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Correlates of low-adherence to oral hypoglycemic medications among Hispanic/Latinos of Mexican heritage with Type 2 Diabetes in the United States

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ABSTRACT

Aims: We examined psychosocial- and social/economic factors related to low medication adherence, and sex differences, among 279 adults of Mexican heritage with Type 2 Diabetes.

Methods: Self-report and health record data were used for cross-sectional analyses. Bivariate analyses tested the association of demographic, psychosocial (depression, anxiety, stress) and social/economic factors (insurance type, health literacy, social support) and medication adherence measured by proportion of days covered. Hierarchical regression analyses examined associations between demographic, psychosocial- and social/economic- related factors and low medication adherence stratified by sex.

Results: More males than females demonstrated low adherence to hypoglycemic medications (75.0.% vs. 70.3%) ($p < 0.05$). We found significant differences between levels social support and medication adherence ($p < 0.05$). In hierarchical models, being US born and higher levels of social support were associated with low adherence among males ($p < 0.05$, and $p < 0.001$).

Conclusions: Approximately 72% of Mexican heritage adults demonstrated low adherence (PDC ≤ 0.50) to their hypoglycemic regimen, and gender differences exist. Interventions should address gender differences in preferences for social support to improve medication-taking behaviors among Mexican heritage males.

1. Introduction

Hispanic/Latinos (Latinos) in the United States (US) are disproportionately affected by Type 2 diabetes compared with other racial/ethnic minority groups [1]. According the Hispanic Community Health Study, Study of Latinos (HCHS/SOL), among persons of Mexican heritage, the largest Latino subpopulation, the prevalence of diabetes is

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approximately 18.3% [2]. Uncontrolled diabetes, defined as a Hemoglobin A1c (HbA1c) > 7.0%, can lead to higher risk for disabling health complications, additional care requirements, and increased healthcare cost [3]. To prevent health complications, individuals with diabetes must maintain glycemic control (Hemoglobin A1c < 7.0%) [4]. Latino adults experience lower rates of glycemic control due to complex barriers related to diabetes self-management, a key factor being low medication adherence [5,6].

Low adherence to oral hypoglycemic medications is associated with higher levels of HbA1c as well, as all-cause hospitalizations and increased all-cause mortality [7]. Among Latino adults, studies suggest that medication adherence ranges from 40% to 73%, and compared to other racial/ethnic groups, Latinos have the lowest medication adherence levels [8,9]. Adherence to prescribed medications is not only influenced by individual factors (e.g., age, sex, education, language), rather influenced by factors related to interpersonal and clinic factors [10]. Therefore different levels of the socio-ecologic framework [11] may be examined to understand Latino adults' low adherence to prescribed medications. For example, modifiable psychosocial condition-related factors of low adherence include anxiety [12], depression [13,14] and stress [15]. Modifiable social/economic related-factors such as limited health literacy [16,17] low social/emotional support [10,18] and lack of regular health care [19].

Sex differences exist in diabetes self-management. Studies suggest that although "males and females" are prescribed similar regimens, differences exist in medication adherence and other self-care behaviors [20,21]. One factor that can play a role among Mexican heritage adults is acculturation. For example, one study found that family responsibilities can take priority over individual needs of less acculturated females and serve as a barrier to diabetes self-management. In this study female participants, shared challenges related to changing dietary patterns while keeping male spouses happy [22]. Further, females experience higher rates of modifiable psychosocial conditions (e.g. depression, stress) that can serve as barriers to medication adherence and diabetes control [23,24]. Males experience a different set of barriers to diabetes self-management. Studies have found traditional sex roles can prevent acceptance of social support [25]. In a qualitative study among primarily Mexican heritage males, participants reported difficulties understanding physician instructions around self-care, frustrations and stress related to disclosing diagnoses to others, and fatalistic mindsets [26]. Therefore, to inform practice, more research is needed to identify sex specific factors correlated with low adherence among Latinos.

