

Non-transmissible diseases

and their association with variability of laboratory tests of Azogues, Biblián and Déleg

Enfermedades no transmisibles y su asociación con la variabilidad de las pruebas de laboratorio de Azogues, Biblián y Déleg

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Abstract

The increase in the incidence and prevalence of noncommunicable diseases (NCDs) constitutes one of the main challenges for health systems. The laboratory contributes to the surveillance of NCDs through the analysis of serum biomarkers. Objective: To establish the association between NCDs and the variability of laboratory tests. Method: Quantitative, observational, correlational, retrospective study, reviewing secondary data corresponding to 198 male and female users aged 25 to 64 with NCDs who underwent laboratory tests in public health establishments in 3 Ecuadorian cities during 2021. The instrument It was a data collection sheet with the variables of interest. Statistical analysis included frequency distribution, measures of central tendency, measures of dispersion, and nonparametric tests (Cramer's V and Chi-square). Results: The sample has an average age of 52 ±9.9 years, 69.2% women, 83.8% from rural areas and 51% housewives. Diabetes and hypertension prevail in 91% of the participants. Elevated serum levels of glucose, cholesterol, urea, and creatinine showed a significant association ($p<0.05$) in people with NCDs. Elevated glucose, hemoglobin, hematocrit, LDL-C, and creatinine values were significantly ($p<0.05$) associated with the city of Biblián. Conclusions: The variability of laboratory tests inform about the health condition and evolution of a person with NCDs.

Key words: laboratory test, health surveillance, noncommunicable diseases.

Resumen

El incremento de la incidencia y prevalencia de las de enfermedades no trasmisibles (ENT) constituye uno de los principales retos para los sistemas de salud. El laboratorio contribuye a la vigilancia de las ENT mediante el análisis de biomarcadores séricos. Objetivo: Establecer la asociación entre las ENT y la variabilidad de las pruebas de laboratorio. Método: Estudio cuantitativo, observacional, correlacional, retrospectivo, de revisión de datos secundarios correspondientes a 198 usuarios hombres y mujeres de 25 a 64 años con ENT que se realizaron pruebas de laboratorio en establecimientos de salud públicos de 3 ciudades ecuatorianas durante 2021. El instrumento fue una ficha de recolección de datos con las variables de interés. El análisis estadístico incluyó la distribución de frecuencias, medidas de tendencia central, medidas de dispersión y pruebas no paramétricas (V de Cramer y Chi-cuadrado). Resultados: La muestra presenta una media de 52 ±9,9 años, mujeres 69,2%, del área rural 83,8% y amas de casa 51%. Prevalen la diabetes y la hipertensión en el 91% de los participantes. Los niveles séricos elevados de glucosa, colesterol, urea y creatinina mostraron asociación significativa ($p<0,05$) en las personas con ENT. Los valores elevados de glucosa, hemoglobina, hematocrito, C-LDL y creatinina se asociaron significativamente ($p<0,05$) a la ciudad de Biblián. Conclusiones: La variabilidad de las pruebas de laboratorio informan sobre el estado de salud y evolución de una persona con ENT.

Palabras clave: prueba de laboratorio, vigilancia de la salud, enfermedades no transmisibles.



One of the greatest challenges facing health systems worldwide today is the fight against the increase in non-communicable diseases (NCDs). The incidence and prevalence of these diseases is currently growing considerably and as a result, the percentages of morbidity, mortality and premature disability have risen, which in turn increases the costs of hospitalization and medical treatment^{1,2}.

Globally, NCDs are the leading cause of mortality, with cardiovascular disease, cancer, diabetes mellitus, arterial hypertension (HT), chronic kidney disease and chronic respiratory diseases being those with the highest incidence. The presence of these pathologies is linked to lifestyle and demographic transitions, which is why it is necessary to transform health systems in all regions, especially in middle and low-income regions²⁻⁴.

