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Prediabetes, undiagnosed diabetes, and diabetes among Mexican adults: findings from the Mexican Health and Aging Study

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Abstract

Purpose—The purpose of the study was to examine the prevalence and determinants of prediabetes, undiagnosed diabetes, and diabetes among Mexican adults from a subsample of the Mexican Health and Aging Study.

Methods—We examined 2012 participants from a subsample of the Mexican Health and Aging Study. Measures included sociodemographic characteristics, body mass index, central obesity, medical conditions, cholesterol, high-density lipoprotein cholesterol, hemoglobin A1c, and vitamin D. Logistic regression was performed to identify factors associated with prediabetes, undiagnosed diabetes, and self-reported diabetes.

Results—Prevalence of prediabetes, undiagnosed, and self-reported diabetes in this cohort was 44.2%, 18.0%, and 21.4%, respectively. Participants with high waist-hip ratio (1.61, 95% confidence interval [CI] = 1.05–2.45) and high cholesterol (1.85, 95% CI = 1.36–2.51) had higher odds of prediabetes. Overweight (1.68, 95% CI = 1.07–2.64), obesity (2.38, 95% CI = 1.41–4.02), and high waist circumference (1.60, 95% CI = 1.06–2.40) were significantly associated with higher odds of having undiagnosed diabetes. Those residing in a Mexican state with high U.S. migration had lower odds of prediabetes (0.61, 95% CI = 0.45–0.82) and undiagnosed diabetes (0.53, 95% CI = 0.41–0.70). Those engaged in regular physical activity had lower odds of undiagnosed diabetes (0.74, 95% CI = 0.57–0.97).

Conclusions—There is a high prevalence of prediabetes and undiagnosed diabetes among Mexican adults in this subsample. Findings suggest the need for resources to prevent, identify, and treat persons with prediabetes and undiagnosed diabetes.

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Keywords

Prediabetes; Undiagnosed diabetes; Mexico; Older adults; Central obesity; BMI; Migration; Physical activity; HbA1c; MHAS

Introduction

The incidence of diabetes is increasing globally, reaching epidemic levels in low- and middle-income countries, which creates concern in the health care systems with limited resources and persistent challenges in treating communicable diseases [1]. As a middle-income country, Mexico is experiencing an epidemiologic transition in which infectious diseases are becoming less important than noncommunicable chronic diseases including diabetes and cardiovascular diseases [2].

Prediabetes is the condition in which the blood glucose level is above normal but still less than that of diabetes. Recently, the American Diabetes Association (ADA) recommended hemoglobin A1c (HbA1c) criteria for diagnosing prediabetes and diabetes [3]. HbA1c measures the average blood sugar level over a 2- to 3-month period [3]. Prediabetes is a high-risk state for diabetes development [4,5]. A systematic review of prospective studies using HbA1c (n = 44,203 participants) found that individuals with A1c values 6.0% or more have a 20 times higher risk of progressing to diabetes within 5 years than persons with A1c less than 5.0% [5]. Previous studies have shown a higher prevalence of microalbuminuria and cardiovascular mortality in patients with prediabetes compared with those with a normal level of glucose [6,7].

Diabetes is a leading cause of disability, decreased total life expectancy, and mortality among the Mexican population [8]. The prevalence of diabetes has increased significantly among Mexican adults aged 50 years and older, from 14.6% in 2001 to 19.3% in 2012, with higher rates in women [9]. According to the Mexican National Health and Nutrition Survey 2012 report, the prevalence of diabetes was 19.4% and 26.3% in those aged 50–59 and 60–69 years, respectively [10]. Developing countries like Mexico, with increasing prevalence of obesity, little awareness of preventive screening, and limited access to health care, may have high rates of undetected diabetes. Wong et al. [9] reported that almost 15% of older adults in Mexico did not have health insurance in 2012, which may limit access to preventive screening. Diaz-Apodaca et al. [11] reported a higher prevalence of undiagnosed diabetes among the Hispanic population than non-Hispanic whites on both sides of the U.S. Mexico border in 2002.

Undiagnosed diabetes increases the risk of morbidity and mortality compared with not having diabetes, leading to high health care costs, loss of work productivity, and absenteeism at work [12–14]. With the growing prevalence of obesity and the epidemiologic transition in Mexico [10], surveillance of prediabetes and undiagnosed diabetes is crucial to understanding the extent of the problem. We performed secondary analyses on a subsample of the Mexican Health and Aging Study (MHAS) to examine the prevalence and factors associated with prediabetes, undiagnosed diabetes, and diabetes in Mexican adults.

Methods

Study population

The sample for this study was drawn from the MHAS, an ongoing nationally representative longitudinal study of adults in Mexico aged 50 years or older and their spouse and/or partner regardless of age, beginning in 2001 [9,15]. Two follow-ups were conducted in 2003 and 2012. In 2012, a new sample of 5896 participants was added to the ongoing cohort interviewed in 2001 and 2003 who remained in the study for the third follow-up (n = 12,569) for a total sample of 18,465 individuals [9]. Of these, a subsample of 2086 provided data on biomarkers: HbA1c, total and high-density cholesterol, and vitamin D [11]. Intravenous and capillary blood was collected by experienced professionals from the Instituto Nacional de Salud Pública de Mexico. The details on the study methodology were reported elsewhere [9].

Study subsample

The target subsample included participants providing biomarker data and interviewed in 2012 in four Mexican states. These states included a highly rural state, a highly urban state, a high–US.-migration state (people who migrated to the United States and came back to Mexico), and a state with a high prevalence of diabetes [9]. Out of 2086 participants, 50 had missing information on HbA1c, 15 reported diabetes in a previous wave (2001 or 2003), and 9 had missing information on self-reported diabetes. The final sample included 2012 participants (Fig. 1). No significant difference was found in the percentage of self-reported diabetes between the subsample and the national sample (17.9% vs. 18.9%) of MHAS [16]. Also, the prevalence of self-reported diabetes in the MHAS national sample has been externally validated and compared with the national prevalence from Mexican National Health and Nutrition Survey data [16].

