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Socio-ecological correlates of non-adherence to prescribed medications among low-income Hispanic/Latino adults with chronic conditions

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Socio-ecological correlates of non-adherence to prescribed medications among low-income Hispanic/Latino adults with chronic conditions

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Public Health (Health Behavior)

by

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Chair

University of California, San Diego
San Diego State University
2017
DEDICATION

This dissertation is dedicated to my daughter, Victoria Elyse Vega, my motivation to achieve this milestone, and my husband Hugo Navarette Vega, for his love, patience, and support during this chapter of our lives. Hugo, without you, I would have not applied to the program or accomplished this career goal.

This work is also dedicated to my family. My parents Willy & Elena Garcia for instilling in me the importance of hard work and higher education, and for their loving dedication to Victoria. My sisters, Bethzaida Ferrari for the unlimited hours of listening, counseling, and support that kept me on my path; Aurea Gonzalez for the great conversations that calmed my doubts; Jomeini Ruiz for the words of encouragement and motivation. My in-law family, Manuel, Maria, and Leticia Vega for all their support and unlimited love and time for Victoria. Lastly, to my nieces and nephews, as a reminder that determination and hard work pays off.
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In addition, I would like to thank Dr. John P. Elder for inspiring me to enroll in the UCSD/SDSU doctoral program, for introducing to the Institute for Behavioral and Community Health (IBACH), and for hiring me to take part of his research team. I will be eternally grateful for his guidance, I may not have finished my first year without his mentorship, kindness, and positivity.

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ABSTRACT OF THE DISSERTATION

Socio-ecological correlates of non-adherence to prescribed medications among low-income Hispanic/Latino adults with chronic conditions

by

Melawhy Lucette Garcia

Doctor of Philosophy in Public Health (Health Behavior)

University of California, San Diego, 2017
San Diego State University, 2017

Professor Gregory A. Talavera, Chair

Background: Hispanic/Latinos experience high rates of uncontrolled chronic conditions that place this large segment of the population at risk for cardiovascular disease and mortality. Despite evidence that poor medication adherence is a major contributor to disparities in glycemic and lipid control; there is a gap in knowledge regarding the measurement and correlates of medication adherence among Hispanic/Latinos.

Aims: Using the World Health Organization’s Multidimensional Adherence Model, this dissertation focused on: 1) examining patient-, social/economic-, health condition-, therapy-, and health system-related correlates of poor adherence; and 2) identifying ways to effectively measure medication adherence among Hispanic/Latinos adults.

Methods: Aims 1 and 2 involved cross-sectional analyses of data on 149 participants enrolled in a randomized trial (Chapter 2); cross-sectional analyses of data on 279 participants
enrolled in a randomized trial (Chapter 3); and, a historical cohort study of 1,485 patients from a federally qualified health center (Chapter 4).

**Results:** As measured by self-report, objective, and health record data, Hispanic/Latinos exhibit high rates of poor medication adherence. Bivariate analyses revealed numerous factors associated with poor adherence. Patient-related factors included younger age, sex, forgetting, multiple medications, and side effects. Health condition-related factors included higher depressive symptomatology, anxiety, and perceived stress. Social/economic-related factors included social support and limited health literacy. In logistic regression analyses, age was inversely related to poor adherence (OR 0.97; CI 0.96-0.99, p < 0.01). Social support predicted low medication adherence (OR = 2.22; 1.03-4.76, p < 0.05) among males. The odds of low adherence were higher among males with limited health literacy (OR = 6.26; 1.06-37.10, p < 0.05). Comparison of measurement methods confirmed patients overestimate adherence to medications by self-report. Objective measures of adherence, including Medication Event Monitoring systems and Proportion of Days covered, showed lower adherence than self-report.

**Conclusion:** This study provides insight to the suboptimal levels of medication adherence among Hispanic/Latinos receiving services at federally qualified health centers. The findings from this study may help to inform future intervention research aiming to improve medication adherence among Hispanic/Latinos in a similar settings. Further research is needed to examine the multidimensional factors related to poor adherence among this population.
CHAPTER 1
INTRODUCTION

OVERVIEW

In the United States (U.S.), chronic illnesses account for most of health care expenditures [1, 2] and disproportionately affect racial and ethnic minority populations [3, 4]. Hispanic/Latinos (H/Ls) residing in the U.S. have a high prevalence of several chronic diseases and comorbid conditions that put them at high risk for cardiovascular disease (CVD) [5, 6]. Although the benefits of pharmacological therapy have been demonstrated [7], H/Ls experience challenges to chronic disease management and demonstrate lower levels of lipid [8] and glycemic control [9, 10], compared to non-Hispanic Whites (NHW).

Chronic disease management requires numerous self-care behaviors, a critical factor being medication adherence. Evidence suggests that in order to experience therapeutic benefits, a person must take ≥ 80% of medication as prescribed (include dosage, time, duration) [11]. Non-adherence to prescribed medications is associated with increases in blood sugar levels, blood pressure, and cholesterol. These increases can lead to many negative health outcomes including all-cause hospitalizations and increased all-cause mortality [12]. Notably, there is a gap in knowledge regarding medication consumption behaviors of H/Ls with chronic conditions, as well as effective ways to measure medication adherence among this population. Most studies include only small samples of H/Ls, which can’t be generalized to low-income H/L with multiple chronic conditions [13–15]. Given that H/Ls are the largest and fastest growing ethnic/minority population in the country [16], and that CVDs are the leading causes of mortality among H/Ls in the U.S. [17], understanding and addressing barriers to control of chronic diseases is imperative.

Therefore, the aims of this dissertation were to: 1) examine patient-, social/economic-, health condition-, therapy-, and health system and utilization-related correlates of poor
medication adherence; and 2) identify ways to effectively measure medication adherence among Hispanic/Latinos.

To address these aims, analyses used self-report, objective, and health record data from Hispanic/Latino adult patients of a large community health center in San Diego, CA. The data sources were as follows: 1) Cross-sectional data (N= 149) collected through Latinos Understanding the Need for Adherence (LUNA), a randomized controlled trial to test a chronic disease management intervention (Chapter 2); 2) cross-sectional data (N = 279) collected through the second iteration of LUNA titled: Latino Understanding the Need for Adherence in Diabetes (LUNA-D), a randomized controlled trial to test an integrative care model to improve diabetes control (Chapter 3); and, 3) a historical cohort study of patients (N = 1,485) of a federally qualified health center through the use of electronic health record data (Chapter 4).

BACKGROUND & SIGNIFICANCE

Risk for Cardiovascular Diseases among Hispanic/Latinos

Hispanic/Latinos face high risk of CVD because of higher rates of diabetes, high blood pressure, obesity, and high cholesterol [18]. According to the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), the overall prevalence of hypercholesterolemia among H/L adults was 52% among men, and 37% among women [5]. The HCHS/SOL also reported on the rates of hypertension, diabetes and obesity. For men and women, these values were: 26.1% and 25.3% for hypertension, 16.7% and 17.2% for diabetes, and 36.5% and 42.6% for obesity [5, 19, 20]. Further, the HCHS/SOL highlights the poor control of these conditions; only 37.5% of HCHS/SOL participants had controlled hypertension [19], 48% demonstrated diabetes control [21], and 64.3% had optimal levels of total cholesterol (TC) [22].
The burden of poor medication adherence

The World Health Organization (WHO) considers poor adherence to treatment for chronic diseases a “worldwide problem of striking magnitude” [23, 25]. In the U.S., it is estimated that non-adherence to prescribed medications is responsible for $290 billion in avoidable health care expenditures per year [26]. Further, medication nonadherence is likely to increase as the U.S. population ages and requires the use of more medication to treat chronic conditions [12]. According to previous studies, individuals with chronic diseases are more likely to be non-adherent to long-term medication prescriptions when compared to patients with acute illnesses [27]. Non-adherence to prescribed medications is associated with increases in blood sugar levels, blood pressure, and cholesterol. These increases can lead to many negative health outcomes including all-cause hospitalizations and increased all-cause mortality [12]. Despite awareness of the importance of medication adherence, few chronic disease management studies focus on medication adherence over other self-management behaviors, and of the studies that address adherence, few include low-income H/Ls [15, 23, 28].

Importance of addressing poor adherence to lipid-lowering medications

High total (TC) and low-density lipoprotein (LDL-C) cholesterol are major risk factors for cardiovascular disease (CVD) and stroke [29]. The 2013 American College of Cardiology (ACC)/ American Heart Association (AHA) Guidelines on the treatment of blood cholesterol call for lifestyle modifications (e.g., healthy diets and regular exercise), both prior to and in combination with the use of cholesterol-lowering drug therapy (e.g., statins) [30]. The 2013 ACC/AHA expert panel found extensive evidence supporting the use of statins for prevention of ASCVD [30]. Evidence from clinical trials suggest that statin medications can reduce major vascular events by between 15% and 25% [31], yet, between 40–60% of those on a therapy adhere to regimens sufficiently to experience treatment benefits [32].
Although the benefits of statins have been demonstrated [33], challenges to controlling cholesterol exist [8]. A retrospective cohort study among 34,501 patients receiving statins found that adherence was close to 80% within three months of the prescribed treatment, and that persistence with statin therapy dropped to 56% by six months [34]. A population-based study using electronic medical and prescription records of 58,266 patients with hypercholesterolemia aged 30 years and older found an elevated risk of stroke death among patients nonadherent to statin therapy (OR = 2.04, 95% CI:1.72 to 2.43) [31]. Despite the proven benefits of statins for the primary and secondary prevention of CVD, few studies focus on statin use among the H/L population in the US and current information regarding medication taking behaviors is limited [35].

Low-density lipoprotein cholesterol (LDL-C) makes up 60-70% of total serum cholesterol, and is the primary target of cholesterol-lowering therapy identified by The National Cholesterol Education Program Expert Panel (NECP) [29]. The NCEP recommends LDL-C lowering drug therapy for persons with multiple risk factors (hypertension, diabetes, obesity, cigarette smoking) whose LDL-C levels are high (≥160 mg/dL) after dietary therapy. Drug therapy is recommended by the NCEP Adult Treatment Panel III (ATP III) as follows: for persons with 0-1 risk factors whose LDL-C levels are between 160-189 mg/dL after dietary therapy, drug treatment is optional, if LDL-C levels are ≥190 mg/dL after dietary therapy, drug treatment should be considered. The NCEP ATPIII classifies LDL-C levels as follows: <100 mg/dL = optimal; 120-129 mg/dL = above/near optimal; 130-159 mg/dL = borderline-high LDL-C, 160-189 mg/dL = high LDL-C; and ≥190 mg/dL = very high LDL-C. Total cholesterol (TC) is classified as follow: <200 mg/dL = desirable, 200-239 mg/dL = borderline high, and ≥240 mg/dL = high cholesterol.
Importance of addressing poor adherence to oral hypoglycemic medications

Individuals with poor glycemic control are at risk for developing a number of health complications including hypertension, dyslipidemia, cardiovascular disease, retinopathy, nephropathy, and neuropathy [36, 37]. Uncontrolled diabetes, defined as a Hemoglobin A1c (HbA1c) >7.0% [38], can also lead to higher risk for disabling health complications, additional care requirements, and increases in healthcare cost [37, 39]. Diabetes self-management is a key factor for glycemic control, and an important component of self-management is taking oral hypoglycemic medications [40]. Non-adherence to oral hypoglycemic medications is associated with an uncontrolled Hemoglobin A1c (HbA1c) as well as other negative health outcomes [12]. In a systematic review of adherence to oral hypoglycemic medications, adherence ranged from 36% to 93%; among H/L, the average was 40% [41].

Measurement of Medication Adherence

One of the major limitations to understanding the complexities of medication adherence is measurement methods. Based on an extensive search, there does not appear to be one standard method of measuring medication adherence for researchers or health professionals [25, 42–46]. Direct measures of adherence can include direct observations of the behavior, drug assays of blood or urine, and use of drug markers [43] which can be costly, time consuming, and not practical [47]. However, the most common ways to measure medication adherence are indirect measures. The most widely used indirect measure is self-report, which requires individuals to recall and quantify adherence in various time periods (e.g., past 7 days or 30 days). Self-report measures can be extremely challenging due to over reporting and difficulty with measurement scales [44]. Similarly, pill counts are a common indirect method because of the low cost and simplicity; however pill counts have been found to overestimate adherence [43, 48].
Objective measures such as Medication Event Monitoring System (MEMS) known as “MEMS caps” have also been used to measure adherence, mostly among HIV-infected individuals, and few studies include H/Ls [13, 14]. Although considered the closest method to a “gold standard”, research shows there are limitations to using MEMS caps which include cost, excessive pill removal (i.e., pocket dosing), and cap failure [49, 50]. Other problems with using electronic pill monitors include incorrect use of pill bottles, interference with daily routines, and measurement effects [45, 51]. Based on a recent literature search, few studies using MEMS caps have been conducted with low-income racial/ethnic minority populations [15], and no studies were found to focus primarily on H/Ls.

Most recently, the use of health information technology (HIT) including electronic health and prescription records has been reported as an objective, noninvasive, promising strategy to measure medication adherence [45, 47, 52]. Medication prescriptions and refill data can be used to create medication possession ratios (MPR), as well as calculate the proportion of days covered (PDC) [53, 54]. Both methods have been used to assess adherence in clinic-based samples [55, 56] with PDC being the preferred method by the Pharmacy Quality Alliance [57]. Lastly, electronic health records can be useful by allowing for the use of medication prescription details and clinical data including lab results to assess control of conditions through lab values (e.g., total cholesterol, Hemoglobin A1c) as well patient health history and demographic profiles.

There is a gap in knowledge regarding the most effective way to measure medication adherence among H/Ls in the U.S. Most studies cited above included only small samples of H/Ls and the findings cannot be generalized to low-income H/Ls with multiple chronic conditions [13–15]. To effectively measure medication adherence and address barriers, researchers must identify the best methods to assess this critical behavior placing H/Ls and other racial and ethnic groups at risk for CVD.
Definitions of Medication Adherence

The most widely used definition of medication adherence is “the extent to which a person’s behavior (taking medication) corresponds with agreed upon recommendations from a health care provider” [25]. A more detailed definition is “medication adherence (synonym compliance) refers to the act of conforming to the recommendations made by the provider including timing, dosage, and frequency of medication taking.” [11]. Indicators of poor medication adherence can include failure to order, pickup, or refill medications in time to avoid coverage gaps, and failed persistence or abandonment of the regimen [27]. Researchers may also focus on medication persistence which refers to the act of continuing treatment for the prescribed duration [11]. This dissertation study will focus on medication adherence and will not examine abandonment or persistence.

Medication adherence cut-points are used in research studies, with arbitrary categories for good and poor adherence. Good adherence is commonly set at 80% or above in observational and randomized controlled clinical trials [11, 47], although skepticism exists about the cut-points as there are few medications for which a cut-point has been empirically studied [50]. One study aiming to identify the adherence value cut-off point that optimally stratifies good versus poor adherence using pharmacy refill data reports that optimal adherence values vary between 63% and 89% and determined that 80% is a reasonable cut-off for chronic conditions [58].