The origin of this type of disease lies in risk factors that can be modifiable and others that are not modifiable. Among the modifiable factors are smoking, physical inactivity, alcohol consumption and inadequate diets (leading to overweight and obesity). Early detection and timely treatment are important strategies in response to NCDs, without forgetting palliative care⁴⁻⁶.

Under this same perspective, the World Health Organization (WHO) reported in April 2021 that 71% of deaths worldwide are due to NCDs (approx. 41 million people), of which 15 million correspond to premature deaths (30-69 years) and 85% of these deaths occur in middle and low-income countries. The majority of annual deaths are from cardiovascular diseases (17.9 million), 9 million from cancer, 3.9 million from respiratory diseases and 1.6 million from diabetes^{4,5}.

In Spain, a high-income country, statistics show that 61% of deaths correspond to NCDs, with malignant tumors, cardiovascular, cerebrovascular, and lower respiratory diseases, Alzheimer's disease and diabetes among the leading causes of mortality. Obesity, sedentary lifestyle, tobacco use, alcohol consumption, poor quality diet and even occupational and environmental factors are also mentioned as risk factors⁷. In Latin America and the Caribbean, NCDs have generated high percentages of avoidable early mortality, high rates of disability, and high treatment costs⁸.

In Ecuador, NCDs are a public health problem and the burden of disease from these pathologies is expected to continue to rise, mainly diabetes mellitus, cardiovascular diseases, hypertensive disease, and chronic respiratory diseases. In the province of Cañar, the situation is similar to the rest of the country, although malignant tumors represent 14.45% of hospitalizations, cardiovascular diseases 14.13% and chronic degenerative diseases 11.39% of hospital admissions⁹.

In District 03D01 confirmed by the cities of Azogues, Biblián and Déleg, a total of 744 cases of diabetes and 1333 of hypertensive disease were registered in 2021. Likewise, the results of the "National Health and Nutrition Survey" (ENSANUT) 2018, reveal an accelerated increase in the rates of overweight and obesity and consequently the growth of NCDs, for example, it is reported that 3.4% of the Ecuadorian population between 40 and 49 years old has diabetes^{10,11}.

The management of chronic diseases should have a primary health care approach, based on education to modify people's lifestyles; however, resources are not sufficient in middle and low-income countries to solve the problem. In this context, an intervention study carried out in Mexico on 188 people with NCDs emphasized the prevention of life-threatening risks, diet, exercise, rest, adherence to treatment, family support and social communication¹².

In this context, laboratory tests play an important role in the diagnosis and surveillance of chronic noncommunicable pathologies; their requirement is based on the needs of each patient to establish reference ranges and identify their physiological or pathological state, by means of metabolic indexes and markers that allow continuous monitoring of risk factors¹³⁻¹⁵.

Cathalifaud et al.¹⁶ propose a series of laboratory tests that could be requested for screening, diagnosis and/or control of NCDs, recommending: blood glucose, creatinine, lipid profile, liver profile, TSH and other tests such as microalbumin-creatinine ratio (MACR) in an isolated urine sample and various imaging tests (especially in cancer).

Laboratory tests in patients with ENT should be directed to look for target organ damage. Laboratory tests are suggested at the beginning of treatment and to evaluate the effectiveness of treatment. Tests to be included are blood count, elemental and microscopic urine examination, blood glucose, glycosylated hemoglobin (HbA1c), serum levels of potassium, calcium, creatinine, lipid profile and liver profile (serum transaminases -TGO or AST and TGP or ALT-)^{17,18}.

Navarrete et al.¹⁹ in 2016 studied the relationship between body mass index (BMI) and serum lipid levels, finding associations between BMI and triglycerides, BMI and cholesterol, and BMI and HDL cholesterol (C-HDL).

A study published in 2021 on metabolic syndrome, carried out in Cuenca-Ecuador, found alterations in TGO (12.4%) and TGP (9%) in the participants, and TGO correlated with triglycerides and C-HDL, although there were no differences in serum transaminase values between the group of people with metabolic syndrome and those without²⁰. Parla et al.²¹ reported that HDL-C decreased in overweight individuals and fasting glucose values were altered in 23.7% of overweight and hypertensive participants.