Prediabetes, undiagnosed diabetes, and diabetes

We used ADA criteria for prediabetes and undiagnosed diabetes based on HbA1c blood levels to determine participant disease status [3]. In 2015, the ADA recommended that the HbA1c be tested using a method that is certified by the National Glycohemoglobin Standardization Program and standardized to the Diabetes Control and Complications Trial reference assay [3]. HbA1c was measured using A1cNow assay, a method that is National Glycohemoglobin Standardization Program certified. Studies have shown excellent correlation between HbA1c and average blood glucose levels [17–19]. Participants with HbA1c levels lower than 5.7% were classified as normal, those with levels between 5.7% and 6.4% were classified as having prediabetes, and those with levels 6.5% or above were classified as having undiagnosed diabetes. Self-reported diabetes was ascertained by the answer to the question “Has a doctor or medical personnel ever told you that you have diabetes?”

Covariates

Sociodemographic variables included age, gender, years of formal education, marital status, residence in a high–U.S.-migration state, and residence in an urban and/or rural location. A high U.S.-migration state was randomly selected from the five Mexican states with the highest levels migration to the United States. Other covariates were a family history of diabetes, smoking status, physical activity, health insurance, physician visits in the last 2 years, information on medical conditions, high-density lipoprotein (HDL) cholesterol, total cholesterol, and vitamin D. Age was categorized into four groups: less than 50, 50–59, 60–69, and 70 years or more. Education was categorized into four groups: none, 1–5, 6, and 7 years or more of education. The presence of medical conditions was assessed by asking participants if they had ever been diagnosed by a physician with the following medical conditions: hypertension, heart attack, or stroke. Physical activity was assessed by asking participants whether they had participated in vigorous physical activity or exercise three times a week or more on average over the last 2 years (yes or no). Vigorous activity included activities such as sports, heavy housework, or leisure activities involving physical labor [20]. Health insurance was dichotomized as yes or no. Physician visits were assessed by asking participants whether they had visited a medical doctor or any other medical personnel, including nurses, clinics, and hospitals in the last 12 months. Responses were categorized as dichotomous (yes or no).

Body mass index (BMI) was categorized into normal weight (18.5 to <25 kg/m^2), overweight (25 to <30 kg/m^2), and obesity (≥30 kg/m^2) [21]. Central adiposity was assessed using actual measurements of waist circumference (WC) and waist-hip ratio (WHR). Participants with WC of more than 102 cm in men and more than 88 cm in women were classified as having high WC (central obesity). Participants with WHR 0.90 or more in men and 0.85 or more in women were considered to have high WHR [22]. Participants with HDL cholesterol levels less than 40 mg/dL for men and less than 50 mg/dL for women were considered to have reduced HDL cholesterol [23] and those with total cholesterol levels of 200 mg/dL or more to have hypercholesterolemia. Serum 25-hydroxyvitamin D was used to measure vitamin D. Participants with vitamin D level less than 20 ng/dL in both men and women were categorized as vitamin D insufficiency [24].

Statistical analysis

Chi-square and analysis of variance were used to examine the distribution of HbA1c levels (normal, prediabetes, undiagnosed diabetes) and self-reported diabetes. Unweighted multivariate logistic regression models were constructed to identify the factors associated with prediabetes, undiagnosed diabetes, self-reported diabetes, and total diabetes (self-reported + undiagnosed diabetes). To test which anthropometric measures were best associated with prediabetes, undiagnosed diabetes, self-reported diabetes, and total diabetes, four models were constructed. The first model included age, gender, marital status, education, residence (rural vs. urban), living in a high–U.S.-migration state, family history of diabetes, physical activity, and BMI categories. For model 2, we removed BMI categories and added high WC. For model 3, we excluded WC and added high WHR to the variables included in the first model without BMI categories. For model 4, we added WC, BMI categories, smoking, physician visits, health insurance, medical conditions, HDL cholesterol, total cholesterol, and vitamin D to the variables included in the third model. All analyses were performed using SAS 9.2 (SAS Institute, Cary, NC).

Results

Table 1 summarizes the characteristics of the sample by HbA1c level and self-reported diabetes. Of the 2012 participants, 890 (44.2%) were identified as having prediabetes, 364 (18.0%) as undiagnosed diabetes based on HbA1C level, and 432 (21.4%) as self-reported diabetes. Percentage of prediabetes, undiagnosed, and self-reported diabetes were significantly higher in the age group of 50 years and more. Participants with prediabetes, undiagnosed diabetes, and self-reported diabetes were significantly more likely to be female. Participants reporting diabetes were significantly associated with a family history of diabetes and less educated compared with participants with normal levels of HbA1c. Participants in a normal category of HbA1c were significantly more likely to reside in a Mexican state with high U.S. migration. Participants with undiagnosed diabetes and self-reported diabetes were more likely to be obese, have high WC, and have high WHR than those with normal levels of HbA1c. Participants with undiagnosed diabetes and self-reported diabetes were less likely to engage in physical activities than those in the normal and prediabetes categories. Participants with self-reported diabetes had higher rates of insurance coverage and physician visits compared with participants in the normal and prediabetes categories. Participants in the self-reported diabetes category were more likely to report hypertension and heart attack. Participants with prediabetes, undiagnosed diabetes, and self-reported diabetes had reduced levels of HDL cholesterol, high levels of total cholesterol, and increased vitamin D insufficiency. No differences across groups were observed in smoking status and rural and/or urban residence.

Tables 2 and 3 present the logistic regression analyses for prediabetes and undiagnosed diabetes, respectively. In model 1, being female was significantly associated with an increased odds of prediabetes while overweight and obesity were significantly associated with an increased odds of undiagnosed diabetes. Participants residing in a high–U.S.-migration state had decreased odds of prediabetes and undiagnosed diabetes. Persons engaging in physical activity displayed decreased odds of undiagnosed diabetes. In model 2, we found high WC significantly associated with increased odds of prediabetes and undiagnosed diabetes. In model 3, we found high WHR significantly associated with increased odds of prediabetes and undiagnosed diabetes. In model 4, high WHR and high total cholesterol were significantly associated with increased odds of prediabetes only, whereas overweight, obesity, and high WC were significantly associated with increased odds of undiagnosed diabetes. Participants residing in a high–U.S.-migration state had decreased odds of prediabetes and undiagnosed diabetes. Participants having 6 years of education compared with no education were significantly associated with decreased odds of prediabetes. Persons with higher levels of physical activity were significantly associated with decreased odds of undiagnosed diabetes.

