Type 2 diabetes, depressive symptoms and disability over a 15-year follow-up period in older Mexican Americans living in the southwestern United States

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A B S T R A C T

Aims: To evaluate how depression and diabetes severity impact disability progression among Mexican Americans over a 15-year period.

Methods: We used seven waves of the Hispanic Established Population for the Epidemiologic Study of the Elderly (H-EPESE). Primary disability outcomes included the Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) scales. Explanatory variables included time since diagnosis with diabetes (no type 2 diabetes, 1–10, 11–20, 21+), an indicator of disease severity, and depression. Longitudinal generalized estimating equation models were used to estimate the relationship between time since diabetes diagnosis, depressive symptoms and ADL and IADL disability progression over a 15-year time period.

Results: Years since diabetes diagnosis was associated with more rapid ADL and IADL disability progression compared to those without type 2 diabetes. Depression accelerated the disabling process in participants who were diagnosed with diabetes 11 years or more years ago.

Conclusions: Longer duration of diabetes and greater symptoms of depression increase vulnerability for disability among older Mexican American adults.

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1. Introduction

Hispanics have elevated rates of type 2 diabetes compared to any other non-Hispanic racial group, and Mexican Americans bear the greatest burden of type 2 diabetes among Hispanics overall (Centers for Disease Control, 2014a). According to the CDC, 10% of Mexican Americans have been diagnosed with type 2 diabetes compared to 6% of non-Hispanic Whites (CDC, 2014b). Mexican Americans disproportionately suffer from type 2 diabetes-related complications, including disability, diabetic retinopathy, and end stage renal disease (Dhamoon, Moon, Paik, Sacco, & Elkind, 2014; Pugh, Stern, Haffner, Eifler, & Zapata, 1988) with little change in this trend over the past few decades (Beard, Gerst, Ghatrif, Markides, & Samper-Ternent, 2009).

To quantify this burden of type 2 diabetes among Mexican Americans, more than 50% have some form of type 2 diabetes-related disability (Beard et al., 2009) including diabetic retinopathy (37%), renal disease (17%), cardiovascular disease (28%), circulatory disease (40%), and as many as 80% of Mexican Americans with diabetes have at least one functional limitation. Timely intervention programs that aim to delay or prevent onset of disability in Mexican Americans are needed. For example, expansion of programs like SONRISA in Arizona (Reinschmidt & Chong, 2007) designed to train Mexican Americans to manage their type 2 diabetes and associated mental health issues could mitigate the repercussions of a growing population with an increased burden of type 2 diabetes and comorbid disability.

The longer a person lives with a type 2 diabetes diagnosis, the more likely they are to develop a disabling condition—such as stroke, neuropathy, hip fractures, visual impairments or amputation—that leads to mortality, functional limitations and disability (Al Snih et al., 2005; Varma et al., 2010). Despite this relationship, most population-based studies continue to use measures of self-reported type 2 diabetes status, current biological measures of fasting blood glucose, or HbA1c, without taking into consideration the length of time since diagnosis (Afable-Munsuz, Gregorich, Markides, & Pérez-Stable, 2013; Afable-Munsuz, Mayeda, Pérez-Stable, & Haan, 2014; Palmer, Espino, Dergance, Becho, & Markides, 2012). Length of time since diagnosis of
type 2 diabetes reflects the damage caused by long-term elevated blood sugar (Otiniano et al., 2012) and insulin resistance (Lorenzo, Lee, & Haffner, 2012; Xiang et al., 2013). Moreover, there is now growing evidence that the longer a person lives with type 2 diabetes, the greater the incidence of depression and other mental health conditions (Ell, Katon, Lee, Guterman, & Wu, 2015; Shah, Mezzio, Ho, & Ip, 2015).

