Factors Associated with Seven-Year Incidence of Diabetes Complications among Older Mexican Americans

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**Key Words**
- Diabetes mellitus
- Diabetes complications, incidence
- Mexican Americans

**Abstract**

Background: Diabetes is common in elderly persons and is highly prevalent in Mexican Americans. Little is known about factors associated with the incidence of diabetes complications. Objective: To examine the social, demographic and health factors associated with a 7-year incidence of diabetes complications among older Mexican Americans with diabetes. Methods: A 7-year prospective cohort of 536 non-institutionalized Mexican Americans aged $\geq 65$ years with diabetes residing in the Southwest of USA. Measures included socio-demographic factors, duration of diabetes, diabetes treatment, medical conditions and body mass index. Diabetes complications were assessed by self-reports of any kidney, eye and circulation problems or amputation due to diabetes over a 7-year period. Results: Subjects with disease duration of $\geq 10$ years were found to have an increased incidence of kidney, eye and circulation problems or amputation over a 7-year period. Hazard ratio (HR) for circulation problems was significantly higher in foreign-born subjects with $\geq 15$ years in the USA. Foreign-born subjects with $< 15$ years in the USA and those with a frequent number of physician visits were at increased risk of kidney complications.

Subjects with baseline eye complications had a higher HR for incidence of amputations in the next 7 years. Subjects with baseline circulation complications had a higher incidence of amputations, eye and kidney complications in the next 7 years. Conclusions: Our data suggest that risks of diabetes complications are influenced by different factors. Prolonged diabetes duration, being foreign-born, living in the USA for a longer period, and frequent physician visits were factors associated with diabetes complications. Designing intervention strategies to reduce diabetes complication risks requires an understanding of the differences in demographic and health predictors of such risks.

**Introduction**

Diabetes mellitus has reached epidemic proportions in the USA [1]. Both prevalence and incidence are increasing. More than 18 million people in the USA have diabetes; about 5 million cases are undiagnosed [2, 3]. The age-adjusted prevalence of diagnosed diabetes per 100 population is 4.9, highest among Black women and Hispanic men [2, 3]. In 2003, the age-adjusted incidence per 1,000 population was 6.6 for Whites, 10.2 for Blacks and 8.8 for Hispanics [2, 3]. Diabetes has its greatest effects on older adults, women, and certain racial and ethnic groups [2,
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3) including African Americans, Hispanics, Asians, Native Americans, and Pacific Islanders [4, 5]. In the USA, 1 in 5 adults ≥65 years has diabetes, accounting for almost 40% of the population with diabetes including a significant portion from the rapidly growing segment of Mexican Americans [2, 3]. Diabetes has a major impact on national healthcare expenditures as well as mortality. In 2002, 11% of national healthcare expenditures were for diabetes care [2, 3]. The estimated economic cost of diabetes was USD 132 billion or USD 13,243 per diagnosed person, which is about 2.4 times greater than the cost for a person without diabetes [2, 3]. Diabetes is now the sixth leading cause of death [2, 3]. Death rates are about 2–4 times higher for adults with diabetes than for those without the disease [2, 3]. More than 200,000 people die each year with diabetes-related complications [2, 3].

Diabetes in Hispanic Americans is a serious health challenge because of the increased prevalence, the greater number of risk factors for diabetes, the greater incidence of several diabetes complications, and the growing number of people of Hispanic ethnicity in the USA [5]. Elderly Mexican Americans with diabetes experience increased complications and higher morbidity and mortality compared with non-Hispanic White counterparts [6]. The National Diabetes Information Clearinghouse (NDIC) has documented higher rates of the diabetes complications including nephropathy (kidney disease), retinopathy (eye disease), and peripheral vascular disease, whereas lower rates of myocardial infarctions (heart attacks) are observed in various studies of Mexican Americans [5].

Diabetic retinopathy is the leading cause of blindness in adults in the USA [7]. There is controversy about differences in the risk of diabetic retinopathy in different racial and ethnic groups. Non-Hispanic Blacks and Mexican Americans compared to non-Hispanic Whites have been found to have greater prevalence as well as severity of diabetes [8, 9]. African, Hispanic, and Native Americans have the highest risk of end-stage renal disease [10]. Hispanics are twice as likely to develop kidney failure as non-Hispanic Whites, largely due to the increased prevalence of diabetes mellitus in the Hispanic population. The San Antonio Heart Study showed that Mexican Americans with diabetes are 6 times more likely to develop end-stage renal disease requiring dialysis than non-Hispanic White diabetics [11]. Hispanics are also less likely than the general US population to be screened for risk factors for kidney disease or receive optimal treatment after diagnosis [12].

