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ORIGINAL RESEARCH

Association of nutritional status and lifestyle with the presence of noncommunicable diseases in the Ecuadorian population. Case-control study

Asociación del estado nutricional y de variables relacionadas con el estilo de vida con la presencia de enfermedades no transmisibles en población ecuatoriana. Estudio de casos y controles

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Abstract

Introduction: Noncommunicable diseases (NCDs) are related to poor nutritional status and unhealthy lifestyles, increasing their burden on the population.
Objective: To evaluate the association of nutritional status and lifestyle with the presence of NCDs in the Ecuadorian population.
Materials and methods: A case-control study was conducted in 352 individuals (176 cases and 176 controls) aged 20 to 64 years residing in District 03D01 in Ecuador. Cases were defined as individuals with 1 or more of the 8 NCDs mentioned in the questionnaire used, while controls were defined as individuals without these NCDs. Information was obtained between May 2022 and March 2023 by administering a validated questionnaire that included direct measurements of height, weight, and blood pressure. Differences in nutritional status (using the body mass index [BMI]) between cases and controls were assessed by means of the Mann-Whitney U test. A multivariate analysis (logistic regression model) was performed to establish the association of the analyzed lifestyle-related variables, BMI, and blood pressure with the presence of an NCD by calculating Odd Ratios (OR).
Results: The median age of the cases was 52 years, with a predominance of women (73.86%) and rural residents (67.61%). According to their responses to the instrument, overweight/obesity was the most frequent NCD (19.88%), followed by high blood pressure (16.48%), and high cholesterol levels (16.48%); additionally, 76.14% had 2 or more NCDs. The median BMI of the cases was 25.48kg/m² and 55.11% suffered from obesity according to this parameter. The multivariate analysis showed that alcohol intake (ORa=2.11; 95%CI: 1.14-3.95), active smoking (ORa=2.33; 95%CI: 1.13-4.88), and smoking cessation (ORa=0.43; 95%CI: 0.22-0.83) were associated with the presence of NCDs. Nutritional status (determined by BMI) was not significantly associated with the presence of NCDs.
Conclusions: Alcohol use and smoking increased the likelihood of developing NCDs, whereas smoking cessation reduced the likelihood of NCDs. Nutritional status was not associated with the presence of NCDs.

Resumen

Introducción. Las enfermedades no transmisibles (ENT) se han relacionado con un mal estado nutricional y estilos de vida poco saludables, lo que incrementa su carga en esta población.
Objetivo. Evaluar la asociación del estado nutricional y factores relacionados con el estilo de vida con la presencia de ENT en población ecuatoriana.
Materiales y métodos. Estudio de casos y controles realizado en 352 individuos (176 casos y 176 controles) de 20 a 64 años del Distrito 03D01 en Ecuador. Los casos se definieron como individuos con 1 o más de las 8 ENT abordadas en el cuestionario utilizado y los controles, como personas sin estas ENT. La información fue obtenida entre mayo de 2022 y marzo de 2023 mediante la administración de un cuestionario validado que incluyó la medición directa de la talla, el peso y la presión arterial. Las diferencias en el estado nutricional (determinado por el índice de masa corporal [IMC]) entre casos y controles fueron evaluadas usando la prueba U de Mann-Whitney. Se realizó un análisis multivariado (modelo de regresión logística) para determinar la asociación de las variables relacionadas con el estilo de vida analizadas, el IMC y la presión arterial con la presencia de ENT mediante el cálculo de Odd Ratios (OR).
Resultados. La mediana de edad de los casos fue 52 años, predominando mujeres (73.86%) y residentes en zonas rurales (67.61%). De acuerdo con sus respuestas en el instrumento, el sobrepeso/obesidad fue la ENT más frecuente (19.88%), seguida de la hipertensión arterial (16.48%) y niveles altos de colesterol (16.48%); además, 76.14% tenían 2 o más ENT. La mediana de IMC en los casos fue 25.48kg/m² y 55.11% eran obesos según este parámetro. En el análisis multivariado, el consumo de alcohol (ORa=2.11; IC95%: 1.14-3.95), el tabaquismo activo (ORa=2.33; IC95%: 1.13-4.88) y haber dejado de fumar (ORa=0.43; IC95%: 0.22-0.83) se asociaron con la presencia de ENT. El estado nutricional (determinado por el IMC) no se asoció significativamente con la presencia de ENT.
Conclusiones. El consumo de alcohol y el tabaquismo aumentan la probabilidad de tener ENT, mientras que haber dejado de fumar la reduce. El estado nutricional no se asoció con la presencia de ENT.

Introduction

Currently, chronic noncommunicable diseases (NCDs) are the leading cause of premature death and disability worldwide, constituting a serious global public health problem.[1-3] These diseases account for 80% of deaths across the globe, with 38 million cases every year, of which 28 million occur in low- and middle-income countries.[3]

NCDs are the result of several risk factors that can be classified into 5 categories: genetic (family history, genetic inheritance, and epigenetic changes), environmental (air pollution, weather changes, UV radiation), sociodemographic (age, gender, ethnicity, education, and income), self-management (tobacco and alcohol use, physical activity, body weight, eating habits, and dental health care), and medical conditions (use of medications, viral infections, stress).[4] The most common effects of NCDs are visual disturbances,[5] diabetic nephropathy, diabetic neuropathy, diabetic foot, cerebrovascular disease, ischemic disease, and peripheral arterial disease.[6]

According to the Pan American Health Organization (PAHO), NCDs involve high treatment costs, resulting in a direct economic burden for health systems, families, and society as a whole. They also generate an indirect economic burden in terms of productivity losses due to situations such as premature death, absenteeism, and reduced work performance.[7]