CONCEPTUAL FRAMEWORK

Taking medications as prescribed is a complex behavior. Most research regarding medication adherence focuses primarily on patient-related factors, which may not be effective. Evidence suggests that medication adherence is not only associated with patient-related factors; rather it involves different levels of the socio-ecological model [27, 59]. The socio-ecologic model allows for the review of medication adherence correlates at different levels of influence
including individual, interpersonal, community, and health system levels [60] and ties directly to the WHO’s Multidimensional Adherence Model. The WHO’s Multidimensional Adherence Model posits that adhering to prescribed medications is influenced by the interplay of five sets of factors. The factors include patient-related, social/economic-related, condition-related, therapy-related, and health system-related factors [25]. See Figure 1.1.

Figure 1.1. Conceptual Framework: Adapted WHO Multidimensional Adherence Model including factors and hypothesized associations to medication adherence.

Research has shown patient-related factors of poor medication adherence include age, gender, socio-economic status, and language preference [54, 61]. Other patient-related factors include lack of knowledge about prescribed medications and beliefs about medication use (e.g., perceived drug harm versus benefits) [62, 63], forgetfulness [64,65], and managing multiple medications [27, 66]. Social/economic factors include cost of medications[67], poor instruction
from primary care providers [68]. Other modifiable social/economic related-factors include limited health literacy, low social support, and lack of regular health care [59, 66]. In this regard, social support has been positively associated with medication taking behaviors [70, 71], while low levels have been associated with poorly controlled chronic conditions [64, 72–74]. Low health literacy is defined as one’s ability to understand, engage, and actively apply health information toward the goal of improving one’s health [20, 75]. An estimated 41% of H/L have lower basic health literacy skills [76] and limited health literacy is associated with low medication adherence [59, 75]. Having health insurance coverage is associated with better health outcomes. A study examining health care access, utilization, and outcomes for type 2 diabetes patients surveyed in the third National Health and Nutrition Examination Survey (NHANES) found that those having a usual source of care were more likely to have an HbA1c <7.0% [77]. However, evidence suggest that H/Ls have low rates of insurance, disparities in access to health care, and are less likely to have physician visits when compared to NHW [78].

Psychologic factors of low adherence include anxiety, depression, and stress. There are well-documented associations between anxiety and numerous chronic medical conditions [79–81]. Research suggests that comorbid anxiety can compromise self-management behaviors including medication adherence [79]. Depression is also associated with poor medication adherence [82–84]. Depression can cause negative mood states known to adversely influence medication adherence by lowering self-efficacy for self-management behaviors [85]. Similarly, stress can interfere with diabetes self-management through effects on self-care behaviors [61, 86, 87].

Health system and utilization-related factors play an important role in patient medication adherence. Patients demonstrate better adherence with ongoing regular care, and care from the same provider over time [88]. Furthermore, evidence suggest that despite importance of medication adherence, primary care providers may not be able to detect poor adherence [15, 89,
90]. Given the multilevel influences on medication adherence, research is needed to identify the strongest predictors of poor adherence among H/Ls with chronic conditions.

**AIMS & HYPOTHESES**

Based on the World Health Organization’s Multidimensional Adherence Model, the aims of this dissertation were to: 1) examine patient-, social/economic-, health condition-, therapy-, and health system and utilization-related correlates of poor medication adherence; and 2) identify ways to effectively measure medication adherence among Hispanic/Latinos.

In Chapter 2, the purpose of this study was to 1) assess statin medication adherence rates using the Medication Event Monitoring System (MEMS) and a self-report measure; 2) identify barriers associated with poor adherence; and 3) assess the relationship between medication adherence, total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C) levels.

**Hypothesis 1:** The majority of participants will demonstrate poor medication adherence to prescribed medications and MEMS measured medication adherence will be lower than the self-report medication adherence.

**Hypothesis 2:** Barriers to medication adherence including cost of medications, confusion related to polypharmacology, and feeling unsure of whether or why medications are necessary will be correlated with poor medication adherence.

**Hypothesis 3a:** Good medication adherence will predict lower levels of total cholesterol and low-density lipoprotein cholesterol.

**Hypothesis 3b.** Good medication adherence will predict desirable to borderline high total cholesterol levels and meeting low-density lipoprotein cholesterol treatment goals.

In Chapter 3, the purpose of the study was to identify modifiable health condition-, and social/economic-related factors to low adherence and to examine sex differences among Hispanic/Latinos with Type 2 diabetes.
Hypothesis 1: Health condition-related factors including higher depression symptomatology and perceived stress will be the strongest predictors of poor adherence to prescribed medications for women in the study.

Hypothesis 2: Social/economic-related factors including low health literacy and low social support will be the strongest predictors of poor medication adherence to prescribed medications for men in the study.

In Chapter 4, the objective of this study is to employ the Multidimensional Adherence Model to identify patient-, health condition-, social/economic-, therapy- and health system-related factors of poor adherence among low-income Hispanic/Latinos prescribed statins.

Hypothesis 1: Older participants will demonstrate lower medication adherence compared to younger participants.

Hypothesis 2: Managing more than one medication prescription will predict poor adherence among study participants.

Hypothesis 3: Health system-related factors will be the strongest predictors of poor adherence compared to other predictors.
REFERENCES


estimates and general information on diabetes and prediabetes in the United States. US Department of Health and Human Services. Atlanta, GA.


CHAPTER 2

STATIN MEDICATION ADHERENCE AND BARRIERS AMONG HISPANIC/LATINO ADULTS USING MEDICATION EVENT MONITORING SYSTEM CAPS

ABSTRACT

Objective: Medication adherence is a crucial behavior for managing and controlling chronic health conditions. Despite the proven benefits of lipid-lowering medications for the prevention of cardiovascular disease and stroke, there are few studies that focus on the use of these medications among Hispanic/Latinos. Of the few studies, even less have used objective measures of medication adherence. The aims of this study were to 1) assess statin medication adherence rates using the Medication Event Monitoring System (MEMS) and a self-report measure; 2) identify barriers associated with poor adherence; and 3) assess the relationship between medication adherence, total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C) levels.

Methods: Self-report, objective measures of adherence, and clinical data from 149 Hispanic/Latino adults were utilized for cross-sectional analyses. Fisher’s Exact test were used to determine the association between barriers to medication adherence, MEMS objectively measured adherence, and the self-report adherence measure. Differences between TC, LDL-C levels and MEMS measured adherence were assessed using one way analyses of variance (ANOVA). In a subsample of 81 participants, adjusted logistic regression analysis examined the associations between good adherence, and both TC classification and meeting LDL-C treatment goals.

Results: According to MEMS, only 40% of the 149 participants demonstrated good adherence (taking more than 80% of medications as prescribed) to prescribed statin medications.
Forgetting, multiple medication prescriptions, and concern about long term side effects were three of ten barriers significantly associated with poor adherence ($p < 0.05$). There were no statistically significant differences in mean TC between the two groups of adherence [$F (1,147) = 1.03, p = 0.31$] and mean LDL-C did not differ between the two groups of adherence [$F (1,147) = 0.75, p = 0.38$]. Similarly, MEMS good adherence was not statistically significantly associated with desirable (OR = 1.51, 95% CI = 0.91-1.09) or borderline high (OR = 0.73, 95% CI = 0.91-1.12) cholesterol levels or meeting LDL-C treatment goals (OR 2.07, 95% CI = 0.98-1.12).

**Conclusions:** The study findings demonstrate low levels of medication adherence among Hispanic/Latino adults prescribed statins. The low number of barriers reported warrants further research to identify barriers experienced by this population. Although not significant, the results are suggestive for lower levels of TC and LDL-C with better adherence. Future research with large sample is needed to test this trend.

**Key words:** Medication adherence, Hispanics/Latinos, Medication Event Monitoring System, Statins
INTRODUCTION

According to the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), the overall prevalence of hypercholesterolemia among Hispanic/Latino (H/L) adults was 52% among men, and 37% among women [1]. The HCHS/SOL also reported on the rates of hypertension, diabetes and obesity. For men and women, these values were: 26.1% and 25.3% for hypertension, 16.7% and 17.2% for diabetes, and 36.5% and 42.6% for obesity [1–3]. Further, the HCHS/SOL highlights the poor control of these conditions; only 37.5% of HCHS/SOL participants had controlled hypertension [4] 48% demonstrated diabetes control [5], and 64.3% had optimal levels of total cholesterol (TC) [6]. Given the prevalence of CVD risk factors, poor control of these conditions among H/Ls, and the growing size of the H/L population in the U.S.[7], there is a need to better understand the determinants of medication adherence in this population.

Medication adherence is often measured via self-report, using various time periods (e.g. past 7 or 30 days) leaving room for error due to recall bias [30]. For example, self-report measures of adherence, widely used in both trials and clinical practice, have been shown to produce higher adherence estimates than MEMS, as people over report good adherence [31]. Currently, the closest method to a “gold standard” is the use of electronic monitoring through wireless MEMS electronic pill-bottle caps which record the time and day and frequency of cap openings. While objective pill bottles caps show promise, they are also prone to measurement error due to incorrect use [15, 19, 32] such as taking out more than one dose at a time, or before expected (pocket dosing) [31]. Of the studies that have used MEMS, few have used them to examine adherence to statin medication among H/Ls. Therefore, the aims of the study were to: 1) assess statin medication adherence using MEMS and a self-report measure; 2) identify barriers associated to poor adherence; and 3) assess the relationship between medication adherence, levels of TC and LDL-C among H/L adults.
METHODS

Research Setting

Data for these analyses were collected as part of a clinical trial titled Latinos Understanding the Need for Adherence (LUNA), conducted in a primary care setting between 2010 and 2013. LUNA was funded by the National Institute on Minority Health and Health Disparities (NIMHD). The LUNA study was a collaboration between the Institute of Behavioral and Community Health (IBACH) at San Diego State University (SDSU) and San Ysidro Health Center, Inc. (SYHC), a federally qualified health center (FQHC) in San Diego County, California. SYHC has 12 medical facilities and serves over 90,000 patients annually. The majority of SYHC patients are of H/L ethnicity, low-income, and primarily Spanish-speaking [33]. SYHC is located in the southernmost region of San Diego County, near the U.S./Mexico border entrance to Tijuana, Baja California, Mexico.

Sample

In this cross-sectional study, we assessed medication adherence using baseline data from 149 H/L adults selected from a larger sample of 508 participants enrolled in the LUNA study. Participants were recruited from a pool of H/L adults receiving services at two SYHC ambulatory medical facilities. Recruitment began in September 2010 and ended August 2013. H/L adults were eligible to participate if they were registered as patients of SYHC, had physician approval, self-identified as Hispanic/Latino, were 40 years of age or older, had one or more traditional cardiovascular (CVD) risk factors (i.e. hypertension, diabetes, high LDL-C, low high-density lipoprotein [HDL-C] cholesterol, overweight or obese, current cigarette smoking), agreed to participate in MEMS monitoring, had a prescription for statin medications, and not enrolled in any other CVD program. Exclusion criteria included the presence of disabilities or severe cognitive impairment to prohibit informed consent or participation in the study, pregnancy or
plans to get pregnant in the next twelve months, and lack of medical insurance at the time of enrollment.

Of the 508 participants enrolled, only 282 (55%) agreed to participate in the MEMS component and, of those, only 157 (55%) were using statins, and only 149 had complete MEMS data and were included in the analyses. Clinical indicators and lab values were extracted from SYHC medical health records. Approval was obtained from the Institutional Review Boards at SDSU and SYHC before the start of participant recruitment.

Measures

Baseline assessments took place at the South Bay Latino Research Center (SBLRC). Bilingual, trained research staff administered informed consent and self-report surveys, and instructed participants on the use of MEMS.

Dependent Variables

Objective Measure of Medication Adherence. Medication Event Monitoring System (MEMS® Version 6, Aardex Ltd., Switzerland) was used to measure medication adherence. MEMS employs a pressure-activated microprocessor in the medication bottle cap that automatically notes the time of bottle opening, calculates the duration that a bottle remained open and reports the data [34]. MEMS bottles were filled by pharmacist at SYHC and distributed to participants to assess adherence to statin medications (dosage 1 per day). The date and time of each bottle cap opening was recorded for an average 120-day period, and data was exported into SPSS by a trained staff member. MEMS data were used two create two variables: 1) Prescribed number of doses taken, as a continuous variable (range 0.00-1.00); and 2) MEMS good adherence, a dichotomous variable with participant taking medications 0-79% of the time = No (0) and participants taking ≥80% of medications as prescribed = Yes (1). This cut point was chosen based on similar studies [9, 12].
**Self-report Measure of Medication Adherence.** The *Adherence and Intensification of Medications Scale (AIMS 14-items)* was used to assess self-reported medication adherence and barriers. AIMS items were developed for a cluster randomized controlled effectiveness study [35]. Self-reported medication adherence over a one-week period was assessed with items 1-4, the items ask about insulin, hypertension, diabetes, and cholesterol medications. Only the item on adherence to cholesterol medications was used for this study. The item asks, “*In a typical week, how many days do you miss a prescribed dose of your cholesterol medications?*” and response options range from Never/0 days (0) to Very often/6-7 days (4). The data was used to create a dichotomize variable, AIMS good adherence, a score of 0 = Yes (1), and a score of 1-4 (Rarely to very Often) = No (0) as categorized in similar studies [24].

**Clinical indicators.** SYHC electronic health records were used to abstract fasting lipid values performed within three months of baseline assessment by reference laboratories LabCorp and Quest Diagnostics. Multiple imputation (MI) was used for TC and LDL-C after verifying missing data were missing at random [36]. Five imputations were conducted, and data from multiple complete datasets were averaged for analyses. For descriptive purposes, TC and LDL-C were reported as continuous values. To assess relationship with the two adherence measures, TC < 200 mg/dL was recoded to desirable (0), 200-239 mg/dL to borderline high (1), and ≥240 mg/dL was recoded to high cholesterol (2). For use in the sub-analyses, LDL-C was recoded as a dichotomous variable, meeting LDL-C treatment goals (range <100-160 mg/dL) (0), and not meeting LDL cholesterol treatment goals (1). The LDL-C goal classification was calculated based on the presence of risk factors recommended by the NCEP treatment guidelines computed prior to analysis [37].

**Predictors**

**Barriers to Medication Adherence.** Ten questions from the AIMS study were used to assess recent patient-related barriers to medication adherence. The questions asked, “*In past 3
months, to what extent has [cost, difficulties besides cost, side effects, not knowing how to take medications, multiple prescriptions, not understanding primary care provider, forgetting, concerns about long-term prescriptions, concern about long term side effects] kept you from taking your medications as prescribed?” Response options ranged from Did not at all keep me from taking these medications as prescribed (0) to Very often kept me from taking these medications as prescribed (4). To assess relationship between barriers and medication adherence measures, the answer options were recoded to Never (0), and Experienced barrier (1).

Covariates

Demographic Characteristics. Items include questions on age, gender, country of birth, years of residence in the U.S., language preference, education, employment, marital status, and income. Other items include number of diagnosed CVD risk factors including type 1 or 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 less than 40 mg/dL), obese (BMI greater than 30.0), and current smoker. Chart abstractions were conducted for all diagnoses, except for smoking (participants were asked if they were a current smoker).