Barcia et al.²² studied the factors associated with chronic kidney disease, finding that HT and diabetes mellitus are the most prevalent. An association was observed between HTN and elevated uric acid and creatinine levels, while diabetes mellitus was associated with altered creatinine values; however, no association was found between excess weight and serum biomarkers of renal function.

In chronic respiratory diseases, a complete blood count is useful to detect the possibility of anemia or polyglobulia. Blood biochemistry may reveal low potassium levels²³. A significant association has been reported between metabolic syndrome and impaired pulmonary function in chronic respiratory diseases²⁴.

As for glucose, blood glucose parameters may be elevated in patients with Sleep Apnea-Hypopnea Syndrome (SAHS) and Overlap Syndrome (OS), while insulin levels are usually elevated in patients with SAHS. Values related to lipid profile in certain chronic respiratory diseases (COPD, SAHS, OS) show no differences in serum concentrations of total cholesterol and LDL cholesterol; however, triglycerides tend to be elevated, especially in patients with SAHS. Patients with SAHS and SO may have higher TGP levels than patients with COPD, while serum TGO concentrations remain normal²⁴.

The study was conducted with the objective of establishing the association between NCDs and the variability of laboratory tests performed on patients attending public health facilities in District 03D01.

Methodology

Quantitative, correlational, retrospective, retrospective, secondary data review study, where the unit of analysis consisted of 198 laboratory test records corresponding to people with non-communicable diseases who attended public health facilities in District 03D01 of the Republic of Ecuador, which includes the cities of Azogues, Biblián and Déleg.

The information collected for the study was taken from a database of 198 men and women, aged 25 to 64 years with non-communicable diseases, who underwent laboratory tests during the year 2021, therefore, no sample calculation was performed, and we worked with the totality of the data.

Inclusion criteria were: duly anonymized records, records containing the study variables (glucose, hemoglobin, hematocrit, lipid profile, liver function tests and renal function tests). Records with incomplete data, outliers or inconsistencies were excluded.

The observation technique was used, collecting anonymized secondary data in a registry card, where the information referring to the variables of interest was extracted, using a Microsoft Excel® spreadsheet that was then emptied in the SPSS v.26 statistical package (test) and in the Jamovi v2.0 software to perform normality tests and the descriptive and inferential analysis, by means of tables and figures.

The presentation of the social and demographic characteristics was done through analysis in the Jamovi software, generating a table with absolute and relative frequencies for the qualitative variables, while the quantitative variables were presented with the mean and standard deviation.

The association between variables was performed using the contingency coefficient C and Cramer's V coefficient, since non-parametric data were obtained and the variables to be measured were nominal polytomous variables. Cramer's V takes values between 0 and 1. Values of V close to 0 indicate that there is no association between the variables and values close to 1 indicate a strong association. The results are presented in ta-

bles and figures generated in SPSS. The following equivalences were considered to establish the association criteria^{25,26}:

0 to 0.10= no association, 0.11 to 0.30= weak association, 0.31 to 0.50 = moderate association and 0.51 to 1= strong association

The study was considered risk-free and is part of the research project "Prevalence and risk factors associated with non-communicable diseases in adult patients in District 03D01". The protocol was submitted for evaluation to the Health Research Bioethics Committee (COBIAS) of the University of Cuenca, which was approved with code 2022-005EO-IE. The authors declare NO conflict of interest.

Results

The sociodemographic characteristics of the 198 patients with NCD show an average age of 52 years, with a female predominance (69.2%), mostly residents of the city of Azogues (37.4%), from rural areas (83.8%), married (71.2%), with completed primary education (47.5%) and housewives in 51% of the cases (Table 1).

Table 1. Sociodemographic characteristics of the sample.