NCDs are long-standing conditions[8] that usually affect people over 40 years of age.[9] The main types of NCDs include cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes mellitus (DM); in that order, they account for the majority of NCD deaths worldwide.[2,8]

DM is a highly prevalent metabolic disease characterized by high blood glucose levels (chronic hyperglycemia) that occurs when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces.[10,11] In these patients, long-term chronic hyperglycemia can affect various organs, especially the eyes, kidneys, nerves, blood vessels, and heart.[11] Consequently, DM favors the development of renal, cardiovascular, and cerebrovascular diseases, as well as blindness, neuropathies, and traumatic amputations.[12] Both types 1 and 2 DM are complex diseases resulting from the interaction of several non-modifiable factors such as age, sex and genetics, as well as modifiable lifestyle-related factors such as overweight and obesity, unhealthy diet, lack of physical activity, and smoking;[10,13] this disease affects approximately 537 million people worldwide, 83 million of whom live in the Americas and more than 500 000 in Ecuador (4.7%).[14]

High blood pressure (HBP) is a major risk factor for cardiovascular disease[15] and is linked to genetic and environmental factors and the renin-angiotensin-aldosterone system.[16,17] Diagnosis is based on blood pressure measurements taken during medical consultation on 2 different days, and it is considered that a patient has HBP if systolic blood pressure is ≥140mmHg and diastolic blood pressure is ≥90mmHg on both or more occasions.[15,16] However, out-of-office measurements (outpatient monitoring or self-monitoring at home) are also recommended to confirm the diagnosis or to rule out the presence of white coat HBP.[15] Risk factors for HBP include alcohol use, obesity, sedentary lifestyle, and high salt intake.[15] According to the World Health Organization (WHO),[18] 1 280 million adults (30-79 years) had HBP worldwide in 2023, with the majority living in low- and middle-income countries. In Ecuador, it was estimated that at least 20% of people over 19 years of age had hypertension in 2021 and that 45.2% of them did not know that they had this condition.[19]

Chronic obstructive pulmonary disease (COPD) refers to a group of diseases that cause airflow obstruction, generating persistent breathing problems due to injury to the airways or other parts of the lung such as the alveoli.[20-24] These diseases include emphysema and chronic bronchitis,[21-23] and although exposure to tobacco smoke has been reported to be the most frequent cause, other risk factors include exposure to air pollutants both at home and in the workplace, genetic factors, and respiratory infections.[20-24] According to the WHO, COPD is the fourth leading cause of death in the world, accounting for 3.5 million deaths in 2021. Moreover, almost 90% of deaths from this NCD in individuals under 70 years of age occur in low- and middle-income countries.[23] It has been reported that the prevalence of COPD worldwide has increased from 10.7% (7.3%-14%) in 1990 to 11.7 (8.4%-15%) in 2010, while this figure in Latin America varies between 7.8% and 19.7% depending on the city.[24]

Cancer is a generic name for a large group of diseases characterized by the rapid proliferation of abnormal cells that grow beyond their usual boundaries and may invade adjacent tissues or spread to other organs (metastasis).[25] Cancer is the leading cause of death worldwide (9 743 832 deaths attributable to cancer in 2022), with lung, breast, colorectal, prostate, and stomach cancers being the most common.[25] Globocan reported that 1 155 885 people in South America[26] had cancer in 2022, of which 78 878 cases occurred in Ecuador, the most common cancers being breast, prostate, and stomach cancer.[27]

Lifestyle relates to the way individuals live;[28] therefore, lifestyle modifications and interventions to reduce the risk of NCDs are key to their prevention.[4] In this regard, it has been reported that adopting a healthy lifestyle that includes physical activity, a diet rich in fruits and vegetables, low sodium intake, and no alcohol and tobacco use has beneficial impacts on health.[29]

According to the WHO, an adult is considered overweight if their BMI is ≥25kg/m², and obese when the value is ≥30kg/m².[30] An estimated 2.5 billion adults worldwide were overweight and 890 million were obese in 2022, which means that 43% of people over 18 years of age were overweight and 16% were obese.[30,31] According to Vinueza-Veloz *et al.*,[32] the prevalence of obesity among adults in the Americas is 28.6%, and in Ecuador the prevalence of overweight and obesity is 64.68%. The PAHO[33] also points out that healthy nutrition is fundamental to prevent diet-related risk factors, such as overweight and obesity, as well as associated NCDs.

In Latin America, multiple studies have looked into the relationship between nutritional status, dietary practices, lifestyle, and the risk of NCDs. For example, in Brazil, as reported by Felisbino-Mendes *et al.*,[34] an increase in the prevalence of overweight and obesity was observed between 1990 and 2017, which in turn has entailed a greater impact in terms of morbimortality, as high BMI was responsible for 7.2% of all deaths and 4.6% of the total disability-adjusted life years lost due to NCDs in the country in 1990, while these figures in 2017 were 12.3% and 8.4%, respectively.

In Ecuador, Barahona *et al.*[35] found in a study of 50 older adults that 28% were obese and 32% overweight, 40% were at metabolic risk and, of these, more than 20% had a high lipid profile; 10% had high levels of glycemia, and 46% had HBP; also, more than 50% consumed few fruits and vegetables and 98% moderately consumed sweets, suggesting that this population has risk factors for NCDs due to their anthropometric characteristics. Also in Ecuador, in a study carried out in 37 university students, De la Cruz Saá *et al.*[36] reported that more than 25% presented with overnutrition, 67.5% had a high percentage of fat, and 94.5% consumed poor quality food, concluding that overnutrition, a high

percentage of fat, poor quality food, and non-compliance with healthy eating habits are risk factors for NCDs.