Depressive Symptomatology. Depressive symptoms were assessed by using the Personal Health Questionnaire 8 (PHQ-8). The PHQ-8 is used to assess recent depression symptomatology over a two-week period. The Spanish version has been proven effective as a measure for depressive symptoms among H/Ls (α 0.86) [38]. The PHQ-8 includes eight of the nine criteria on which the DSM-IV diagnoses of depression and excludes the ninth item that assesses suicidal thoughts. Response ranged from Not at all (0) to Nearly every day (3) with 0 to 3 points assigned to each answer option. A sum score is calculated with a range between 0 and 24. Depression symptomatology was reported as continuous for descriptive purposes.
Statistical analyses

Participant characteristics were summarized using descriptive statistics including means and standard deviations or frequency distributions. Bivariate analysis was conducted to test which demographic variables (including number of CVD risk and depressive symptomatology) were significantly associated with the either of the two medication adherence measures (MEMS or AIMS) as well TC and LDL-C. Only age was significantly correlated with TC and tested as a covariate. Fisher’s Exact test was used to determine the association between recent barriers to medication adherence with MEMS good adherence, as well as with AIMS good adherence. Differences between mean TC and mean LDL-C based on MEMS good adherence were assessed using one-way analysis of variance (ANOVA) test. In a subsample analysis of 81 participants (with complete cholesterol data including High-density lipoprotein [HDL] cholesterol and Triglycerides), two logistic regression models were used to test the association between good medication adherence measured by MEMS and TC classification (desirable, borderline high, high), and meeting LDL-C treatment goals (yes or no) adjusted for age. All statistical analyses were performed using IBM Statistical Package for the Social Sciences (SPSS) Statistics version 24.

RESULTS

Sample Characteristics

Sample demographic characteristics for 149 participants are displayed in Table 2.1. Participants ranged in age from 40 to 86 years ($M = 62.5$ years, $SD = 9.3$). Most participants were female (71.1%), born in Mexico (91.1%), and preferred to speak Spanish (98.0%). Just less than 44% had an elementary/primary education and 15.5% completed high school. The majority were unable to work or retired (59.6%), with only 14.4% of participants employed for wages.
Table 2.2 includes clinical characteristics and medication adherence. The mean number of CVD risk factors was 3 ($SD = 0.8$), the mean TC was 180.7 mg/dL ($SD = 40.1$), and the mean LDL-C was 99.7 mg/dL ($SD = 32.4$). The mean MEMS prescribed doses taken was 60.8% ($SD = 40.2$), with only 40.9% of participants demonstrating good adherence (≥80% of doses taken as prescribed). Self-reported medication adherence varied, with 51.4% of participants reported having good adherence (never missing a dose in the last 7 days) and only 3.0% reported missing doses very often (6-7 days).

**Bivariate Associations**

Table 2.3 shows the association between patient-related barriers to adherence, MEMS good adherence, and AIMS good adherence. The relationship between barriers related to multiple medication prescriptions and MEMS good adherence was significant ($p = 0.02$, Fisher’s exact test). Participants who experienced barriers related to multiple medications were more likely to demonstrate poor adherence (12.5%) than good adherence (1.6%). No other barriers were associated with MEMS good adherence. The relationship between forgetting and AIMS good adherence was significant ($p = 0.01$, Fisher’s exact test). A greater percentage of participants who reported barriers related to forgetting demonstrated good adherence (29.2%) compared to poor adherence (7.2%). The relationship between concern about long term side effects of medications and AIMS adherence was also significant ($p = 0.02$, Fisher’s exact test).

Tables 2.4 shows results from the ANOVA tests used to assess differences in TC and LDL-C cholesterol levels based on MEMS good adherence. Participants were divided into two groups based on adherence (good adherence = No [0]; good adherence = Yes [1]). There were no statistically significant differences in mean TC between the two groups of adherence $F (1,147) = 1.03, p = 0.31$. Similarly, mean LDL-C did not differ between the two groups of adherence $F (1,147) = 0.75, p = 0.38$. 


Regression Analysis

In the subsample regression analysis (Table 2.5.), MEMS good adherence did not statistically significantly predict desirable (OR = 1.51, 95% CI = 0.91-1.09) or borderline high (OR = 0.73, 95% CI = 0.91-1.12) cholesterol, as well as meeting LDL-C treatment goals (OR 2.07, 95% CI = 0.98-1.12).

DISCUSSION

Although most participants reported never or rarely missing a dose of cholesterol medications, only 40% of study participants demonstrated good adherence based on objective (MEMS) monitoring. Participant understanding of instructions and beliefs about the need for medication (e.g., only taking medication when feeling symptoms) may lead to misperceptions about good adherence. For example, other studies have found that participants who believe their condition is under control do not think they have to take their medications, and this may influence over reporting of good adherence [39, 40].

Few participants reported barriers to medication adherence. We hypothesized that cost of medications, confusion related to polypharmacology, and feeling unsure of whether or why medications are necessary would associated with poor adherence. Our hypothesis was partially supported in that there was a significant association between experiencing barriers related to multiple medications and poor adherence. The most common barrier was forgetting to take medications, followed by concern about long term side effects of medications. Contrary to what would be expected, forgetting and concern about long term side effects was positively associated with good adherence, compared to poor adherence. Although no significant associations were found, participants forgetting to take their medications were more likely to demonstrate poor adherence based on MEMS monitoring. This inconsistent finding warrants further research. It may be that participants were not comfortable disclosing their barriers and poor adherence.
Based on the low number of barriers reported and poor medication adherence displayed, the AIMS questionnaire may not be a sensitive and specific measure of barriers in this population.

The baseline MEMS medication adherence rate is consistent with the medication adherence rates of similar studies with the same measure [11, 23]. Similarly, the AIMS self-reported medication adherence findings are similar to those of other studies that have shown that participants over report medication adherence [19, 39, 41]. In terms of clinical characteristics, study findings are inconsistent from other studies where MEMS adherence was associated with controlled cholesterol [42]. In this study MEMS good adherence was not associated with lower levels of TC or LDL-C. Based on low levels of TC and LDL-C observed, participants may have not been taking their medications because of lack of symptomology and having their cholesterol levels under control, which has been reported in other studies [43, 44].

As seen in this study, self-reported adherence and MEMS adherence varied significantly, with participants over reporting good adherence. This finding points to the need include other medication adherence measures to triangulate findings. A promising method is Ecological momentary assessment (EMA). EMA has been shown to be reliable and valid for measuring medication adherence among pediatric populations [45], as well HIV/AIDS medication adherence studies [46]. The use of EMA should be tested with this population, as it may be an effective way to conduct real-time assessment of medication taking behaviors among H/L adults, as well capture the context in which the behavior occurs.

**Strengths and Limitations**

The strengths of this study include the study population, which was entirely of Hispanic/Latino heritage. This study utilized MEMS for the assessment of medication adherence, which is considered the “gold standard” for medication adherence measurement. Further, this
study contributes to the literature about inconsistencies between MEMS and self-report adherence measures.

The study has several limitations. First, this study was a cross-sectional study of a larger randomized controlled trial, participants included in the analyses self-selected to enroll in the MEMS component of the study. Second, using MEMS may have influenced medication adherence, as participants knew their medication taking behaviors were being monitored. Third, the AIMS self-report medication adherence measure consisted of only one item on taking cholesterol medications. The other items in the scale inquired about medications for other chronic conditions, and the majority focused on barriers to medication adherence.

**Conclusion**

In conclusion, study findings show the low levels of medication adherence among Hispanic/Latino adults prescribed statins and that prescriptions for multiple medications, forgetting, and concern about long term effects were the most common patient-related barriers associated with medication adherence. The barriers can be addressed in a clinical setting through physician and/or pharmacist counseling, as well through intervention research tailored to teach participants effective behavioral strategies to overcome barriers. Future research should examine barriers to medication adherence at different levels of the socio-ecologic framework given that the patient-related barriers tested may not have been appropriate for this population. Lastly, intervention research should test other strategies such as EMA to ensure accurate measurement of adherence to effectively address barriers and improve health outcomes.
ACKNOWLEDGMENTS

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Chapter 2 is currently being prepared for submission to The Journal of Primary Care and Community Health. Sheila F. Castañeda, Matthew A. Allison, John P. Elder, Bess H. Marcus, and Gregory A. Talavera are co-authors.
### Table 2.1. Sample demographic characteristics, N=149

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>(N= 149)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (range 40-86)</td>
<td>62.5 (9.3)</td>
<td></td>
</tr>
<tr>
<td>Years in the U.S</td>
<td>28.8 (14.9)</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>71.1 (106)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>28.9 (43)</td>
<td></td>
</tr>
<tr>
<td>Country of birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>91.1 (133)</td>
<td></td>
</tr>
<tr>
<td>U.S. born</td>
<td>8.9 (13)</td>
<td></td>
</tr>
<tr>
<td>Preferred language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>98.0 (146)</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>2.0 (3)</td>
<td></td>
</tr>
<tr>
<td>Highest level of education</td>
<td></td>
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</tr>
<tr>
<td>Elementary/primary</td>
<td>43.7 (62)</td>
<td></td>
</tr>
<tr>
<td>Middle school/secondary</td>
<td>21.8 (31)</td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>15.5 (22)</td>
<td></td>
</tr>
<tr>
<td>Vocational/GED/college</td>
<td>19.0 (27)</td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed for wages</td>
<td>14.4 (21)</td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>13.0 (19)</td>
<td></td>
</tr>
<tr>
<td>Homemaker</td>
<td>13.0 (19)</td>
<td></td>
</tr>
<tr>
<td>Retired/Unable to work</td>
<td>59.6 (87)</td>
<td></td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single/Never married</td>
<td>9.5 (14)</td>
<td></td>
</tr>
<tr>
<td>Married/Living with partner</td>
<td>48.3 (71)</td>
<td></td>
</tr>
<tr>
<td>Divorced/Widowed/Separated</td>
<td>42.2 (62)</td>
<td></td>
</tr>
<tr>
<td>Household income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$10,000</td>
<td>35.3 (49)</td>
<td></td>
</tr>
<tr>
<td>$10,001-$20,000</td>
<td>46.0 (64)</td>
<td></td>
</tr>
<tr>
<td>&gt;$20,000-$29,999</td>
<td>12.9 (18)</td>
<td></td>
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<tr>
<td>&gt;$30,000</td>
<td>5.8 (8)</td>
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Table 2.2. Clinical Characteristics and Medication Adherence, N=149

<table>
<thead>
<tr>
<th>Clinical Characteristics</th>
<th>Mean, Standard Deviation (M, SD) (N= 149)</th>
</tr>
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<tbody>
<tr>
<td>Total cholesterol (mg/dL)</td>
<td>180.7 (40.1)</td>
</tr>
<tr>
<td>LDL-C&lt;sup&gt;a&lt;/sup&gt; cholesterol (mg/dL)</td>
<td>99.7 (32.4)</td>
</tr>
<tr>
<td>CVD risk factors</td>
<td>3.0 (0.08)</td>
</tr>
<tr>
<td>Depressive symptomatology&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.1 (5.1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medication Adherence</th>
<th>Percent (n) (N=149)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEMS&lt;sup&gt;c&lt;/sup&gt; measured adherence</td>
<td></td>
</tr>
<tr>
<td>Prescribed doses taken (M, SD)</td>
<td>60.8 (40.2)</td>
</tr>
<tr>
<td>≥80% good adherence</td>
<td>40.9 (61)</td>
</tr>
<tr>
<td>&lt;80% poor adherence</td>
<td>59.1 (88)</td>
</tr>
<tr>
<td>Self-reported adherence&lt;sup&gt;d&lt;/sup&gt; (Valid N = 134)</td>
<td></td>
</tr>
<tr>
<td>Never (0 days)</td>
<td>51.5 (69)</td>
</tr>
<tr>
<td>Rarely (1 day)</td>
<td>35.8 (48)</td>
</tr>
<tr>
<td>Sometimes (2-3 days)</td>
<td>9.0 (12)</td>
</tr>
<tr>
<td>Often (4-5 days)</td>
<td>0.7 (1)</td>
</tr>
<tr>
<td>Very often (6-7 days)</td>
<td>3.0 (4)</td>
</tr>
</tbody>
</table>

<sup>a</sup>LDL-C, Low-density lipoprotein cholesterol

<sup>b</sup>Patient Health Questionnaire on Depressive symptomatology; range 0-24, higher risk for depression

<sup>c</sup>MEMS, Medication Event Monitoring System

<sup>d</sup>Self-reported adherence missed dose in last 7 days
Table 2.3. Association between patient-related perceived barriers to adherence, objective MEMS good adherence, and self-reported good adherence

<table>
<thead>
<tr>
<th>Barriers experienced in past three months</th>
<th>Objective Measure Good Adherence (≥ 0.80) (N=149)</th>
<th>Self-Report Measure Good Adherence (6-7 days) (N=134)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (N)</td>
<td>Yes (N)</td>
</tr>
<tr>
<td>Cost</td>
<td>3.4 (3)</td>
<td>8.2 (5)</td>
</tr>
<tr>
<td>Difficulties accessing medications</td>
<td>10.2 (9)</td>
<td>4.9 (3)</td>
</tr>
<tr>
<td>Side effects</td>
<td>3.4 (3)</td>
<td>4.9 (3)</td>
</tr>
<tr>
<td>Not enough knowledge about medication</td>
<td>3.4 (3)</td>
<td>3.3 (2)</td>
</tr>
<tr>
<td>Multiple medication prescriptions</td>
<td>12.5 (11)</td>
<td>1.6 (1)</td>
</tr>
<tr>
<td>No explanation from primary care provider</td>
<td>2.3 (2)</td>
<td>0</td>
</tr>
<tr>
<td>Unsure about benefits</td>
<td>5.7 (5)</td>
<td>1.6 (1)</td>
</tr>
<tr>
<td>Forgetting</td>
<td>23.9 (21)</td>
<td>11.5 (7)</td>
</tr>
<tr>
<td>Concern about taking medications</td>
<td>12.5 (11)</td>
<td>3.3 (2)</td>
</tr>
<tr>
<td>Concern about long term effects of medication</td>
<td>11.4 (10)</td>
<td>6.6 (4)</td>
</tr>
</tbody>
</table>

Fisher’s Exact Test
^ Approaching significance p <0.10; *p <0.05 ** p < .01
Table 2.4. ANOVA for MEMS Medication Adherence and Total Cholesterol and LDL-C, N=149

<table>
<thead>
<tr>
<th>Dependent variable: Total Cholesterol</th>
<th>DF</th>
<th>F</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>1</td>
<td>1.02</td>
<td>0.31</td>
</tr>
<tr>
<td>Within</td>
<td>147</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent variable: LDL-C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>1</td>
<td>0.75</td>
<td>0.38</td>
</tr>
<tr>
<td>Within</td>
<td>147</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*<sup>p</sup><0.05

Note: Good adherence = Yes: Mean Total Cholesterol = 176.74 mg/dL
       Good adherence = No:  Mean Total Cholesterol = 183.52 mg/dL
       Good adherence = Yes: Mean LDL-C = 96.97 mg/dL
       Good adherence = No:  Mean LDL-C = 101.65 mg/dL
Table 2.5. Logistic regression for age, and MEMS good adherence and total cholesterol classification and meeting LDL-C treatment goals, N=81

<table>
<thead>
<tr>
<th>Total Cholesterol Classification&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Meeting LDL-C treatment goals&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirable (&lt; 200 mg/dL)</td>
<td></td>
</tr>
<tr>
<td>OR (95% CI)</td>
<td>P-value</td>
</tr>
<tr>
<td>Age</td>
<td>0.00 (0.91-1.09)</td>
</tr>
<tr>
<td>MEMS Good Adherence</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.00 Ref</td>
</tr>
<tr>
<td>Yes</td>
<td>1.51 (0.06-1.93)</td>
</tr>
</tbody>
</table>

OR= Odds Ratios, CI= Confidence Interval
* p<.05; **p<.01

<sup>a</sup> Model 1: Reference category: High total cholesterol classification (≥ 240 mg/dL)
  Chi-square model fit 6.37 (df = 4, p = .173)

<sup>b</sup> Model 2: Reference category: Not meeting LDL-C treatment goals
  Goodness of Fit \( \chi^2 \) 14.58 (df = 8, p = .068)
REFERENCES


CHAPTER 3

CORRELATES OF LOW-ADHERENCE TO ORAL HYPOGLYCEMIC MEDICATIONS
AMONG HISPANIC/LATINOS WITH TYPE 2 DIABETES

ABSTRACT

**Background:** Hispanic/Latino adults have disproportionately high rates of uncontrolled diabetes which may be explained by low medication adherence.