Depression is commonly comorbid with type 2 diabetes in Mexican Americans. Depressive symptoms may manifest as a result of the type 2 diabetes diagnosis, difficulties with diabetes management, declining health status and physical functioning (Ford et al., 2014; Glassy, Lemus, Cronan, Glassy, & Talavera, 2010). Estimates suggest that 31% of Mexican Americans with type 2 diabetes had at least some depressive symptomology, while 11% of diabetes patients meet the diagnostic criteria for major depressive disorder (Anderson, Freedland, Clouse, & Lustman, 2001; Black, Markides, & Ray, 2003). Mexican Americans with type 2 diabetes have twice the odds of depression compared to non-diabetic Mexican American adults (Anderson et al., 2001). Adults with co-morbid type 2 diabetes and clinical depression have higher levels of the biomarker hemoglobin A1c and are less medically compliant with their diabetes treatment (Shah et al., 2015). Moreover, comorbid type 2 diabetes and depression are associated with increased fall risk in older adults (Tchalla et al., 2014) and disability (Schmitz et al., 2011). Still, few studies have examined the relationship between years since diagnosis of type 2 diabetes, severity of depressive symptoms and the progression of disability longitudinally in the Mexican American population.

Given that Mexican Americans have a higher prevalence of uncontrolled type 2 diabetes, type 2 diabetes-related disability and a high burden of depressive symptoms than most race/ethnic groups, this study will extend previous research by evaluating the relationship between the number of years in which a person has been suffering from type 2 diabetes (a proxy of disease severity) and two measures of disability progression (activities of daily living [ADL] and instrumental activities of daily living [IADL]). We will also determine whether this relationship varies as a function of depressive symptomatology. While studies have evaluated the relationship between diabetes and depression (Anderson et al., 2001) or diabetes, depression and disability cross-sectionally (Ell et al., 2015; Mishra, Sharma, Bhandari, Bhochhibhoya, & Thapa, 2015), few studies have assessed how the established pattern progression of disability in those with diabetes could be compounded by the severity of depression symptoms over time (Black, 1999; Stynen, Jansen, & Kant, 2015).

Additionally, most studies have used the ADL measure as the primary indicator of disability, without considering how diabetes impacts the progression of IADL, such as money management or driving independently, which are often the first signs of loss of independence in older adults. Most studies that have investigated this relationship have not included Mexican Americans or Hispanics in general (de Souza Moreira, Sampaio, Cavalcanti Furtado, Dias, & Kirkwood, 2015; Stynen et al., 2015). Further, while previous studies have not taken into account the length of time that an individual has had the diagnosis, which could impact the rate of disability progression through biological processes associated with the disease (e.g. small vessel disease, stroke, peripheral vascular disease). These biological processes could be compounded by perceived disease burden and depressive symptoms, thus leading to earlier onset and more rapid escalation of disability (Lange & Piette, 2005; Sharkey, Ory, & Wang, 2006). In light of these previous findings, we will also evaluate whether the relationship between duration of time with diabetes diagnosis and progression of disability varies as a function of severity of depressive symptomology. Specifically, we expect that the relationship between years since type 2 diabetes diagnosis and disability progression over time will be moderated by depression severity.

2. Subjects, materials, and methods

2.1. Data

The Hispanic Established Population for the Epidemiologic Study of the Elderly (H-EPESE) is a cohort study of older (65 + years) Mexican American adults living in the Southwest United States (U.S.) collected between 1993/94 and 2012/13 (Markides, Rudkin, Angel, & Espino, 1997). The initial purpose of the H-EPESE was to document the aging process among Mexican Americans, the largest Hispanic population in the U.S. The sample was selected using a probability design to represent older Mexican American adults living in Texas, Arizona, California, Colorado, and New Mexico. Baseline data were collected between 1993 and 1994, and seven subsequent waves (1995/96, 1998/99, 2000/01, 2003/04, 2005/06, 2007/08, 2010/11, and 2012/13) were collected over a 20-year follow-up period. For this study, we used the first 7 waves of data, since the 2012/13 wave was not yet available to the authors for analysis. Given this large representative sample and multiple follow-up data collection points, the H-EPESE provides a unique opportunity to assess longitudinal relationships between type 2 diabetes, disability and depression in a high-risk population of older adults. While average age of diabetes diagnosis in Hispanics in the U.S. was 45.5 in 1997 (the most proximate year available to when the H-EPESE data was collected) (CDC, 2015), the average years since diagnosis in this sample is 12.9. Given the age distribution of our sample, the majority of participants in the H-EPESE had diabetes for about a decade, suggesting that the majority of the sample were likely diagnosed after the age of 50. While there is the possibility that because of the age range of H-EPESE participants, we could have systematically omitted those who were diagnosed earlier than 55 and had diabetes for less than a decade since our sample begins at age 65, those potential participants would have been missed.