In view of the above, the objective of the present study was to evaluate the association of nutritional status and lifestyle with the presence of NCDs in an Ecuadorian population.

Materials and methods

Study type

Case-control study.

Study population and sample

The study population comprised the participants (men and women aged 20 to 64 years) of the research project *Prevalencia y factores de riesgo asociados a enfermedades no trasmisibles en el paciente adulto del Distrito 03D01* (Prevalence and risk factors associated with non-communicable diseases among adult patients in District 03D01), which was carried out between May 15, 2022, and March 31, 2023, in residents of the 3 cities of this Ecuadorian district (Azogues, Biblián, and Déleg, N=993).

Cases were defined as individuals presenting one or more of the following conditions: DM, HBP, overweight or obesity, heart (cardiovascular) disease, increased blood cholesterol levels (hypercholesterolemia), increased blood triglyceride levels (hypertriglyceridemia), thyroid gland problems, and cancer, all of which are the NCDs considered in the instrument used. On the other hand, controls were defined as individuals with no such NCDs.

Sample size was calculated in the EPIDAT v4.2 software, considering a confidence level of 80%, a case/control ratio of 1, a statistical power of 85%, an expected odds ratio (OR) of 4.66 (for alcohol use/HBP), and a proportion of exposed controls of 21.6%.[37] This resulted in a minimum sample of 22 cases and 22 controls for each of the 8 NCDs considered in the instrument used, for a total of 176 cases and 176 controls (352 individuals).

Cases and controls were matched by age range, sex, and place of residence to control for possible confounding bias and were randomly selected from the 993 individuals who participated in the research project. Pregnant women, individuals with acute diseases at the time of data collection, and individuals with incomplete or inconsistent information were excluded.

Procedures, study variables, and instruments

Information on lifestyle and presence of NCDs was collected using the questionnaire validated by Fernández-Altuna *et al.*[38] in the Mexican population, which has already been applied in studies conducted in the Ecuadorian population.[39,40] This instrument consists of 53 questions grouped into 8 domains or dimensions: family history, personal history of NCDs or presence of NCDs, current symptomatology (last 12 months), physical activity, eating habits, substance use, rest habits, physical examination (weight [kg], height [m], and blood pressure [mmHg]).

Basic sociodemographic information (age, sex, city of residence, place of residence [rural or urban], educational level [primary school completed, secondary school completed, or higher/university], and marital status) was also obtained by means of an ad hoc questionnaire. Data were entered on individual record cards.

Weight, height, and blood pressure were measured in accordance with the guidelines provided by the Manual of Anthropometry Procedures of the Ecuadorian Ministry of Public Health.[41] Nutritional status was classified following the WHO[31] and the Centers for Disease Control and Prevention[42] as underweight (BMI<18.5kg/m²), normal weight (BMI between 18.5kg/m2 and 24.9kg/m²), overweight (BMI between 25kg/m² and 29.9kg/m²), and obese (BMI≥30 kg/m²). BMI was calculated by dividing weight into kilograms by height in meters squared.[42] For the measurement of anthropometric parameters and blood pressure, duly calibrated portable generic tools (digital scale, measuring rod, digital sphygmomanometer, and stethoscope) were used.

Data were collected at the participants' homes by members of the research team with the support of nursing students working on their thesis from the Universidad Católica de Cuenca, who were duly trained for this purpose. The training included theoretical and practical sessions on study objectives, instrument use, and ethical aspects such as data confidentiality and informed consent. Simulations were conducted to standardize the process and reduce errors; researchers periodically supervised collaborators to ensure adherence to established protocols during data collection, which took place between May 15, 2022 and March 31, 2023.

Statistical analysis

The information collected was entered into a database created in Microsoft Excel for subsequent analysis in the Jamovi v2.3.28 and EPIDAT v4.2 software. Data are described using absolute frequencies and percentages for categorical variables and medians and interquartile ranges (IQR) for continuous variables because the data showed a nonparametric distribution (Kolmogorov-Smirnov test).

After verifying the assumptions of normality, the Mann-Whitney U test was selected to evaluate differences in nutritional status between cases and controls. For this comparison, participants were classified as normal weight (BMI<25kg/m²) and overweight/obese (≥25kg/m²).

Subsequently, a multivariate analysis (logistic regression) was performed to determine, by calculating Odds Ratios (crude [OR] and adjusted [ORa]) and their respective 95% confidence intervals (95%CI), the association between the presence of NCDs and the lifestyle-related variables considered in the instrument, namely, alcohol use, physical activity, eating habits, junk food intake, coffee intake, soft drink intake, use of drugs such as sleeping pills or psychoactive substances, active smoking, smoking history (i.e., smoking at some time in life and smoking cessation), rest habits (feeling rested after sleeping), BMI, systolic blood pressure (SBP), and diastolic blood pressure (DBP). The R^2 Nagelkerke test was used to evaluate the goodness of fit of the logistic regression model. In addition, multicollinearity was evaluated by means of the variance inflation factor (VIF), considering a value <2 as acceptable.

A statistical significance level of $p<0.05$ was established for all statistical tests.

Ethical considerations

The study was approved by the Bioethics Committee for Health Research of the Universidad de Cuenca in accordance with minutes 2022-005EO-IE of May 12, 2022, and followed the ethical principles for biomedical research involving human subjects established in the Declaration of Helsinki[43] and the International Ethical Guidelines for Health-related

Research Involving Humans of the Council for International Organizations of Medical Sciences and the WHO.[44] In addition, all participants signed an informed consent form in which they consented to their participation in the study and authorized the use of their data in the study.