Variable	f	%	x
Age	-	-	52,17 ±9,9
Sex at birth			
Male	61	30,8	-
Female	137	69,2	-
Canton of residence			
Azogues	74	37,4	-
Biblián	70	35,3	-
Déleg	54	27,3	-
Area of residence			
Urban	166	16,2	-
Rural	32	83,8	-
Marital Status			
Single	33	16,7	-
Married	141	71,2	-
De facto union	6	3,0	-
Divorced/separated	11	5,6	-
Widowed	7	3,5	-
Schooling			
No schooling	19	9,6	-
Incomplete elementary school	48	24,2	-
Primary School Complete	94	47,5	-
High School Incomplete	8	4,1	-
High School Complete	26	13,1	-
Third Level	3	1,5	-
Fourth Level	0	0	-
Occupation			
Unemployed	35	17,7	-
Homemaker	101	51,0	-
Occasional Work	41	20,7	-
Paid Work	21	10,6	-
TOTAL	198	100	-

Note: f = frequency; x = mean; = standard deviation.

Regarding noncommunicable diseases in the study population, 6 types of NCDs were detected in the selected sample, with AHT and diabetes mellitus standing out, which together accounted for 91.5% of the cases (n=181). The NCDs found in the records of the 3 cities analyzed were diabetes, HT, renal failure and rheumatic diseases. The only case of renal insufficiency was found in the city of Azogues, while in the city of Biblián there were no chronic respiratory diseases. Table 2 shows in detail the presence of non-communicable pathologies found in District 03D01.

Table 2. Prevalence of NCDs in District 03D01, year 2021

Pathology	f	%
Arterial hypertension	114	57,6
Diabetes mellitus	67	33,9
Rheumatic diseases	7	3,5
Renal insufficiency	5	2,5
Chronic respiratory diseases	4	2,0
Heart failure	1	0,5
Total	198	100

Note: f = frequency.

On the other hand, in the association between laboratory alterations and NCDs, the statistical analysis using Cramer's V coefficient showed a moderate association between hyperglycemia

and the presence of NCDs (especially diabetes and HT), which is statistically significant ($p < 0.001$).

Likewise, statistical significance ($p = 0.002$) was found, but with a weak association between NCDs and variability in cholesterol values, especially in patients with diabetes mellitus, renal failure and HT.

In turn, renal function tests (urea and creatinine) showed a weak association with NCDs, with renal failure being the one with the greatest alteration of these markers, presenting a p value < 0.05 .

Table 3 also shows the V values obtained for the rest of the tests and the results of the contingency coefficient C, which indicates higher levels of association than Cramer's V.

Association between serum biomarkers by city of District 03D01.

