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Prevalence and Correlates of Self-Reported Medication Non-Adherence among Older Adults with Coronary Heart Disease, Diabetes Mellitus, and/or Hypertension

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Abstract

Background—Information about the about the prevalence and correlates of self-reported medication nonadherence using multiple measures in older adults with chronic cardiovascular conditions is needed.

Objective—To examine the prevalence and correlates of self-reported medication nonadherence among community-dwelling elders with chronic cardiovascular conditions.

Methods—Participants (n=897) included members from the Health, Aging and Body Composition study with coronary heart disease, diabetes mellitus, and/or hypertension at year 10. Self-reported nonadherence was measured by the 4-item Morisky Medication Adherence Scale (MMAS-4) and 2-item cost-related nonadherence (CRN-2) scale at year 11. Factors (demographic, health status, and access to care) were examined for association with the MMAS-4 and then for association with the CRN-2 scale.

Results—Nonadherence per the MMAS-4 and CRN-2 scale was reported by 40.7% and 7.7% of participants, respectively, with little overlap (3.7%). Multivariable logistic regression analyses found that black race was significantly associated with nonadherence per the MMAS-4 (p=0.002) and the CRN-2 scale (p=0.005). Other correlates of nonadherence per the MMAS-4 (with independent associations) included having cancer (p=0.04), a history of falls (p=0.02), sleep disturbances (p=0.04) and having a hospitalization in the previous 6 months (p=0.005).

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Conversely, being unmarried (p=0.049), having worse self-reported health (p=0.04) and needs being poorly met by income (p=0.02) showed significant independent associations with nonadherence per the CRN-2 scale.

Conclusions—Self-reported medication nonadherence was common in older adults with chronic cardiovascular conditions and only one factor – race – was associated with both types. The research implication of this finding is that it highlights the need to measure both types of self-reported nonadherence in older adults. Moreover, the administration of these quick measures in the clinical setting should help identify specific actions such as patient education or greater use of generic medications or pill boxes that may address barriers to medication nonadherence.

Keywords

medication adherence; chronic disease; aged

INTRODUCTION

Chronic cardiovascular diseases (i.e., coronary heart disease [CHD], hypertension [HTN], or the CHD risk equivalent diabetes mellitus [DM]), are some of the most common conditions in older adults.[1] Optimal management of these conditions with medications is important as they are among the most frequent causes of morbidity and mortality in older adults.[2] Unfortunately, national US data show that inadequate control of these conditions occurs in up to 50% of older adults.[3-7]

Medication nonadherence is among the most common potentially modifiable causes of inadequate control of these cardiovascular co-morbidities.[2] Indeed, studies using pharmacy refill data for the three individual conditions identify upwards of 50% of older adults having medication nonadherence.[8-11] Yet, these studies are limited in that they do not take into account that two-thirds of Medicare beneficiaries have at least two chronic co-morbid conditions.[12]

Although several self-reported measures of medication adherence are currently available, one of the most commonly used reliable and valid instruments is the Morisky Medication Adherence Scale (MMAS).[13] While the MMAS has been studied extensively, most of what is known comes from studies of single conditions (e.g., hypertension, osteoporosis); thus, little is known about the magnitude of medication nonadherence among older adults with chronic cardiovascular co-morbidity. Cost-related nonadherence (CRN), which is not tapped by the MMAS, is another major concern in older adults.[14] Despite substantial medication nonadherence in older adults, systematic evaluation of self-reported medication nonadherence using both the MMAS and CRN items has not been undertaken in the same population of elders. Therefore, little is known about potential shared risk factors between the two measurements.

Thus, this study aims to examine the prevalence and correlates of self-reported medication nonadherence among community-dwelling older adults with chronic cardiovascular (or risk equivalent) conditions (i.e., CHD, HTN, and/or DM) using the MMAS; and to examine the prevalence of CRN and its relationship to factors associated with nonadherence measured by the MMAS in order to describe potential shared risks. While identifying medication nonadherence in older adults via pharmacy claims provides valuable information on the prevalence of nonadherence, the inclusion of validated self-reported measures was the method chosen by the Health ABC Study so these measures could easily be combined with the core information gathered during clinical interviews. Importantly, the findings from this study are likely to be robust because they make use of data from a well-characterized, racially and gender balanced community-resident cohort of older adults with detailed

assessment of demographic characteristics, health status, healthcare access and medication use.

METHODS

Source of Data

Data were used from the Health, Aging and Body Composition (Health ABC) study, a population-based, prospective, observational study of community-dwelling older adults.[15] The baseline sample included 3,075 black and white men and women aged 70-79 years who reported no difficulty walking ¼ mile, climbing 10 steps, and lived in specified zip codes surrounding Pittsburgh, PA, and Memphis, TN.[15] Individuals meeting the above criteria were enrolled between 1997 and 1998. This study was approved by the University of Pittsburgh and University of Tennessee Memphis Institutional Review Boards, and informed consent was obtained from each participant prior to data collection.

