. The young people who consume alcoholic beverages showed 1.35 times higher risk of having hyperlipidemia, in addition to a prevalence of 15.2% in hypertriglyceridemia, 19.0% in hypercholesterolemia, 59.1% risk of cLDL, and 16.9% of the risk of cHDL. It is worth noting that the excessive consumption of alcohol accelerates the biosynthesis of the lipids in the liver, increasing the catchment of fatty acids and hepatic secretion of lipoproteins (cHDL, cTotal) [45,46]. Additionally, it shows a close relationship between alcohol consumption and an increase in blood pressure [15,40,41].

Regarding the nutritional factor, the young university students are considered a vulnerable population mainly because, during this stage, the habits and behaviors that are influenced by the individual preferences and change in the self-image perceptions are consolidated. Besides, the easy access and low cost of hypercaloric food promote the excessive consumption in young students [47]. Among food preferences, although it was not a significant factor, it was found that the majority of the students consume food rich in carbohydrates (94.7%), fried food and those with a high content of grease (88.6%), and canned food and cold meats (69.3%), which showed the lack of healthy patterns in the nutrition of the university students, influenced by the disposition of highly energetic food, with high grease and proteins of animal origin contained, to a relatively low cost, socio-cultural customs, and a fast pace of living [47].

The present study aimed to generate preventive measures and establish screening programs for the early detection of hyperlipidemias to promote a healthy university population.

5. Limitation

This study did not gather data regarding the participants' weight, height, or glucose levels, factors that can be taken into account for future research.

6. Conclusions

The prevalence of hyperlipidemia in university students was 33.8%, which sex (male) and alcoholic beverage consumption as the main factors that increase the risk of developing hyperlipidemia. The results obtained indicate the importance of early detection of blood lipid levels in young people to prevent the early development of NCDs. This study can serve as a basis for future research and contribute to the improvement of promotion and prevention strategies in university settings.

Declarations

Author contribution statement

A. Ramírez and J. Peláez: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

J. Gordon: Performed the experiments; Wrote the paper.

I. Bermúdez: Analyzed and interpreted the data; Wrote the paper.

References

[1] Y. Galvis Perez, J. Barona Acevedo, .J.A. Cardona Arias, Prevalencia de dislipidemias en una Institución prestadora de servicios de salud de Medellín (Colombia), 2013, Revista CES Medicina 30 (1) (2013) 3–4. Available at: http://revistas.ces.edu.co/index.php/medicina/article/view/3166.

[2] World Health Organization, World Conference on Noncommunicable Diseases. Geneva, 2017. Available at: https://www.who.int/conferences/global-ncd-conference/Roadmap-ES.pdf?ua=1.

[3] World Health Organization, Report on the global situation of noncommunicable diseases: meeting the nine global targets on noncommunicable diseases, a shared responsibility. Geneva, Available at: http://apps.who.int/iris/bitstream/handle/10665/149296/WHO_NMH_NVI_15.1_spa.pdf;jsessionid=61407065D79EA53F224008D9123B04FF?sequence=1, 2014.

[4] World Health Organization, Monitoring Progress on Noncommunicable Diseases. Geneva, 2017. Available at: http://apps.who.int/iris/bitstream/handle/10665/259806/9789243513027-spa.pdf?sequence=1.

[5] Pan American Health Organization, Noncommunicable Diseases: Country Profiles, Report of a WHO scientific group, Geneva, 2012. Available at: https://www.paho.org/hq/dmdocuments/2012/PAHO-NCD-Country-Profiles-2012-Spa-3.pdf.

[6] A.R. Villarouca, L.S. Nascimento, T.R. Sousa, Prevalência de componentes metabólicos em universitários, Rev. Latino-Am. Enferm. 22 (6) (2014) 1041. Available at: http://www.scielo.br/pdf/rlae/v22n6/es_0104-1169-rlae-22-06-01041.pdf.

[7] Ministerio de Salud y Protección Social, Guía de Práctica Clínica para la prevención, detección temprana, diagnóstico, tratamiento y seguimiento de las dislipidemias en la población mayor de 18 años. Colombia, Available at: https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/INEC/IETS/GPC-Dislipidemi-completa.pdf, 2014.

[8] C.I. Ponte, P.J. Isea, A.J. Lorenzatti, J.P. López, et al., Dislipidemia aterogénica en Latino América: prevalencia, causas y tratamiento, Rev. Venez. Endocrinol. Metab. 15 (2) (2017) 106–129. Available at: http://www.svemonline.org/wp-content/uploads/2017/07/revista-svem-vol-15-2-2017.pdf.