**Purpose:** To identify modifiable health conditions and social/economic factors related to low medication adherence and to examine sex differences among Hispanics/Latinos adults with Type 2 diabetes.

**Methods:** Cross-sectional analyses of self-report and electronic health record data for 279 Hispanic/Latino adults who completed baseline assessments for a randomized controlled trial. Bivariate analyses tested the association of demographic, health conditions (depression, anxiety, and stress) and social/economic factors (type of insurance, health literacy, social support) and different medication adherence levels (low, medium, and high). Adjusted logistic regression analyses examined associations between modifiable health condition- and social/economic-related factors and low medication adherence stratified by sex.

**Results:** More males than females reported low adherence to hypoglycemic medications (54.8% vs. 46.9%) \(p < .05\). Similarly, the Proportion of Days Covered (PDC) method showed that a greater percentage of men demonstrated low adherence (Males 75% and Females 70%) although differences were not significant. Bivariate analyses revealed significant differences between levels of social support, depressive symptomatology, anxiety disorder, perceived stress and medication adherence \(p < .05\). In logistic regression analyses, social support predicted low medication adherence \(OR = 2.22; 1.03-4.76\) among males, but not among females \(OR = 1.15; 0.64-2.08\). Although no differences were observed in bivariate analysis, the odds of low
adherence were 6.26 higher among males with limited health literacy compared to males with adequate health literacy (OR = 6.26; 1.06-37.10). Health literacy did not predict low adherence for females (OR = 1.35 (0.38-4.77). Other variables of interest including depression symptomatology, anxiety disorders symptomatology, and perceived stress did not predict low adherence among the study population.

**Conclusion:** Approximately 50% of Hispanic/Latino adults are not adherent to their hypoglycemic regimen. A couple of psychosocial predictors of low medication adherence were significantly predictive of medication adherence in men, but not women. Therefore, interventions should target health literacy to improve medication taking behaviors among H/L adult males.

**Keywords:** Hispanic/Latino, Type 2 Diabetes, Glycemic control, Morisky Medication Adherence Scale, Proportion of Days Covered
INTRODUCTION

Hispanic/Latinos (H/L) are disproportionately affected by Type 2 diabetes compared with other racial/ethnic minority groups [1, 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, 4]. To prevent health complications, individuals with diabetes must maintain glycemic control (Hemoglobin A1c < 7.0%) [5–7]. H/L adults experience lower rates of glycemic control due to complex barriers related to diabetes self-management (e.g. diet and physical activity) [8, 9], and a key factor being low medication adherence) [10, 11].

Low adherence to oral hypoglycemic medications is associated with higher levels of HbA1c as well, as all-cause hospitalizations and increased all-cause mortality [12, 13]. Among H/L adults, studies suggest that medication adherence ranges from 40% to 73%, and compared to other racial/ethnic groups, H/L have the lowest medication adherence levels [14–17]. Multiple factors across different levels of the socio-ecologic framework [18] may be used to understand H/L adults’ low adherence to prescribed medications. Modifiable condition-related factors of low adherence include anxiety [19–21], depression [22–25] and stress [26–28]. Modifiable social/economic related-factors such as limited health literacy [29–31], low social support [32–34], and lack of regular health care [31, 35, 36]. Sex differences in diabetes self-management behaviors [37, 38], including medication adherence, exist [38–40]. Women experience higher rates of modifiable health conditions (e.g. depression, stress) [41–43]. However, more research is needed to identify sex specific factors correlated with low adherence among H/L.

Based on the growing size of the H/L population in the U.S. [44], projected increases in diabetes prevalence [2], and disproportionate rates of uncontrolled diabetes among this population [45], there is a need for a better understanding of modifiable health condition- and social/economic-related correlates of low adherence to prescribed medications. To date, few
studies have focused on adherence to diabetes medications among H/L adults. Therefore, the purpose of this study was to identify modifiable health condition-, and social/economic-related factors of low adherence, and to examine sex differences among Hispanic/Latinos with Type 2 diabetes.

METHODS

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 is an ongoing randomized trial of a behavioral intervention using the integrated model of care [46] combined with group health promotion compared to usual care provided at the San Ysidro Health Center, Inc. (SYHC). The study was approved by the Institutional Review Board at San Diego State University and SYHC, and participants provided written informed consent.

Participants

The recruitment sampling frame included a query of the electronic health records of all Hispanic/Latino adults with a diagnosis of Type 2 diabetes (N=2,383). A limited number of physician referrals to the project were also included. Eligible patients with diabetes were then contacted by phone to describe the study and explore interest in participation. Eligibility criteria included self-identified as H/L, ≥18 years of age, registered patient of SYHC, 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, or current smoker, depression/anxiety). 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 visit at the South Bay Latino Research Center.
Bilingual research staff obtained informed consent, administered a baseline self-report survey in the participants preferred language (English or Spanish) and performed physical measurements. For these analyses, the sample included participants who were enrolled between July 2014 and December 2016.

**Measures**

*Primary Outcome of Medication Adherence*

**Self-report measure of Medication Adherence.** The 8-item *Morisky Medication Adherence Scale (MMAS)* was used to assess medication taking behaviors such as forgetting or stopping medications due to side effects [47]. Response options for items 1-7 are yes (1) or no (0), and one question is reverse-coded. Item 8 uses a five-point Likert scale ranging from never/rarely to all the time. A sum score is calculated adding the values from all the items, and categories are coded as optimal/high adherence (score of 8), medium adherence (score of 6 or 7), and low adherence (score of ≤5). Both English (α = 0.83) [48] and Spanish (α = 0.77) [49] versions have demonstrated good reliability.

**Objective measure of Medication Adherence.** *Proportion of Days Covered (PDC)* was calculated from prescription refill data extracted from electronic health records (EHR) at SYHC. PDC was calculated as the sum of the days covered (based on fill date and days' supply) divided by days monitored [50, 51]. PDC can range from 0.00 to 1.00 (medication was available each day of the study period). PDC was calculated for oral hypoglycemic medications for a 24-month period prior to enrolling in the study. A continuous score was reported in Table 1, and a categorical PDC variable including three levels: low adherence (≤ 0.50), medium adherence (0.50-0.79), and high adherence (PDC ≥ 0.80) was used in regression models.
**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 include not at all/0-1 day (0 points) to nearly every day/12 to 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) [52] and Spanish (α 0.84) [53] versions are valid and reliable measures of depressive symptomology among H/Ls. The **Generalized Anxiety Disorder Questionnaire (GAD-7)**, was used to assess anxiety disorder symptomatology [54]. 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) [54]. The GAD-7 English (α 0.92) [55] and Spanish (α 0.88) [56] 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 [26]. 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) [26] and Spanish (α = 0.81) [57]. 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.

**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 [58]. 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 ($\alpha = 0.82$) [58] and Spanish ($\alpha = 0.78$) [59] 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 [60]. 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 [61]. 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.

**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 SYHC electronic medical 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 less than 40 mm/dL), obesity classification (BMI greater than 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, any 4 only). All laboratory assessments were performed by SYHC’s reference laboratories, either LabCorp and 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 at SYHC.

**Statistical Analyses**

Descriptive 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, health condition- and social/economic-related factors and the two medication adherence measures (MMAS and PDC) (Table 3). Demographic variables associated (p < 0.05) with either medication adherence measure were included as covariates in logistic regression models. In logistic regression models, the sample was stratified by sex based on differences observed in bivariate analysis and to test specific proposed hypotheses. Adjusted logistic regression models were used to test the association between health condition-related factors (depression symptomatology, anxiety disorder symptomatology, and perceived stress), and social/economic-related factors (type of insurance, social support, and health literacy) and medication adherence. Although health literacy was not significantly associated in bivariate analysis, it was included in the regression analysis based on previous research findings. A total of four models were tested: model 1 for females using MMAS, model 2 for females using PDC, model 3 for males using MMAS, and model 4 for males using PDC. Overall fit of the logistic regression models was assessed by the Chi-square Goodness of Fit Test [62]. If the model Chi-square p-values was < 0.05, then the model was considered a good fit for the observed values. Statistical analyses were performed using SAS (Version 9.4).
RESULTS

Demographic characteristics

A total of 279 participants were included in the analyses. Table 3.1 includes 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%), female (63.6%), born outside the U.S. with more than 10 years of residence in the U.S. (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 mean number of CVD risk factors was 2.1 (SD=1.1), and the mean number of prescribed medications was 3.6 (SD=0.7). At baseline, the mean HbA1c was 8.5 (SD=1.8).

Table 3.2 includes socioeconomic-, health condition-related factors, and medication adherence scores stratified by sex. The majority (72%) of participants were enrolled in a public health insurance, and only 1.8% (n=5) had private insurance. Women were more likely to have public insurance (76.0%) compared to men (65.4%). Almost all participants (92.0%) demonstrated limited health literacy. The mean social support score was 3.1 (SD=0.6) indicating participants perceived they receive a moderate amount of social support for managing their chronic conditions. The mean depressive symptomology score was 5.9 (SD=4.7) for the overall sample. Females displayed higher levels of depressive symptomatology than males (Mean [M] 6.4 [SD=5.0] vs. 5.1 [SD=4.1]). This similar trend was observed for anxiety disorder and perceived stress.

Almost half (49.8%) of participants self-reported low adherence, 21.5% medium adherence, and 28.7% high adherence. Males reported higher levels of low adherence (54.8%) compared to females (46.9%). 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 (PDC 75.0% / MMAS 54.8%) than females (PDC 70.3% / MMAS 46.9%) were categorized with low adherence as measured by both adherence measures.

**Bivariate Analyses**

Table 3.3. shows results of bivariate chi-square analyses and one-way ANOVA tests to determine which factor were significantly associated with low, medium, and high adherence as measured by PDC and MMAS. Significant bivariate relationships existed between sex and MMAS reported adherence [$\chi^2 (2, 279) = 6.35 (p = .04)$]; age and PDC measured adherence [$\chi^2 (2, 279) = 4.89 (p = .08)$]; U.S. born and PDC measured adherence [$\chi^2 (4, 273) = 11.60 (p = .02)$]. Age and U.S. born were included as covariates in logistic regression analyses.

There was a significant bivariate relationship between social support and PDC adherence [F(2,279) = 2.56, p=.01]; and the relationship between social support and MMAS adherence approached significance [F(2,278) = 2.56, p=.07]. Participants with higher levels of social support demonstrated higher levels of adherence as measured by MMAS and PDC. No significant differences were observed between type of medical insurance, level of health literacy, and low, medium, and high adherence.

There was a significant bivariate relationship between depressive symptomatology and MMAS reported adherence [F(2,278) = 4.47, p=.01] and generalized anxiety disorder symptomatology and MMAS reported adherence [F(2,278) = 3.84, p=.02]. Additionally, the association between perceived stress and MMAS reported adherence approached significance [F(2,278) = 2.64, p=.07]. Higher depressive symptomatology $M = 6.59 \ (SD=4.64)$ was observed among participants with low adherence. Conversely lower depressive symptomatology $M = 4.65 \ (SD=4.81)$ was observed among participants who reported high medication adherence.
Participants with lower generalized anxiety scores $M=3.61$ ($SD=4.43$) and lower perceived stress $M=7.62$ ($SD=3.06$) were more likely to report higher adherence.

**Regression Analyses**

Table 3.4 displays results from adjusted logistic regression including odd ratios (OR) and corresponding 95% confidence intervals (CI) for all health condition- and social/economic-related factors to low medication adherence. Four models were tested to examine sex and MMAS and PDC differences. Model 1 displays findings for females using the MMAS. The model chi-square goodness of fit test was insignificant ($\chi^2=8.78$, df = 7, $p = .26$) and there was no significant health condition- or social/economic-related factors that predicted low adherence among females using the MMAS. Model 2 displays findings for females using the PDC measure. The model chi-square goodness of fit test was insignificant ($\chi^2=11.82$, df = 9, $p = .22$) and there was no significant condition- or social/economic-related factors that predicted low adherence among females using the PDC measure. Model 3 displays results for males using the MMAS. The model chi-square goodness of fit test was insignificant ($\chi^2=9.67$, df = 7, $p = .20$) and there was no significant health condition- or social/economic-related factors that predicted low adherence among males using the MMAS. Model 4 displays findings for males using the PDC measure. The model chi-square goodness of fit test was insignificant ($\chi^2=11.59$, df = 9, $p = .23$) and there were no significant health condition-related factors that predicted low adherence.

However, among males, two social/economic-related factors predicted low adherence using the PDC measure: limited health literacy and social support. Specifically, limited health literacy predicted low adherence (OR= 6.26), adjusting for other factors ($p < .05$). The odds of having low adherence were six times higher for males with limited health literacy compared to males with adequate health literacy levels. Also among males, social support predicted low
medication adherence (OR= 2.22) using the PDC measure. That is, for every unit increase in social support, the odds of having low medication adherence increased 2.22 times (p < .05).

**DISCUSSION**

This study highlights the low levels of adherence to oral hypoglycemic medications among H/L adults with type 2 diabetes receiving care at community health center. Almost half of participants reported low medication adherence, and the mean medication adherence calculated by the PDC measure was 42%. Significant differences were observed in rates of medication adherence based on age, sex, and country of birth. Males and participants under 65 years of age demonstrated higher rates of low adherence compared to females and participants over 65 years of age. In bivariate analysis, significant differences were observed for health conditions including depressive symptomatology, anxiety disorder symptomatology and perceived stress; participants with lower scores for these conditions reported higher levels of adherence.