Tables 4 and 5 present the logistic regression analyses for self-reported diabetes and total diabetes (self-reported + undiagnosed diabetes). In model 1, family history was associated with self-reported diabetes and total diabetes, but being female and married were significantly associated only with increased odds of self-reported diabetes. Participants residing in a high–U.S.-migration state and those who engaged in physical activity had decreased odds of self-reported diabetes and total diabetes. In model 2, high WC was significantly associated with increased odds of self-reported diabetes and total diabetes. In model 3, high WHR was significantly associated with increased odds of self-reported diabetes and total diabetes. In model 4, family history of diabetes, high WHR, physician visit, hypertension, and vitamin D insufficiency were significantly associated with increased odds of self-reported diabetes and total diabetes. CVD was associated with increased odds of self-reported diabetes, and high WC was associated with increased odds of total diabetes. Older age, residing in a high–U.S.-migration state, 7 or more years of education, and obesity were significantly associated with decreased odds of self-reported diabetes. Older age, residing in a high–U.S.-migration state, and engagement in physical activity were significantly associated with decreased odds of total diabetes.

Discussion

This study examined the prevalence and factors associated with prediabetes, undiagnosed diabetes, and self-reported diabetes among Mexican adults from a subsample of the MHAS. The percentage of prediabetes, undiagnosed diabetes, and total diabetes (undiagnosed and self-reported) in this study cohort was 44.2%, 18.0%, and 39.4%, respectively. We found that adults with high WHR and total cholesterol were more likely to have prediabetes. Adults with overweight, obesity, and high WC were more likely to have undiagnosed diabetes. Adults with a family history of diabetes, high central obesity, physician visits, and vitamin D insufficiency were more likely to have diabetes. Those residing in a high–U.S.-migration state and participating in vigorous physical activity were less likely to have prediabetes, undiagnosed diabetes, or diabetes.

Compared with previous studies in the Mexican population, we found a higher prevalence of adults with prediabetes and undiagnosed diabetes [11,25–27]. Previous studies in Mexico were limited by small samples of younger populations in urban areas. Using impaired fasting glucose criteria, two studies were conducted involving 288 young Mexicans aged 18–30 years and 2811 adults aged 20 years and older [26,27]. The prevalence of prediabetes was 15% and 21.8%, respectively [26,27]. Data from the Mexican Diabetes Prevention Study in 2008 showed a prediabetes prevalence of 18.6% among city-dwelling adults aged 30–65 years [25]. The Central America Diabetes Initiative study reported a prevalence of prediabetes in those aged 60 years and older of 22.0% in Belize, 28.8% in San Jose, 35.0% in San Salvador, 27.6% in Guatemala City, 20.0% in Tegucigalpa, and 20.0% in Managua [28]. Our results are in line with a recent report published in the Diabetes Atlas by the International Diabetes Foundation that showed a prevalence of undiagnosed diabetes in North America and the Caribbean of 25.0%–29.4% in persons 20–79 years in 2012 [29].

We found significant associations among central obesity and prediabetes, and general and central obesity with undiagnosed diabetes consistent with results from the Mexican Diabetes Prevention Study [25]. The higher percent of prediabetes and undiagnosed diabetes in Mexican older adults compared to other countries may be partially explained by the higher rates of obesity in Mexico than in other countries in North, Central, and South America [30]. In 2012, the National Health and Nutrition Interview Survey of Mexico reported that 38.7% of older adults were overweight, and 32.7% were obese [10]. Biological evidence suggests that the lower levels of adiponectin associated with central obesity may increase the risk of type 2 diabetes [31–33]. We also found that women had a higher percent of prediabetes, undiagnosed diabetes, and self-reported diabetes than men, which may be explained by the higher prevalence of central obesity in women than men in this population [10]. In developing countries like Mexico, a high prevalence of undiagnosed diabetes may be explained by the limited health resources for preventive care and the lack of awareness of the need for regular screening for chronic diseases.

Our results showed some differences in the demographic and clinical characteristics of undiagnosed diabetes and self-reported diabetes. Overweight, obesity, and high WC were common risk factors, while family history, high WHR, hypertension, cardiovascular disease, vitamin D insufficiency, and physician visits were risk factors for self-reported diabetes. Living in a state with high U.S.-migration and physical activity appeared to play a protective role in undiagnosed diabetes and self-reported diabetes. Our findings on the association between vitamin D insufficiency and diabetes are in line with previously published studies [34,35]. Previous studies have found that return migrants have better socio-economic status, social networking, and relatively better awareness of their health compared to non-migrants [36]. This protective effect might be explained by the increase in household income through remittances from abroad, a major portion of which is spent on health care [37].

Our study has some limitations. First, this study used cross-sectional data from 2012 which limits the interpretation of causality between all covariates and prediabetes, undiagnosed diabetes, and total diabetes. Second, we used a subsample from the larger sample interviewed in 2012 which limits the generalizability of results to the national Mexican population [9]. Third, our study lacks information on the use of medications, medical conditions such as anemia, and prior surgical history or acute blood loss that can falsely lower HbA1c. We used only HbA1c criteria to identify cases of prediabetes and undiagnosed diabetes. The ADA recommends that a positive test for diabetes be confirmed by repeating the same test [3]. An HbA1c concentration of 6.5% or more has acceptable sensitivity and specificity, and it is linked to the risk of microvascular complications in nondiabetic adults [38]. Fourth, our measure of physical activity was self-reported, which introduces potential bias in estimating outcomes. Finally, we had no access to medical records to obtain detailed information on health service use, which may influence the relationship between physician visits and screening for prediabetes and diabetes. The study strengths include the large sample and careful collection of biomarker data from adults living in rural and urban regions in Mexico; inclusion of anthropometric measurements collected by trained interviewers, which increases the accuracy of the association between BMI, WC, and WHR with prediabetes and undiagnosed diabetes; and information on physician visits and health insurance coverage, making it relevant from a policy perspective.

Conclusions

Early detection of prediabetes and regular screening of persons at high risk of diabetes (people with obesity, high WC, and high WHR) will be helpful in reducing health care costs and future medical complications [13,39]. With the implementation of a national health insurance program “Seguro Popular” in Mexico, the percent of adults with prediabetes and undiagnosed diabetes may decrease [40]. Mexican adults with diabetes have gained access to health care and have shown improvement in controlling blood glucose [41]. However, Seguro Popular does not cover management of complications because of diabetes such as amputation, post-amputation rehabilitation, and renal dialysis. Additional research is needed to examine the role of obesity prevention, increased physical activity, and enhanced screening to reduce diabetes in Mexican older adults and to provide evidence for including such programs as part of the Seguro Popular.