African Americans and Hispanics with diabetes have a higher prevalence of peripheral arterial disease than non-Hispanic Whites [13]. Haffner et al. [8] reported a moderate excess of peripheral vascular disease (as judged by ankle-arm blood pressure ratios) in Mexican American diabetics relative to non-Hispanic White diabetics. Although many studies have reported a higher rate of amputations from all causes in African Americans compared to other groups, Hispanics have proportionally more amputations associated with diabetes than African Americans or non-Hispanic Whites [14–16].

Earlier analyses from the Hispanic Established Population for the Epidemiological Study of the Elderly (H-EPESE) survey showed that about 60% of subjects with diabetes had one or more diabetic complications [17]. However, little is known about factors associated with the increased incidence of diabetic complications in older Mexican Americans. We used data from the H-EPESE study to examine the social, demographic and health factors associated with a 7-year incidence of diabetic complications in older Mexican Americans with type 2 diabetes.

Methods

Data used are from the H-EPESE, a longitudinal study of Mexican Americans aged ≥65 years, residing in Texas, New Mexico, Colorado, Arizona and California. Subjects were selected from five Southwestern states (Texas, California, Arizona, Colorado, and New Mexico) using area probability sampling procedures. The sample and its characteristics have been described elsewhere [18, 19]. The sampling procedure assured a sample that is generalizable to approximately 500,000 older Mexican Americans living in the Southwest [18, 19]. The present study used baseline data (1993–94), and data obtained from a 2-year follow-up (1995–1996), a 5-year follow-up (1998–1999) and a 7-year follow-up assessment (2000–2001). Of the 3,050 subjects interviewed at baseline, 737 had a self-reported diagnosis of diabetes and were taking medications for diabetes. Of the 737 subjects, 201 were excluded due to missing data on covariates at baseline. Subjects excluded were significantly more likely to be older and to report a history of a stroke, hypertension, circulation problems or amputations compared with the subjects included in the study. At the end of the 7-year follow-up (2000–2001), 260 subjects were re-interviewed; 22 subjects refused to be re-interviewed; 43 subjects were lost to follow-up, and 211 subjects were confirmed dead through the National Death Index (NDI) and reports from relatives.

Measures

Diabetes Mellitus

We assessed diabetes by asking if subjects had ever been told by a doctor that they had diabetes. Respondents who reported a diabetes diagnosis were asked about disease duration (categorized as <10 and ≥10 years) and treatment received (categorized as none, oral hypoglycemic, insulin, or oral hypoglycemic/insulin
Respondents were asked if as a result they had problems with their kidneys, eyes, or circulation or if they have any amputations due to diabetes at each follow-up. Kidney problems were assessed through the following question: 'As a result of your diabetes, have you ever had any problems with your kidneys or not?' Eye problems were assessed through the following question: 'As a result of your diabetes, have you ever had any problems with your eyes or not?' Circulation problems were assessed through the following question: 'As a result of your diabetes, have you ever had any problems with the circulation in your legs or arms or not?' Amputations were assessed through the following question: 'Have you ever had any part of your body amputated as a result of your diabetes or not?'

**Covariates**

Baseline predisposing factors included age (categorized as 65–74, 75–84, and 85+), gender, marital status (married vs. unmarried), formal years of education, and nativity (born in the USA and foreign-born, divided into living in the USA for <15 years and for ≥15 years).

Blood pressure was measured by standard mercury sphygmomanometer after the subject was comfortably seated using an appropriate cuff size. Two sitting blood measures were taken for each subject with a 60-s interval between the two according to the standard protocol used in the third National Health and Nutrition Examination (NHANES) [20]. An average systolic and diastolic blood pressure was calculated for each subject. Hypertension in this study was defined using the same criteria utilized in the third NHANES [20]. If a subject had been told by a physician that he/she had high blood pressure and the subject reported currently taking medication for high blood pressure, or if the average systolic blood pressure was ≥140 mm Hg or the average diastolic ≥90 mm Hg, the subject was considered to have hypertension.