Based on the growing size of the Mexican heritage population in the US [27] and disproportionate rates of uncontrolled diabetes among this population [28], there is a need for a better understanding of modifiable correlates of low adherence to oral hypoglycemic mediations. Given the large percentage of Mexican heritage adults residing in the US/ Mexico border region of California, and the proportion who rely on care from federally qualified health centers, there is a need to examine low adherence as well effective ways to measure adherence among this population. Based on a review of the current literature, there is a gap in research focused on measuring adherence to diabetes medications and identifying effective measurement tools for Latinos. Therefore, the aim of this study was to identify modifiable psychosocial conditions- and social/economic-related factors of low adherence, and to examine sex differences among Mexican heritage adults with Type 2 diabetes using proportion of days covered as a measure of adherence.

2. Subjects

The recruitment sampling frame included a query of the electronic health records of all adult Latino patients with a diagnosis of Type 2 diabetes (N = 2383) from San Ysidro Health, a federally qualified health center (FQHC). This FQHC is located in the south most region of San Diego County California near the US/Mexico Border. Mexican heritage patients of the FQHC, are in a border environment that allows entry to Mexico for leisure as well as medical care. Proximity to the border can affect their rate of acculturation, as well as adherence to cultural bound beliefs which can both affect diabetes self-management behaviors [29]. Eligible patients were contacted by telephone to describe the study and explore interest in participation. Eligibility criteria included self-identifying as Hispanic/Latino, ≥18 years of age, registered patient of the FQHC, physician approval, established diagnosis of Type 2 Diabetes, not currently using insulin, and having a diagnosis of two or more cardiovascular (CVD) risk factors (i.e., hypertension, dyslipidemia, obesity, current smoker). Exclusion criteria included pregnancy, plans to move out of the area, and severe preexisting health problem prohibiting informed consent. Eligible participants were scheduled for a baseline screening visit at the South Bay Latino Research Center (SBLRC). Bilingual research staff obtained informed consent, administered self-report surveys in the participants preferred language (English or Spanish), and performed measurements. The analytic sample included 279 participants enrolled between July 2014 and December 2016.

3. Materials and Methods

3.1. *Study design*

Data for this cross-sectional study come from the baseline assessment of the Latinos Understanding the Need for Adherence in Diabetes (LUNA-D) Study. The LUNA-D study was a randomized controlled trial testing a behavioral intervention using the integrated model of care [30] combined with group health promotion compared to usual care provided at the FQHC. The study was approved by the Institutional Review Boards at San Diego State University and San Ysidro Health, and participants provided written informed consent.

3.2. *Measures*

3.2.1. *Primary outcome of medication adherence*

Objective Measure of Medication Adherence. *Proportion of Days Covered (PDC)* was calculated from prescription refill data extracted from electronic health records at the FQHC. PDC was calculated as the sum of the days covered (based on fill date and days' supply) divided by days monitored [31,32].

PDC can range from 0.00 to 1.00 (medication was available each day of the study period = 1). PDC was calculated for oral hypoglycemic medications for a 24-month period prior to enrolling in the study. A continuous score and a categorical variable including three levels: optimal/high adherence (PDC ≥ 0.80), medium adherence (>0.50–0.79), and low adherence (≤0.50) were included in Table 2. The categorical variable was used in bivariate analyses and reported in Table 3. For regression analyses, a binary variable was created low adherence (≤0.50), and med/high adherence (>0.50).