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References

1. Word Health Organization. Many countries hit by health threats from both infectious and chronic diseases. 2013. [cited 2014 December 4]; Available from: http://www.who.int/mediacentre/news/releases/2011/health_statistics_20110513/en/
2. Stevens G, Dias RH, Thomas KJ, Rivera JA, Carvalho N, Barquera S, et al. Characterizing the epidemiological transition in Mexico: national and subnational burden of diseases, injuries, and risk factors. PLoS Med. 2008; 5(6):e125. [PubMed: 18563960]
3. American Diabetes Association. Classification and diagnosis of diabetes. Diabetes Care. 2015; 38(Suppl 1):S8–16.
4. Tabák AG, Herder C, Rathmann W, Brunner EJ, Kivimäki M. Prediabetes: a high-risk state for diabetes development. Lancet. 2012; 379(9833):2279–90. [PubMed: 22683128]
5. Zhang X, Gregg EW, Williamson DF, Barker LE, Thomas W, Bullard KM, et al. A1C level and future risk of diabetes: a systematic review. Diabetes Care. 2010; 33(7):1665–73. [PubMed: 20587727]
6. Tapp RJ, Shaw JE, Zimmet PZ, Balkau B, Chadban SJ, Tonkin AM, et al. Albuminuria is evident in the early stages of diabetes onset: results from the Australian Diabetes, Obesity, and Lifestyle Study (AusDiab). Am J Kidney Dis. 2004; 44(5):792–8. [PubMed: 15492944]
7. Barr EL, Zimmet PZ, Welborn TA, Jolley D, Magliano DJ, Dunstan DW, et al. Risk of cardiovascular and all-cause mortality in individuals with diabetes mellitus, impaired fasting glucose, and impaired glucose tolerance: the Australian Diabetes, Obesity, and Lifestyle Study (AusDiab). Circulation. 2007; 116(2):151–7. [PubMed: 17576864]
8. Andrade FC. Measuring the impact of diabetes on life expectancy and disability-free life expectancy among older adults in Mexico. J Gerontol B Psychol Sci Soc Sci. 2010; 65B(3):381–9. [PubMed: 20028950]
9. Wong R, Michaels-Obregon A, Palloni A. Cohort profile: the Mexican Health and Aging Study (MHAS). Int J Epidemiol. 2015 Epub ahead of print.
10. Encuesta Nacional de Salud y Nutrición. Resultados Nacionales. 2012. [cited 2015 March 25]; Available from: http://ensanut.insp.mx/doctos/ENSANUT2012_PresentacionOficialCorta_09Nov2012.pdf
11. Díaz-Apodaca BA, Ebrahim S, McCormack V, de Cosío FG, Ruiz-Holguín R. Prevalence of type 2 diabetes and impaired fasting glucose: cross-sectional study of multiethnic adult population at the United States-Mexico border. Rev Panam Salud Pública. 2010; 28(3):174–81. [PubMed: 20963264]
12. Flores-Le Roux JA, Comin J, Pedro-Botet J, Benaiges D, Puig-de Dou J, Chillarón JJ, et al. Seven-year mortality in heart failure patients with undiagnosed diabetes: an observational study. Cardiovasc Diabetol. 2011; 10:39. [PubMed: 21569580]

13. Zhang Y, Dall TM, Mann SE, Chen Y, Martin J, Moore V, et al. The economic costs of undiagnosed diabetes. Popul Health Manag. 2009; 12(2):95–101. [PubMed: 19361252]
14. Lauruschkat AH, Arnrich B, Albert AA, Walter JA, Amann B, Rosendahl UP, et al. Prevalence and risks of undiagnosed diabetes mellitus in patients undergoing coronary artery bypass grafting. Circulation. 2005; 112(16):2397–402. [PubMed: 16230496]
15. MHAS. Mexican Health and Aging Study. [Accessed March, 2015] MHAS 2012-Sample design. Available in http://mhasweb.org/Resources/DOCUMENTS/2012/Methodological_Document_2012–SECpdf ; Available from: http://mhasweb.org/Resources/DOCUMENTS/2012/Methodological_Document_2012%E2%80%93SEC.pdf
16. Wong R, Michaels-Obregon A, Palloni A, Gutierrez-Robledo LM, Gonzalez-Gonzalez C, Lopez-Ortega M, et al. Progression of aging in Mexico: the Mexican Health and Aging Study (MHAS) 2012. Salud Publica Mex. 2015; 57(Suppl 1):S79–89. [PubMed: 26172238]
17. Mattewal A, Aldasouqi S, Solomon D, Gossain V, Koller A. A1cNow InView: a new simple method for office-based glycohemoglobin measurement. J Diabetes Sci Technol. 2007; 1(6):879–84. [PubMed: 19885160]
18. Nathan DM, Kuenen J, Borg R, Zheng H, Schoenfeld D, Heine RJ. Translating the A1C assay into estimated average glucose values. Diabetes Care. 2008; 31(8):1473–8. [PubMed: 18540046]
19. Health Quality O. Point-of-care hemoglobin A(1c) testing: an evidence-based analysis. Ont Health Technol Assess Ser. 2014; 14(8):1–30.
20. Gerst K, Michaels-Obregon A, Wong R. The impact of physical activity on disability incidence among older adults in Mexico and the United States. J Aging Res. 2011; 2011:420714. [PubMed: 21584238]
21. National Heart Lung and Blood Institute. Classification of overweight and obesity by BMI, waist circumference, and associated disease risks. 2014. [cited 2014 September 15]; Available from: http://www.nhlbi.nih.gov/health/public/heart/obesity/lose_wt/bmi_dis.htm
22. Berber A, Gomez-Santos R, Fanghanel G, Sanchez-Reyes L. Anthropometric indexes in the prediction of type 2 diabetes mellitus, hypertension and dyslipidaemia in a Mexican population. Int J Obes Relat Metab Disord. 2001; 25(12):1794–9. [PubMed: 11781760]
23. National Heart L, and Blood Institute. High blood cholesterol: what you need to know. 2015. [cited 2015 October 25]; Available from: http://www.nhlbi.nih.gov/health/resources/heart/heart-cholesterol-hbc-what-html
24. Centers for Disease Control and Prevention. national report on biochemical indicators of diet and nutrition in the U S population 1999–2002, in fat-soluble vitamins & micronutrients: vitamin D. Atlanta: 2008.
25. Guerrero-Romero F, Rodríguez-Morán M, Pérez-Fuentes R, Sánchez-Guillén MC, González-Ortiz M, Martínez-Abundis E, et al. Prediabetes and its relationship with obesity in Mexican adults: the Mexican Diabetes Prevention (MexDiab) Study. Metab Syndr Relat Disord. 2008; 6(1):15–23. [PubMed: 18370832]
26. Ureña-Bogarín EL, Martínez-Ramírez HR, Torres-Sánchez JR, Hernández-Herrera A, Cortés-Sanabria L, Cueto-Manzano AM. Prevalence of pre-diabetes in young Mexican adults in primary health care. Fam Pract. 2014; 32:1–6.
27. Zvarova K, Zvarova Z, Callas PW, Malone-Rising D. New estimates of prediabetes and type 2 diabetes prevalence in Mexican Quintana Roo. Int J Diabetes Dev Ctries. 2013; 33(1):8–12.
28. Barceló, A.; Gregg, E.; Flores, EP.; Wong, R.; Gerzoff, R.; Cafiero, E., et al. Survey of diabetes, hypertension and chronic disease risk factors. Washington DC: Pan American Health Organization; 2010.
29. International Diabetes Federation. IDF diabetes atlas. 2013. [cited 2015 March 15]; Available from: http://www.idf.org/sites/default/files/EN_6E_Atlas_Full_0.pdf
30. The State of Food and Agriculture. Food systems for better nutrition. 2013. [cited 2015 March 14]; Available from: http://www.fao.org/docrep/018/i3301e/i3301e.pdf
31. Gil-Campos M, Canete RR, Gil A. Adiponectin, the missing link in insulin resistance and obesity. Clin Nutr. 2004; 23(5):963–74. [PubMed: 15380884]