Personal data confidentiality was guaranteed at all times, since the database used in the study was completely anonymized and is stored in the Zenodo repository.[45]

Results

Participants' median age was 53 years (IQR=19.0; cases: 52 years, controls: 54 years); 73.86% were female, 67.61% lived in rural areas, 47.73% had completed secondary school (cases: 47.16%; controls: 48.29%), and 75% were married or in domestic partnerships (cases: 78.98%; controls: 71.02%). Table 1 presents the sociodemographic characteristics of the cases and controls.

Table 1. Sociodemographic characteristics of the sample (n=352).

Variable		Cases n=176 n (%)	Controls n=176 n (%)	Total n=352 n (%)
Age *	20 to 29 years old	20 (11.36)	20 (11.36)	40 (11.36)
	30 to 39 years old	21 (11.93)	21 (11.93)	42 (11.93)
	40 to 49 years old	41 (23.30)	41 (23.30)	82 (23.30)
	50 to 59 years old	52 (29.55)	52 (29.55)	104 (29.55)
	60 to 64 years old	42 (23.86)	42(23.86)	84 (23.86)
Sex *	Male	46 (26.14)	46 (26.14)	92 (26.14)
	Female	130 (73.86)	130 (73.86)	260 (73.86)
Place *	Urban	57 (32.39)	57 (32.39)	114 (32.39)
	Rural	119 (67.61)	119 (67.61)	238 (67.61)
City	Azogues	78 (44.32)	89 (50.57)	167 (47.44)
	Biblián	19 (10.80)	27 (15.34)	46 (13.07)
	Déleg	79 (44.88)	60 (34.09)	139 (39.49)
Schooling level	Completed primary school	81 (46.02)	73 (41.48)	154 (43.75)
	Completed high school	83 (47.16)	85 (48.29)	168 (47.73)
	Superior/university	12 (6.82)	18 (10.23)	30 (8.52)
Marital status	Single	12 (6.82)	23 (13.07)	35 (9.94)
	Married/domestic partnership	139 (78.98)	125 (71.02)	264 (75.00)
	Divorced/separated	17 (9.66)	19 (10.80)	36 (10.23)
	Widowed	8 (4.54)	9 (5.11)	17 (4.83)

* Case-control matching criteria to control for confounding bias.

Table 2 shows clinical and lifestyle characteristics, anthropometric measurements, blood pressure measurements, and nutritional status for cases and controls. It should be noted that only data for affirmative answers (Yes) were included in the instrument, discarding the options "No" and "Don't know and don't remember".

Table 2. Clinical and lifestyle characteristics, nutritional status, and anthropometric measurements of participants (n=352).

Variable		Cases n=176 n (%)	Controls n=176 n (%)	Total n=352 n (%)
Hereditary-family history (Has anyone in your family [parents, siblings, children] suffered or suffers from this condition?	Diabetes	60 (34.09)	52 (29.54)	112 (31.82)
	High blood pressure	84 (47.73)	83 (47.16)	167 (47.44)
	Obesity	69 (39.20)	64 (36.36)	133 (37.78)
	Heart diseases	47 (26.70)	35 (19.89)	82 (23.29)
	Cerebral vascular disease	28 (15.91)	19 (10.79)	47 (13.35)
	Nephropathy	47 (26.70)	26 (14.77)	73 (20.74)
	Cancer	50 (28.41)	27 (15.34)	77 (21.88)
Personal history or presence of diseases (Have you suffered or do you suffer from any of the following diseases)	Diabetes mellitus	24 (13.64)	0 (0)	24 (6.82)
	High blood pressure	29 (16.48)	0 (0)	29 (8.24)
	Overweight/obesity	35 (19.88)	0 (0)	35 (9.94)
	Heart disease	4 (2.27)	0 (0)	4 (1.14)
	Increased blood cholesterol	29 (16.48)	0 (0)	29 (8.24)
	Increased blood triglycerides	22 (12.50)	0 (0)	22 (6.25)
	Thyroid problems	12 (6.82)	0 (0)	12 (3.41)
	Cancer	21 (11.93)	0 (0)	21 (5.96)
Current symptomatology (In the last year have you experienced any of these symptoms?)	Headache	110 (62.50)	112 (63.64)	222 (63.07)
	Tinnitus	74 (42.05)	80 (45.45)	154 (43.75)
	Weight loss	67 (38.07)	49 (27.84)	116 (32.95)
	Weight gain	66 (37.50)	80 (45.45)	146 (41.48)
	Increased frequency of urination	53 (30.11)	34 (19.32)	87 (24.72)
	Increased hunger sensation	71 (40.34)	75 (42.61)	146 (41.48)
	Increased desire to drink water	45 (25.57)	28 (15.91)	73 (20.74)
Physical activity	Do you work out or play sports?	113 (64.20)	115 (65.34)	228 (64.77)
	What type of exercise or sport do you practice most often? (n=228)			
	Walking or running	86 (76.11)	76 (66.09)	162 (71.05)
	Soccer	19 (16.81)	20 (17.39)	39 (17.11)
	Dancing (ballroom, Zumba, etc.)	3 (2.65)	6 (5.22)	9 (3.95)
	Bicycle	1 (0.89)	9 (7.82)	10 (4.38)
	Basketball	1 (0.89)	1 (0.87)	2 (0.88)
	Swimming	3 (2.65)	3 (2.61)	6 (2.63)
	Other	0 (0)	0 (0)	0 (0)
	How often do you engage in this activity per week? [median (IQR)]	2.00 (4.00)	2.00 (4.00)	2.00 (4.00)
	On average, how long do you perform this activity? [median (IQR)	30.00 (30.00)	30.00 (60.00)	30.00 (45.00)
	How long (in months) have you been doing this activity? [median (IQR)	5.00 (7.00)	5.00 (7.00)	5.00 (7.00)
Nutrition	Foods that I eat the most per day (legumes and foods of animal origin)	72 (40.91)	53 (30.11)	125 (35.51)
	Foods that I eat the most per day (cereals)	52 (29.55)	69 (39.20)	121 (34.38)
	Foods that I eat the most per day (vegetables and fruit)	52 (29.55)	54 (30.68)	106 (30.11)
	Junk food intake (e.g., snacks, processed juices, sugary cereals)	115 (65.34)	121 (68.75)	236 (67.04)
	How often per week [median (IQR)]?	2.00 (3.00)	2.00 (3.00)	2.00 (3.00)