Study Design, Sample, and Data Collection

This analysis used data from a subset of 897 participants with DM, CHD, and/or HTN participating in the Year 10 (2006-07) and Year 11 (2007-08) interviews. The three conditions were operationally defined using a combination of self-report, medication use, and clinical data from the Year 10 visit, with the medication adherence outcome measured at Year 11. Specifically, prevalent DM was defined as any of the following: self-report physician diagnosis, diabetes medication use, or an impaired fasting glucose level (≥126 mg/dL). CHD was defined as any self-report of the condition or presence of an adjudicated CHD outcome at baseline (or any time thereafter until Year 10). HTN was defined as any self-report of the condition and any antihypertensive medication use. Other relevant measures included demographic characteristics, multiple aspects of health status, access to healthcare factors, and medication use.

Self-reported Medication Nonadherence Outcomes

The 4-item MMAS (MMAS-4) and a 2-item CRN scale (CRN-2) as measured at Year 11 (among participants reporting medication use at both Years 10 and 11) were used for measurement of medication nonadherence.[13,14,16] MMAS-4 is one of the most widely used reliable and valid measures of self-reported medication adherence and includes the following items: 1) Do you ever forget to take your medicine?; 2) Are you careless at times about taking your medicine?; 3) When you feel better do you sometimes stop taking your medicine?; and 4) Sometimes if you feel worse when you take the medicine, do you stop taking it?[13] The CRN-2 has been used in national surveillance research (e.g., Medicare Current Beneficiary Survey) of older adults and includes the following items: 1) During the past 3 months have you not filled a prescription because it was too expensive?; and 2) During the past 3 months have you skipped a dose, or taken a smaller dose to make the prescription last longer because you were worried about the cost of the medicine?[14,16] For each of the medication nonadherence outcomes, a dichotomous outcome was created counting a positive response to any item as medication nonadherence.

Potential Correlates

Demographic factors included dichotomous variables for sex, race, site, and marital status. Age was treated as a continuous variable. Race was self-reported as black or white and was included in the study to assess potential differences in adherence. Categorical variables were created for education (less than a high school education, high school graduate, and post-secondary education), and health literacy (≤6th grade level, 7th-8th grade level, and ≥9th grade level).[17]

Chronic cardiovascular conditions (i.e., DM, CHD, and HTN) were represented by both a dichotomous and a categorical (presence of 1, 2, or 3 conditions) measure. Additionally, a categorical measure was calculated for the number of regularly scheduled medications. Dichotomous or categorical measures were created for self-reported health conditions and other health status factors, including: a) self-rated health (poor/fair vs. good/very good/ excellent); b) health conditions and syndromes (osteoporosis; history of cancer; having depressive symptoms [score > 15 on Center for Epidemiologic Studies depression scale]; history of a cerebrovascular accident; dyslipidemia [low-density lipoprotein >130]; history of falls; sleep disturbances; vision problems; hearing problems; c) cognitive impairment (modified mini-mental state score < 80); d) physical function (persistent lower extremity limitation and intensity of exercise); and e) health behaviors (current smoking status; receipt of a flu shot in the previous year; body mass index [BMI; weight (kg)/height (m^2)] and classification of underweight/normal < 25.0, overweight 25.0-29.9, and obese > 30.0).[18-22]

Family income was dichotomized as < $25,000 or ≥ $25,000. Other assets were categorized as none, 1-2, and 3-7 asset classes of: 1) checking/savings accounts; 2) money market accounts; 3) CDs, savings bonds, or treasury bills; 4) investment property or housing other than current residence; 5) businesses or farms; 6) stocks and mutual funds; and 7) individual retirement accounts and Keogh accounts.[23,24] Other access to healthcare factors included dichotomous variables for: needs being met by income (poorly vs. fairly well/very well); having delayed medical care in the past 12 months due to money problems; home ownership; health insurance (other than Medicare); prescription medication insurance; usual healthcare provider (private doctor vs. other [public clinic/health maintenance organization/ hospital outpatient clinic/emergency room/other]); and hospitalization during the previous 6 months.