32. Snijder MB, Heine RJ, Seidell JC, Bouter LM, Stehouwer CD, Nijpels G, et al. Associations of adiponectin levels with incident impaired glucose metabolism and type 2 diabetes in older men and women: the hoorn study. Diabetes care. 2006; 29(11):2498–503. [PubMed: 17065691]
33. Spranger J, Kroke A, Möhlig M, Bergmann MM, Ristow M, Boeing H, et al. Adiponectin and protection against type 2 diabetes mellitus. Lancet. 2003; 361(9353):226–8. [PubMed: 12547549]
34. Song Y, Wang L, Pittas AG, Del Gobbo LC, Zhang C, Manson JE, et al. Blood 25-hydroxy vitamin D levels and incident type 2 diabetes: a meta-analysis of prospective studies. Diabetes Care. 2013; 36(5):1422–8. [PubMed: 23613602]
35. Boucher BJ. Vitamin D insufficiency and diabetes risks. Curr Drug Targets. 2011; 12(1):61–87. [PubMed: 20795936]
36. Wong R, Gonzalez-Gonzalez C. Old-age disability and wealth among return Mexican migrants from the United States. J Aging Health. 2010; 22(7):932–54. [PubMed: 20876848]
37. Airola J. The use of remittance income in Mexico. Int Migr Rev. 2007; 41(4):850–9.
38. Bonora E, Tuomilehto J. The pros and cons of diagnosing diabetes with A1C. Diabetes Care. 2011; 34(Suppl 2):S184–90. [PubMed: 21525453]
39. Barquera S, Nonato IC, Salinas CA, Ridaura RL, Arredondo A, Dommarco JR. Diabetes in Mexico: cost and management of diabetes and its complications and challenges for health policy. Global Health. 2013; 9(3):1–9. [PubMed: 23327564]
40. Grogger J, Arnold T, León AS, Ome A. Heterogeneity in the effect of public health insurance on catastrophic out-of-pocket health expenditures: the case of Mexico. Health Policy Plan. 2015; 30:593–9. [PubMed: 24924422]
41. Sosa-Rubí SG, Galárraga O, López-Ridaura R. Diabetes treatment and control: the effect of public health insurance for the poor in Mexico. Bull World Health Organ. 2009; 87(7):512–9. [PubMed: 19649365]

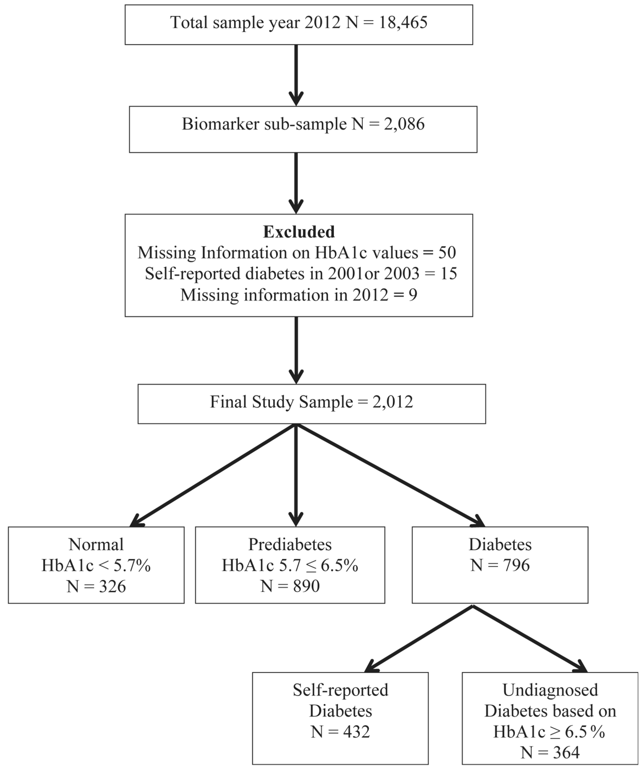

Fig. 1.

Flow chart for the whole study sample.