Table 2. Clinical and lifestyle characteristics, nutritional status, and anthropometric measurements of participants (n=352). (Continued)

Variable			Cases n=176 n (%)	Controls n=176 n (%)	Total n=352 n (%)
Substance use	Active Smoking (Do you currently smoke?)		38 (21.59)	24 (13.54)	62 (17.61)
	How many cigarettes do you smoke per day? [median (IQR)]		2.00 (1.00)	2.00 (2.00)	2.00 (2.00)
	How long have you been smoking [median (IQR)]?		19 (2.75)	19 (3.25)	19 (2.75)
	Have you ever smoked and then quit?		117 (33.24)	131 (74.43)	248 (70.45)
	Alcohol use		45 (25.57)	30 (17.04)	75 (21.31)
	How much alcohol do you drink per month [median (IQR)]?		2.00 (2.00)	2.00 (1.75)	2.00 (2.00)
	How many drinks do you have per occasion? [median (IQR)].		5.00 (3.00)	5.00 (2.75)	5.00 (2.00)
	Coffee intake		90 (51.14)	97 (55.11)	187 (53.13)
	How often do you drink coffee per week [median (IQR)]?		3.00 (3.00)	4.00 (3.00)	3.00 (2.00)
	How many cups of coffee do you drink per day? [median (IQR)]		1.00 (3.00)	2.00 (4.00)	2.00 (4.00)
	Soft drinks intake		109 (61.93)	107 (39.39)	216 (61.36)
	How many times a week do you drink soft drinks? [median (IQR)]		2.00 (1.00)	2.00 (2.00)	2.00 (2.00)
	How many bottles or cans [median (IQR)]?		1.00 (1.00)	1.00 (0.00)	1.00 (0.25)
	Use of sleeping pills, marijuana, cocaine, inhalants, ecstasy, or similar (psychoactive)		11 (6.25)	7 (3.98)	18 (5.11)
	How often do you use these substances per week? [median (IQR)]		2.00 (3.50)	3.00 (4.00)	2.00 (3.75)
Rest habits	How long (in hours) do you sleep on average per day? [median (IQR)		7.00 (1.50)	7.00 (1.00)	7.00 (1.75)
	Do you snore (reported by a family member)?		70 (39.77)	89 (25.28)	159 (45.17)
	Do you feel rested when you wake up (adequate rest)?		167 (47.44)	161 (45.74)	328 (93.18)
Physical examination - anthropometric measurements	Weight in kg [median (IQR)]		65.34 (12.00)	65.86 (11.00)	62.00 (12.00)
	Height in m [median (IQR)]		1.58 (0.07)	1.57 (0.08)	1.58 (0.08)
	Body mass index in kg/m² ([median (BMI)]		25.48 (5.38)	25.88 (4.79)	25.7 (4.99)
	Nutritional status	Normal weight	79 (44.89)	71 (40.34)	150 (42.61)
		Overweight/obesity	97 (55.11)	105 (59.66)	202 (57.39)
	Blood pressure	Systolic blood pressure in mmHg [median (IQR)]	120 (6.25)	120 (10.0)	120 (10.0)
		Diastolic blood pressure in mmHg [median (IQR)]	70 (0.0)	70 (0.0)	70 (0.0)

The most common family history of NCDs included HBP (cases: 47.73%; controls: 47.16%), obesity (cases: 39.20%; controls: 36.36%), and DM (cases: 34.09%; controls: 29.54%). Regarding the presence of NCDs (cases) based on the responses to this question, it was found that overweight/obesity was the most common condition (19.88%), followed by HBP (16.48%), increased blood cholesterol levels (16.48%), and DM (13.64%). It should be noted that 134 of the 176 cases (76.14%) had 2 or more NCDs.

The most frequent symptoms experienced in the last 12 months (current symptomatology) were: headache (cases: 62.50%; controls: 63.64%), tinnitus (cases: 42.05%; controls: 45.45%), and increased sensation of hunger (cases: 40.34%; controls: 42.61%).

Regarding physical activity, 64.77% of the participants reported that they exercised or played some sport (cases: 64.20%; controls: 65.34%), mainly walking (cases: 76.11%; controls: 66.09%) and soccer (cases: 16.81%; controls: 17.39%). These participants also reported that they performed these activities 2 days a week for 30 minutes and that they had been doing them for 5 months (these values are expressed as medians).

With respect to dietary habits, the following was observed: when asked which food group they consumed the most per day (response options: a. legumes and foods of animal origin, b. cereals, and c. vegetables and fruits), legumes and foods of animal origin was

the most frequent group (total: 35.51%; cases: 40.91%; controls: 30.11%). In turn, 67.04% of the respondents reported consuming junk food (cases: 65.34%; controls: 68.75%), with a median consumption of 2 times per week.