After excluding cases for missing data on depression symptomology at baseline, our final sample for this analysis was 2823 of the total 3050 (93%). To identify missing data patterns that could bias our results, we conducted an analysis to determine to what extent participants with missing baseline data on depressive symptomology differed from those with complete data. Those of older age and female gender were significantly more likely to have missing data on depression at baseline. We adjusted for both of these variables in our analysis to reduce potential bias.

2.2. Measures

2.2.1. Type 2 diabetes status

Type 2 diabetes status was measured using self-reported physician diagnosis of type 2 diabetes. At baseline, 672 participants self-reported having been diagnosed with type 2 diabetes by a physician. Fig. 1 presents the number of participants and percentage of the original sample that we retained in each wave.

2.2.2. Years since diagnosis

Using self-reported age at diagnosis data, the number of years since diagnosis was calculated. Because this distribution was not approximately normal, we categorized this variable to represent years since type 2 diabetes diagnosis. These four categories included: 0 = no type 2 diabetes, 1 = 1–10 years since diagnosis, 2 = 11–20 years since diagnosis, and 3 = 21 + years since diagnosis. Greater time since diagnosis is reflective of disease severity (Al Snih et al., 2005; Varma et al., 2010).

2.2.3. Depression

Depressive symptoms during the previous week were measured using the Center for Epidemiologic Studies Depression Scale (CES-D) with scores ranging from 0 (no depressive symptoms) to 60 (Radloff, 1977). The Center for Epidemiologic Studies-Depression (CES-D) has high reliability at detecting high depressive symptoms among
Hispanics with chronic diseases, including type 2 diabetes (Ell et al., 2011, 2015; Glassy et al., 2010). Using established cutpoints (Black et al., 2003), we created three categories representing no depressive symptoms (0 CES-D score), minor depressive symptoms (1–15 CES-D score) or significant depressive symptomology (16+ CES-D score).

2.2.4. Outcome: disability

2.2.4.1. Self-reported disability. The seven-item Katz Activities of Daily Living (ADL’s) scale and the eight-item Instrumental Activities of Daily Living (IADL’s) scale were used to ascertain disability status (Katz, Ford, Moscowitz, Jackson, & Jaffe, 1963; Lawton & Brody, 1969). The ADL scale measured participant’s ability to care for themselves, with indicators such as bathing, dressing, grooming, feeding and toileting. The total number of indicators was summed to create an index of no disability (0) to seven (7) with higher scores indicative of greater disability. The IADL scale measured participants’ ability to shop for themselves, pay bills, prepare meals, take medications, do housework and drive or take the bus. Participants were asked if they need help with any self-care activity listed above, and they responded “yes” or “no” to each activity. A summative score was created with a higher score indicative of greater disability. Responses were summed within scales and retained as time-varying continuous variables for regression analysis.

2.2.5. Covariates

Covariates included age at baseline (65–74; 75–85; and 86 or older), gender, marital status (married, separated, divorced, widowed, or never married) at baseline, and total number of years of formal education completed (0 years; 1–6 years; 7+ years). Cut-points for years of education were created based on the frequency distributions with the majority of the sample having no greater than 6 years of formal schooling (74%) and less than 10% graduating from high school. Because previous studies using the H-EPESE dataset suggest that older adults commonly suffer from other conditions in addition to diabetes (Fillenbaum, Pieper, Cohen, Cornoni-Huntley, & Guralnik, 2000; Otiniano, Du, Ottenbacher, & Markides, 2003), we controlled for self-reported past experience of a heart attack, stroke, cancer or hypertension in all multivariate models.