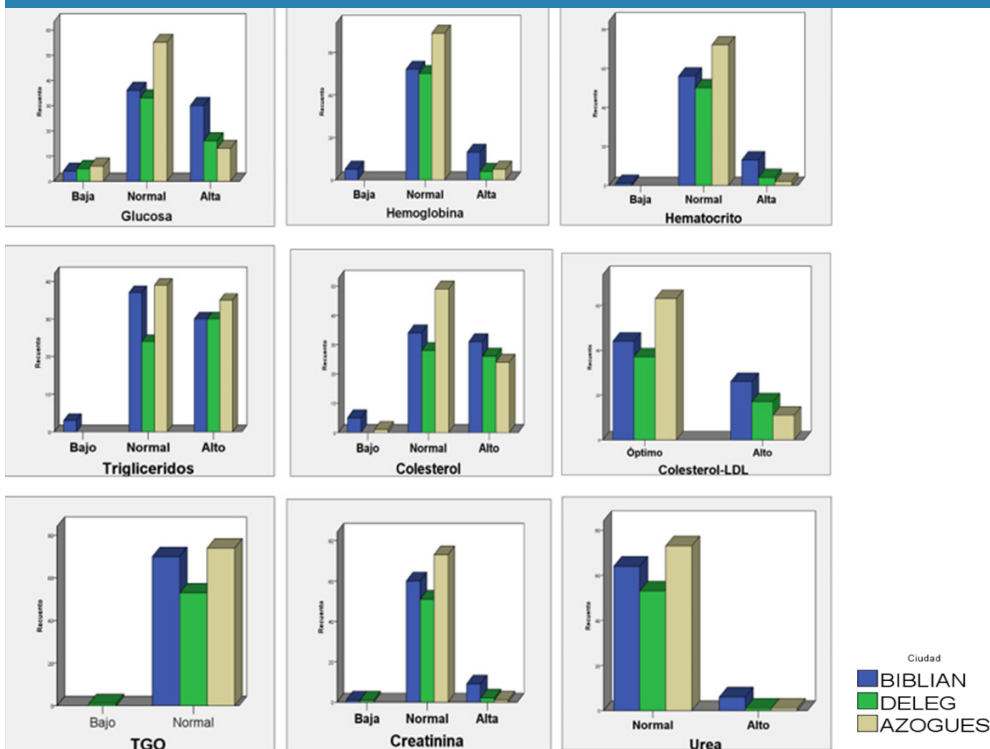
The variability of laboratory tests according to the city of District 03D01 was evaluated using the Chi-square statistic (X^2), with significant association observed in glucose ($p = 0.023$), hemoglobin ($p = 0.003$), hematocrit ($p = 0.012$), C-LDL ($p = 0.008$) and creatinine ($p = 0.033$). Figure 1 shows the details of each biomarker, highlighting the elevation of values in the city of Biblián.

Table 3. Bivariate analysis of ENT and serum biomarkers.

Coefficient of Association	Glucose	Hemoglobin	Hematocrit	Triglycerides	Cholesterol	C-HDL	C-LDL	TGO	TGP	Urea	Creatinina
Cramer's V	0,45*	0,14	0,11	0,24	0,26*	0,09	0,23	0,06	0,14	0,30*	0,29*
Contingency C	0,53*	0,19	0,15	0,17	0,35*	0,13	0,22	0,06	0,20	0,28*	0,38*

Note: * $p < 0.05$.

Figure 1. Variability of laboratory tests in NCDs by city. District 03D01.



Discussion

The research conducted sought to associate the variability of laboratory tests with non-communicable diseases present in the population of District 03D01, made up of 3 Ecuadorian cities (Azogues, Biblián and Déleg). The possibility of influence of NCDs on the alteration of 11 blood markers was studied: glucose, hemoglobin, hematocrit, triglycerides, cholesterol, C-HDL, C-LDL, TGO, TGP, urea and creatinine.

First, the laboratory test records of 198 people with NCD were analyzed to describe the sociodemographic characteristics of women (n= 61; 69.2%) and men (n=37; 30.8%) with an average age of 52 years, where 83.8% reside in rural areas, living with a partner (74.2%), with completed primary education (47.5%) and occupation housewife (n=101, 51%); 51%, which is similar to that presented in a quasi-experimental study in 188 patients (135 women and 53 men) with NCDs (obesity, AHT, diabetes and breast cancer) who received treatment in hospitals of the Instituto de Salud del Estado de México (ISEM) in the city of Toluca, with the most frequent occupation being housewife (n=101; 51%); housewife (n=105); however, the mean age differed, as it was located at 34.68 ± 8.00 ¹².

One of the objectives was to identify the type of NCDs present in chronic patients who underwent laboratory tests in the health facilities of District 03D01, with a massive presence of people with AHT (57.6%) and diabetes mellitus (33.9%); however, rheumatic diseases (3.5%), renal failure (2.5%), chronic respiratory diseases (2%) and heart failure (0.5%) were also found less frequently.

In this context, Montoya¹¹ indicates that in Ecuador, NCDs are the main cause of illness and avoidable premature death that generate a great socioeconomic burden that influences individual and family health. For their part, Serra et al.² state that "the magnitude of the NCD problem is greater than in previous years", especially in the young adult group, due to the high prevalence of HTN and diabetes.