Concerning substance use, 17.61% reported that they were active smokers (cases: 21.59%; controls: 13.54%), while 70.45% stated that they had smoked at some point in their lives but had already quit (cases: 33.24%; controls: 74.43%). Moreover, it was reported that 21.31% consumed alcoholic beverages (cases: 25.57%; controls: 17.04%); 53.13% (cases: 51.14%; controls: 55.11%) coffee; 61.36% (cases: 61.93%; controls: 39.39%) soft drinks; and 5.11% (cases: 6.25%; controls: 3.98%) sleeping pills, marijuana, cocaine, inhalants, ecstasy, or similar.

As for sleeping habits, the following was found: the median daily sleep time was 7 hours, 45.17% of the respondents snored (cases: 39.77%; controls: 25.28%), and 93.18% felt rested upon awakening (cases: 47.44%; controls: 45.74%).

With respect to physical examination and the measurement of anthropometric variables, the following was found: median weight, height, and BMI were 62kg (cases: 65.34 kg; controls: 65.86 kg), 1.58m (cases: 1.58 m; controls: 1.57 m), and 25.7kg/m² (cases: 25.48 kg/m²; controls: 25.88 kg/m²), respectively, while 57.39% suffered from overweight/obesity (cases: 55.11%; controls: 59.66%). The median SBP was 120mmHg and the median DBP was 70mmHg.

Based on the results of the Mann-Whitney U test, there were no significant differences in nutritional status (as assessed by BMI) between cases and controls (U=14 375; p=0.244). Figure 1 shows the data distribution for cases and controls and the differences in median BMI values (25.48 in cases vs. 25.88 in controls).

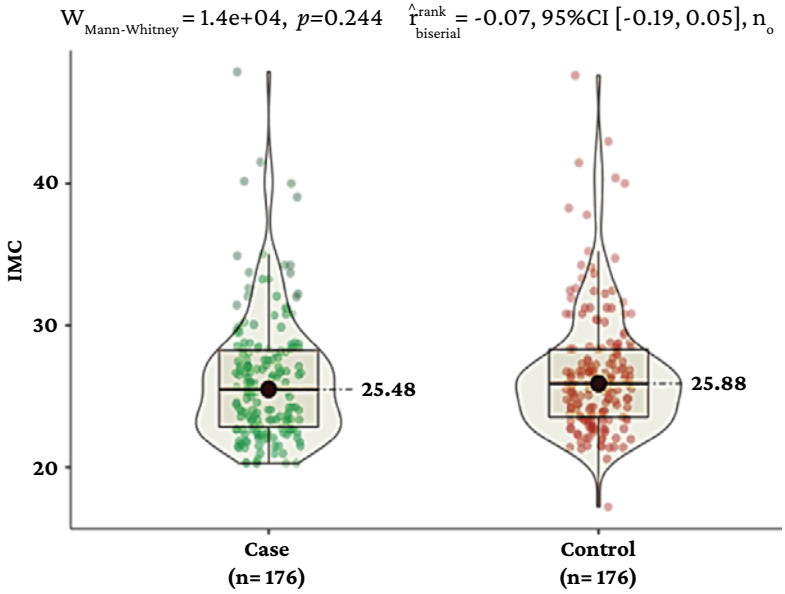

Figure 1. Comparison of nutritional status between cases and controls.
Note: The figure shows a narrow dispersion of the data in both groups. IQR for cases: 5.38; IQR for controls: 4.79.

In the multivariate analysis, no lifestyle-related variable showed a significant association with the presence of NCDs in the crude logistic regression model. However, after adjusting the model (Figure 2) to reduce confounding bias, alcohol consumption (aOR=2.11, 95%CI: 1.14-3.95; p=0.013) and active smoking (aOR=2.33, 95%CI: 1.13-4.88; p=0.023) were found to significantly increase the probability of having NCDs. On the contrary, smoking cessation reduces this probability by 57% (aOR=0.43, 95%CI: 0.22-0.83; p=0.013).

The other lifestyle-related variables evaluated (physical activity, eating habits, junk food consumption, coffee consumption, soft drink consumption, use of substances such as sleeping pills or psychoactive substances, and rest habits) did not show a significant association with the presence of NCDs in the adjusted model. BMI, SBP, and DBP were also not significantly associated with the presence of NCDs (Figure 2).

