VALIDITY OF THE AMERICAN DIABETES ASSOCIATION DIABETES RISK TEST AS SCREENING FOR PREDIABETES IN A SAMPLE OF PERUVIAN WORKERS

VALIDEZ DE LA PRUEBA DE RIESGO DE LA ASOCIACIÓN AMERICANA DE DIABETES COMO CRIBADO PARA PREDIABETES EN UNA MUESTRA DE TRABAJADORES PERUANOS

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ABSTRACT

Objectives: To evaluate the validity of the American Diabetes Association (ADA Test) risk test as a screening for prediabetes in a sample of Peruvian workers. **Methods:** Cross-sectional study of diagnostic tests. Secondary analysis of the data generated by the electronic health record of an occupational polyclinic, carried out in January and February 2020. The sample was made up of workers from different areas who attended for their occupational medical evaluation. Prediabetes was considered with a fasting glucose ≥ 100 mg / dl but less than 126 mg / dl. **Results:** 397 subjects were evaluated. The prevalence of hyperglycemia was 29% (115/397). With a cutoff ≥ 3 points, the ADA Test presented an area under the curve of 0.868, a sensitivity of 94.8%, and a specificity of 51.8%. The positive predictive value (PPV) was 44.5% and the negative predictive value (NPV) was 96.1%. Finally, the positive likelihood coefficient calculated was 1.96, and the negative was 0.101. **Conclusions:** The ADA test, with a 3-point cutoff, proves to be a simple pragmatic screening tool for undiagnosed cases of prediabetes. Suppose current results are confirmed in future research, due to their simplicity. In the case, it can facilitate various initiatives aimed at introducing and expanding early prevention and management strategies based on this trial.

Key words: Prediabetic state; Diabetes mellitus; Screening; Primary prevention; Perú (source: MeSH NLM).

RESUMEN

Ojetivos: Evaluar la validez de la prueba de riesgo de la Asociación Americana de Diabetes (Prueba ADA) como cribado para prediabetes en una muestra de trabajadores peruanos. **Métodos:** Estudio transversal de pruebas diagnósticas. Análisis secundario de los datos generados por el registro electrónico en salud de un policlínico ocupacional, realizado en los meses enero y febrero del año 2020. La muestra estuvo conformada por trabajadores de diferentes áreas que asistieron para su evaluación médica ocupacional. Se consideró prediabetes con una glucosa en ayunas ≥ 100 mg/dl pero menor a 126 mg/dl. **Resultados:** Se evaluaron 397 sujetos. La prevalencia de prediabetes fue 29% (115/397). Con un corte ≥ 3 puntos, la Prueba ADA presentó un área bajo la curva de 0.868, una sensibilidad del 94,8% y una especificidad del 51,8%. El valor predictivo positio fue de 44,5% y negativo fue de 96,1%. Por último, el coeficiente de verosimilitud positivo calculado fue de 1,96, y el negativo fue de 0,101. **Conclusión:** La prueba ADA, con un corte de 3 puntos, demuestra ser una herramienta de detección pragmática simple para casos no diagnosticados de prediabetes. Si los resultados actuales se confirman en investigaciones futuras, debido a su simplicidad, puede facilitar diversas iniciativas orientadas a introducir y ampliar estrategias de gestión y prevención temprana a partir de esta prueba.

Palabras clave: Estado prediabetes; Diabetes mellitus; Cribado; Prevención primaria; Perú (fuente: DeCS BIREME).

INTRODUCTION

Type 2 diabetes mellitus (DM2) is a progressive disease that causes multiple complications over time, both micro and macrovascular, increasing cardiovascular mortality[1,2]. Thus, DM2 is a serious public health problem worldwide[3,4]. For example, in the United States (USA) and China, the prevalence of DM2 is around 11.6%[5,6]. While, in Peru, the prevalence of DM2 is 7%, and the incidence is 19 cases per 1000 inhabitants[7,8].