Table 1

Descriptive characteristics of the sample by HbA1c and self-reported diabetes, *n* = 2012

Variable	Normal	Prediabetes	Undiagnosed diabetes	Self-reported diabetes	p^*
n (%)	326 (16.2)	890 (44.2)	364 (18.0)	432 (21.4)	—
Hba1Ac distribution mean (SD)	5.3 (0.28)	6.0 (0.21)	7.5 (1.83)	8.9 (2.37)	
Age (y), mean (SD)	61.1 (11.6)	61.9 (10.9)	62.2 (10.5)	63.0 (9.0)	.08
<50	36 (11.0)	76 (8.5)	28 (7.6)	77 (23.6)	.001
50 to <59	126 (38.6)	350 (39.3)	130 (35.7)	213 (23.9)	
60 to <69	87 (26.6)	251 (28.2)	122 (33.5)	84 (23.0)	
≥70	77 (23.6)	213 (23.9)	84 (23.0)	101 (23.3)	
Female	174 (53.3)	531 (59.6)	222 (60.9)	281 (65.0)	.001
Married	219 (67.1)	617 (69.3)	256 (70.3)	307 (71.0)	.24
Family history of diabetes	93 (30.1)	256 (30.7)	114 (32.6)	213 (52.7)	<.0001
Residence (urban vs. rural)	200 (61.3)	498 (55.9)	215 (59.0)	242 (56.0)	.39
High U.S. migration state	219 (67.1)	504 (56.6)	175 (48.0)	222 (51.3)	<.0001
Years of formal education, mean (SD)	6.6 (4.7)	6.1 (4.8)	5.8 (4.2)	5.0 (4.0)	<.0001
No education	36 (11.1)	148 (16.7)	44 (12.1)	71 (16.5)	.0004
1–5 y	85 (26.4)	239 (27.0)	103 (28.3)	145 (33.8)	
6 y	74 (22.9)	183 (20.7)	98 (27.0)	101(23.6)	
≥7 y	127 (39.4)	313 (35.4)	118 (32.5)	111 (25.9)	
Physical activity	152 (46.6)	428 (48.0)	144 (39.5)	166 (38.4)	.0008
BMI (kg/m^2), mean (SD)	27.6 (4.8)	28.3 (5.2)	30.5 (5.3)	29.5 (5.3)	<.0001
BMI category					
Normal (18.5 to <25)	95 (29.5)	246 (28.0)	43 (12.0)	84 (20.0)	<.0001
Overweight (25 to <30)	132 (40.9)	339 (38.7)	135 (37.7)	167 (39.8)	
Obese (≥30)	95 (29.5)	291 (33.2)	180 (50.2)	168 (40.1)	
High waist circumference, *n* (%)	162 (50.0)	498 (56.7)	266 (74.0)	301 (71.8)	<.0001
Male, mean (SD)	96.9 (10.8)	98.8 (12.4)	103.7 (12.2)	102.5 (13.0)	<.0001
Female, mean (SD)	93.5 (11.7)	95.2 (12.7)	100.1 (12.1)	99.6 (11.9)	<.0001
High waist-hip ratio, n (%)	268 (82.7)	766 (87.3)	328 (91.3)	395 (94.2)	<.0001
Male, mean (SD)	0.97 (0.06)	0.98 (0.07)	1.00 (0.06)	1.01 (0.08)	<.0001

Variable	Normal	Prediabetes	Undiagnosed diabetes	Self-reported diabetes	P^*
Female, mean (SD)	0.90 (0.06)	0.90 (0.06)	0.91 (0.07)	0.93 (0.05)	<.0001
Smoking status					
Never	188 (57.6)	569 (63.9)	227 (62.3)	271 (62.7)	.16
Ever	90 (27.6)	209 (23.4)	85 (23.3)	119 (27.5)	
Current	48 (14.7)	112 (12.5)	52 (14.2)	42 (16.5)	
Physician visits	251 (76.9)	694 (77.9)	295 (81.0)	411 (95.1)	<.0001
Insurance coverage	264 (81.2)	740 (83.2)	309 (84.8)	384 (89.1)	.001
Medical conditions					
Hypertension	119 (36.6)	317 (35.7)	142 (39.2)	266 (61.5)	<.0001
Stroke	5 (1.5)	13 (1.4)	6 (1.6)	12 (2.7)	.13
Heart attack	10 (3.0)	19 (2.1)	8 (2.2)	24 (5.5)	.01
Biomarker, *n* (%)					
Low HDL cholesterol	198 (63.0)	582 (67.1)	261 (73.3)	315 (75.0)	<.0001
High total cholesterol	100 (31.8)	376 (43.3)	162 (45.5)	165 (39.2)	.0008
Vitamin D insufficiency	225 (71.8)	672 (77.6)	283 (79.4)	372 (88.7)	<.0001

Values are presented as mean (SD) or *n* (%).

Chi-square tests were used for categorical variables and *t* tests for continuous variables.

* The *P* value was significant ($P < .05$) and compared with the normal group.

Table 2

Multivariate logistic regression analysis for prediabetes, *n* = 1216

Variable	Model 1, *n* = 1115	Model 2, *n* = 1118	Model 3, *n* = 1118	Model 4, *n* = 1106
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age	1.00 (0.99–1.02)	1.00 (0.98–1.01)	1.00 (0.98–1.01)	1.00 (0.99–1.02)
Female	1.45 (1.08–1.94) *	1.32 (0.97–1.80)	1.55 (1.16–2.08) *	1.22 (0.84–1.78)
Married	1.32 (0.96–1.82)	1.34 (0.98–1.84)	1.35 (0.98–1.86)	1.39 (0.99–1.95)
Family history of diabetes	1.07 (0.79–1.43)	1.06 (0.79–1.42)	1.06 (0.79–1.42)	1.12 (0.82–1.52)
Urban	0.80 (0.59–1.08)	0.81 (0.60–1.09)	0.82 (0.61–1.11)	0.80 (0.58–1.10)
High migration state	0.64 (0.48–0.86) *	0.61 (0.45–0.83) *	0.61 (0.46–0.83) *	0.61 (0.45–0.82) *
Education				
No education	Reference	Reference	Reference	Reference
1–5 y	0.65 (0.40–1.05)	0.64 (0.39–1.04)	0.67 (0.41–1.08)	0.60 (0.36–1.00)
6 y	0.62 (0.37–1.02)	0.59 (0.35–0.98) *	0.61 (0.36–1.00)	0.57 (0.33–0.97) *
≥7 y	0.66 (0.40–1.09)	0.64 (0.39–1.05)	0.69 (0.42–1.13)	0.65 (0.38–1.09)
Physical activity	1.09 (0.83–1.43)	1.11 (0.84–1.46)	1.10 (0.83–1.45)	1.18 (0.88–1.57)
BMI (kg/m^2) category				
Normal (18.5 to <25)	Reference	Reference	Reference	Reference
Overweight (25 to <30)	1.06 (0.76–1.48)	—	—	0.73 (0.48–1.11)
Obese (≥30)	1.20 (0.84–1.72)	—	—	0.72 (0.42–1.22)
Central obesity				
High waist circumference	—	1.33 (1.01–1.78) *	—	1.23 (0.80–1.90)
High waist-hip ratio	—	—	1.67 (1.15–2.42) *	1.61 (1.05–2.45) *
Smoking status				
Never	Reference	Reference	Reference	Reference
Ever	—	—	—	0.75 (0.53–1.07)
Current	—	—	—	0.99 (0.63–1.54)
Physician visits	—	—	—	0.99 (0.69–1.42)
Insurance coverage	—	—	—	1.12 (0.76–1.64)
Medical conditions				
Hypertension	—	—	—	0.96 (0.70–1.31)
CVD (heart attack or stroke)	—	—	—	0.64 (0.29–1.38)
Biomarker				
HDL cholesterol	—	—	—	1.33 (0.97–1.83)
High total Cholesterol	—	—	—	1.85 (1.36–2.51) *
Vitamin D insufficiency	—	—	—	1.29 (0.92–1.82)