3.2.2. *Modifiable health condition-related factors*

The *8-item Personal Health Questionnaire (PHQ-8)* was used to assess depression symptomatology over a two-week period. Response options included not at all/0–1 day (0 points) to nearly every day/12–14 (3 points). Sum scores can be categorized from no significant depressive symptoms (0–4 points) to severe depressive symptoms (20–24 points). The English (α 0.81) [33] and Spanish (α 0.84) [34] versions are valid and reliable measures of depressive symptomology among Latinos. The *Generalized Anxiety Disorder Questionnaire (GAD-7)*, was used to assess anxiety disorder symptomatology [35]. The GAD-7 consists of 7 questions that assess how often a person was bothered or had problems related to anxiety (e.g., afraid, easily annoyed or irritable). The GAD-7 English (α 0.89) [36] and Spanish (α 0.88) [37] versions are valid and reliable. The response options were in a 4-point Likert scale format, ranging from not at all (0 points) to nearly every day (3 points). A total score was calculated by adding scores for the 7 questions (range 0–21). Anxiety symptomatology can be classified from none/normal (score of 0–4) to severe anxiety (15–21). The *Perceived Stress Scale (PSS) is a 14-item*, self-report instrument used to measure different types of stress over the last month [38]. The PSS includes five subscales, only the general distress/perceived stress subscale was used for this study. The four-item subscale demonstrates adequate reliability in both English (α = 0.72) [38] and Spanish (α = 0.81) [39]. The response options are on a 5-point scale ranging from never (0) to very often (4). The total score is obtained by reversing the scores of two items (6 and 7) prior to summing the scores. A higher score indicates a higher level of perceived stress.

3.2.3. *Modifiable social/economic factors*

The *Chronic Illness Resources Survey (CIRS)* was used to measure different levels of socio-environmental support for self-management of chronic conditions [40]. The CIRS includes seven subscales; only four subscales (13 items) were included in this study to measure support from the participant's healthcare team, family and friends, personal support, and neighborhood support. Both English (α = 0.82) [40] and Spanish (α = 0.78) [41] versions of the CIRS have been found to be valid and reliable in assessing support for self-management. Response options ranged from not at all (1) to a great deal (5). Subscale scores were calculated by totaling the score for all items and dividing by the number of items in the subscale [42]. The *Newest Vital Sign (NVS)* instrument was used to measure healthy literacy. The NVS is a nutrition label accompanied by six questions to assess the participant's capacity to accurately answer the questions based on the nutritional label [43]. This method of assessing health literacy for chronic disease management has been found effective among this population in a prior study [44]. One item from the NVS was included in this study, the item read "*if you were to eat the whole amount of ice cream, how many calories would you consume?*" Responses were coded as correct (0) or incorrect (1). Participants with incorrect responses were categorized with limited health literacy and those with correct responses with adequate health literacy. *Type of medical insurance* was categorized as public, private, and no insurance reported.

3.2.4. *Covariates*

Demographic characteristics included age, gender, country of birth, preferred language of interview, education level, employment status, marital status, and income. Clinical characteristics were extracted from the FHQC electronic health records including CVD risk factors and HbA1c. CVD risk factors were determined based on actual values extracted from the EHR and based on current national guidelines. Type 2 diabetes (HbA1c > 6.5%), hypertension (systolic blood pressure 140 mm Hg or greater), dyslipidemia (total cholesterol 240 mg/dL or greater, LDL cholesterol 160 mg/dL or greater, or HDL cholesterol <40 mm/dL), obesity classification (BMI > 30.0). Current smoking status was derived by self-report data (currently smoking cigarettes). A sum score was created for number of CVD risk factors (i.e., presence of 0, any 1 only, any 2 only, any 3 only, and any 4 only). All laboratory assessments were performed by the FQHC's reference laboratories, either LabCorp or Quest Diagnostics. Participants were asked to have a fasting blood drawn for the baseline assessments if they had not had an HbA1c test in the last 3 months.