As hypothesized, sex differences in social/economic-related factors of low medication adherence were observed. Although health literacy was not significantly associated with medication adherence in bivariate analysis of the overall sample, it was included in regression analysis based on theory and previous research findings [29, 69]. In regression analysis, males with limited health literacy were six times more likely to demonstrate low medication adherence compared to females. One plausible explanation could be social support for taking medications. That is, it may be that, although females demonstrate limited health literacy, they receive social support that positively impacts their medication taking practices. Among males in this study, higher levels of social support also predicted low adherence. Although this finding is counterintuitive, other research studies have shown that social support may have different effects for men and women with diabetes [33]. For example, more social support than wanted may be experienced as pestering and adversely affect adherence to self-management behaviors [63].
These findings warrant further research to explore what other factors play a role in low medication adherence among males.

Inconsistencies in medication adherence levels between self-report and objective measures of adherence are well documented [64, 65]. In this study, based on the PDC measure, most participants (72%) displayed low adherence, although only close to half self-reported low adherence. This finding is consistent with the literature on patients overestimating their level of adherence [66], and highlights the importance of using more than one measure of adherence to assess medication taking behaviors. Similar to other studies, differences in non-modifiable predictors (age, sex, country of birth) of low medication adherence were observed in this study [67, 68]. For example, a study on medication adherence among Medicare beneficiaries including H/L adults found that participants under 65 years of age were less likely to be adherent compared to older participants due to comorbid conditions and disability [69]. This study adds to the evidence that limited health literacy can result in low adherence levels [29].

This study contributes to the growing body of literature by focusing on disparities in medication adherence among H/L with diabetes, an underrepresented population in medication adherence research. Further, the study follows recommendations for using more than one adherence measure and includes the Morisky Medication Adherence Scale, the most widely used self-report measure, as well the PDC measure, the preferred measure of adherence by the Pharmacy Quality Alliance [51].

Limitations

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 WHO’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 [15]. 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 to other clinical settings and populations. Upon completion of the LUNA-D study subsequent analyses should focus on repeated measures of adherence and the effect of the special intervention on medication adherence.

**Clinical Implications**

Over reporting of good adherence can be a challenge for primary care providers to try and figure out causes of poor glycemic control among H/L patients. The use of health information technology (HIT) such as the use of EHR for calculating PDC is a promising strategy [70]. 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.

**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 minority populations. Research interventions should target limited health literacy and examine the role of social support to improve medication taking behaviors among H/L adult males. Further research is needed to identify predictors of low adherence among low-income H/L adults receiving services in FQHC clinic settings to address the multidimensional factors that may lead to uncontrolled diabetes.
ACKNOWLEDGEMENTS

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Chapter 3 is currently being prepared for submission to The Journal of Behavioral Medicine. Sheila F. Castañeda, Matthew A. Allison, John P. Elder, Bess H. Marcus, and Gregory A. Talavera are co-authors.
**Table 3.1. Demographic and clinical characteristics stratified by sex, N=279**

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

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

$^b$HbA1c = Hemoglobin A1c
Table 3.2. Social/economic-, condition-related factors, and medication adherence characteristics stratified by sex, N=279

<table>
<thead>
<tr>
<th>Social/economic related factors</th>
<th>All % (n)</th>
<th>Females % (n=175)</th>
<th>Males % (n=104)</th>
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</thead>
<tbody>
<tr>
<td>Type of Insurance</td>
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</tr>
<tr>
<td>Private insurance</td>
<td>1.8 (5)</td>
<td>2.3 (4)</td>
<td>1.0 (1)</td>
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<tr>
<td>Public insurance</td>
<td>72.0 (201)</td>
<td>76.0 (133)</td>
<td>65.4 (68)</td>
</tr>
<tr>
<td>No insurance reported</td>
<td>26.2 (73)</td>
<td>21.7 (38)</td>
<td>33.7 (35)</td>
</tr>
<tr>
<td>Health literacy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate health literacy</td>
<td>9.0 (25)</td>
<td>8.0 (14)</td>
<td>10.6 (11)</td>
</tr>
<tr>
<td>Limited health literacy</td>
<td>91.0 (254)</td>
<td>92.0 (161)</td>
<td>89.4 (93)</td>
</tr>
<tr>
<td>Social support (M, SD) (Range 0-5)</td>
<td>3.03 (0.64)</td>
<td>3.05 (0.62)</td>
<td>3.00 (0.66)</td>
</tr>
<tr>
<td>Condition-related factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depressive symptomatology (M, SD) (Range 0-24)</td>
<td>5.94 (4.74)</td>
<td>6.43 (5.04)</td>
<td>5.12 (4.08)</td>
</tr>
<tr>
<td>Anxiety disorder symptomatology (M, SD) (Range 0-20)</td>
<td>4.70 (4.22)</td>
<td>5.03 (4.47)</td>
<td>4.14 (3.7)</td>
</tr>
<tr>
<td>Perceived Stress (M, SD) (Range 0-16)</td>
<td>8.20 (2.99)</td>
<td>8.55 (3.09)</td>
<td>7.62 (2.70)</td>
</tr>
<tr>
<td>Number of prescribed medications(^a) (M, SD) (Range 0-5)</td>
<td>3.58 (0.68)</td>
<td>3.60 (0.69)</td>
<td>3.55 (0.66)</td>
</tr>
<tr>
<td>Medication adherence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-reported adherence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low adherence</td>
<td>49.8 (139)</td>
<td>46.9 (82)</td>
<td>54.8 (57)</td>
</tr>
<tr>
<td>Medium adherence</td>
<td>21.5 (60)</td>
<td>26.3 (46)</td>
<td>13.5 (14)</td>
</tr>
<tr>
<td>High adherence</td>
<td>28.7 (80)</td>
<td>26.9 (47)</td>
<td>31.7 (33)</td>
</tr>
<tr>
<td>Proportion of days covered (M, SD) (Range 0-1.00)</td>
<td>0.42 (0.20)</td>
<td>0.42 (0.20)</td>
<td>0.41 (0.20)</td>
</tr>
<tr>
<td>Low adherence</td>
<td>72.0 (201)</td>
<td>70.3 (123)</td>
<td>75.0 (78)</td>
</tr>
<tr>
<td>Medium adherence</td>
<td>23.3 (65)</td>
<td>24.6 (43)</td>
<td>21.2 (22)</td>
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<tr>
<td>High adherence</td>
<td>4.7 (13)</td>
<td>5.1 (9)</td>
<td>3.8 (4)</td>
</tr>
</tbody>
</table>

\(^a\) Number of prescribed medications includes medication for diabetes, hypertension, cholesterol, chronic pain, and asthma
Table 3.3 Bivariate analyses of demographic, condition, and social/economic factor and medication adherence measures, N=279

<table>
<thead>
<tr>
<th>Chi-Square Analysis</th>
<th>Low (n)</th>
<th>Medium (n)</th>
<th>High (n)</th>
<th>Sig</th>
<th>Low (n)</th>
<th>Medium (n)</th>
<th>High (n)</th>
<th>Sig</th>
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<tbody>
<tr>
<td>Sex</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>54.8 (57)</td>
<td>13.5 (14)</td>
<td>31.7 (33)</td>
<td>6.35</td>
<td>75.0 (78)</td>
<td>21.2 (22)</td>
<td>3.8 (4)</td>
<td>.076</td>
</tr>
<tr>
<td>Female</td>
<td>46.9 (82)</td>
<td>26.3 (46)</td>
<td>26.9 (47)</td>
<td>(p = .04)*</td>
<td>70.3 (123)</td>
<td>24.6 (43)</td>
<td>5.1 (9)</td>
<td>(p = .68)</td>
</tr>
<tr>
<td>Age</td>
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</tr>
<tr>
<td>&lt; 65 years</td>
<td>51.5 (120)</td>
<td>20.6 (48)</td>
<td>27.9 (66)</td>
<td>1.63</td>
<td>74.7 (174)</td>
<td>21.0 (49)</td>
<td>4.3 (10)</td>
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</tr>
<tr>
<td>≥ 65 years</td>
<td>41.3 (19)</td>
<td>26.1 (12)</td>
<td>32.6 (15)</td>
<td>(p = .44)</td>
<td>58.7 (27)</td>
<td>34.8 (16)</td>
<td>6.5 (3)</td>
<td>(p = .08)*</td>
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<tr>
<td>U.S. born</td>
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<tr>
<td>Yes</td>
<td>57.1 (16)</td>
<td>10.7 (3)</td>
<td>32.1 (9)</td>
<td>6.57</td>
<td>50.0 (14)</td>
<td>46.4 (13)</td>
<td>3.6 (1)</td>
<td>.10</td>
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<tr>
<td>No (U.S. residence &lt; 10 years)</td>
<td>50.0 (9)</td>
<td>5.6 (1)</td>
<td>44.4 (8)</td>
<td>(p = .16)</td>
<td>88.9 (16)</td>
<td>11.1 (2)</td>
<td>0</td>
<td>(p = .02)*</td>
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<tr>
<td>No (U.S. residence ≥ 10 years)</td>
<td>48.9 (114)</td>
<td>24.0 (50)</td>
<td>27.0 (63)</td>
<td></td>
<td>73.4 (171)</td>
<td>21.5 (50)</td>
<td>5.2 (12)</td>
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<td>Language preference</td>
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<tr>
<td>English</td>
<td>64.3 (18)</td>
<td>17.9 (5)</td>
<td>17.9 (5)</td>
<td>2.77</td>
<td>67.9 (19)</td>
<td>21.4 (6)</td>
<td>10.7 (3)</td>
<td>.57</td>
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<td>Spanish</td>
<td>49.8 (121)</td>
<td>21.9 (55)</td>
<td>29.9 (75)</td>
<td>(p = .25)</td>
<td>72.5 (182)</td>
<td>23.5 (59)</td>
<td>4.0 (10)</td>
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<td>Education level</td>
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<tr>
<td>High school diploma/GED or less</td>
<td>48.6 (105)</td>
<td>24.1 (52)</td>
<td>27.3 (59)</td>
<td>3.83</td>
<td>71.3 (154)</td>
<td>23.6 (51)</td>
<td>5.1 (11)</td>
<td>.49</td>
</tr>
<tr>
<td>Greater than high school diploma/GED</td>
<td>54.0 (34)</td>
<td>12.7 (8)</td>
<td>33.3 (21)</td>
<td>(p = .15)</td>
<td>74.6 (47)</td>
<td>22.2 (14)</td>
<td>3.2 (2)</td>
<td>(p = .80)</td>
</tr>
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<td>Employment</td>
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<tr>
<td>Employed for wages</td>
<td>55.1 (65)</td>
<td>18.6 (22)</td>
<td>26.3 (31)</td>
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<td>77.1 (91)</td>
<td>18.6 (22)</td>
<td>4.2 (5)</td>
<td>.71</td>
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<tr>
<td>Unemployed/Retired/Unable to work</td>
<td>46.0 (74)</td>
<td>23.6 (38)</td>
<td>30.4 (49)</td>
<td>(p = .31)</td>
<td>68.3 (110)</td>
<td>26.7 (43)</td>
<td>5.0 (8)</td>
<td>(p = .26)</td>
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<td>Marital status</td>
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<tr>
<td>Single</td>
<td>60.5 (23)</td>
<td>15.8 (6)</td>
<td>23.7 (9)</td>
<td>3.30</td>
<td>73.7 (28)</td>
<td>18.4 (7)</td>
<td>7.9 (3)</td>
<td>.80</td>
</tr>
<tr>
<td>Married/Living with partner</td>
<td>51.0 (74)</td>
<td>21.4 (31)</td>
<td>27.5 (40)</td>
<td>(p = .51)</td>
<td>73.1 (106)</td>
<td>22.8 (33)</td>
<td>4.1 (6)</td>
<td>(p = .77)</td>
</tr>
<tr>
<td>Divorced/Widowed/Separated</td>
<td>43.8 (42)</td>
<td>24.0 (23)</td>
<td>32.3 (31)</td>
<td></td>
<td>69.5 (66)</td>
<td>26.3 (25)</td>
<td>4.2 (4)</td>
<td></td>
</tr>
<tr>
<td>Annual household income</td>
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<tr>
<td>&lt; $20,000</td>
<td>48.4 (88)</td>
<td>22.5 (41)</td>
<td>29.1 (33)</td>
<td>0.52</td>
<td>70.3 (128)</td>
<td>25.8 (47)</td>
<td>3.8 (7)</td>
<td>.29</td>
</tr>
<tr>
<td>≥ $20,000</td>
<td>52.6 (51)</td>
<td>19.6 (19)</td>
<td>27.8 (27)</td>
<td>(p = .77)</td>
<td>75.3 (73)</td>
<td>18.6 (18)</td>
<td>6.2 (6)</td>
<td>(p = .30)</td>
</tr>
<tr>
<td>Type of insurance</td>
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<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>20.0 (1)</td>
<td>60.0 (3)</td>
<td>20.0 (1)</td>
<td>5.53</td>
<td>80.0 (4)</td>
<td>20.0 (1)</td>
<td>0</td>
<td>.19</td>
</tr>
<tr>
<td>Public insurance</td>
<td>50.7 (102)</td>
<td>19.4 (39)</td>
<td>29.9 (60)</td>
<td>(p = .23)</td>
<td>72.6 (146)</td>
<td>21.9 (44)</td>
<td>5.5 (11)</td>
<td>(p = .75)</td>
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<td>No insurance</td>
<td>49.3 (36)</td>
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<td>26.0 (19)</td>
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<td>69.9 (51)</td>
<td>27.4 (20)</td>
<td>2.7 (2)</td>
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</tr>
<tr>
<td>Health literacy</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Adequate health literacy</td>
<td>60.0 (15)</td>
<td>20.0 (5)</td>
<td>20.0 (15)</td>
<td>1.32</td>
<td>84.0 (21)</td>
<td>12.0 (3)</td>
<td>4.0 (1)</td>
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<tr>
<td>Limited health literacy</td>
<td>48.8 (124)</td>
<td>21.7 (65)</td>
<td>29.5 (75)</td>
<td>(p = .51)</td>
<td>70.9 (180)</td>
<td>24.4 (62)</td>
<td>4.7 (12)</td>
<td>(p = .35)</td>
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</tbody>
</table>

* Approaching significance at the .05 level (.05 > p < .10), *P ≤ .05, ** P ≤ .01
<table>
<thead>
<tr>
<th>Mean Comparisons</th>
<th>One Way ANOVA</th>
<th>Self-reported Adherence</th>
<th>Proportion of Days Covered Adherence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>Low (SD)</td>
<td>Medium (SD)</td>
</tr>
<tr>
<td>Social support</td>
<td>2.94 (0.59)</td>
<td>3.06 (0.69)</td>
<td>3.14 (0.66)</td>
</tr>
<tr>
<td>Depressive symptoms</td>
<td>6.59 (4.64)</td>
<td>6.13 (4.60)</td>
<td>4.65 (4.81)</td>
</tr>
<tr>
<td>Anxiety disorder</td>
<td>5.10 (4.14)</td>
<td>5.21 (3.91)</td>
<td>3.61 (4.43)</td>
</tr>
<tr>
<td>Perceived stress</td>
<td>8.57 (2.87)</td>
<td>8.12 (3.07)</td>
<td>7.62 (3.06)</td>
</tr>
<tr>
<td>Number of CVD risk factors*</td>
<td>1.95 (1.10)</td>
<td>2.28 (1.25)</td>
<td>2.06 (1.08)</td>
</tr>
<tr>
<td>Number of prescribed medicationsb</td>
<td>3.53 (0.75)</td>
<td>3.63 (0.68)</td>
<td>3.65 (0.53)</td>
</tr>
</tbody>
</table>