[9] P. Pramparo, C. Boissonnet, H. Schargrodsky, Evaluation of cardiovascular risk in seven cities in Latin America: the main conclusions of the CARMELA study and substudies, Rev. Argent. Cardiol. 79 (2011) 377–382. Available at: https://www.redalyc.org/articulo.oa?id=305326988014.

[10] R. Martínez, P. Soliz, R. Caixeta, P. Ordunez, Años de vida perdidos por muerte prematura: una medida versátil y abarcadora para el monitoreo de la mortalidad por enfermedades no transmisibles, Rev Panam Salud Pública, 2019. Available at: www.paho.org/journal.

[11] Institute for Health Metrics and Evaluation, Findings from the Global burden of Disease Study, EEUU, Seatle, 2018. Available at: http://www.healthdata.org/sites/default/files/files/policy_report/2019/GBD_2017_Booklet.pdf.

[12] World Health Organization, The Top Ten Causes of Death. Geneva, 2018. Available at: https://www.who.int/es/news-room/fact-sheets/detail/the-top-10-causes-of-death.

[13] World Health Organization, The World Health Report: Global Health: Today's Challenges. Geneva, 2003. Available at: https://www.who.int/whr/2003/en/Chapter1-en.pdf?ua=1.

[14] J.A. Salomon, New Disability Wights for the Global burden of Disease, World Health Organization, Geneva, 2013. Available at: https://apps.who.int/iris/bitstream/handle/10665/270832/PMC2995197.pdf?sequence=1&isAllowed=y.

[15] C. Almonacid Urrego, M.D.S. Camarillo Romero, M.Z. Gil, et al., Evaluación de factores de riesgo asociados a enfermedad cardiovascular en jóvenes universitarios de la localidad Santafé de Bogotá. Colombia, 2016. Available at: https://www.researchgate.net/publication/309175526_Evaluacion_de_factores_de_riesgo_asociados_a_enfermedad_cardiovascular_en_jovenes_universitarios_de_la_Localidad_Santafe_en_Bogota_Colombia.

[16] D.F. Polit, B.P. Hungler, Investigación científica en ciencias de la salud, 5 ed., McGraw-Hill Interamericana, México, 2002.

[17] E. Antal, Y. Tille, Simple random sampling with over-replacement, J. Stat. Plann. Inference 141 (1) (2011) 597–601.

[18] World Health Organization, International Ethical Guidelines for Health-Related Research Involving Humans. Geneva, 2016. Available at: https://cioms.ch/wp-content/uploads/2017/12/cioms-ethicalguideline_sp_interior-final.pdf.

[19] Asociación Médica Mundial, Declaración de Helsinki. Ferney-Voltaire: Francia, 2013. Available at: https://www.wma.net/es/que-hacemos/etica-medica/declaracion-de-helsinki/.

[20] F.K. Dankar, M. Gergely, S.K. Dankar, Informed consent in biomedical research, Comput. Struct. Biotechnol. J. 17 (2019) 463–474.

[21] Ministerio de Salud, Resolución 008430, Available at: https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/DE/DIJ/RESOLUCION-8430-DE-1993.PDF, 1993.

[22] World Health Organization, Maternal, Newborn, Child and Adolescent. Geneva, 2018. Available at: https://www.who.int/maternal/_child_adolescent/topics/adolescent/es/.

[23] National Cholesterol Education Program, Adult Treatment Panel III, Executive summary of the third report of the national cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults. (Adult Treatment Panel III), JAMA Med. Assoc. 285 (19) (2001) 2486–2497. Available at: https://www.ncbi.nlm.nih.gov/pubmed/12485966.

[24] J. Bax, A. Vahanian, A. Auricchio, et al., ESC/EAS guidelines for the management of dyslipidemias: the task force for the management of dyslipidemias of the European society of cardiology (ESC) and the European atherosclerosis society (EAS), Eur. Heart J. 32 (14) (2016) 1769–1818. Available at: https://www.ncbi.nlm.nih.gov/pubmed/21712404.

[25] J.A. Nelder, R.W.M. Wedderburn, Generalized linear models, J. Royal Statis. Soc. Series A Gen. 135 (3) (1972) 370–384.

[26] A.J. Dobson, A.G. Barnett, An Introduction to Generalized Linear Models, Chapman &Hall, CRC, Florida, 2018.

[27] D.W. Hosmer, S. Lemeshow, Applied Logistic Regression, Jhon Wiley and Sons, New York, 2004.

[28] T.R. Core, A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria, 2020. Available at: https://www.R-project.org/.

[29] A.F. Gómez, M.C. Tarqui, Prevalencia de sobrepeso, obesidad y dislipidemia en trabajadores de salud del nivel primario, Rev Duazary Inter Cienc Salud. Perú. 14 (2) (2017) 141–148.