Therefore, public health policies must focus on detecting subjects in previous states, such as prediabetes, which is a state that can be reversed and thus prevent progression to DM2[9-11]. However, laboratory tests are not always available in primary care settings[12]. For this reason, the need to implement a simple, rapid, and laboratory-free detection method is impetuous[13]. One of these tools is the American Diabetes Association (Risk TestADA TestADA Test Risk Score)[14].

The ADA test consists of 7 questions, with a score of 0-11 points. Initially, it has been used to detect a high risk of DM2. If the score was greater than or equal to 5 points, the patient has indicated a discarded test for DM2[14]. However, this test has shown good screening values for prediabetes in other studies, although these present different cut-off points, depending on where the study was carried out[15-19].

Extrapolating these results to the Latino population, particularly the Peruvian, is not recommended for optimal clinical decision-making[20,21]. Therefore, starting from a workgroup, which is progressively exposed to risk factors, such as age, stress, incorrect eating behavior, among others[22-24], this research proposes to estimate the diagnostic validity of the ADA test as a screening for prediabetes in a sample of Peruvian workers.

METHODS

Design

A cross-sectional study of diagnostic tests. Secondary analysis of the data generated by the electronic health record of an occupational polyclinic located in Lima, Peru. This registry was carried out in January and February of the year 2020.

Population and sample

The database included information on the results of the occupational examinations carried out on workers who attended the Polyclinic. The workers belong to the ages between 18 to 65 years, who belonged to different employers in the City of Lima - Peru, whose main work areas are administrative, management, accountant, assistant, supervisor, bricklayer, operator, driver, and analyst.

In this studio, Workers who do not have fasting glucose, with fasting glucose ≥ 126 mg/dl, pregnant women were excluded, with a history of diabetes or prediabetes, and took medications that modify glucose levels. In that way, we worked with all the evaluated individuals in the study period and fulfilled the selection criteria. Consecutive non-probability sampling was carried out.

The database included 417 workers. Once the inclusion and exclusion criteria were applied, we worked with 397 subjects.

Procedures

The flow chart of care in the medical center is detailed below. When the worker arrived at the polyclinic, he signed a letter of commitment at the reception, declaring that all the information provided is accurate. You were given a file with the medical history to fill in your data. After that, the nursing team measured the total height with a stadiometer, while the weight was measured with an electronic scale, but before the subject was instructed to wear light clothing. All data were noted in the medical record.

Subsequently, it is passed to the laboratory, where the staff first verified that the worker had performed at least 8 hours of fasting. Then, a 5 ml blood sample was taken by venipuncture. The sample was centrifuged for 5 minutes to separate the serum to be processed in a Chemray 240 automatic equipment. The workers who did not comply with the requested fasting time did not take the laboratory test.

Finally, the worker went to the medical office of the polyclinic, where the medical evaluation was carried out. First, the occupational evaluating physician asked her questions about her biological, pathological, and family history. Then a physical exam was performed. Subsequently, a musculoskeletal examination was performed, where he was also asked about physical activity. Finally, depending on the type of work, other exams were indicated. All the data collected by the occupational physician were noted in the medical history.

An administrative staff registers all the information in the clinical history in the polyclinic's database.

ORIGINAL PAPER

Variables and instruments

The ADA test is a questionnaire that consists of 7 variables, with a score of 0 to 11 points. These variables are age: categorized as <40 years (0 points), 40-49 years (1 point), 50-59 years (2 points), 60 years and over (3 points); sex: male (1 point) and female (0 points); history of gestational diabetes: yes (1 point) and no (0 points); family history of diabetes: yes (1 point) and no (0 points); history of hypertension: yes (1 point) and no (0 points); performance or not of physical activity: yes (1 point) and no (0 points); and weight: normal weight (0 points), overweight (1 point), obesity (2 points) and morbid obesity (3 points)[25].

For the diagnosis of prediabetes, fasting glucose was used. It was worked as a categorical variable. A value <100 mg / dl was considered "normal", while values between ≥ 100 mg / dl and <126 mg / dl were classified as "prediabetes"[14].