One Way ANOVA = One Way Analysis of Variance

* 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 .05 level (.05 > p < .10); ** p < 0.05; *** p < 0.01
<table>
<thead>
<tr>
<th>Condition related factors</th>
<th>Female</th>
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<th>Male</th>
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<tr>
<td></td>
<td>Self-reported</td>
<td>PDC</td>
<td>Self-reported</td>
<td>PDC</td>
<td>Self-reported</td>
<td>PDC</td>
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<td>Low Adherence(^1)</td>
<td>Low Adherence(^2)</td>
<td>Low Adherence(^3)</td>
<td>Low Adherence(^4)</td>
<td>Low Adherence(^3)</td>
<td>Low Adherence(^4)</td>
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</tr>
<tr>
<td>Depressive symptomatology</td>
<td>1.04 (0.97-1.23)</td>
<td>0.16</td>
<td>1.04 (0.94-1.16)</td>
<td>0.40</td>
<td>1.03 (0.89-1.19)</td>
<td>0.65</td>
<td>1.05 (0.91-1.22)</td>
</tr>
<tr>
<td>Anxiety disorder symptomatology</td>
<td>0.99 (0.86-1.13)</td>
<td>0.86</td>
<td>0.91 (0.81-1.02)</td>
<td>0.12</td>
<td>1.07 (0.87-1.30)</td>
<td>0.49</td>
<td>1.04 (0.86-1.26)</td>
</tr>
<tr>
<td>Perceived Stress</td>
<td>1.01 (0.86-1.19)</td>
<td>0.91</td>
<td>1.06 (0.92-1.22)</td>
<td>0.41</td>
<td>1.09 (0.87-1.36)</td>
<td>0.44</td>
<td>0.95 (0.75-1.21)</td>
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</table>

<table>
<thead>
<tr>
<th>Social/economic related factors</th>
<th>Female</th>
<th></th>
<th>Male</th>
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<td>Self-reported</td>
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<td>Self-reported</td>
<td>PDC</td>
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<td></td>
<td>Low Adherence(^5)</td>
<td>Low Adherence(^6)</td>
<td>Low Adherence(^7)</td>
<td>Low Adherence(^8)</td>
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<tr>
<td>Social support</td>
<td>0.65 (0.34-1.24)</td>
<td>0.19</td>
<td>1.15 (0.64-2.08)</td>
<td>0.63</td>
<td>0.57 (0.27-1.21)</td>
<td>0.14</td>
<td>2.22 (1.03-4.76)</td>
</tr>
</tbody>
</table>

| Health literacy | Male | | |  |
|-----------------|---------|---------|---------|---------|---------|---------|---------|
| Adequate        | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | |
| Limited         | 1.30 (0.32-5.14) | 0.71 | 1.35 (0.38-4.77) | 0.64 | 0.13 (0.01-1.31) | 0.08 | 6.26 (1.06-37.10) | 0.04* |

<table>
<thead>
<tr>
<th>Type of Insurance</th>
<th>Female</th>
<th></th>
<th>Male</th>
<th></th>
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<tbody>
<tr>
<td>Private insurance</td>
<td>1.00 (Ref)</td>
<td>1.00 (Ref)</td>
<td>1.00 (Ref)</td>
<td>1.00 (Ref)</td>
<td>1.00 (Ref)</td>
<td>1.00 (Ref)</td>
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<tr>
<td>Public insurance</td>
<td>0.96 (0.32-2.91)</td>
<td>0.94</td>
<td>0.52 (0.20-1.29)</td>
<td>0.15</td>
<td>0.95 (0.31-2.90)</td>
<td>0.94</td>
<td>1.21 (0.39-3.86)</td>
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<tr>
<td>No insurance reported</td>
<td>0.76 (0.16-3.65)</td>
<td>0.74</td>
<td>1.02 (0.27-3.80)</td>
<td>0.96</td>
<td>0.37 (0.06-2.20)</td>
<td>0.27</td>
<td>2.53 (0.42-15.17)</td>
</tr>
</tbody>
</table>

Note: Models 2 and 4 low are adjusted for age and U.S. Born
PDC= Proportion of Days Covered, OR= Odds Ratios, CI= Confidence Interval, Ref= Reference category
* p<.05; **p<.01
\(^1\)Model 1: Chi-Square: 8.78 (df=7, p=.26)
\(^2\)Model 2: Chi-Square: 11.82 (df=9, p=.22)
\(^3\)Model 3: Chi-Square: 9.67 (df=7, p=.20)
\(^4\)Model 4: Chi-Square: 11.59 (df=9, p=.23)
REFERENCES


CHAPTER 4
MULTIDIMENSIONAL FACTORS OF POOR ADHERENCE TO STATIN THERAPY
AMONG HISPANIC/LATINO ADULT PATIENTS IN A FEDERALLY QUALIFIED
HEALTH CENTER SETTING

ABSTRACT

**Background:** Hispanic/Latinos exhibit poor adherence to prescribed medications and poor lipid control due to multidimensional factors. Although statin medications improve lipid control and reduce major vascular events, few studies have examined medication adherence among low-income Hispanic/Latino adults.

**Objective:** The objective of this study was to employ the Multidimensional Adherence Model to identify patient-, health condition-, social/economic-, therapy- and health system-related factors of poor adherence (taking < 80% of medications as prescribed) among low-income Hispanic/Latinos prescribed statins.

**Design:** Historic cohort study of 1,485 Hispanic/Latino adults based on electronic health record data from a federally qualified health center. The proportion of days covered (PDC) metric was used to assess adherence to statin medications. Chi-square and Independent sample t-test were used to assess bivariate associations between multidimensional factors and medication adherence. Multivariable logistic regression analysis examined predictors of poor adherence.

**Results:** Almost 90% of patients demonstrated poor adherence, and the mean proportion of days covered was 0.46 ($SD = 0.25$). Age was inversely related to poor adherence. Specifically, for every one unit decrease in age, there was a 3% increased likelihood of poor adherence (OR 0.97; CI 0.96 - 0.99, $p < 0.001$). No other factors of interest were found to be significant predictors of poor adherence.
**Conclusions:** The use of electronic health records assisted with identifying suboptimal medication adherence rates among Hispanic/Latinos in this study. Further research is needed to identify factors related to poor adherence.

**Keywords:** Lipids, medication adherence, electronic health records, proportion of days covered, Hispanic/Latinos
INTRODUCTION

According to national data, nearly 31 million adults (aged ≥ 20 years) had a high total cholesterol (TC), and an estimated 73.5 million had elevated low-density lipoprotein cholesterol (LDL-C) [1]. High total cholesterol (≥240 mg/dl) and high Low-density lipoprotein cholesterol (≥ 160 mg/dL) are major risk factors for cardiovascular disease (CVD) and stroke [2]. Findings from the 2011-2012 National Health and Nutrition Survey (NHANES), showed that H/L adults in the U.S. had a higher prevalence of high TC (14.2%) when compared to non-Hispanic Blacks (9.8%) and non-Hispanic Whites (13.5%) [3]. In the Hispanic Community Health Study / Study of Latinos (HCHS/SOL), the prevalence of high TC was 44% among men and nearly 41% among women [4]. HCHS/SOL data also showed a high prevalence of elevated LDL-C (36%) among study participants [5].

The 2013 American College of Cardiology (ACC)/ American Heart Association (AHA) expert panel found extensive evidence supporting the use of statins for prevention of atherosclerotic cardiovascular disease (ASCVD) [6]. Using statin medications reduces major vascular events by 20% [6], yet only 40% – 60% of those on a statin therapy adhere sufficiently to experience potential treatment benefits [7]. Although, the benefits of statin therapy have been demonstrated [8], challenges to controlling dyslipidemia exist among racial and ethnic minority groups [9, 10]. In the Multi-Ethnic Study of Atherosclerosis (MESA), H/L participants demonstrated lower levels of treatment and control of dyslipidemia compared to non-Hispanic Whites [9]. In the HCHS/SOL, about half (49%) of those with high TC were not aware of their condition, almost 70% of those eligible for treatment were not treated, and among those prescribed medications, only 64% were controlled [11]. Non-adherence to prescribed medications is a worldwide problem, and in the U.S. is responsible for $290 billion in avoidable health care expenditures per year [12]. According to the World Health Organization (WHO),
medication adherence is a multidimensional phenomenon determined by the interplay of five sets of factors. The factors include patient-, social/economic-, condition-, therapy-, and health system-related factors [19].

Health information technology (HIT) has the potential to improve health system efficiency and quality of patient care [39] and health outcomes [40]. HIT is defined as a variety of electronic methods used to manage information about people’s health and health at the individual and group levels [41]. Methods can include electronic health records and notes, prescribing systems, clinical decision support, automated reminders, and care coordination [40]. However, not all health care facilities have the capacity to provide care using HIT. Federally Qualified Health Centers (FQHCs), community health centers that provide primary care to underserved and marginalized populations across the U.S., are less likely to operate HIT systems that are functioning to full capacity [42].

Given that CVD is one the leading causes of mortality among H/Ls in the U.S. [43], and the impact of high TC and LDL-C on CVD risk, emphasis should be placed on treatment and control rates among H/L adults in FQHC settings. Therefore, the objective of this study was to employ the Multidimensional Adherence Model to examine patient-, health condition-, social/economic-, therapy- and health system and utilization related factors of poor medication adherence among Hispanic/Latinos prescribed statins.

**METHODS**

**Study Design**

This historical cohort study is based on a convenience sample of 1,485 Hispanic/Latino adult patients prescribed statins medications from January 2015 to December 2016. Patient data
were extracted from the San Ysidro Health Center’s electronic health records. Administrative approval was granted from San Ysidro Health Center, Inc.

**Setting and Sample**

San Ysidro Health Center, Inc. (SYHC) is a large federally qualified health center (FQHC) in San Diego County, located near the U.S. / Mexico border. SYHC operates 12 medical facilities and serves over 90,000 patients annually. The majority of SYHC patients are impoverished, underserved, and primarily Spanish speaking [44]. Patients were identified though a query of electronic health records based on the following eligibility criteria: self-identify as Hispanic/Latino, over 18 years of age, prescribed lipid-lowering therapy (statins), with at least one clinic visit in the past twelve months. The EHR query resulted in a list of 3,190 patients. Of those 914 were excluded for not being Hispanic/Latino, 435 were excluded due to International Classification of Diseases (ICD-9) diagnosis of severe health conditions that may require ongoing doctor’s visits and follow-up care (cancer, severe mental health disorders, etc.), and 356 were excluded for not having adequate prescription data available. The final analytic sample included 1,485 patients.

**Measures**

All patient data was extracted from the SYHC’s electronic medical health records and de-identified before data cleaning. Data cleaning and coding was conducted using SPSS Version 23 and SAS Version 9.4.

**Medication Adherence (Dependent Variable)**

*Objective Measure of Medication Adherence.* Proportion of Days Covered (PDC) was used to measure adherence to prescribed statin medications over a 24-month period. Proportion of Days Covered (PDC) is the most widely accepted method to calculate adherence to prescribed
PDC is calculated as the sum of the days covered (based on fill date and days’ supply) divided by the number of follow-up days [15]. The higher number of PDC the higher the adherence rate (range 0.00 to 1.00). PDC was reported as a mean for descriptive purposes, and dichotomized for bivariate and regression analyses. Good adherence (≥ .80 PDC) was categorized as Yes (1) and poor adherence (< .80 PDC) categorized as No (0), consistent with similar studies on adherence [47, 48].

Predictors

Health system-related and utilization factors. Three health system and utilization related factors were examined for this study, including continuity of care, number of office visits, and number of walk-in visits. Continuity of care was assessed with two items, name of primary care provider and name of prescribing provider. If patients received primary care and prescriptions from the same provider continuity of care was categorized as Yes (1), if not, categorized as No (0) [49]. Number of office and walk-in visits in the past 12-months were summed and a mean score for each variable was used for bivariate and regression analyses.

Therapy-related factors. Two therapy-related factors were examined. Number of prescribed medications, which includes on-going prescriptions for cholesterol, diabetes, hypertension, asthma, and chronic pain during the study period. A sum score was calculated for each patient and the mean number of prescribed medications was used for analyses. Number of cardiovascular disease risk factors included ICD-9 or 10 diagnoses of type 2 diabetes (250.xx, E11.xx), hyperlipidemia (272.xx, E78), and hypertension (401.9); obesity classification (Body mass index [BMI] ≥ 30) (278.0, E66.01); record of tobacco use (Z72.0) or tobacco use disorder (305.1). A sum CVD risk score was computed for each patient and the mean number of CVD risk factors was used for analyses.
Health condition-related factors. Two conditions were examined as potential predictors or poor medication adherence, depression disorder (209, 311, F32.9, F33.xx) and anxiety disorder (300, F41.xx). Both conditions were included based on ICD 9 or 10 diagnosis.

Social/economic-related factors. Income and health insurance were examined as social/economic-related factors. Self-reported annual house household income was dichotomized as < $20,000 and ≥ $20,000. Type of health insurance was dichotomized to “private or public insurance” and “no insurance reported.” Based on the low frequency of private insurance observed, private and public insurance were combined.

Patient-related factors. Sociodemographic characteristics include age, sex, and preferred language (English or Spanish). Sociodemographic characteristics were included in bivariate and regression analyses. Lab results available for the study period were averaged and reported as mean values for descriptive purposes. Lab values included total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides.

Statistical Analyses

Patient characteristics were calculated using means, frequencies, and standard deviations. Bivariate analyses were conducted to test which factors are significantly associated with the PDC score. Chi-square analyses were used for nominal variables and independent sample t-test for continuous variables. Multivariable logistic regression was used to test the contribution of three factors identified in bivariate analyses: age, number of office visits, and number of walk-in visits. Overall fit of the model was assessed by the Hosmer and Lemeshow Goodness of Fit (GOF) and the model Chi-square fit test [50]. Bivariate analyses used an alpha level of < 0.10, and regression analyses used an alpha level of < 0.05. All statistical analyses were performed using SAS v. 9.4.
RESULTS

Demographic characteristics

Patient characteristics (N = 1485) are summarized in Table 4.1. The mean age of the patients was 62.6 (SD = 10.7), and the majority of patients were female (63.5%). Most patients preferred to speak Spanish (86.5%), reported an annual household income of less than $20,000 (89.4%), and had private or public insurance (90.5%). Almost twenty percent (17.2%) of patients were diagnosed with depressive disorder, and 11.6% had anxiety disorder. The mean number of CVD risk factors was 2.6 (SD = 0.9) and the mean number of prescribed medications was 3.8 (SD = 1.1). The mean total cholesterol was 181.7 mg/dL (SD = 42.5) and mean LDL-C was 90.9 (SD = 38.2). The majority of patients (86.7%) demonstrated poor medication adherence, and the mean proportion of days covered was 0.46 (SD = 0.25). Almost three-fourths (72.7%) of patients had continuity of care from the same provider, and the mean number of office visits in the past 12 months was 7.0 (SD = 14.0).