3.3. *Statistical analyses*

Descriptive and clinical characteristics were reported as percentages for categorical variables and as means for continuous variables (Tables 1 and 2). Bivariate analyses including Chi-square tests and One-way Analysis of Variance (ANOVA) tests were used to assess the association between demographic variables (age, nativity, language preference, educational level, marital status), psychosocial conditions (depression symptomatology, anxiety disorder symptomatology, and perceived stress)- and social/economic-related (type of insurance, social support, and health literacy) factors and medication adherence measured by PDC (Table 3). Demographic, psychosocial conditions, and social/economic factors associated with medication adherence were selected a priori based on existing literature. Four models for each measure of adherence were constructed to determine the association between demographic characteristics (model 1), psychosocial conditions (model 2), social/economic factors (model 3) and all explanatory variables (model 4). The sample was stratified by sex based on differences observed in bivariate analysis and to test specific proposed hypotheses. An alpha coefficient of 0.05 was used to indicate statistical significance. Statistical analyses were performed using SPSS (Version 25) and SAS (Version 9.4).

Table 1 – Demographic and clinical characteristics stratified by sex, N = 279.

	All Percent (*n*)	Females (n = 175) Percent (*n*)	Males (n = 104) Percent (*n*)
Patient-related factors			
Age			
<65 years	83.5 (233)	84.6 (148)	81.7 (85)
≥65 years	16.5 (46)	15.4 (27)	18.3 (19)
US born			
Yes	10.0 (28)	8.0 (14)	13.5 (14)
No (US residence < 10 years)	6.5 (18)	6.9 (12)	5.8 (6)
No (US residence ≥ 10 years)	83.5 (233)	85.1 (149)	80.8 (84)
Language preference			
English	10.0 (28)	8.6 (15)	12.5 (13)
Spanish	90.0 (251)	91.4 (160)	87.5 (91)
Education level			
High school diploma/GED or less	77.4 (216)	76.0 (133)	79.8 (83)
Greater than high school diploma/GED	22.6 (63)	24.0 (42)	20.2 (21)
Employment			
Employed for wages	42.3 (118)	37.7 (66)	50.0 (52)
Unemployed/Retired/Unable to work	57.7 (161)	62.3 (109)	50.0 (52)
Marital Status			
Single	13.6 (38)	14.3 (25)	12.5 (13)
Married/Living with partner	52.0 (145)	43.4 (76)	66.3 (69)
Divorced/Widowed/Separated	34.4 (96)	42.4 (74)	21.2 (22)
Annual Household Income			
<$20,000	65.2 (182)	68.6 (120)	59.6 (62)
≥$20,000	34.8 (97)	31.4 (55)	40.4 (42)
Number of CVD Risk Factors[a] *(M, SD) (Range 1–4)*	2.06 (1.13)	2.11 (1.16)	1.97 (1.09)
HbA1c[b] *(M, SD) (Valid = 188)*	8.54 (1.83)	8.53 (1.74)	8.55 (1.98)
Dyslipidemia			
No	15.1 (42)	12.6 (22)	20.2 (21)
Yes	84.9 (237)	87.4 (153)	79.8 (83)
Hypertension			
No	13.6 (38)	12.6 (22)	15.4 (16)
Yes	86.4 (241)	87.4 (153)	84.6 (88)
Obesity			
No	40.9 (114)	33.1 (58)	53.8 (56)
Yes	59.1 (165)	66.9 (117)	46.2 (48)
Current Smoker			
No	91.4 (255)	92.0 (161)	90.4 (94)
Yes	8.6 (24)	8.01 (14)	9.6 (10)

[a] Number of CVD risk factors include diagnoses of type 2 diabetes, dyslipidemia, hypertension, obesity, and being current smoker (self-reported).
[b] HbA1c = Hemoglobin A1c.

4. Results

A total of 279 participants were included in the analyses. Tables 1 and 2 include participant demographic and clinical characteristics stratified by sex. The mean age was 55.2 years of age (SD = 9.8), most participants were under 65 years of age (83.5%). The majority of participants were female (63.6%), born in Mexico (89%), with >10 years of residence in the US (83.5%), and preferred to speak Spanish (90.0%). The majority (77.4%) of participants reported a high school/GED diploma or less, and a household income lower than $20,000 (65.2%). The majority (72%) of participants were enrolled in a public health insurance program, 1.8% had private insurance, and 26% were not insured. More males (34%) than females (22%) had no insurance.