History of heart attack was assessed through the following question: 'Has a doctor ever told you that you had a heart attack, or coronary, or myocardial infarction, or coronary thrombosis?' History of stroke was assessed through the following question: 'Did a doctor ever tell you that you had a stroke, a blood clot in the brain, or brain hemorrhage?'

Body mass index (BMI) was computed as weight in kilograms divided by height in meters squared. Physician utilization was assessed by the following question: 'How many times in the past 12 months have you visited with a medical doctor?'

**Outcome**

The 7-year incidence of eye, kidney or circulation complications and amputations in subjects with diabetes at baseline was: (a) new eye complications among those without eye complications at baseline; (b) new kidney complications among those without kidney complications at baseline; (c) new circulation complications among those without circulation complications at baseline, and (d) new amputations among those without amputations at baseline.

**Statistical Analysis**

Cox proportional hazards models were used to calculate the hazard ratio (HR) of new onset of any diabetes complication (eyes, kidney, circulation, and amputations) over a 7-year period as a function of socio-demographic factors, medical conditions, and previous diabetes complications. Those subjects who died and those who were lost to follow-up were censored at the date of the last follow-up. All analyses were performed using the SAS System for Windows, Version 9.3.1 (SAS Institute, Inc., Cary, N.C., USA).

**Results**

Table 1 presents baseline characteristics of the sample. The mean age of sample subjects was 71.7 (SD = 5.8). On average, subjects had 7.6 physician visits per year and 4.8 years of education, and a BMI of 28.9 kg/m². Slightly more than 80% reported having high blood pressure, 9.3% to have had a stroke, and 15.5% to have had a heart attack. More than half of the subjects (53.5%) had diabetes for ≥10 years. Over 60% of subjects were on oral hy-
poglycemic agents, 28% were on insulin, and 3.9% subjects were on no diabetic medications and were controlling their diabetes with diet and exercise. Table 1 also shows prevalence of diabetes complications at baseline: eye complications were reported in 14.7% of subjects, kidney complication in 1.7%, circulation problems in 31.5%, and amputations in 7.3%. Approximately 58% of subjects had one or more diabetes complications at baseline.

Table 2 presents the incidence of diabetic complications over the 7-year study period. At the end of the 7-year period, the incidence of new diabetes-related complications was 58.9% for eyes, 26.2% for kidneys, 60.4% for circulation, 17.2% for amputation, and 58.1% for overall any diabetes-related complication.

Table 3 shows the HR predicting the 7-year incidence of diabetes complications. The HR for increased risk of eye complication was 1.46 (confidence interval (CI) 1.15–1.85) in subjects with diabetes for 10 years, 1.72 (CI 1.34–2.21) in subjects with circulation problems, and 1.62 (CI 1.06–2.48) for subjects with circulation problems plus amputations at baseline. The HR for increased risk of kidney complications was 2.39 (CI 1.29–4.42) in foreign-born subjects who were living in the USA for >15 years, 1.06 (CI 1.02–1.10) in subjects with more frequent physician visits, 1.44 (CI 1.01–2.08) in subjects with longer disease duration (≥10 years) and 2.07 (CI 1.39–3.08) in subjects with only circulation problems at baseline.
The HR for increased risk of circulation problems was 1.28 (CI 1.00–1.65) in foreign-born subjects who were living in the USA for >15 years and 1.42 (CI 1.12–1.79) in subjects with longer disease duration (≥10 years). The HR for increased risk of amputations was 1.84 (CI 1.17–2.92) in subjects with longer disease duration, 4.95 (CI 1.93–12.9) for subjects with only eye complications at baseline and 7.97 (CI 4.59–13.84) for subjects with only circulation problems at baseline. No subject with only a kidney complication at baseline had an amputation over the follow-up period.

Discussion

This study examined the social, demographic and health factors associated with a 7-year incidence of diabetes complications among older Mexican Americans with diabetes. Our study showed subjects with prolonged diabetes duration were at high risk for eye, kidney, and circulation complications and limb amputations. Being foreign-born and living in the USA for >15 years were associated with higher risk of circulation complications while living in the USA for <15 years and frequent physician visits were associated with increased kidney complications. Baseline diabetes complications were also important risk factors for future development of diabetes complications. Previously unreported findings are that different social and health factors influence different diabetes complications in the elderly.