Bivariate analyses

Table 4.2. shows results of bivariate analyses. Patients with good adherence were significantly older (M = 64.8 years) than those who displayed poor adherence (M = 62.2 years) (T= -3.14, df = 1483, p = .01). Number of office and walk-in visits varied between those with poor and good adherence. Patients with good adherence had a higher number of office visits in the past 12-months (M = 8.7) compared to those with poor adherence (M = 6.8), although significance was not reached (T = -1.66, df = 1483, p = .09). Similarly, patients with good adherence had a higher number of walk-in visits (M = 2.3) compared to those with poor adherence (M = 1.9), although significance was not reached (T = -1.67, df = 1483, p = .09).
Regression analyses

Multivariable logistic regression findings are summarized in Table 4.3. One model was tested to examine factors approaching significance (p < .10) or significantly associated (p < .05) with medication adherence in the bivariate analyses. The Hosmer and Lemeshow Goodness of Fits (GOF) Test showed that the model was a good fit for the data ($\chi^2 = 3.472$, df = 8, p = .901). The model Chi-square was significant ($\chi^2 = 13.40$, df = 3, p = .004) indicating that there are statistically significant differences in medication adherence. Age was inversely related to poor adherence (OR 0.97), after adjusting for office and walk-in visits (p < 0.01). More specifically, for every one unit decrease in age, there was a 3% increased likelihood of poor adherence. There was no difference in likelihood of poor adherence based on number of office (OR 0.99, 95% CI: 0.98-1.01, p = 0.36) or walk-in (OR 0.96, 95% CI: 0.93-1.01, p = 0.11) visits in the past 12-months.

DISCUSSION

To our knowledge this is the first study to examine the WHO’s multidimensional factors of medication adherence among low-income H/L receiving services in a federally qualified health center setting. Adherence to statin therapy was 46%, and most patients displayed poor adherence (86.7%). Despite the low levels of adherence, mean total cholesterol ($M = 181.7$ mg/dL; $SD = 42.5$) was at a desirable level. Similarly, the mean LDL-D level ($M = 90.9$ mg/dL; $SD = 38.2$) was optimal. Our a priori hypothesis that older patients would have lower medication adherence rates was not supported. Indeed, higher age was a significant predictor of good adherence. One possibility is that older participants may have had higher cholesterol levels than younger participants, and this may have prompted them to adhere to statin medication regimens more closely than younger participants. The hypothesis that patients with more than one prescription
and chronic condition would have lower rates of adherence was also not supported. Results showed that there were no significant differences in adherence based on number of prescriptions or chronic conditions. It was also hypothesized that health-system-related factors would be the strongest predictors of poor adherence among this patient sample. Our hypothesis was not confirmed. However, although not significant, lower numbers of office and walk-in visits in the past 12 were associated with poor adherence.

This study confirms the poor adherence rates among H/Ls reported in other studies [38, 51]. Findings from other studies suggest that patients omit medications based on asymptomatic conditions or feelings of control [34]. In this study, good lipid control could have led to poor adherence among patients during the study period. In contrast to other studies, the health system and utilization-related factors examined were not predictors of poor adherence. For example, there were no differences in adherence based on continuity of care. Other studies have found that not receiving continuous care from the same provider increases the likelihood of poor adherence [35, 49]. Nonetheless, this study contributes to the growing body of literature regarding medication adherence to prescribed medications for chronic conditions among a sample of all H/L patients receiving services in an FQHC setting. In addition, this study examined all multidimensional factors of adherence identified by the World Health Organization [19].

Limitations

There are limitations to consider. First, the inclusion criteria and the geographic location of this study limit the generalizability of findings to other populations. Second, due to data limitations, other factors associated such as language differences between patients and providers, private vs. public insurance, and cost associated with medications were not examined. Moreover, adherence to prescribed medications was not measured directly; the proportion of days covered adherence metric assumes that possession implies the medication was taken. Nonetheless, using
PDC is the preferred method of measuring medication adherence by the Pharmacy Quality Alliance [53].

**Research and clinical implications**

Given the emphasize on meaningful use of health information technology [39], the use of PDC to systematically monitor medication adherence shows promise. Adding a mean PDC score for patients in clinic EHR systems can provide primary care providers with estimated adherence levels and identify gaps in refilling long-term prescriptions for chronic conditions. Counting on this information, primary care providers can engage patients in informed and tailored conversation about concerns, beliefs, and barriers to adherence. Engaging in open conversation may lead to shared decision making to improve adherence. It was initially intended to examine language concordance between primary care providers and patients; this was not possible due to missing information regarding interpretation services needed in the EHR data.

**Conclusion**

To our knowledge, this study is novel in that it examines adherence to statin therapy among low income Hispanic/Latinos receiving services in a FQHC setting. This study provides insight to the suboptimal levels of statin medication adherence among H/L receiving services at FQHC, and highlights the fact that patients may not be aware of long-term consequences of poor adherence to statin medications. Further research is needed to examine the multidimensional factors related to poor adherence among this population.
ACKNOWLEDGEMENTS

This study was made possible by San Ysidro Health Center, Inc. The authors thank the staff and patients of San Ysidro Health Center, Inc. for their important contributions. All authors have no conflicts of interest to report.

Chapter 4 is currently being prepared for submission to The Journal of Clinical and Translational Science. Sheila F. Castañeda, Matthew A. Allison, John P. Elder, Bess H. Marcus, and Gregory A. Talavera are co-author.
### Table 4.1. Sample Characteristics (N= 1,485)

<table>
<thead>
<tr>
<th>Category</th>
<th>Percent (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient-related factors</strong></td>
<td></td>
</tr>
<tr>
<td>Age (M, SD) (Range 26-94)</td>
<td>62.6 (10.7)</td>
</tr>
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<td>Sex</td>
<td></td>
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<td>Female</td>
<td>62.3 (925)</td>
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<tr>
<td>Male</td>
<td>37.7 (560)</td>
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<td>Preferred language</td>
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<td>English</td>
<td>13.5 (201)</td>
</tr>
<tr>
<td>Spanish</td>
<td>86.5 (1284)</td>
</tr>
<tr>
<td>Total cholesterol (mg/dL) (M, SD) (valid n=1334)</td>
<td>181.7 (42.5)</td>
</tr>
<tr>
<td>LDL cholesterol (mg/dL) (M, SD) (valid n=1286)</td>
<td>90.9 (38.2)</td>
</tr>
<tr>
<td>HDL cholesterol (mg/dL) (M, SD) (valid n=1334)</td>
<td>47.7 (12.2)</td>
</tr>
<tr>
<td>Triglycerides (mg/dL) (M, SD) (valid n= 1411)</td>
<td>192.9 (128.1)</td>
</tr>
<tr>
<td><strong>Social/economic-related factors</strong></td>
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</tr>
<tr>
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<tr>
<td>&lt;$20,000</td>
<td>89.4 (1304)</td>
</tr>
<tr>
<td>≥$20,000</td>
<td>10.6 (155)</td>
</tr>
<tr>
<td><strong>Type of insurance</strong></td>
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<td>Private or public insurance</td>
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<td>No insurance reported</td>
<td>9.5 (141)</td>
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<td><strong>Health condition-related factors</strong></td>
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<td></td>
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<td>82.3 (1230)</td>
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<td>Yes</td>
<td>17.2 (255)</td>
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<tr>
<td>Anxiety disorder</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>88.4 (1312)</td>
</tr>
<tr>
<td>Yes</td>
<td>11.6 (173)</td>
</tr>
<tr>
<td><strong>Therapy-related factors</strong></td>
<td></td>
</tr>
<tr>
<td>Number of medications prescribed(^a) (M, SD)</td>
<td>3.8 (1.1)</td>
</tr>
<tr>
<td>Number of CVD risk factors(^b) (M, SD)</td>
<td>2.6 (0.9)</td>
</tr>
<tr>
<td><strong>Health system-related factors</strong></td>
<td></td>
</tr>
<tr>
<td>Continuity of care from same provider</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>27.3 (406)</td>
</tr>
<tr>
<td>Yes</td>
<td>72.7 (1079)</td>
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<tr>
<td>Office visits in past 12 months</td>
<td>7.0 (14.0)</td>
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<tr>
<td>Walk-in visits in the past 12 months</td>
<td>1.9 (3.1)</td>
</tr>
<tr>
<td>Medication Adherence</td>
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<tr>
<td>Proportion of days covered (PDC) (M, SD) (Range 0-1.00)</td>
<td>0.46 (0.25)</td>
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<tr>
<td>Good adherence (≥.80 PDC)</td>
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<tr>
<td>No</td>
<td>86.7 (1288)</td>
</tr>
<tr>
<td>Yes</td>
<td>13.3 (197)</td>
</tr>
</tbody>
</table>

\(^a\) Number of medications prescribed includes medications for diabetes, hypertension, cholesterol, asthma, and chronic pain

\(^b\) CVD risk factors include diagnoses of type 2 diabetes, dyslipidemia, hypertension, obesity, and tobacco use or tobacco disorder
Table 4.2. Bivariate relationships of demographic, social/economic, condition, and health system related factors with statin medication adherence, N=1,485

<table>
<thead>
<tr>
<th>Chi-Square Analyses</th>
<th>Good Adherence (≥.80)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent (n)</td>
<td></td>
</tr>
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<td></td>
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<td><strong>Patient-related factors</strong></td>
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<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
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<tr>
<td>Female</td>
<td>86.9 (804)</td>
<td>13.1 (121)</td>
</tr>
<tr>
<td>Male</td>
<td>86.4 (522)</td>
<td>13.6 (76)</td>
</tr>
<tr>
<td>Preferred language</td>
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<tr>
<td>English</td>
<td>88.1 (177)</td>
<td>11.9 (24)</td>
</tr>
<tr>
<td>Spanish</td>
<td>86.5 (1111)</td>
<td>13.5 (24)</td>
</tr>
<tr>
<td><strong>Social/economic-related factors</strong></td>
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<tr>
<td>Annual household income (valid=1459)</td>
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<tr>
<td>&lt;$20,000</td>
<td>86.6 (1130)</td>
<td>13.3 (174)</td>
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<tr>
<td>≥$20,000</td>
<td>86.5 (134)</td>
<td>13.5 (21)</td>
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<td>Private or public insurance</td>
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<td>No</td>
<td>86.8 (1167)</td>
<td>13.17 (177)</td>
</tr>
<tr>
<td>No insurance reported</td>
<td>85.5 (121)</td>
<td>14.2 (20)</td>
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<td><strong>Condition-related factors</strong></td>
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</tr>
<tr>
<td>Depressive disorder</td>
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<td>No</td>
<td>87.2 (1073)</td>
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<td>84.3 (215)</td>
<td>12.7 (40)</td>
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<td>Anxiety disorder</td>
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<td>No</td>
<td>86.4 (1134)</td>
<td>13.6 (178)</td>
</tr>
<tr>
<td>Yes</td>
<td>89.1 (154)</td>
<td>10.9 (19)</td>
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<td><strong>Health system-related factors</strong></td>
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</tr>
<tr>
<td>Continuity of care from same provider</td>
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<td></td>
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<tr>
<td>No</td>
<td>88.7 (360)</td>
<td>11.3 (46)</td>
</tr>
<tr>
<td>Yes</td>
<td>86.0 (928)</td>
<td>14.0 (151)</td>
</tr>
</tbody>
</table>

Mean Comparisons

<table>
<thead>
<tr>
<th>Good Adherence (≥.80)</th>
<th>M (SD)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Yes</td>
</tr>
<tr>
<td><strong>Patient-related factors</strong></td>
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<td></td>
</tr>
<tr>
<td>Age</td>
<td>62.2 (10.8)</td>
<td>64.8 (10.0)</td>
</tr>
<tr>
<td></td>
<td>(n = 1288)</td>
<td>(n = 197)</td>
</tr>
<tr>
<td><strong>Therapy-related factors</strong></td>
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<td></td>
</tr>
<tr>
<td>Number of medications prescribed a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3.8 (1.1)</td>
<td>3.8 (1.1)</td>
</tr>
<tr>
<td></td>
<td>(n = 1288)</td>
<td>(n = 197)</td>
</tr>
<tr>
<td>Number of CVD risk factors b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>2.6 (0.9)</td>
<td>2.5 (0.8)</td>
</tr>
<tr>
<td></td>
<td>(n = 1288)</td>
<td>(n = 197)</td>
</tr>
<tr>
<td><strong>Health system-related factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office visits in past 12 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>6.8 (13.4)</td>
<td>8.7 (18.7)</td>
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<tr>
<td></td>
<td>(n = 1288)</td>
<td>(n = 197)</td>
</tr>
<tr>
<td>Walk-in visits in the past 12 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.9 (3.1)</td>
<td>2.3 (3.1)</td>
</tr>
<tr>
<td></td>
<td>(n = 1288)</td>
<td>(n = 197)</td>
</tr>
<tr>
<td>Behavioral health visits in the past 12 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0.3 (2.0)</td>
<td>0.4 (2.0)</td>
</tr>
<tr>
<td></td>
<td>(n = 1288)</td>
<td>(n = 197)</td>
</tr>
</tbody>
</table>

Note: Chi-Square test and independent sample t-test were used to compare variables across medication adherence;

* Number of medications prescribed includes medications for diabetes, hypertension, cholesterol, asthma, chronic pain;

b CVD risk factors=diagnoses of diabetes, dyslipidemia, hypertension, obesity, and being current smoker

^ Approaching significance at the .05 level (.05 > p < .10); *P ≤ .05; ** P ≤ .01
Table 4.3. Logistic regression for patient- and health system-related factors of poor adherence to statin medications, N=1,485

<table>
<thead>
<tr>
<th>Poor Medication Adherence (&lt;0.80)</th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient-related factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.97</td>
<td>0.96-0.99</td>
<td>0.003**</td>
</tr>
<tr>
<td><strong>Health system-related factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office visits in past 12 months</td>
<td>0.99</td>
<td>0.98-1.01</td>
<td>0.364</td>
</tr>
<tr>
<td>Walk-in visits in the past 12 months</td>
<td>0.96</td>
<td>0.93-1.01</td>
<td>0.112</td>
</tr>
</tbody>
</table>

OR= Odds Ratios, CI= Confidence Interval
* p<.05; **p<.01
Model Chi-Square: 13.41 (df = 3, p=.004); GOF $\chi^2$ 3.4725 (df = 8, p = .901)
REFERENCES


CHAPTER 5
DISCUSSION

OVERVIEW

This dissertation study sought to contribute to the current understanding of medication adherence rates observed among Hispanic/Latinos receiving services in community health center settings. Given that evidence shows medication adherence is not solely dependent on the patient, rather that factors at multiple levels of the socio-ecologic framework contribute to poor adherence [1, 2], this study employed the World Health Organization’s (WHO’s) Multidimensional Adherence Model [3]. The WHO’s Multidimensional Adherence Model suggests that adhering to medications as prescribed is influenced by the interplay of five sets of factors. The factors include patient-related, social/economic-related, health condition-related, therapy-related, and health system and utilization-related factors [3].

