



Original article

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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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].

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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 [10,11], 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. [12] 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 [13–15]. With the growing prevalence of obesity and the epidemiologic transition in Mexico [10,11], surveillance of prediabetes and undiagnosed diabetes is crucial to understand 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 [9,16]. 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–U.S.-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 [17]. 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 [17].

Prediabetes, undiagnosed diabetes, and diabetes

We used ADA criteria for prediabetes and undiagnosed diabetes based on HbA1c blood levels to determine participant disease

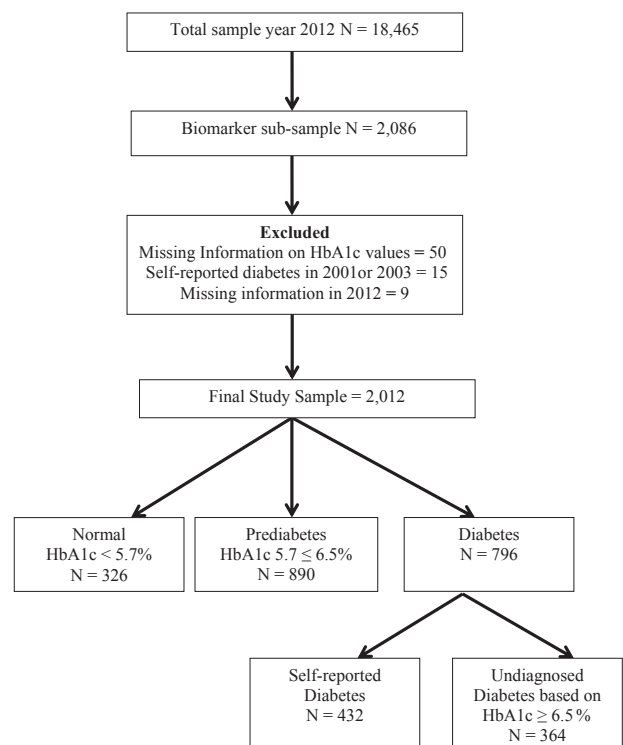


Fig. 1. Flow chart for the whole study sample.

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 [18–20]. 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

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