On the contrary, Castañeda et al.¹ in a retrospective study carried out in Colombia (Trinidad municipality) based on secondary data taken from the Individual Service Provision Records, indicated a predominance of care for chronic respiratory system diseases (33.9% men and 25.3% women), followed by circulatory system diseases (HTN, heart failure, cerebrovascular disease) with 19.1% of care in men and 17.1% in women. Endocrine, nutritional and metabolic diseases, led by diabetes, accounted for 2.7% of visits in women and 2.4% in men. Chronic kidney disease is also reported, but a precise frequency cannot be established because it is grouped with other pathologies of the genitourinary system.

A moderate and statistically significant association was found between elevated blood glucose levels and the presence of diabetes and HT. Similarly, there was a weak association with statistical significance between NCDs and variability in cholesterol, urea and creatinine values, while the rest of the blood markers showed no association with NCDs.

Despite the existence of a weak association, in the analysis of the records of patients in District 03D01, the scientific evidence

reviewed indicates variations in some serum markers in the presence of NCDs, including elevated levels of glucose, cholesterol, LDL-C, triglycerides, TGO, TGP, creatinine, and decreased values of LDL-C and potassium¹⁹⁻²⁴.

Finally, a statistically significant association was found between laboratory alterations and the city of residence of the patients with NCD, with altered values of glucose, hemoglobin, hematocrit, LDL-C and creatinine in patients from Biblián, although this phenomenon cannot be explained with certainty, since there is a lack of studies that allow comparison of these results, which is a limitation.

Another limitation of this research is its methodological design; being retrospective and of secondary data, it was not possible to obtain records of other types of NCDs such as cancer, nor was it possible to categorize respiratory and rheumatic diseases. In addition, because the data were taken from the laboratory records of a group of patients from a specific District of the country, the results could not be generalized. Therefore, it would be appropriate to conduct longitudinal studies that would allow more general value judgments to be made.

Despite the limitations, the results are consistent with the hypothesis proposed and agree to a large extent with the scientific literature and the known physiological processes, making this study an important precedent for future research to solve the problem of the variability of blood markers in people with NCD for a better follow-up of the clinical evolution and medical treatment.

In conclusion, the values of serum laboratory tests suffer alterations in patients with NCDs, providing important information on the health status of an individual. Diabetes and AHT are the most prevalent pathologies found in people with NCDs in District 03D01 who underwent laboratory tests; however, they coexist in smaller proportions with renal failure, rheumatic diseases, chronic respiratory diseases, and heart failure. The biomarkers significantly associated with serum alterations in people with NCDs in District 03D01 are: glucose, total cholesterol, urea and creatinine, which tend to be more prevalent in the city of Biblián.

References

1. Castañeda-Porras O, Segura O, Parra AY. Prevalence of chronic non-communicable diseases, Trinidad-Casanare. *Rev méd Ris* [Internet]. 2018 [citado 07 oct 2022]; 24(1):38-42. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0122-06672018000100007&lng=en
2. Serra Valdés M, Serra Ruíz M, Viera García M. Chronic noncommunicable diseases: current magnitude and future trends. *Rev. Finlay* [Internet]. 2018 [citado 07 oct 2022]; 8(2):140-148. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2221-24342018000200008&lng=es
3. Catoe H, Jarvis J, Gupta S, Ginsburg O, de Lima Lopes G. The Road to Addressing Noncommunicable Diseases and Cancer in Global Health Policy. *Am Soc Clin Oncol Educ B* [Internet]. 2017 [citado 07 oct 2022]; (37):29–33. https://doi.org/10.1200/EDBK_100012
4. San Mauro I, De la Calle L, Sanz S, Garicano E, Ciudad M, Collado L. Enfoque genómico de la enfermedad cardiovascular. *Rev. Nutr. Hosp*



[Internet]. 2016 [citado 07 oct 2022]; 33(1):148-155. <http://dx.doi.org/10.20960/nh.23>