The mean HbA1c was 8.5% (SD = 1.8%). Adherence assessed by proportion of days covered (M = 0.40 [SD = 0.2]) resulted in different adherence levels; 72.0% of participants were categorized as low adherers (0.0–0.49%), 23.3% with medium adherence (0.50–0.79), and 4.6% were categorized with high adherence (0.80–1.00%). More males (75.0%) than females (70.3%) were categorized with low adherence as measured by proportion of days covered. See Table 2.

Table 2 – Social/economic-, psychosocial condition-related factors, and medication adherence characteristics stratified by sex, N = 279.

	All % (*n*)	Females (n = 175) % (*n*)	Males (n = 104) % (*n*)
Social/Economic related factors			
Type of Insurance			
Private insurance	1.8 (5)	2.3 (4)	1.0 (1)
Public insurance	72.0 (201)	76.0 (133)	65.4 (68)
No insurance reported	26.2 (73)	21.7 (38)	33.7 (35)
Health Literacy			
Adequate health literacy	9.0 (25)	8.0 (14)	10.6 (11)
Limited health literacy	91.0 (254)	92.0 (161)	89.4 (93)
Social support (M, SD) (Range 0–5)	3.03 (0.64)	3.05 (0.62)	3.00 (0.66)
Condition-related factors			
Depressive Symptomatology (PHQ-8) (M, SD) (Range 0–24)	5.94 (4.74)	6.43 (5.04)	5.12 (4.08)
Anxiety Disorder (M, SD) (Range 0–20)	4.70 (4.22)	5.03 (4.47)	4.14 (3.7)
Perceived Stress (M, SD) (Range 0–16)	8.20 (2.99)	8.55 (3.09)	7.62 (2.70)
Number of prescribed medications[c] (M, SD) (Range 0–5)	3.58 (0.68)	3.60 (0.69)	3.55 (0.66)
Medication Adherence			
Proportion of days covered (M, SD) (Range 0–1.00)	0.42 (0.20)	0.42 (0.20)	0.41 (0.20)
Low adherence	72.0 (201)	70.3 (123)	75.0 (78)
Medium adherence	23.3 (65)	24.6 (43)	21.2 (22)
High adherence	4.7 (13)	5.1 (9)	3.8 (4)

[c] Number of prescribed medications includes medication for diabetes, hypertension, cholesterol, chronic pain, and asthma.

Table 3 shows results of bivariate chi-square analyses and one-way ANOVA tests to determine which factors were significantly associated with low, medium, and high adherence as measured by PDC. Significant bivariate relationships existed between age, US born and PDC measured adherence ($p < 0.05$). There was also a significant bivariate relationship between social support and PDC adherence ($p < 0.05$). Participants with higher levels of social support demonstrated higher levels of adherence as measured by PDC. Higher depressive symptomatology M = 6.01 (SD = 4.84) and higher anxiety symptomatology M = 4.82 (SD = 4.31) were observed among participants with low adherence.

In hierarchical logistic regression, the relationship between demographic characteristics (model 1), psychosocial conditions (model 2), social/economic related factors (model 3), and all explanatory variables (model 4) and medication adherence measured by PDC were examined stratified by sex. Results indicated significant relationships of the different explanatory variables only for males using the proportion of days covered medication adherence measure (see Table 4). In the first model, there were no demographic characteristics associated with low medication adherence. In the second model, including social/economic related factors, being US born, single, and having social support were significantly associated with low adherence ($p < 0.05$). In the third model, including psychosocial condition-related factors, being US born, single, and having social support remained significantly associated with low adherence ($p < 0.05$, $p < 0.05$, and $p < 0.001$) and there was no significant association between depression, anxiety, and stress and low medication adherence. The final regression model indicated the same results as model 3, being US born, single, and having social support remained significantly associated with low medication adherence ($p < 0.05$, $p < 0.05$, and $p < 0.001$). There were no significant relationships between the explanatory variables for females.