Statistical analysis

The analysis was performed using Stata Software version 15.0 (Stata Corp. College Station, TX, USA). For descriptive analysis, qualitative variables were summarized in proportions, while the quantitative variables were presented as the mean and the standard deviation by the normality distribution of the age variable, which was evaluated through bias, kurtosis, and histogram. According to the group of the presence or not of prediabetes, the Fisher's exact test or the Student's T-test was performed for the bivariate analysis, depending on the nature of the variable.

The analysis of ROC curves (an acronym for Receiver Operating Characteristic, and their respective area under the curve (AUC) were used as a statistical and graphical method to evaluate the discriminative diagnostic performance both for the test score. ADA and fasting glucose levels. Sensitivity, specificity, positive (PPV) and negative predictive value (NPV), and positive and negative likelihood ratio were calculated with different cut-off points of the ADA test. The Youden index and sensitivity values were used to calculate the optimal cut-off point.

Ethical aspects

Only the variables of interest for the study were requested from the polyclinic. The data provided by the institution were anonymous, and access to the study material was limited to the principal investigator. For this reason, there was no contact with human beings; therefore, the risks for the subjects of analysis were minimal.

In addition, it had the permission of the institution (polyclinic), and the research project was submitted for evaluation by the Ethics Committee of the Southern Scientific University (CIEI-Científica).

RESULTS

A total of 397 subjects were included. The prevalence of prediabetes was 29%. The most common characteristics observed were being male (74.6%), being under 40 years of age (69%), and the proportion of subjects who performed physical activity (50.6%). The rest of the characteristics of the participants can be observed in detail in Table 1. In the bivariate analysis, all the variables associated with the ADA Test were shown to be significantly associated with respect to prediabetes.

Table 2 shows us that the ADA Test presented an AUC of 0.87. In addition, with a cutoff ≥ 3 points, a sensitivity of 94.8% and a specificity of 51.8% were obtained; a PPV of 44.5% and an NPV of 96.1%; finally, the positive likelihood coefficient calculated was 1.96, and the negative was 0.101. In figure 2, you can see the ROC curve according to the total.

Table 1. Descriptive characteristics of the ADA Test in the study population and bivariate analysis regarding the presence of prediabetes.

Characteristics	Total (n=397) n (%)	Prediabetes no (n=282) n (%)	si (n=115) n (%)	p*
Gender				0.036
Female	101 (25.4)	80 (79.2)	21 (20.8)	
Male	296 (74.6)	202 (68.2)	94 (31.8)	
Age (years)¶	35,35 (± 10,54)	32,66 (± 9,07)	41,95 (± 11)	<0.001
Age (categorized)				<0.001
< 40 years	274 (69)	225 (82.1)	49 (17.9)	
40 - 49 years	79 (19.9)	45 (57.0)	34 (43)	
50 - 59 years	35 (8.8)	10 (28.6)	25 (71.4)	
≥ 60 years	9 (2.3)	2 (22.2)	7 (77.8)	
Nutritional Status				<0.001
Normal weight	133 (33.5)	116 (87.2)	17 (12.8)	
Overweight	180 (45.3)	123 (68.3)	57 (31.7)	
Obesity I	69 (17.4)	41 (59.4)	28 (40.6)	
Obesity II	15 (3.8)	2 (13.3)	13 (86.7)	
Physical activity				<0.001
No	196 (49.4)	113 (57.7)	83 (42.4)	
Yes	201 (50.6)	169 (84.1)	32 (15.9)	
Family history of Diabetes Mellitus 2				0.012
No	266 (67)	202 (75.9)	64 (24.1)	
Yes	131 (33)	80 (61.1)	51 (38.9)	
Family history of Gestational Diabetes **				0.018
No	92 (91.1)	76 (82.6)	16 (17.4)	
Yes	9 (8.9)	4 (40)	5 (55.6)	
History of hypertension				0.012
No	388 (97.7)	279 (71.9)	109 (28.1)	
Yes	9 (2.3)	3 (33.3)	6 (66.7)	
ADA test				<0.001
< 3 points	254 (64)	235 (92.5)	19 (7.5)	
≥ 3 puntos	143 (36)	47 (32.9)	96 (67.1)	