Our study shows some similarities and some differences in findings as compared to previous studies of diabetes complications. For example, the San Luis Valley Diabetes Study [21] which examined the incidence of diabetic retinopathy in Hispanic and non-Hispanic subjects reported that poor glycemic control, high blood pressure, and insulin treatment were factors associated with retinopathy, but did not find any excess risk for incident retinopathy among Hispanic compared with non-Hispanic White subjects over a period of 4.8 years. Moss et al. [22] reported increased visual impairment and blindness in subjects with late-onset diabetes who were taking insulin in a population-based cohort in the southern part of Wisconsin and that female sex, age, presence of systolic hypertension, proteinuria, and elevated glycated hemoglobin (HbA1c) were factors associated with an increased incidence of visual impairment in this group. Moss et al. [22] also found that HbA1c and smoking were associated with an increased incidence of visual impairment in the group with late-onset diabetes, who were not taking insulin. Our study indicates prolonged duration of diabetes was the only risk factor for the increased incidence of eye complications. Type of treatment for diabetes did not affect the outcome.

Studies found rising kidney failure and end-stage renal disease requiring dialysis in African American and Hispanic populations with type 2 diabetes. For example, Garza et al. [23] reported that Mexican American ethnicity and female sex hasten the rate of decline of renal function, while age, hypertension duration, and diabetes duration slow the rate of decline of renal function. Very little is known about predictors of increased risk of diabetic kidney complications in older Mexican Americans. Our study findings indicate an increased incidence of kidney complications in Mexican Americans who were foreign-born and residing in the USA for a shorter period (<15 years) and among those with a high number of physician visits. The reason for this could be undiagnosed kidney problems, unavailability of proper screening and optimal treatment in the subjects’ home country, lack of access to healthcare and advanced stage of disease at the time of presentation in the USA. These are important areas for future investigations.

Several risk factors have also been described for the increased incidence of diabetes-related lower extremity peripheral arterial disease and amputation. For example, Moss et al. [22] found that HbA1c, proteinuria, presence of retinopathy and insulin treatment were risk factors associated with circulation complications and that male sex, abnormal HbA1c, proteinuria, presence of retinopathy and circulation problems at baseline are risk factors for future amputation. Our study found an increased 7-year incidence of diabetes-related lower extremity circulation problems in subjects who were foreign-born and residing in the USA for a comparatively longer period (>15 years). We also found that prolonged diabetes duration (≥10 years) and presence of eye or circulation problems at baseline are risk factors for future amputations.

There were several limitations in this study. First, the findings were based on self-reported data with no clinical evaluation or pathological proof of complications due to diabetes. We also did not have specific information on patient’s glycemic control of diabetes and other past medical history, e.g. history of uncontrolled hypertension, other atherosclerotic and vascular diseases, which may have contributed to increased diabetic complications. Second, by including subjects in the sample who were re-interviewed at each follow-up, we examined the cohort of survivors over a 7-year period. As a result, the incidence of diabetic complications may be underestimated.
This study has several strengths including its large community sample size, the prospective design, and the 7-year period of follow-up. Despite the limitations identified above, the incidence of diabetes complications appears high in Mexican American elders with diabetes, and our study is an important step toward understanding reasons for increased complications. Additional research is needed to address other modifiable factors leading to the increased incidence of diabetic complications in this fast-growing population. Population studies are also needed to address long-term quality of life related to diabetes complications and to determine the long-term effectiveness of diabetic education programs, particularly in underserved populations such as Mexican Americans elders where language and cultural factors are important in program success.

In conclusion, our data suggest that risks of diabetes complications are high in Mexican Americans and are influenced by different social, demographic and health factors. Longer disease duration was the most important risk factor for increased complications. Foreign-born subjects living in the USA for >15 years were at higher risk of circulation complications, while living in the USA for <15 years and frequent physician visits were associated with increased kidney complications. Our findings provide better understanding of the differences in demographic and health predictors of risks of diabetic complications. Our findings also underscore the need for clinicians and researchers to identify and design intervention strategies to reduce diabetic complications. Early recognition of risk factors and optimal treatment of diabetes mellitus is a possible way of reducing diabetic complications in this population.

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