Statistical Analysis

The medication nonadherence outcomes and correlates were summarized with appropriate descriptive statistics (means, standard deviations, frequencies and percentages). Bivariate logistic regression was conducted to identify each of the individual correlates (i.e., demographic, health status, and access to care factors) of nonadherence for each dichotomous dependent variable. Then, stepwise selection with backward elimination using the more comprehensive measure (MMAS-4) was conducted separately for each of health status and access to health care domains of covariates. Specifically, covariates significant at the liberal α=0.15 criteria and those deemed important *a priori* (e.g., demographics) were included in the final multivariable logistic regression model to calculate adjusted odds ratios (AORs) and their 95% confidence intervals (95% CIs). This final model represented a parsimonious set of independent correlates. Then, in order to meet the number of events per variable (EPV) criterion regarding the number of variables to include in a logistic regression CRN-2 model, we did the following.[25,26] First, to identify potential shared correlates between the two adherence measures, the six most significant correlates from the MMAS-4 model were included in a multivariable logistic regression model to examine their association with nonadherence per CRN-2. For the second CRN model, the six most significant factors identified using stepwise selection with backward elimination were included.

The underlying statistical assumption of collinearity was evaluated using variance inflation factors, and the regression diagnostic of goodness-of-fit was verified using Hosmer-Lemeshow test. All statistical analyses were conducted using SAS® Version 9.3 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

At Year 10 (2006-07), HTN was the most prevalent chronic cardiovascular condition (n=684; 76.3%) followed by CHD (n=381; 42.5%) and DM (n=338; 37.7%). The prevalence of chronic cardiovascular co-morbidity (among CHD, HTN and/or DM) was approximately 45%, with 33.9% of the sample having two of the three conditions and 11.2% having all three conditions (Table 1). Among the 897 members from the overall Health ABC cohort (n=3075) included in this study, the mean [standard deviation] age was 82.1 [2.8] years, 52.5% were female and 37.0% were black (Table 1). Approximately 75% of the sample reported good to excellent health. However, 12.6% of participants had a hospitalization in the previous 6 months.

Overall, 40.7% and 7.7% reported medication nonadherence based on the MMAS-4 and CRN-2, respectively, at year 11. Only 33 (3.7%) participants met nonadherence criteria on both the MMAS-4 and CRN-2. The most common response item on the MMAS-4 was a positive answer to the question, “Do you ever forget to take your medicine?” (34.5%). Each of the two response items on the CRN-2 was approximately equal in prevalence (~4-5%).

Table 2 shows the bivariate correlates for both measures of medication nonadherence. Common factors bivariately associated with medication nonadherence per the MMAS-4 and the CRN-2 were black race, site and self-rated health (Table 2). However, in multivariable analysis, only race remained significantly associated (independent of other correlates) with medication nonadherence on both the MMAS-4 and the CRN-2 (Table 3). The final multivariable model for MMAS-4 also revealed that having a history of cancer, falls, sleep disturbances, and prior hospitalization were independently associated factors (Table 3). For the final CRN-2 backward selection model, being unmarried, having worse self-reported health and needs being poorly met by income were shown to be significantly and independently associated factors.

DISCUSSION

In this study, self-reported medication nonadherence was found to be common among community-dwelling older adults with a high prevalence of chronic cardiovascular co-morbidity. The finding that the prevalence of self-reported medication nonadherence per the MMAS-4 was 40% is similar to previous research using the MMAS-4 in older adults with single conditions, where the prevalence ranged from 33%-57%.[13,27-30] While overall medication nonadherence is common in older adults, CRN was found to be less common, with an overall prevalence of 7.7%. This figure is less than the prevalence of overall CRN for all medications in the post-Part D era, which was found to be 11.5% using data from the Medicare Current Beneficiary Survey.[16] It is not entirely clear why our finding was lower than this previous estimate, but it is important to note that the current study sample had fewer participants (38.8% vs. 55.1%) with income levels <$25,000 than the previously mentioned study.[16] Additionally, the current study sample was slightly more educated and had better self-reported health.

There was only one correlate – black race – of the six factors found to be significantly associated with nonadherence based on the MMAS-4 and forced into the final CRN-2 model. Racial differences in medication nonadherence have previously been reported, even after controlling for access-related factors.[8,31-33] In this study, it was found that black participants were between 85-114% more likely to report medication nonadherence than white participants, after controlling for various demographic, health status, and access to care factors. This is important because racial differences in medication adherence can lead to negative health outcomes among minorities. More research is needed to better understand

the most effective interventions to reduce racial differences in medication adherence and racial disparities in health outcomes.