Patient-related factors examined in this dissertation study included sociodemographics such as age, sex, language preference, marital status, as well as beliefs and practices (Chapters 2-4). Social/economic-related factors included health insurance, social support, and healthy literacy (Chapter 3-4) [4–8]. Health condition-related factors included depression symptomatology or diagnoses [9–11], anxiety disorder symptomatology [12–14], and perceived stress (Chapters 3 and 4) [15–18]. Therapy-related factors included the number of cardiovascular disease risk (CVD) factors (i.e. diabetes, hyperlipidemia, hypertension, obese classification, and current smoker) as well number of prescribed medications (Chapters 3 and 4) [7, 19]. Health system and utilization-related factors included continuity of care from the same provider, number of office visits, and number of walk-in visits in the past 12 months (Chapter 4) [20, 21].

This dissertation project was completed with three different studies, employing baseline data from two randomized controlled trials (Chapters 2 and 3), and a historic cohort study using
health record data (Chapter 4). The use of three data sources allowed for the examination of all WHO’s multidimensional factors as well as the comparison of two self-report measures and two objective measures of medication adherence. In addition, medication adherence was examined for cholesterol lowering medications (Chapter 2 and 4) and oral hypoglycemic medications (Chapter 3). Taken together, this body of work provides an important examination of medication consumption behaviors for two prevalent chronic conditions among H/L adults in the U.S. Furthermore, this study expands on the current literature regarding the measurement of medication adherence among H/Ls. Study findings demonstrate the need for continued research focused on factors related to medication adherence among H/Ls.

**STUDY FINDINGS**

Chapter 2 of this dissertation examined medication adherence with two measures, the Adherence and Intensification of Medications Scale (AIMS), a self-report measure [22], and using Medication Event Monitoring System (MEMS) electronic pill-bottle caps. MEMS electronic pill-bottle caps are considered the closest method to a “gold standard” of objectively measuring medication adherence. Based on a current literature review, the use of MEMS is not common due to cost and feasibility, and few studies have examined adherence among H/Ls [23, 24]. To this end, the use of MEMS in this study contributes to the gap in research using MEMS with H/Ls with chronic conditions.

Results from Chapter 2 were consistent with medication adherence rates of similar studies that demonstrated poor rates of adherence among H/L adults [25, 26]. Similarly, the discrepancy between self-report and MEMS adherence rates observed in this study is consistent with the findings of other studies that showed participants over report good adherence [27–29]. The use of the AIMS self-report scale allowed for the examination of ten barriers to medication adherence (e.g., cost, beliefs, and side effects). Contrary to what was expected based on previous
research [25, 29], few participants reported ever experiencing barriers (in the last 30 days) to taking cholesterol lowering medications. Of those that did report barriers, the most common barriers were forgetting to take medications, followed by concern about long-term side effects of medications. Based on the low number of barriers reported and the poor adherence levels demonstrated, it may be that the AIMS questionnaire was not the correct measure of barriers for the study population. Lastly, contrary to other studies that have shown associations between good adherence and cholesterol levels [30, 31], good adherence measured by the MEMS was not significantly associated with lower levels of total cholesterol (TC) or low-density lipoprotein cholesterol (LDL-C). It is possible this finding may be due to the small sample size, given that results are suggestive of lower values of cholesterol with better adherence.

Chapter 3 of this dissertation examined sex differences and modifiable dimensions of the WHO’s Multidimensional Adherence Model including health condition- and social/economic-related factors and their relationship to medication adherence. Modifiable health conditions included depression symptomatology, perceived stress, and anxiety disorder symptomatology. Modifiable social/economic-related factors included health literacy, social support, and health insurance status. As recommended in previous studies focusing on adherence with H/Ls [32, 33], medication adherence was examined with two different measures. The study collaboration with the community health center allowed for the use of health records for calculating the Proportion of Days Covered (PDC), an objective measure of medication adherence. The PDC medication adherence was used to compare with results from the Morisky Medication Adherence Scale (MMAS), the most widely used self-report measure of medication adherence [34, 35].

Results from this study confirm the findings from previous studies and Chapter 2, in that participants demonstrated low levels of adherence to oral hypoglycemic medications [36, 37]. Similarly, inconsistencies between the self-reported and objectively measured medication adherence were observed. Although only close to half of participants reported low adherence,
objectively measured low adherence using the PDC was 72%. Study findings also confirmed sex differences in medication adherence rates observed in previous studies [38, 39]. Female participants reported higher rates of adherence compared to male participants, and this sex difference was confirmed with the PDC measure, with more males being categorized with low adherence. In bivariate analysis, significant relationships were observed between age, country of birth, social support, depression symptomatology, and anxiety disorder symptomatology and medication adherence. The relationship between perceived stress and medication adherence approached significance. Although health literacy was not significantly associated with medication adherence in bivariate analysis, it was included in regression analysis based the previous findings indicating that low health literacy is associated with poor medication adherence [8, 40].

In regression analysis, social support and limited health literacy predicted poor adherence only among males. Higher social support increased the odds of low medication adherence for males. While this relationship may be counterintuitive, previous studies have demonstrated similar findings [38, 41]. The source (e.g. spouse, family, physician) and type of social support (e.g. emotional, instrumental, structural) is received differently between males and females [42]. The odds of low adherence were six times higher for males with limited health literacy compared to males with adequate health literacy. It may be plausible that the addition of other variables to the analysis unsuppressed the relationship between limited health literacy and medication adherence. This finding is consistent with other research and points to the importance of health literacy for medicating taking behaviors [40, 43]. The rates low medication adherence, limited health literacy, and low educational attainment highlight the importance of tailoring diabetes self-management education for low-income ethnic minority populations. Given the findings in this study, research interventions should target limited health literacy and examine the role of social support to improve medication taking behaviors among H/L males.
Chapter 4 provided the opportunity to examine all levels of the WHO’s Multidimensional Adherence Model through a historic cohort study of H/L adults based on health record data. This study examined factors related to poor adherence to lipid lowering medications using the PDC method. Given that health system and utilization-related factors play an important role in patient outcomes, the examination of this level of influence on medication taking behaviors was of interest in this study. Furthermore, this study allowed for needed research on community health centers and their capacity to use health information technology (HIT) such as patient prescription records and clinical values to improve patient outcomes [44].

In this study, the mean PDC was 46%, and close to 90% of participants demonstrated poor adherence (< .80) to lipid lowering medications as measured by the PDC method. Based on the poor adherence rates observed, it would be expected that cholesterol levels would be uncontrolled. However, most participants in this study demonstrated desirable levels of total cholesterol and low-density lipoprotein cholesterol. A plausible explanation is the proximity to the U.S/Mexico border and the availability of less expensive medications in Tijuana, Baja California resulting in participants acquiring their medications without their prescriptions being recorded in the EHR.

In bivariate analyses, participants with good adherence were significantly older than participants with poor adherence. Although not significant, participants with good adherence had more office and walk-in visits in the past 12 months than participants with poor adherence. These findings are consistent with the literature regarding the importance of ongoing healthcare visits to properly manage chronic conditions [45]. No other variables of interest (e.g. type of insurance, continuity of care, number of prescribed medications) were associated with medication adherence. In regression analysis, age was inversely related to poor adherence after adjusting for number of office and walk-in visits. This finding is contrary to anticipated results regarding health system and utilization-related factors. For example, it was hypothesized that not having
continuity of care from the same provider would predict poor adherence, this relationship was not observed. Nonetheless, this study demonstrates the potential of using health record data to monitor patient medication adherence as well as healthcare utilization to inform patient visits.

LIMITATIONS

Generalizability

The findings from this dissertation study should not be generalized to other Hispanic/Latino populations in the U.S. All dissertation research was conducted with H/L adults receiving services in a community health center setting near the U.S. / Mexico border in San Diego County, California. Chapters 2 used cross-sectional data on a subset of participants enrolled in a randomized controlled trial focused on chronic disease management and prevention among H/L adults diagnosed with one or more chronic conditions. The inclusion criteria for this study only allowed participants who self-selected to participate in optional MEMS component of the study. Those who participated in the MEMS component had a significantly higher number of comorbid conditions than those who refused to participate. Similarly, Chapter 3 used cross-sectional data of participants enrolled for a randomized controlled aiming to improve glucose control among H/L diagnosed with Type 2 diabetes. Chapter 4 used data extracted from patient health records. The inclusion criteria included H/L adults prescribed lipid-lowering medications and who were active patients of the clinic.

H/L adults residing in San Diego near the Tijuana border experience a different living and social context. Evidence suggests that living in close proximity to the border (within 15 miles), being diagnosed with chronic conditions, and not having a source of usual medical care increases the odds of obtaining care and prescriptions drugs in Mexico [46]. Furthermore, most H/Ls in this region are of Mexican background, and previous research has shown significant
differences in demographic characteristics, health status, and disease burden between different H/L background groups [47, 48].

Causality

This dissertation study used cross-sectional data to examine factors associated with poor medication adherence. Therefore, we are unable to make strong inferences about causality between medication adherence and other variables of interest. For example, Chapter 3 analyses showed that participants with higher depression symptomatology had lower medication adherence compared to participants with less depression symptomatology. It is also possible that lower medication adherence led to feelings of depression due to inability to carry out diabetes self-management (i.e., taking medications as prescribed).

Measurement

Measurement of medication adherence

In Chapters 2 and 3, two measures of medication adherence allowed for comparison of rates between self-report and objective measures. In Chapter 2 medications adherence was examined using MEMS caps, and by self-report. The self-report measure was limited to one a single item regarding adherence to cholesterol medications “In a typical week, how many days do you miss a prescribed dose of your cholesterol medications?” with the following response options: Never/0 days (0), Rarely/1 day (1), Sometimes/2-3 days (2), Often/4-5 days (3), and Very often/6-7 days (4). Although initially proposed, no statistical analysis was applied to assess interchangeability of measures. The self-report measure response format did not allow for analysis of agreement with the MEMS measure of adherence. Regardless, the inclusion of both measures was useful in providing insight to inconsistencies between self-report and objective measures of adherence. In Chapter 3, medication adherence was measured by the Morisky Medication Adherence, and self-report findings were compared with the medication rates
calculated with the PDC method. Similar to findings in Chapter 2, a greater number of participants demonstrated poor adherence through the use of PDC compared to self-reported rates of poor adherence. In Chapter 4, only the PDC method was used to assess adherence. The possibility that participants may acquire medications in Tijuana points to the need to inquire about practices for acquiring medications.

Self-report and Social desirability

Chapters 2 and 3 of this dissertation study included self-report measures of numerous participant characteristics. In Chapter 4, participant’s demographic information was also collected through self-report. Although efforts were made to include reliable and valid measures, participants may not have understood or interpreted the questions as intended. The use of self-report measures is also a limitation given that self-report measures have been shown overestimate expected outcomes (i.e., minutes of physical activity), or conversely, result in underestimation (i.e., body weight). Furthermore, social desirability may have influenced self-report among study participants. For example, in Chapters 2 participants were asked about barriers to medication adherences such as forgetting, beliefs about medication effectiveness, and stopping medication regimens when feeling in good health. Results showed that few participants reported ever experiencing these barriers, this may be the case due fear of judgement or mistrust of research assistants. Chapters 2 and 3 also included questions regarding psychosocial health (i.e., depression, anxiety, and stress). Barriers to reporting depression, anxiety, or stress symptomology may include stigma associated with mental health conditions.

PUBLIC HEALTH SIGNIFICANCE

Despite the study limitations, this dissertation provides new evidence regarding the low rates of medication adherence and factors that may influence adherence among Hispanic/Latinos. Chapter 2 adds to the limited number of studies measuring adherence with MEMS caps and
points to the need to assess barriers to medication adherence at different study times to examine changes over the study period. Chapter 3 focused on modifiable health conditions and social/economic factors as well as sex differences in medication taking behaviors. This study provides a greater understanding of modifiable factors and sex differences that can be addressed through future research interventions. Chapter 4 investigated different levels of the socio-ecologic framework and allowed for the use of health information technology to examine factors related to poor adherence. This study adds to the evidence on the utility of using electronic health records to systematically monitor medication prescription data to identify gaps in coverage. Given the prevalence of diabetes and dyslipidemia among H/L in the U.S. and the evidence of poor control of these conditions, this dissertation study adds to the gaps in research focused on medication adherence among Hispanic/Latinos in U.S.

RECOMMENDATIONS FOR RESEARCH AND CLINICAL PRACTICE

Research

The examination of different self-report and objective measures of adherence allowed for comparison of adherence rates in the different studies. The inconsistencies observed in adherence rates and limitations for testing interchangeability point to the need for future research in this area. Future research should identify self-report measures of adherence that can be tested for interchangeability with MEMS caps, and that are sensitive to change over time. Furthermore, to identify measures effective for use with this population, efforts should be made to triangulate findings through the use of other promising methods including ecological momentary assessment (EMA). EMA has been found been reliable and valid for measuring adherence with other populations and should be tested with this population.

This dissertation examined different factors that influence medication adherence put forth by the World Health Organization based on the findings from various systematic reviews and
clinical trials. Given the results from Chapters 2-4 wherein variables tested did not predict low adherence, this dissertation highlights the need to further examine the WHO’s multidimensional factors in larger cross-sectional and longitudinal studies. Furthermore, implementation of longitudinal research to carefully monitor and track medication adherence and associated glucose and cholesterol levels is needed. Findings also point to the need to engage the target population in qualitative or mixed methods research to identify other factors related to poor adherence as well inquire about practices for acquiring prescription medications for individuals living near the U.S./Mexico border. The collaboration between academic researchers and community health centers in the design and implementation of clinical research studies is an effective way to improve patient care and health outcomes. Based on the process of implementing the studies included in this dissertation, changes to the tracking and extraction of health record data have been identified.

**Clinical practice**

The use of health information technology (HIT) such as the use of electronic health records for calculating PDC is a promising strategy [49]. In Chapter 3, the PDC method showed that participants who reported good adherence, had significant gaps in medication coverage during prescribed periods. Routine monitoring of medication prescriptions and refill history can result in identification of patients with poor adherence. Systematically monitoring medication coverage and updating electronic health records with prompts for physicians or other clinical staff to discuss medications is a way of practicing patient-centered care. Language concordance between primary care providers and patients was a variable of interest in this study; however due to missing information regarding interpretation services in the health record data, this variable was not examined. For this reason, efforts should be made to collect complete patient demographics and update health records in order to examine all factors related to poor adherence.
CONCLUSIONS

Although Hispanic/Latinos in the U.S. experience disproportionately high rates of uncontrolled diabetes and cholesterol, few studies have examined measurement of medication adherence, and factors across levels of the socio-ecological model related to poor adherence rates among this population. To address these gaps in research, this dissertation employed the WHO’s Multidimensional Adherence model to examine factors related to poor adherence. Furthermore, by analyzing data from various studies, this dissertation examined different measures of medication adherence. The findings from this study may help inform future intervention research aiming to improve medication adherence among H/Ls in similar context. In addition, the findings have implications for clinical practice to improve systematic monitoring of patient medication prescriptions to improve clinical outcomes.
REFERENCES