5. Discussion

This study highlights the low levels of adherence to oral hypoglycemic medications among Mexican heritage adults with Type 2 receiving care at an FQHC in the US Mexico border region of California. Significant differences were observed in rates of medication adherence based on age, sex, and country of birth. Similarly, this study found significant differences in adherence based psychosocial conditions including depressive symptomatology, anxiety disorder symptomatology and perceived stress; participants with lower scores for these conditions demonstrated higher levels of adherence.

As hypothesized, sex differences in social/economic-related factors of low medication adherence were observed. Among males, being US born, single, and having higher levels of social support predicted low adherence. The finding regarding social support can seem counterintuitive, however, other research studies have shown that social support may have different effects for Latino males and females with diabetes

Table 3 – Bivariate analyses of explanatory variables and medication adherence measures, N = 279.

Chi-Square Analysis	Proportion of days covered Adherence % (n)			
	Low	Medium	High	Sig
Sex				
Male	75.0 (78)	21.2 (22)	3.8 (4)	
Female	70.3 (123)	24.6 (43)	5.1 (9)	0.68
Age				
<65 years	74.7 (174)	21.0 (49)	4.3 (10)	
≥65 years	58.7 (27)	34.8 (16)	6.5 (3)	**0.08**^
US born				
Yes	50.0 (14)	46.4 (13)	3.6 (1)	
No (US residence < 10 years)	88.9 (16)	11.1 (2)	0	**0.02***
No (US residence ≥ 10 years)	73.4 (171)	21.5 (50)	5.2 (12)	
Language preference				
English	67.9 (19)	21.4 (6)	10.7 (3)	
Spanish	72.5 (182)	23.5 (59)	4.0 (10)	0.27
Education level				
High school diploma/GED or less	71.3 (154)	23.6 (51)	5.1 (11)	
Greater than high school diploma/GED	74.6 (47)	22.2 (14)	3.2 (2)	0.80
Employment				
Employed for wages	77.1 (91)	18.6 (22)	4.2 (5)	
Unemployed/Retired/Unable to work	68.3 (110)	26.7 (43)	5.0 (8)	0.26
Marital Status				
Single	73.7 (28)	18.4 (7)	7.9 (3)	
Married/Living with partner	73.1 (106)	22.8 (33)	4.1 (6)	0.77
Divorced/Widowed/Separated	69.5 (66)	26.3 (25)	4.2 (4)	
Annual Household Income				
<$20,000	70.3 (128)	25.8 (47)	3.8 (7)	
≥$20,000	75.3 (73)	18.6 (18)	6.2 (6)	0.30
Type of Insurance				
Private insurance	80.0 (4)	20.0 (1)	0	
Public insurance	72.6 (146)	21.9 (44)	5.5 (11)	0.75
No insurance	69.9 (51)	27.4 (20)	2.7 (2)	
Health Literacy				
Adequate health literacy	84.0 (21)	12.0 (3)	4.0 (1)	
Limited health literacy	70.9 (180)	24.4 (62)	4.47 (12)	0.35

Bivariate analyses of predictor variables and medication adherence measures, N=279

One Way ANOVA	Proportion of days covered Adherence M (SD)				
	Low	Medium	High	F	Effect size (R^2)
Mean Comparisons					
Social support	2.96 (0.64)	3.13 (0.58)	3.45 (0.80)	4.84	**0.03***
Depressive Symptomatology	6.01 (4.84)	5.96 (4.64)	4.61 (3.42)	0.53	0.00
Anxiety Disorder	4.82 (4.31)	4.36 (3.96)	4.46 (4.35)	0.31	0.00
Perceived Stress	8.13 (3.08)	8.33 (2.80)	8.53 (2.60)	0.19	0.00
Number of CVD Risk Factors[a]	2.00 (1.11)	2.27 (1.20)	1.69 (1.03)	2.07	0.01
Number of Prescribed Medications[b]	3.58 (0.65)	3.60 (0.72)	3.61 (0.87)	0.03	0.00

One Way ANOVA = One Way Analysis of Variance.