[30] C.E. González, B.Y. Díaz, R.A. Mendizábal, et al., Prevalencia de obesidad y perfil lipídico alterado en jóvenes universitarios, Rev. Nutr. Hosp. 29 (2) (2014) 315–321. Available at: http://www.aulamedica.es/nh/pdf/7054.pdf.

[31] S.J. Gotthelf, P.C. Rivas, Prevalence of dyslipidemia and its association with nutritional status in the population of the city of the Salta during 2014, Rev. Fed Arg Cardiol. 45 (4) (2016) 184–189. Available at: https://www.researchgate.net/publication/312028169.

[32] Y.S. Barja, G.P. Arnaiz, P.L. Villarroel, et al., Dislipidemias en escolares chilenos: prevalencia y factores asociados, Rev. Nutr. Hosp. 31 (2015) 2079–2087.

[33] G.I. García, A. Novelo, N.M. López, et al., Prevalencia de dislipidemias en población urbana aparentemente sana de Yucatán, Rev Latinoam Patologia Clinica Medicinia Laboratorio 62 (3) (2015) 150–156. Available at: https://www.medigraphic.com/cgi-bin/new/resumen.cgi?idarticulo=59460.

[34] R.W. Freire, M.F. Moura, A.C. Soares, et al., Analise do perfil lipidico de uma população de estudantes universitarios, Rev. Latino-Am. Enferm. 21 (5) (2013) 9. Available at: http://bases.bireme.br/cgibin/wxislind.exe/iah/online/?IsisScript=iah/iah.xis&src=google&base=LILACS&lang=p&nextAction=lnk&exprSearch=688749&indexSearch=ID.

[35] P.L. Casavalle, L. Romano, M. Pandolfo, et al., Prevalencia de dislipidemia y sus factores de riesgo en niños y adolescentes con sobrepeso y obesidad, Rev Esp española de nutrición Humana y dietética. 18 (3) (2014) 137–144. Available at: http://renhyd.org/index.php/renhyd/article/view/67/94.

[36] D.L. Rodríguez, B.J. Fernández, S.M. Díaz, et al., Sobrepeso y dislipidemias en adolescentes, Rev. Cubana de Pediatría. 86 (4) (2014) 433–444. Available at: https://www.medigraphic.com/pdfs/revcubped/cup-2014/cup144d.pdf.

[37] A.J. Machado, D.M. Machado, Prevalencia de factores de riesgo cardiovascular en pacientes con dislipidemia afiliados al sistema de salud en Colombia, Rev. Peru. Med. Exp. Salud Pública 30 (2) (2013) 205–211.

[38] D.M. Martínez, M.P. Soca, H.R. Rodríguez, Prevalencia de hipertrigliceridemia y factores de riesgo cardiovascular en estudiantes de la Universidad de Ciencias Médicas. Rev Medisur. Holguín: Cuba, 2018. Available at: http://www.medisur.sld.cu/index.php/medisur/article/view/3626.

[39] Y. Zhang, E. Vittinghoff, et al., Associations of blood pressure and cholesterol levels during Young adulthood with later cardiovascular events, J. Accounting 74 (3) (2019) 330–341.

[40] M. Shahwan, A. Jairoun, A. Farajallah, S. Shanabli, Prevalence of dyslipidemia and factors affecting lipid profile in patients with type 2 diabetes. Diabetes & Metabolic Syndrome, Clin. Res. Rev. 13 (2019) 2387–2392.

[41] G.J. Méndez, L.M. Azaustre, El consumo de alcohol en universitarios. Estudio de las relaciones entre las causas y los efectos negativos, Rev Complutense de educación. 28 (3) (2015) 689–704.

[42] Z.S. Betancourth, B.L. Tácan, P.E. Córdoba, Consumo de alcohol en estudiantes universitarios colombianos, Universidad y. Salud. 19 (1) (2017) 37–50.

[43] C. Ja Kim, J. Park, S. Kang, Health-promoting lifestyles and cardio-metabolic risk factors among international students in South Korea, Collegian 22 (2015) 215–223. Korea del Sur.

[44] G. Nepal, E. Tuladhar, et al., Dyslipidemia and associated cardiovascular risk factors

among young Nepalese university students, Cureus 10 (1) (2018) 2089.

[45] D.B. Rosoff, K. Charlet, J. Jung, J. Lee, C. Muench, A. Luo, Association of high-intensity binge drinking with lipid and liver function enzyme levels, J. Am. Med. Assoc. (2019).

[46] L. Yang, C. Yang, et al., Lipophagy and alcohol-induced fatty liver, Front. Pharmacol. 10 (2019) 495.

[47] World Health Organization, Non-communicable-diseases. Geneva, Available at: https://www.who.int/es/news-room/fact-sheets/detail/noncommunicable-diseases, 2018.