CI = confidence interval; OR = odds ratio.

"*n*" varies because of missing data. Participants with undiagnosed diabetes and self-reported diabetes were not included in this analysis. High waist circumference was greater than 102 cm in men and greater than 88 cm in women. High WHR was 90 or more in men and 85 or more in women. Low HDL cholesterol value was less than 40 mg/dL for men and less than 50 mg/dL for women. Total cholesterol value of less than 200 mg/dL was a borderline high category. Vitamin D insufficiency was 25-hydroxyvitamin D less than 20 ng/dL.

*The *P* value was significant ($P < .05$).

Table 3

Multivariate logistic regression analysis for undiagnosed diabetes, *n* = 1580

Variable	Model 1, *n* = 1457	Model 2, *n* = 1461	Model 3, *n* = 1444	Model 4, *n* = 1446
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age	1.00 (0.99–1.01)	0.99 (0.98–1.01)	0.99 (0.98–1.01)	1.00 (0.98–1.01)
Female	1.00 (0.75–1.32)	0.80 (0.60–1.07)	1.20 (0.91–1.58)	0.83 (0.59–1.18)
Married	1.08 (0.80–1.46)	1.10 (0.82–1.49)	1.13 (0.84–1.51)	1.08 (0.79–1.48)
Family history of diabetes	1.02 (0.78–1.33)	1.04 (0.79–1.35)	1.06 (0.81–1.39)	1.00 (0.76–1.32)
Urban	0.95 (0.73–1.25)	0.98 (0.74–1.28)	1.03 (0.79–1.36)	0.95 (0.71–1.26)
High migration state	0.56 (0.43–0.74) *	0.53 (0.41–0.69) *	0.57 (0.44–0.74) *	0.53 (0.41–0.70) *
Education				
No education	Reference	Reference	Reference	Reference
1–5 y	1.31 (0.85–2.01)	1.32 (0.86–2.03)	1.45 (0.95–2.23)	1.35 (0.87–2.10)
6 y	1.51 (0.96–2.36)	1.51 (0.96–2.35)	1.70 (1.09–2.66) *	1.61 (1.02–2.55) *
≥7 y	1.04 (0.66–1.64)	1.03 (0.66–1.62)	1.16 (0.74–1.82)	1.06 (0.67–1.69)
Physical activity	0.70 (0.54–0.91) *	0.72 (0.56–0.93) *	0.69 (0.53–0.89) *	0.74 (0.57–0.97) *
BMI (kg/m^2) category				
Normal (18.5 to <25)	Reference	Reference	Reference	Reference
Overweight (25 to <30)	2.37 (1.60–3.50) *	—	—	1.68 (1.07–2.64) *
Obese (≥30)	3.99 (2.71–5.90) *	—	—	2.38 (1.41–4.02) *
Central obesity				
High waist circumference	—	2.67 (1.99–3.59) *	—	1.60 (1.06–2.40) *
High waist-hip ratio	—	—	1.94 (1.26–3.00) *	1.18 (0.74–1.87)
Smoking status				
Never	Reference	Reference	Reference	Reference
Ever	—	—	—	0.96 (0.69–1.35)
Current	—	—	—	1.28 (0.85–1.92)
Physician visits	—	—	—	1.10 (0.78–1.55)
Insurance coverage	—	—	—	1.06 (0.73–1.53)
Medical conditions				
Hypertension	—	—	—	0.95 (0.72–1.27)
CVD (heart attack or stroke)	—	—	—	1.27 (0.63–2.55)
Biomarker				
HDL cholesterol	—	—	—	1.28 (0.94–1.74)
High total cholesterol	—	—	—	1.13 (0.86–1.48)
Vitamin D insufficiency	—	—	—	1.21 (0.90–1.61)

CI = confidence interval; OR = odds ratio.

"*n*" varies because of missing data. High waist circumference was greater than 102 cm in men and greater than 88 cm in women. High WHR was 90 or more in men and 85 or more in women. Low HDL cholesterol was less than 40 mg/dL for men and less than 50 mg/dL for women. Total cholesterol value less than 200 mg/dL was a borderline high category. Vitamin D insufficiency was 25-hydroxyvitamin D less than 20 ng/dL.

*The *P* value was significant ($P < .05$).