* P-value calculated with the Chi-square test, except for the age variable (in years) that Student's t-test was used and for the antecedent variable of gestational diabetes, that the Fisher's exact test was used
** It has only been taken take into account the female population.
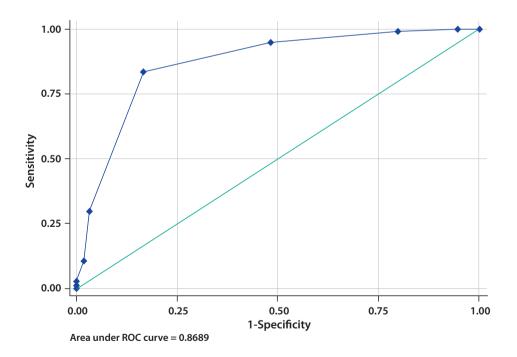¶ Mean plus standard deviation.

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Table 2. Diagnostic values according to the cut-off point of the ADA test for prediabetes.

Cut-off point	Sens (%)	Esp (%)	VPP	VPN	Youden's index	CV+	CV-
0	100	0	28.96	-	0	1	-
1	100	5.3	33.62	100	0.532	1.05	0
2	99.1	20.2	30.15	98.3	0.194	1.24	0.043
3	94.8	51.8	44.48	96.1	0.466	1.96	0.101
4	83.5	53.3	67.13	92.5	0.668	5	0.198
5	29.6	96.8	79.06	77.2	0.264	9.26	0.727
6	10.4	98.2	70.54	72.9	0.087	5.88	0.912
7	2.6	100	100	71.6	0.026	-	0.973
8	0.9	100	100	71.2	0.009	-	0.991
> 8	0	100	-	-	-	-	1

Sens: sensitivity, Esp: specificity, PPV: positive predictive value, NPV : negative predictive value, CV +: positive likelihood coefficient, CV-: negative likelihood coefficient.

Area under ROC curve = 0.8689

Figure 1. ROC curve of the ADA Test with respect to the diagnosis of prediabetes.

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DISCUSSION

Due to the increase in the frequency of DM2 cases in Peru, the prevention of this disease has become an important priority in public health. It is important to have a simple, rapid, and laboratory-free screening tool[13] to detect elevated glucose levels prior to the state of DM2, even in the absence of biochemical analysis. To our knowledge, this is the first study to examine this test in the Peruvian population.

The AUC of the ADA Test was high (0.87), demonstrating the ability of this test to approach the BG. The cut-off point for detecting prediabetes in the present study was 3. In this way, we can use it as a screening method due to its high sensitivity, where, out of every 100 people who undergo this test, 95 subjects with prediabetes would be detected.

This cut-off point differs from that found in other studies. In the US and China, the ADA test was used to detect diabetes, with a cut-off point of 3 and 5 points, respectively. In the Philippines, the cut-off point established for prediabetes and diabetes was 4 points[15,17,19]. The study carried out in South India used the ADA test, but without comparison with any other diagnostic test, and only compared the cut-off point of 5 points for prediabetes, using glycosylated hemoglobin[16].

Its use in the Latino population so far has only been evaluated in Latinos residing in the United States, considering glycosylated hemoglobin as GS, to detect prediabetes, using a cut-off point of 4. However, all the population studied were women[18].

Although the main explanation for these differences found with other studies was that the methodology was not the most suitable, we must also consider the differences between the population characteristics between these countries. This shows that the same cut should not always be used for a certain pathology[20].

The limitations of this study should be considered. First, the subjects belong to the labor group. Therefore, the results of the ADA test may not be totally representative of the working population nor of the Peruvian population; however, it is possible that they have similar conditions, and some inference can be made. Second, while there are two more methods to diagnose this disease, which are glycosylated hemoglobin and glucose tolerance test, the results obtained by fasting glucose will give us a reliable result, so the final results will not be far from the actual value of the test.

Due to the importance of detecting prediabetes in areas where there is no access to conventional laboratory tests, it is recommended to continue carrying out studies with respect to the ADA Test in other Peruvian populations. In this way, it would work with a more representative sample. It will be possible to corroborate whether the behavior of said test as a screening method for prediabetes is maintained.