[a] Number of CVD risk factors include diagnoses of type 2 diabetes, dyslipidemia, hypertension, obesity, and being current smoker (self-reported).

[b] Number of prescribed medications includes medication for diabetes, hypertension, cholesterol, chronic pain, and asthma

^ Approaching significance at the 0.05 level ($0.05 > p < 0.10$).

* $P \leq 0.05$.

Table 4 – Results of Hierarchical Logistic Regression Analysis on Proportion of Days Covered (PDC) Low-adherence to Medications for Male participants (N = 104).

	Model 1 Demographic characteristics			Model 2 Social/Economic related factors			Model 3 Psychosocial related factors			Model 4 Demographic, Social/Economic, Psychosocial factors		
	β (SE)	Exp (B)	95% CI	β (SE)	Exp (B)	95% CI	β (SE)	Exp (B)	95% CI	β (SE)	Exp (B)	95% CI
Predisposing demographic factors												
Age												
<65 years	−0.99 (0.61)	0.37	0.11, 1.23	−1.14 (0.66)	0.32	0.08, 1.16	−1.00 (0.68)			−1.00 (0.68)	0.36	0.09, 1.40
≥65 years	–	–	–	–	–	–	–			–	–	–
US born												
Yes (US born)	1.39 (0.83)	4.02	0.78, 20.53	1.92 (0.94)	6.85	1.08, 43*	2.03 (0.98)	7.65	1.10, 52.99*	2.03 (0.98)	7.65	1.10, 52.99*
No (US residence ≥ 10 years)	–	–	–	–	–	–	–	–	–	–	–	–
Language preference												
English	−0.63 (0.86)	0.51	0.09, 2.83	−1.34 (1.03)	0.26	0.03, 1.99	−1.28 (1.09)	0.27	0.03, 2.35	−1.28 (1.09)	0.27	0.03, 2.35
Spanish	–	–	–	–	–	–	–	–	–	–	–	–
Education level												
High school diploma/GED or less	0.63 (0.73)	1.87	0.44, 7.95	0.55 (0.77)	1.72	0.37, 7.89	0.56 (0.79)	1.75	0.36, 8.41	0.56 (0.80)	1.75	0.36, 8.41
>High school diploma/GED	–	–	–	–	–	–	–	–	–	–	–	–
Marital Status												
Single	−1.97 (1.07)	0.14	0.01, 1.15	−2.49 (1.28)	0.08	0.01, 1.01^	−2.79 (1.35)	0.06	0.04, 0.86*	−2.79 (1.35)	0.61	0.01, 0.86*
Married/Living with partner	−0.06 (0.58)	0.93	0.29, 2.97	−0.09 (0.62)	0.91	0.27, 3.12	−0.45 (0.69)	0.64	0.16, 2.49	−0.45 (0.70)	0.64	0.16, 2.49
Divorced/Widowed/Separated	–	–	–	–	–	–	–	–	–	–	–	–
Social/economic related factors												
Annual Household Income												
<$20,000				0.25 (0.56)	1.28	0.42, 3.87	0.40 (0.59)	1.49	0.46, 4.77	0.40 (0.59)	1.49	0.46, 4.77
≥$20,000				–	–	–	–	–	–	–	–	–
Type of Insurance												
Private insurance				−0.18 (0.54)	0.83	0.28, 2.44	−0.19 (0.58)	0.82	0.26, 2.60	−0.19 (0.58)	0.82	0.26, 2.60
Public insurance				−16.71 (40.97)	0.000	0.000	−15.94 (42.97)	0.000	0.000	−15.94 (42.97)	0.000	0.000
No insurance reported				–	–	–	–	–	–	–	–	–
Social support				1.36 (0.45)	3.89	1.62, 9.39*	1.42 (0.46)	4.15	1.66, 10.37**	1.42 (0.46)	4.15	1.66, 10.37**
Health literacy												
Adequate				−1.66 (1.19)	0.18	0.01, 1.96	−1.82 (1.29)	0.16	0.013, 2.03	−1.82 (1.29)	0.16	0.01, 2.03
Limited				–	–	–	–	–	–	–	–	–