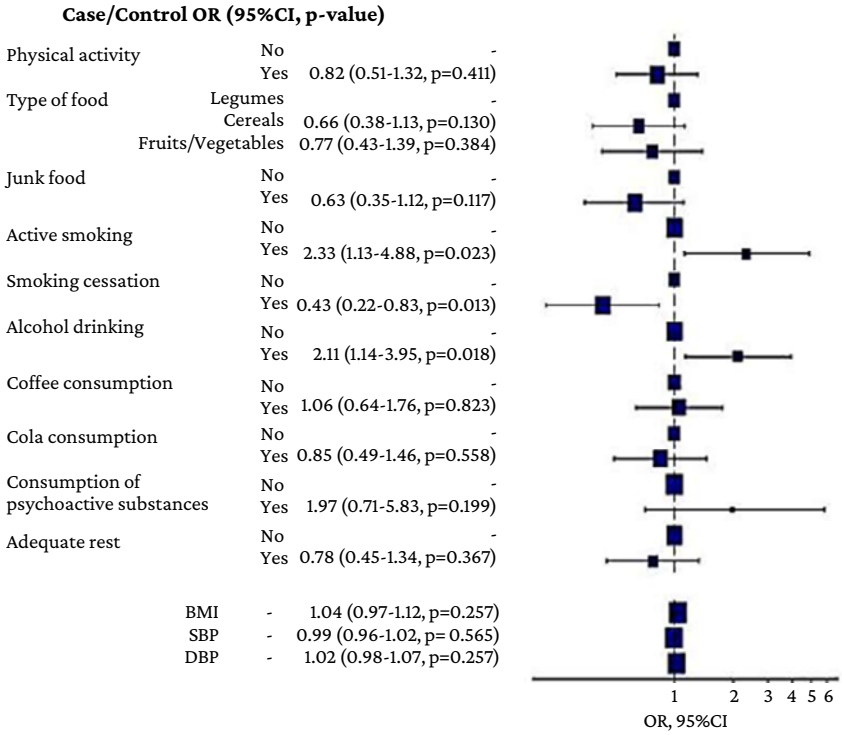

Figure 2. Multivariate analysis (adjusted logistic regression model): lifestyle factors and nutritional status factors in noncommunicable diseases. District 03D01-Ecuador.
BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure.

Although the explanatory power of the model is low (R^2Nagelkerke=0.0946), the overall *p*-value (0.029) is statistically significant, suggesting an association between the 3 predictor variables (alcohol consumption, active smoking, and smoking cessation) with the response variable (presence of NCD). Furthermore, the collinearity in all the variables of the model is acceptable (VIF<2).

Discussion

The present case-control study analyzed the association between the presence of NCDs and nutritional status and lifestyle factors in the Ecuadorian population aged 20 to 64 years residing in District 03D01, including the cities of Azogues, Biblián, and Déleg.

The median age of the cases was 52 years, with a predominance of women (73.86%) and a higher frequency of individuals residing in rural areas (67.61%). The most common marital status and educational level were married/domestic partnership (78.98%) and completed high school (47.16%).

These results partially agree with what was described by Kyprianidou *et al.*[46] in a study conducted between May 2018 and June 2019 in 1 140 adults (>18 years) residing in 5

municipalities of Cyprus, in which the mean age in the subgroup of individuals who had at least one NCD (n=590; 51.75%) was 47.5±17.5 years, 58.30% were female, 63.22% were married, 77.45% lived in an urban area, and the most frequent educational level was higher education (57.28%).

Similarly, our findings are partially similar to those reported by das Neves Júnior *et al.*[47] in a study conducted in Rio Grande do Norte (Brazil) between January 2018 and March 2020 in 80 adults diagnosed with at least one NCD, in which a predominance of women (87.5%) was also observed. However, the frequency of married individuals or in stable partnership was lower (53.75%), the average age was much higher (58.4 years), and the most frequent educational level was incomplete primary school (62.5%). These differences between studies could be explained by sample size and geographic differences, among other factors.

Likewise, studies that have been performed in individuals with specific NCDs have reported results partially similar to ours. For example, Vinueza-Veloz *et al.*,[32] in a study conducted in Ecuador with data from 89 212 adults from the ENSANUT-EC 2018 study to identify population groups at risk of overweight and obesity, reported that in the case of overweight individuals (n=36 356, 40.75%) and those with obesity (n=19 192, 21.51%), the average age was 42 and 44 years, the average years of schooling was 4.49 and 4.5, males were predominant (51% and 63.9%), and most lived in urban area (62.8% and 69%) and cohabited with a partner or spouse (69.9% and 72.6%).

Meanwhile, Vásquez *et al.*,[48] in a study conducted in 1 068 adults with type 2 DM treated in 2021 in the outpatient services of 53 health institutions in Bogotá (Colombia), reported that the mean age of the participants was 63.97 years, 65.15% were women, and 75.66% had only completed primary school. Also, Peña *et al.*,[49] in a study of 399 adults living in the urban area of Cuenca, Ecuador, conducted to establish the prevalence and factors associated with HBP in this population, reported that in the group of individuals with HBP (n=45) women predominated (75.55%), as well as individuals who were married or living in a domestic partnership (55.55%).

In the present study, the most frequent family history conditions among the cases were: HBP (47.73%), obesity (39.20%), and DM (34.09%). These findings are consistent with those reported in the literature, where the most common family history conditions were HBP and diabetes, with prevalences ranging from 17.3% to 38.2% and from 13.2% to 41.9%, respectively.[50-52] These data illustrate the importance of considering family history as a relevant risk factor in clinical evaluation and the implementation of strategies to prevent NCDs.

According to the responses to the questionnaire, the most frequent NCD was overweight/obesity (19.88%), followed by HBP (16.48%), dyslipidemias (high cholesterol: 16.48%; high triglycerides: 12.5%), DM (13.64%), and cancer (11.93%). This contrasts with the results reported by Das Neves Júnior *et al.*[47] in their study, which found that the most frequent NCDs were HBP (82.5%), DM (56.3%), osteoarticular disease (20%), and dyslipidemias (6.3%). These differences may be related to the fact that the study by Das Neves Júnior *et al.*[47] includes only patients with a confirmed diagnosis of NCD, which biases the results towards higher prevalences of specific diseases.

Our results also differ from those of Kyprianidou *et al.*,[46] who found in their study that the most prevalent NCDs were hyperlipidemia (17.4%), HBP (12.9%), thyroid disease (8.4%), and gastric reflux (7. 4%). The same was true for the study by Barboza-Palomino,[12] in which 412 adults (18-64 years of age) living in Ayacucho (Peru) were studied to determine the prevalence of the most relevant risk factors associated with cardiovascular disease, finding that the most frequent NCDs were obesity (29.9%), dyslipidemia (29.6%), HBP (14.6%), and DM (7.8%).