2.3. Analytical methods

2.3.1. Descriptive analyses

All measures were examined for normality and descriptive data was examined to identify outliers. Chi-square tests and analyses of
variance were performed to assess associations between type 2 diabetes and CES-D categories at baseline with disability. We assessed potential bias due to attrition in participants with type 2 diabetes due to mortality by assessing the probability that participants would survive to subsequent waves of follow-up by duration of time since diagnosis with type 2 diabetes. Our analysis indicated that although participants with type 2 diabetes at baseline died earlier than those who did not have the disease, there were not significant differences in the likelihood of survival according to the exposure of interest (years with type 2 diabetes). Fig. 2 shows the survival curve stratified by type 2 diabetes status for the sample. These findings are consistent with existing evidence that survival rates of persons with type 2 diabetes are highly dependent upon diabetes and comorbidity control, rather than the amount of time with the disease (Leal, Gray, & Clarke, 2009). Therefore, we do not expect that any systematic bias in years with type 2 diabetes was introduced due to earlier mortality.

We conducted a test for collinearity between age and years since diabetes diagnosis. This analysis yielded significant results, therefore we opted to include one model that includes age as a contrast to subsequent models without the age-adjustment. The removal of age in the GEE regression did affect the significance of the effect size of years since diabetes diagnosis significantly.

2.3.2. Inferential analyses

Bivariate and multivariate generalized estimating equation (GEE) regression models were used to assess the relationship between years since type 2 diabetes diagnosis, depression and progression of disability for each outcome (ADL and IADL disability indicators). Four stepwise regression models were fit: a model 1) adjusting for age and other demographic characteristics, 2) adjusting for demographic characteristics without age, 3) adjusting for demographics without age and comorbidities, and 4) adjusting for demographics without age, including comorbidities and an interaction term. Multiplicative interaction terms were added to each model to test for any potential modification of the relationship between type 2 diabetes and disability as a function of depressive symptomology. Given the well-established relationship between diabetes and the progression of disability in older Mexican Americans (Ford et al., 2014; Glassy et al., 2010), we tested the strength of the relationship between diabetes and disability at different levels of depressive symptoms, rather than determining the presence or absence of a relationship between diabetes and disability based on depression status (Baron & Kenny 1986). All analyses were conducted using Stata 13 SE (Stata Corp, 2013).

3. Results

Table 1 presents baseline characteristics of the H-EPESE sample by disability measure at baseline. The majority of the sample was between 65 and 74 years old (67.3%) and female (57.6%). Most participants had 1–6 years of education (56.3%) and were married (55.5%). Overall, about 17% of the sample had type 2 diabetes and nearly half of those with type 2 diabetes were diagnosed less than 10 years ago. Two-thirds of the sample had mild depressive symptoms (1–16 CES-D score) category and 21.2% were moderately/severely depressed (16 or more CES-D score). Most participants reported less than one ADL disability (.53; sd = 1.6) and 2.06 (sd = 2.7) IADL disabilities. Most participants had higher IADL (2.32 vs. 1.71, p = .000) disability than males (Table 1), however there were no gender differences in ADL status. Participants who were widowed or never married had greater average ADL (widowed mean = .718, p = .000; never married mean = .686, p = .046) and IADL (widowed mean = 2.86, p = .000; never married mean = 2.27, p = .007) disability compared to married participants.

The overall number of years since type 2 diabetes diagnosis was associated with differential baseline ADL and IADL status except for participants who were living with type 2 diabetes for 10 years or less at baseline (Table 1). Specifically, participants with 11–20 years and 21 years or more since type 2 diabetes diagnosis had significantly higher average ADL disability than those without a type 2 diabetes diagnosis (11–20 years mean = .685, p = .049; 21+ years mean = 1.36, p = .000). All participants with type 2 diabetes had significantly greater IADL disability at baseline than those without type 2 diabetes (0–10 years mean = 2.35, p = .005; 11–20 years mean = 2.61, p = .001; 21+ years mean = 3.63, p = .000).