CONCLUSION

With a 3-point cutoff, the ADA test proves to be a pragmatic and straightforward screening tool for undiagnosed cases of prediabetes. Suppose current results are confirmed in future research due to their simplicity. In that case, it can facilitate various initiatives aimed at introducing and expanding early prevention and management strategies based on this trial.

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BIBLIOGRAPHIC REFERENCES

1. Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. Nat Rev Endocrinol. 2018;14(2):88–98. Disponible en: https://doi.org/10.1038/nrendo.2017.151

2. Alegría Ezquerra E, Castellano Vázquez JM, Alegría Barrero A. Obesity, Metabolic Syndrome and Diabetes: Cardiovascular Implications and Therapy. Rev Esp Cardiol. 2008;61(7):752–64. Disponible en: https://doi.org/10.1016/S1885-5857(08)60212-1

3. Zimmet PZ, Magliano DJ, Herman WH, Shaw JE. Diabetes: a 21st century challenge. Lancet Diabetes Endocrinol. 2014;2(1):56–64. DOI: https://doi.org/10.1016/S2213-8587(13)70112-8

4. Díaz L, Delgado E. Diabetes mellitus. Criterios diagnósticos y clasificación. Epidemiología. Etiopatogenia. Evaluación inicial del paciente con diabetes. Medicine. 2016;12(17):935–46. DOI: https://doi.org/10.1016/j.med.2016.09.001

5. National Diabetes Statistics Report | Data & Statistics | Diabetes | CDC [Internet]. 2020 [citado el 19 de febrero de 2020]. Disponible en: https://www.cdc.gov/diabetes/data/statistics/statistics-report.html

6. Xu Y, Wang L, He J, Bi Y, Li M, Wang T, et al. Prevalence and control of diabetes in Chinese adults. JAMA. 2013;310(9):948–59. DOI: https://doi.org/10.1001/jama.2013.168118

7. Carrillo-Larco R, Bernabé-Ortiz A. Diabetes mellitus tipo 2 en Perú: una revisión sistemática sobre la prevalencia e incidencia en población general. Rev Peru Med Exp Salud Publica. 2019;36(1):26–36. DOI: http://dx.doi.org/10.17843/rpmesp.2019.361.4027

8. Villena JE. Diabetes Mellitus in Peru. Ann Glob Health. 2015;81(6):765–75. DOI: https://doi.org/10.1016/j.aogh.2015.12.018

9. Knowler W, Barrett-Connor E, Fowler S, Hamman R, Lachin J, Walker E, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med. 2002;346(6):393–403. Disponible en: https://doi.org/10.1056/NEJMoa012512

10. Roncero-Ramos I, Alcala-Diaz JF, Rangel-Zuñiga OA, Gomez-Delgado F, Jimenez-Lucena R, García-Rios A, et al. Prediabetes diagnosis criteria, type 2 diabetes risk and dietary modulation: The CORDIOPREV study. The CORDIOPREV study. Clin Nutr.2020;39(2):492-500. DOI: https://doi.org/10.1016/j.clnu.2019.02.027

11. Vatcheva KP, Fisher-Hoch SP, Reininger BM, McCormick JB. Sex and age differences in prevalence and risk factors for prediabetes in Mexican-Americans. Diabetes Res Clin Pract. 2020;159:107950. DOI: https://doi.org/10.1016/j.diabres.2019.107950

12. Bellido-Zapata A, Ruiz-Muggi JE, Neira-Sánchez ER, Málaga G. Implementación y aplicación de la "Guía de práctica clínica para el diagnóstico, tratamiento y control de la diabetes mellitus tipo 2 en el primer nivel de atención" en una red de establecimientos de salud públicos de Lima. Acta méd. peruana. 2018;35(1):14–9. Disponible en: http://www.scielo.org.pe/scielo.php?pid=S1728-59172018000100003&script=sci_abstract