This variability in the frequency of specific types of NCDs across studies could be explained by differences between samples, such as sociodemographic characteristics and those related to the environments in which they live. Another possible explanation could be the variability in data collection methods, as some studies are based on medical records or self-reports, while others use direct clinical measurements, which can lead to discrepancies in prevalence estimates.

In the present study, headache (62.50%), tinnitus (42.05%) and increased feeling of hunger (40.34%) were the most frequently reported symptoms by respondents with at least one NCD (cases). Although comparing this aspect with other research is somewhat difficult due to the diversity of the clinical presentation of NCDs and the lack of specific studies that address these diseases collectively, we found that these symptoms are among the most frequently described symptoms for NCDs. For example, symptoms of diabetes include increased thirst, urination and appetite, fatigue, blurred vision, non-healing ulcers and weight loss for no apparent reason,[53] whereas symptoms of HBP include severe headache, nausea or vomiting, confusion, vision disturbances, and nosebleeds.[54]

On the other hand, despite the fact that in the present study 19.88% of the cases (i.e., those with at least one NCD) had overweight/obesity, there were no significant differences in nutritional status (measured by BMI) between cases and controls (p=0.244). This is consistent with the findings of Gómez-Avellaneda & Alvarado-Chávez,[55] who, in a study of 189 patients hospitalized in the surgery, medicine, trauma surgery and tropical services of the Hospital Nacional Cayetano Heredia in Lima, Peru, did not find a significant association between anthropometric indicators and NCDs. This lack of significant differences could be attributed to the influence of other risk factors, such as family history, lifestyle, or genetic predisposition, which could play a more decisive role in the population studied. Moreover, discrepancies in the findings could be connected to methodological variations, including sample size, demographic characteristics of the populations analyzed, or the handling of confounding variables in the statistical analyses, which could alter the relationship between BMI and NCDs.

Regarding lifestyle, based on the results of the adjusted logistic regression model, alcohol consumption (aOR=2.11) and active smoking (aOR=2.33) significantly increase the probability of developing an NCD, while smoking cessation reduces it (aOR=0.43). These findings concur with the relevant literature, where a strong association between alcohol[12,37,56,57] and tobacco[12,37,56-59] use has been described with an increased risk of NCDs. In this regard, although we found no studies on the positive impact of smoking cessation on NCD risk, our findings stress the importance of investigating this issue.

As for dietary habits, although a high proportion of participants reported consuming junk food (total: 67.04%; cases: 65.34%; controls: 68.75%), this variable was not associated with the presence of NCDs. This differs from what has been reported in several studies conducted in the region, where unhealthy diets are associated with the development of these diseases.[12,36,37,56] This discrepancy may be caused by methodological factors such as sample size or reporting biases, as well as the influence of other more determinant risk factors such as tobacco and alcohol consumption. Variations in food composition or local dietary patterns could also be involved. These findings highlight the need for research that addresses such issues and explores the contextual factors that affect this relationship.

The present study has some limitations that should be considered when interpreting the results. First, there is a possibility of selection bias because, while we matched for age, sex, and area of residence, the cases and controls may not adequately represent

the general population of District 03D01. Second, collecting data through a self-report instrument may have generated information bias due to possible errors caused by inaccurate memories or incomplete information provided by the participants. Third, as this is a case-control study, it is not possible to establish causal relationships between nutritional status, lifestyle factors, and the presence of NCDs, thus reducing it to the identification of associations. Finally, the low R^2 Nagelkerke value (0.094) suggests that there are important factors that were not considered in the model, such as genetic determinants, socioeconomic level or environmental exposure, as well as complex interactions between these factors, which could be key determinants and require further research.

Another limitation is sample size, which was calculated based on specific parameters, but may be insufficient to detect associations in less frequent variables, thus restricting the generalizability of the findings. In addition, the results may not be representative of other regions of Ecuador due to the particular characteristics of District 03D01, for example the predominance of a rural population. An additional aspect to consider is the variability in the definition of NCD, since some conditions such as overweight/obesity or thyroid problems were defined without any standardized diagnostic confirmation (self-reporting in the questionnaire). There were also limitations regarding the analysis of dietary habits, as the instrument used did not delve into the quality of the diet or the daily caloric intake of the participants. Lastly, while certain factors were adjusted to reduce confounding bias, some important elements, such as specific genetic background or socioeconomic status, were not adequately controlled for, leaving open the possibility of residual confounding.

Despite these limitations, the present study provides valuable information on the association of nutritional status and lifestyle variables with the presence of NCDs in an Ecuadorian population. However, further studies are needed to confirm the findings and establish a causal relationship.

Conclusions

In the present study, alcohol consumption and active smoking were identified as risk factors for the development of NCDs, while smoking cessation showed a protective effect. Therefore, public policies focused on smoking cessation and reduction of alcohol consumption should be developed and implemented in the country, as this could reduce the burden of NCDs.

Although no significant association was observed between BMI and the presence of NCDs, which could be related to the fact that family history of NCDs and lifestyle may have a greater impact on the development of these diseases, such an association has been reported in other studies, making it necessary to analyze it in different population contexts.

Finally there was a high frequency of family history of NCDs (15.91-47.73%) in individuals with at least one NCD in the present study, confirming the relevance of this aspect as a key risk factor that should be considered in the clinical evaluation of patients and in the planning of preventive interventions for these diseases.

Conflicts of interest

None stated by the authors.

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