After adjusting for age and other demographic characteristics in model 1, years since type 2 diabetes diagnosis categories had differential trajectories, with 21 or more years having the greatest increase in ADL and IADL disability over the 15-year follow-up period (Table 2). Compared to participants without type 2 diabetes, those who were diagnosed with type 2 diabetes 10 years ago or less had an average increase of .275 (p < .001) units of ADL disability and .734 (p < .001) units of IADL disability compared to participants without type 2 diabetes over the 15-year follow-up period. Participants who had a diagnosis of type 2 diabetes for 11–20 years had an increase of .470 (p < .001) units of ADL disability and .831 (p < .001)
In other words, both depressive symptoms and years with diabetes were significantly associated with the progression of ADL disability during the follow-up period of this study. These effects were observed for participants diagnosed with type 2 diabetes for more than 20 years ago and with a more dramatic increase in ADL and IADL disability over the 15-year follow-up period of this study, after controlling for demographic and comorbidity covariates. In addition, depression moderated this relationship among participants who had type 2 diabetes for 21 or more years for ADL disability only. In other words, both depressive symptoms and years with diabetes were significantly and independently related to disability progression longitudinally. However, participants who had diabetes for 21 or more years and moderate/severe depression had the greatest increase in ADL disability, but not IADL disability over the follow-up period.

Results suggest that years since type 2 diabetes diagnosis was differentially associated with ADL and IADL disability progression over the 15-year follow-up period. This association became stronger as the time since type 2 diabetes diagnosis increased. For example, participants diagnosed with type 2 diabetes more than 20 years ago had an average increase of .792 units of IADL disability. Finally, participants diagnosed with type 2 diabetes 21 or more years ago had an average increase of .953 units of IADL disability. However, the effect size for participants diagnosed with type 2 diabetes more than 20 years ago and moderate/severe depression was .734 units, that for participants with diabetes for the same amount of time and moderate/severe depression was .470 units, and for participants with diabetes for 21 years or more for the same amount of time and moderate/severe depression had an average decline of 1.40 units over time, which is nearly double than those who have had type 2 diabetes 21 or more years without depression (.792). In other words, the effect of having diabetes for two or more decades on units of IADL disability. Finally, participants diagnosed with type 2 diabetes 21 or more years ago had an average increase of .792 units of ADL disability and 1.40 units of IADL disability.
had greatest increases in ADL and IADL disability over the 15-year follow-up period. Furthermore, this relationship was not impacted by other common diabetes comorbidities, including having experienced a heart attack, stroke, cancer or hypertension.

A small number of recent studies have used years since diagnosis of type 2 diabetes as an important indicator of the severity of type 2 diabetes and to distinguish more recently diagnosed from those with long-term exposure to the disease (Ell et al., 2015). There is also research to suggest that longer duration of type 2 diabetes is an indicator of more severe disease (Seth, Kaur, & Kaur, 2015) and a risk factor for other chronic conditions (Onitilo et al., 2014; Salinas-Martínez et al., 2014). While these findings are consistent with previous studies, the results from our study support the notion that this relationship exists among Mexican Americans, a historically under-researched group that experiences substantial burden of disease and is typically medically underserved (Salinas, de Heer, Lapeyrouse, Heyman, & Balcazar, 2015).

This study also builds upon the extant literature as previous studies have focused only on ADL disabilities (Black et al., 2003; Ell et al., 2015) and not IADL disabilities. Our study therefore provides evidence that in older Mexican Americans, diabetes is associated not only with functional limitations such as grooming and bathing, but also with instrumental activities such as managing money and driving which could have a large impact on independent living. Moreover, our findings indicate that the effect of time since diagnosis on the progression of disability is independent of other common comorbidities that are common in this population.

Our findings also suggest that the relationship between type 2 diabetes and ADL disability varied by depression status, but not IADL after controlling for comorbidities. Depression is well established as a predictor of type 2 diabetes control (De la Roca-Chiapas et al., 2013). There is evidence to suggest that the relationship between type 2 diabetes and depression on glucose control is time dependent, and longer duration of both conditions raises the risk of uncontrolled type 2 diabetes (Georgiades et al., 2007). Limited evidence to date suggests that comorbid type 2 diabetes and depression is associated with lower functional status in clinic-based samples (Ciechanowski, Katon, Russo, & Hirsch, 2003). Findings from our study are consistent with this limited body of literature generally and with previous research using three waves of the H-EPESE dataset specifically, which showed significant interaction effects between type 2 diabetes status and depression on self-reported disability using ADL status (Black et al., 2003). The current study expands upon previous findings by Black and colleagues (Black, 1999; Black et al., 2003) by adding a longer follow-up period, including IADL functioning and evaluating years since types 2 diabetes diagnoses as our primary independent variable (Black et al., 2003).