13. Costa A, Yuri A, Solà J, Conget I. Detección de la diabetes mellitus en consultas externas hospitalarias. Utilidad de un cuestionario de cribado. Med Clin (Barc). 2003;120(8):287–91. DOI: https://doi.org/10.1016/S0025-7753(03)73679-3

14. American Diabetes Association. Prevention or Delay of Type 2 Diabetes: Standards of Medical Care in Diabetes—2020. Dia Care. 2020;43(Supplement 1):S32–6. DOI: https://doi.org/10.2337/dc20-S003

15. Poltavskiy E, Kim DJ, Bang H. Comparison of screening scores for diabetes and prediabetes. Diabetes Res Clin Pract. 2016;118:146–53. DOI: https://doi.org/10.1371/journal.pone.0184840

16. Prabhu G, Poovitha M. To Determine the Usefulness of ADA Risk Score to Predict T2dm/Pre Diabetes in South Indian Rural Population. Pre Diabetes. 2019;6(8):4. DOI: https://doi.org/10.1016/j.diabres.2016.06.022

17. Agarwal G, Guingona MM, Gaber J, Angeles R, Rao S, Cristobal F. Choosing the most appropriate existing type 2 diabetes risk assessment tool for use in the Philippines: a case-control study with an urban Filipino population. BMC Public Health. 2019;19(1):1169. Disponible en: https://www.ijcmr.com/uploads/7/7/4/6/77464738/ijcmr_2685_v1.pdf

18. Scanlan AB, Maia CM, Perez A, Homko CJ, O'Brien MJ. Diabetes Risk Assessment in Latinas: Effectiveness of a Brief Diabetes Risk Questionnaire for Detecting Prediabetes in a Community-Based Sample. Diabetes Spectr. 2018;31(1):31–6. DOI: https://doi.org/10.1186/s12889-019-7402-0

19. Woo Y, Lee C, Fong C, Tso A, Cheung B, Lam K. Validation of the diabetes screening tools proposed by the American Diabetes Association in an aging Chinese population. PLoS ONE. 2017;12(9):e0184840. DOI: https://doi.org/10.2337/ds16-0051

20. Glümer C, Vistisen D, Borch-Johnsen K, Colagiuri S, DETECT-2 Collaboration. Risk scores for type 2 diabetes can be applied in some populations but not all. Diabetes Care. 2006;29(2):410–4. DOI: https://doi.org/10.2337/diacare.29.02.06.dc05-0945

21. Juarez LD, Gonzalez JS, Agne AA, Kulczycki A, Pavela G, Carson AP, et al. Diabetes Risk Scores for Hispanics Living in the United States.: A systematic review. Diabetes Res Clin Pract. 2018;142:120–9. Disponible en: https://doi.org/10.1016/j.diabres.2018.05.009

22. Mejia CR, Espejo RP, Zevallos KR, Castro TA, Vargas AB, Millan GK. Factores asociados al riesgo cardiovascular según Framingham en taxistas de una empresa de Huancayo, Perú. Rev Asoc Esp Espec Med Trab. 2016;25(1):19–25. Disponible en: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1132-62552016000100004

23. Rosas A Á, Lama G G, Llanos-Zavalaga F, Dunstan Y J. Prevalencia de obesidad e hipercolesterolemia en trabajadores de una institución estatal de Lima - Perú. Rev Peru Med Exp Salud Publica. 2002;19(2):87–92. Disponible en: http://www.scielo.org.pe/scielo.php?pid=S1726-46342002000200007&script=sci_abstract

24. Ruesta P, C R. Determinación de los factores de riesgo cardiovascular en trabajadores a turnos en plataformas marítimas de una petrolera del Norte del Perú. Acta méd. peruana. 2011;28(2):67–72. Disponible en: http://www.scielo.org.pe/scielo.php?pid=S1728-59172011000200002&script=sci_abstract

25. Bang H, Edwards A, Bomback A, Ballantyne C, Brillon D, Callahan M, et al. Development and validation of a patient self-assessment score for diabetes risk. Ann Intern Med. 2009;151(11):775–83. DOI: DOI: 10.7326/0003-4819-151-11-200912010-00005