Table 4

Multivariate logistic regression analysis for self-reported diabetes, *n* = 2012

Variable	Model 1, *n* = 1844	Model 2, *n* = 1848	Model 3, *n* = 1848	Model 4, *n* = 1830
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age	1.00 (0.99–1.01)	1.00 (0.98–1.01)	1.00 (0.98–1.01)	0.98 (0.96–0.99)
Female	1.30 (1.00–1.69) *	1.13 (0.86–1.48)	1.39 (1.07–1.80)	1.04 (0.74–1.46)
Married	1.35 (1.02–1.79) *	1.33 (1.01–1.76) *	1.35 (1.02–1.79) *	1.30 (0.96–1.76)
Family history of diabetes	2.48 (1.96–3.13) *	2.42 (1.91–3.05)	2.41 (1.91–3.05)	2.52 (1.96–3.24) *
Urban	0.98 (0.76–1.26)	0.98 (0.76–1.25)	1.01 (0.79–1.29)	0.88 (0.67–1.15)
High migration state	0.73 (0.57–0.94) *	0.71 (0.55–0.91) *	0.72 (0.56–0.92) *	0.66 (0.51–0.86) *
Education				
No education	Reference	Reference	Reference	Reference
1–5 y	1.01 (0.70–1.46)	1.02 (0.71–1.47)	1.05 (0.73–1.51)	1.12 (0.76–1.65)
6 y	0.89 (0.60–1.31)	0.88 (0.59–1.30)	0.93 (0.63–1.38)	0.96 (0.63–1.47)
≥7 y	0.61 (0.41–0.92) *	0.61 (0.40–0.91) *	0.65 (0.43–0.97) *	0.57 (0.37–0.88) *
Physical activity	0.78 (0.61–0.99) *	0.79 (0.62–1.00)	0.79 (0.62–1.00)	0.93 (0.72–1.21)
BMI (kg/m^2) category				
Normal (18.5 to <25)	Reference	Reference	Reference	Reference
Overweight (25 to <30)	1.32 (0.96–1.81)	—	—	0.84 (0.56–1.25)
Obese (≥30)	1.31 (0.95–1.82)	—	—	0.59 (0.37–0.95) *
Central obesity				
High waist circumference	—	1.54 (1.18–2.03) *	—	1.46 (0.98–2.16)
High waist-hip ratio	—	—	2.43 (1.51–3.91) *	2.08 (1.24–3.51) *
Smoking status				
Never	Reference	Reference	Reference	Reference
Ever	—	—	—	1.30 (0.95–1.78)
Current	—	—	—	1.02 (0.66–1.58)
Physician visits	—	—	—	3.98 (2.4–6.58) *
Insurance coverage	—	—	—	1.33 (0.89–1.98)
Medical conditions				
Hypertension	—	—	—	2.02 (1.55–2.63) *
CVD (heart attack or stroke)	—	—	—	1.83 (1.09–3.08) *
Biomarker				
HDL cholesterol	—	—	—	1.12 (0.89–1.51)
High total cholesterol	—	—	—	0.79 (0.60–1.03)
Vitamin D insufficiency	—	—	—	2.11 (1.61–2.76) *

CI = confidence interval; OR = odds ratio.

"*n*" varies because of missing data. High waist circumference was greater than 102 cm in men and greater than 88 cm in women. High WHR was 90 or more in men and 85 or more in women. Low HDL cholesterol less than 40 mg/dL for men and <50 mg/dL for women. Total Cholesterol value of less than 200 mg/dL was a borderline high category. Vitamin D insufficiency was 25-hydroxyvitamin D less than 20 ng/dL

*The P value was significant ($P < .05$).

Table 5

Multivariate logistic regression analysis for total diabetes (self-reported and undiagnosed diabetes) *n* = 2012

Variable	Model 1, *n* = 1844	Model 2, *n* = 1848	Model 3, *n* = 1848	Model 4, *n* = 1830
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age	1.00 (0.99–1.01)	0.99 (0.98–1.00)	0.99 (0.98–1.01)	0.98 (0.95–0.99) *
Female	1.16 (0.93–1.44)	0.93 (0.74–1.16)	1.32 (1.06–1.63) *	0.91 (0.69–1.20)
Married	1.21 (0.96–1.53)	1.21 (0.96–1.52)	1.24 (0.99–1.56)	1.16 (0.91–1.48)
Family history of diabetes	1.70 (1.39–2.08) *	1.68 (1.37–2.05) *	1.70 (1.39–2.08) *	1.64 (1.33–2.02) *
Urban	0.95 (0.77–1.17)	0.96 (0.78–1.19)	1.01 (0.82–1.25)	0.89 (0.71–1.15)
High migration state	0.60 (0.49–0.74) *	0.57 (0.46–0.70) *	0.60 (0.49–0.74) *	0.55 (0.45–0.69) *
Education				
No education	Reference	Reference	Reference	Reference
1–5 y	1.13 (0.82–1.56)	1.16 (0.84–1.59)	1.21 (0.89–1.66)	1.20 (0.86–1.67)
6 y	1.14 (0.81–1.59)	1.17 (0.83–1.63)	1.26 (0.90–1.76)	1.24 (0.87–1.76)
≥7 y	0.76 (0.54–1.06)	0.76 (0.54–1.07)	0.84 (0.60–1.18)	0.75 (0.53–1.07)
Physical activity	0.71 (0.58–0.87) *	0.73(0.59–0.89) *	0.73 (0.59–0.89) *	0.80 (0.65–0.99) *
BMI (kg/m^2) category				
Normal (18.5 to <25)	Reference	Reference	Reference	Reference
Overweight (25 to <30)	1.85 (1.41–2.42) *	—	—	1.24 (0.89–1.71)
Obese (≥30)	2.56 (1.94–3.37) *	—	—	1.31 (0.89–1.92)
Central obesity				
High waist circumference	—	2.26 (1.81–2.83) *	—	1.60 (1.17–2.20) *
High waist-hip ratio	—	—	2.30 (1.63–3.25) *	1.55 (1.06–2.26) *
Smoking status				
Never	Reference	Reference	Reference	Reference
Ever	—	—	—	1.16 (0.86–.44)
Current	—	—	—	1.21 (0.87–1.70)
Physician visits	—	—	—	1.82 (1.35–2.45) *
Insurance coverage	—	—	—	1.19 (0.88–1.61)
Medical conditions				
Hypertension	—	—	—	1.37 (1.10–1.70) *
CVD (heart attack or stroke)	—	—	—	1.60 (0.97–2.64)
Biomarker				
HDL cholesterol	—	—	—	1.23 (0.97–1.57)
High total cholesterol	—	—	—	0.98 (0.79–1.21)
Vitamin D insufficiency	—	—	—	1.64 (1.30–2.05) *

CI = confidence interval; OR = odds ratio.

"*n*" varies because of missing data. High waist circumference was greater than 102 cm in men and greater than 88 cm in women. High WHR was 90 or more in men and 85 or more in women. Low HDL cholesterol value was less than 40 mg/dL for men and less than 50 mg/dL for women.

Total cholesterol value of less than 200 mg/dL was a borderline high category. Vitamin D insufficiency was 25-hydroxyvitamin D less than 20 ng/dL

*The *P* value was significant ($P < .05$).