Importantly, our findings indicate that the role of moderate/severe depression on ADL functional decline is critical among persons who have had type 2 diabetes for more than twenty years. Depression did not have the same effect on IADL disability after accounting for comorbid conditions. Our current knowledge on this relationship in the Hispanic population, and Mexican Americans specifically, is limited despite the elevated risk of diabetes and disability observed in this population. Therefore, this study adds to the literature by documenting the extent to which comorbid depression modifies the progression into disability and loss of independence in persons with diabetes for long periods of time.

Early identification of depressive symptoms in a clinic setting, particularly for those patients with long-term type 2 diabetes may help to delay disability, thereby maintaining functional independence for patients with type 2 diabetes. Patients with long-term type 2 diabetes should be screened routinely for depression during annual exams (Abrams et al., 2015; Ell et al., 2011). However, evidence still suggests that depression is often undiagnosed or unrecognized among Hispanics due to cultural and linguistic barriers between health professionals and patients, despite its high prevalence (Dilsaver & Akiskal, 2005). Moreover, high uninsurance rates among Hispanics creates added barriers to time screening of both mental and physical health conditions (Salinas et al., 2015). The potential for prevention at the primary care level is vast (de Groot et al., 2012; Huang et al., 2012), as simple screenings during regular office visits could prevent or delay loss of independence or earlier nursing home placements and mortality.

While these findings contribute to our knowledge of the interplay between type 2 diabetes, depression and the progression of disability among Mexican Americans, there are a number of limitations that need to be acknowledged. First, although the H-EPESE data is characterized by a long-term follow-up period and a large-scaled sampling effort across the southwestern U.S., it is only representative of older Mexican Americans living in this area. Therefore, these findings should be replicated across other Hispanic national groups and persons diagnosed with diabetes at younger ages. Since diabetes is commonly diagnosed when one is between 40 and 50 years of age, there may be differential effects of depression on disability progression in persons with diabetes in this age range. Second, while the use of years of diagnosis has enabled us to consider how not just the status of having type 2 diabetes but the potential progression that may occur with longer time living with the disease, we relied on self-reported data as clinical measures (i.e. HbA1c, fasting blood glucose) were unavailable. Moreover, survey measures may be subject to recall bias, as participants may not remember how many years exactly since they have been diagnosed with type 2 diabetes. Finally, while the CES-D has been used in numerous studies and is highly reliable, it is not a diagnostic tool, but rather briefly screens for symptoms consistent with depression. About 7% of our sample did not have complete data for the CES-D and differential completion of this tool was explained by age and gender. These patterns may have biased our findings, as participants who were more likely to be clinically depressed may have been less likely to complete the CES-D.

In light of these weaknesses, this study has notable strengths. First, data were collected from a large cohort of Mexican American adults, and measures were stable over time. This is a unique strength that allowed us to assess how depression impacted disability status as the cohort aged. Additionally, we were able to distinguish duration with type 2 diabetes as a diagnosis and determined that time with the disease is an important distinction to make when considering the disablement process due to physiological processes associated with the disease (Lorenzo et al., 2012; Otiniano et al., 2012; Xiang et al., 2013). Moreover, there is now growing evidence that the longer a person lives with type 2 diabetes, the greater the incidence of depression and other mental health conditions (Ell et al., 2015; Shah et al., 2015). Therefore, the findings from this study are novel and demonstrate that type 2 diabetes is associated with both progression and onset of disability, with more severe increases in disability for Mexican Americans who have had type 2 diabetes for longer periods of time. This finding was consistent regardless of disability measurement tool, highlighting the robust relationships observed. Future research should further explore a possible mediated relationship between duration with type 2 diabetes, depression, and disability, as it is possible that a portion of the variation in disability is explained through changes in depression status.

5. Conclusion

Comorbid depression in persons with diabetes for 20 or more years may have more rapid progression into ADL disability than those with diabetes the same amount of time without depression.

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