5. World Health Organization. Mortality and morbidity from NCDs [Internet]. 2021 Geneva: Global Health Observatory. [consultado 07 oct 2022]. http://www.who.int/gho/ncd/mortality_morbidity/en/
6. Ministerio de Salud de la Nación. Manual para el cuidado de personas con enfermedades crónicas no transmisibles: manejo integral en el primer nivel de atención: Argentina 2016 [Internet]. 1a ed. Buenos Aires: Dirección de Promoción de La Salud y Control de Enfermedades No Transmisibles: Organización Panamericana de la Salud; 2017 [citado 07 oct 2022]. 154 p. Disponible en: <https://iris.paho.org/handle/10665.2/34520https://iris.paho.org/handle/10665.2/34520>
7. Mayoral Cortes JM, Aragonés Sanz N, Godoy P, Sierra Moros MJ, Cano Portero R, González Moran F, et al. Las enfermedades crónicas como prioridad de la vigilancia de la salud pública en España. *Gac Sanit* [Internet]. 2016 [citado 07 oct 2022]; 30(2):154-7. Disponible en: <https://www.sciencedirect.com/science/article/pii/S021391111500254X>
8. Londoño Agudelo E. Las enfermedades crónicas y la ineludible transformación de los sistemas de salud en América Latina. *Rev Cubana Salud Pública* [Internet]. 2017 [citado 07 oct 2022]; 43(1):68-74. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-34662017000100007&lng=es
9. Instituto Nacional de Estadística y Censo. Registro Estadístico de Camas y Egresos Hospitalarios 2021 [Internet]. INEC; 2021 [consultado 07 oct 2022]. Disponible en: <https://www.ecuadorencifras.gob.ec/salud-salud-reproductiva-y-nutricion/https://www.ecuadorencifras.gob.ec/camas-y-egresos-hospitalarios/>
10. Instituto Nacional de Estadística y Censo. Encuesta Nacional de Salud y Nutrición 2018 [Internet]. INEC; 2018 [consultado 07 oct 2022]. Disponible en: <https://www.ecuadorencifras.gob.ec/salud-salud-reproductiva-y-nutricion/>
11. Montoya R. Situación de Enfermedades crónicas no trasmisibles en Ecuador. *Revista informativa OPS/OMS*. 2014; 32:14-23
12. Domínguez López AA, Oudhof van Barneveld J, González-Arratia NI, Flores Galaz MM. Efecto de un programa de atención primaria de salud en pacientes mexicanos con enfermedades crónicas no trasmisibles. *Revista de Psicología (PUCP)* [Internet]. 2020 [citado 07 oct 2022]; 38(2):529-552. Disponible en: <https://dx.doi.org/10.18800/psico.202002.007>
13. Álvarez Prats M, Triana Mantilla ME, Rodríguez Villalonga LE, Torres Reyes X. Perfil lipídico mínimo para el diagnóstico del riesgo de enfermedad vascular periférica de los miembros inferiores. *Rev Cubana Angiol Cir Vasc* [Internet]. 2019 [citado 07 oct 2022]; 20(3):e56. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1682-00372019000300002&lng=es
14. Bermúdez AJ, Robayo DB. Vigilancia por laboratorio de las enfermedades crónicas: una estrategia para las enfermedades metabólicas. *Nova* [Internet]. 2016 [citado 07 oct 2022]; 14(26):85-93. Disponible en: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S1794-24702016000200011&lng=en
15. Jiménez Mateos P. Marcadores sanguíneos utilizados en el diagnóstico y pronóstico del riesgo cardiovascular. En: Libro de la salud cardiovascular del Hospital Clínico San Carlos y de la Fundación BBVA [Internet]. Bilbao: Fundación BBVA; 2009 [citado 07 oct 2022]. p. 231-238. Disponible en: https://www.fbbva.es/microsites/salud_cardio/fbbva_libro-Corazon_pres.html