	Model 1 Demographic characteristics			Model 2 Social/Economic related factors			Model 3 Psychosocial related factors			Model 4 Demographic, Social/Economic, Psychosocial factors		
	β (SE)	Exp (B)	95% CI	β (SE)	Exp (B)	95% CI	β (SE)	Exp (B)	95% CI	β (SE)	Exp (B)	95% CI
Psycho-social condition related factors												
Depressive symptomatology							0.03 (0.08)	1.03	0.87, 1.21	0.30 (0.08)	1.03	0.87, 1.21
Anxiety disorder							−0.15 (0.12)	0.86	0.68, 1.10	−0.15 (0.12)	0.86	0.67, 1.09
Perceived Stress							0.17 (0.14)	1.18	0.89, 1.55	0.16 (0.14)	1.18	0.89, 1.55

	Model 1	Model 2	Model 3	Model 4
−2 Log likelihood	103	91	89	89
Cox and Snell R-squared	0.121	0.214	0.230	0.229
Nagerlkerke R-squared	0.179	0.317	0.340	0.339

Notes:

PDC = Proportion of Days Covered, AOR = Adjusted Odds Ratios, CI = Confidence Interval, Ref = Reference category.

^ $p < 0.10$.

* $P < 0.05$.

** $P < 0.01$.

[45]. These findings warrant further research to explore what other factors play a role in low medication adherence among males.

In this study, based on the PDC measure, most participants (72%) demonstrated low adherence. This finding is consistent with the literature on patients' levels of adherence [46]. Similar to other studies, differences in non-modifiable correlates (age, sex, country of birth) of low medication adherence were observed in this study [47,48].

This study contributes to the growing body of literature by focusing on disparities in medication adherence among Latinos of Mexican heritage with diabetes, an underrepresented population in medication adherence research. Further, the study follows recommendations for using the PDC measure, the preferred measure of adherence by the Pharmacy Quality Alliance [32].

Despite its strengths, the study is limited by the cross-sectional design, as well as the limited scope of factors related to poor adherence. The World Health Organization's Adherence Model calls for five dimensions including therapy-, and healthcare system-related factors not assessed in this study. Healthcare system-related factors must be examined in order to improve patient care and health outcomes [8]. Furthermore, participants were primarily low-income and Spanish speaking and recruited from a federally qualified health center setting, and this may affect generalizability of our findings.

5.1. *Clinical implications*

Over reporting of good adherence can be a challenge for primary care providers in their efforts to adjust medications and trouble shoot other causes of poor glycemic control among Mexican heritage patients. The use of health information technology (HIT) such as the use of electronic health records for calculating PDC is a promising strategy. In our study, the PDC measure showed that participants who may report good adherence had significant gaps in medication coverage during prescribed periods. Routine monitoring of medication refill history can result in identification of patients with poor adherence in order to intervene during office visits as well through behavioral health classes. Other HIT strategies can include automated alert messaging to remind patients to refill or pick-up their prescriptions, and schedule office visits.

5.2. *Conclusion*

The levels of low medication adherence, limited health literacy, and low educational attainment suggest the importance of tailoring diabetes self-management education for low-income ethnic minority populations. Research interventions should target patients with limited health literacy and examine the complex role of social support to improve medication-taking behaviors among Mexican heritage males. Further research is needed to identify predictors of low adherence among low-income Mexican heritage adults receiving services in clinic settings to address the multidimensional factors that may lead to uncontrolled diabetes.

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Declaration of interest

The authors declared that there is no conflict of interest.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2019.04.007.

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