16. Cathalifaud Zilleruelo DH, Caris Lazo JA, Tapia Mora P, Vivaldo Crisóstomo CA, Inostroza Casanueva MF, Moore Clive PM. Laboratorio e imágenes para el tamizaje de enfermedades en el Adulto Mayor, parte I: Enfermedades crónicas no transmisibles. *rmed* [Internet]. 2020 [citado 07 oct 2022]; 14(1):16. <https://www.revistachilenademedicinafamiliar.cl/index.php/sochimef/article/view/365>
17. Giménez MI, Gallo A. El laboratorio en la hipertensión arterial. En: Gómez Llambi H, Piskorz D, editores. Hipertensión arterial Epidemiología, fisiología, fisiopatología, diagnóstico y terapéutica [Internet]. Buenos Aires: Sociedad Argentina de Hipertensión Arterial, SAHA; 2017. <https://www.saha.org.ar/formacion/libro>
18. Barba Evia JR. México y el reto de las enfermedades crónicas no transmisibles. El laboratorio también juega un papel importante. *Rev Mex Patol Clin Med Lab* [Internet]. 2018 [citado 07 oct 2022]; 65(1):4-17. <https://www.medigraphic.com/cgi-bin/new/resumen.cgi?IDARTICULO=7968>
19. Navarrete Mejía PJ, Loayza Alarico MJ, Velasco Guerrero JC, Huatuc Collantes ZA, Abregú Meza RA. Índice de masa corporal y niveles séricos de lípidos. *Horiz. Med.* [Internet]. 2016 [citado 07 oct 2022]; 16(2):13-18. Disponible en: http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1727-558X2016000200003&lng=es
20. Encalada-Torres L, Macero R, Tenecela E, Toledo C, Wong S. Transaminasas séricas y síndrome metabólico en adultos mayores de 65 años de la sierra ecuatoriana. *Acta bioquím. clín. latinoam.* [Internet]. 2017 [citado 07 oct 2022]; 51(4):603-608. Disponible en: http://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S0325-29572017000400005&lng=es
21. Parlá Sardiñas J, Cabrera Rode E, Rodríguez Acosta J, Cubas Dueñas I, Arnold Domínguez Y, Hernández Rodríguez J et al. Utilidad del fenotipo hipertensión-obesidad abdominal para identificar personas con riesgo cardiovascular global moderado y alto. *Rev Cubana Endocrinol* [Internet]. 2020 [citado 07 oct 2022]; 31(3):e248. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1561-29532020000300003&lng=es
22. Batista Garcet C, Batista Garcet Y, Jiménez Jiménez C, Rodríguez Pincay R. Perfil renal como ayuda al diagnóstico en habitantes de la parroquia la América del cantón Jipijapa: perfil renal como ayuda al diagnóstico. *UNESUM-Ciencias* [Internet]. 2020 [citado 07 oct 2022]; 4(3):141-56. Disponible en: <https://revistas.unesum.edu.ec/index.php/unesumciencias/article/view/206>
23. Díez J de M, Álvarez-Sala R. Manual de Neumología Clínica. 2 ed. Madrid: ERGON; 2009.
24. Landete Rodríguez P. Characterization of metabolic and cardiovascular comorbidities associated with chronic respiratory diseases [Internet] [Doctoral Thesis]. [Madrid]: Universidad Autónoma de Madrid; 2018 [cited.07 oct 2022]. <https://repositorio.uam.es/handle/10486/684188>
25. Sáenz Vela HM, Gutiérrez Flores L, Minor Campa EE. Asociación estadística entre el ingreso y los derechos sociales en México. *NOESIS* [Internet]. 2022 [citado 07 oct 2022]; 27(53):22-45. <http://erevistas.uacj.mx/ojs/index.php/noesis/article/view/1065>
26. Betancourt Velásquez AC, Caviedes Niño IL. Metodología de correlación estadística de un sistema integrado de gestión de la calidad en el sector salud. *SIGNOS* [Internet]. 2018 [citado 07 oct 2022]; 10(2):119-139. <https://revistas.usantotomas.edu.co/index.php/signos/article/view/4681>