The MMAS analysis also found that having a history of cancer was protective, whereas having a history of falls or sleep disturbances, or being hospitalized in the previous 6 months increased the risk of nonadherence. It is not clear why those with a history of cancer were less likely to report nonadherence; we were unable to measure beliefs about medications and motivation levels, which may be important in describing this association. Moreover, the findings that a history of falls and sleep disturbances increase the likelihood of being nonadherent are both consistent with previous findings.[34,35] Furthermore, there is a strong body of literature on the potential negative effects of care transitions in older adults, and this finding further highlights the importance of closely monitoring persons recently hospitalized for potential medication nonadherence.[36] This is of utmost concern for those elders with conditions that increase their risk for readmission, including cardiovascular conditions.[37] Unlike other studies, the current study did not find an association between age, sex, or the total number of regularly scheduled medications with this measure of nonadherence.[13, 38-41]

The study identified three unique factors associated with CRN-2, but not the MMAS-4, in the final model based on a backward selection approach. Specifically, it was found that poor self-rated health, having needs poorly met by income and marital status to be associated with the CRN-2. While the finding that poor self-rated health and needs poorly met by income are associated with more cost-related nonadherence are not surprising, the finding that those who are married were less likely to report nonadherence is a new finding in the literature. This finding is supported, however, by previous research showing that CRN is modified by multiple social contextual factors.[42] A study by Luz et al examined the association between social capital and CRN in a population of older adults in Brazil and reported that low levels of social capital were associated with CRN.[43] The finding from this current study highlights the importance of considering social contextual factors, such as marriage (one of the main sources of social capital), when assessing CRN among older adults. In contrast to previous work, this analysis did not find CRN to be related to age, sex, number of medications, depression, lower participant incomes, and lack of drug coverage.[42,44] It is important to note that a recent systematic review of self-reported barriers to adherence to anti-hypertensive medications found that financial burden of medications is often underrepresented as a potential barrier to adherence in cardiovascular disease and, thus deserves further study.[45]

There are several potential limitations that deserve mention. The authors were unable to measure medication nonadherence for individual classes of medications. However, the approaches used in this study are similar to other studies interested in determining overall medication adherence.[16,46-48] Additionally, because this was an observational study, unmeasured factors may have confounded the results. There was, however, control for numerous demographic, health status, and access to health care factors. Another limitation is the fact that the measures of medication nonadherence used in this study had different self-reporting reference time frames (i.e., non-specific for MMAS-4 and 3 months for CRN-2). Furthermore, the measures of medication adherence used in this analysis were obtained at a single point in time, and may not reflect long-term behavior. Finally, the Health ABC participants were from two regions of the US, and thus these findings may not generalize to all other community-dwelling older adults.

CONCLUSION

Self-reported medication nonadherence was common in older adults with chronic cardiovascular conditions and only one factor – race – was associated with both cost and other sources of nonadherence. The research implication of this finding is that it highlights

the need to measure multiple potential types, or sources of self-reported nonadherence in older adults. Moreover, the administration of these quick measures in the clinical setting should help identify specific actions such as patient education or greater use of generic medications or pill boxes that may address barriers to medication nonadherence.

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Table 1

Characteristics of Year 10/11 Health ABC Coronary Heart Disease, Diabetes Mellitus, and Hypertension Sample (n=897)

Variable, n (%)	
Demographics	
Age, mean (SD)	82.1 (2.8)
Female	471 (52.5)
Black race	332 (37.0)
Education	
Less than high school	181 (20.2)
High school	297 (33.1)
Postsecondary	417 (46.5)
Missing	2 (0.2)
Literacy level	
≤6th grade	155 (17.3)
7th – 8th grade	151 (16.8)
≥ 9th grade	591 (65.9)
Memphis site	460 (51.3)
Married	405 (45.2)
Health Status Factors	
Coronary Heart Disease (CHD)	381 (42.5)
Diabetes Mellitus (DM)	338 (37.7)
Hypertension (HTN)	684 (76.3)
Number of chronic cardiovascular conditions (DM, CHD, HTN)	
1	492 (54.9)
2	304 (33.9)
3	101 (11.2)
Number of regularly scheduled medications	
0-4	360 (40.1)
5-8	377 (42.0)
≥ 9	160 (17.9)
Osteoporosis	100 (11.1)
Missing	15 (1.7)
Cancer	218 (24.3)
Depression (CES-D > 15)	96 (10.7)
Missing	68 (7.6)
Cognitive impairment (3MS < 80)	123 (13.7)
Missing	1 (0.1)
CVA	102 (11.4)

Variable, n (%)	
Dyslipidemia (LDL >130)	180 (20.1)
Missing	77 (8.6)
BMI (kg/m^2)	
< 25	253 (28.2)
25-30	378 (42.1)
> 30	266 (29.7)
Moderate/high intensity exercise	238 (26.5)
Missing	6 (0.7)
Self-rated health	
E/VG/G	686 (76.5)
F/P	205 (22.9)
Missing	6 (0.6)
Physical function limitation	233 (26.0)
Missing	1 (0.1)
Falls	287 (32.0)
Missing	7 (0.8)
Sleep disturbances	403 (44.9)
Missing	68 (7.6)
Vision problems	29 (3.2)
Hearing problems	43 (4.8)
Current smoker	26 (2.9)
Missing	6 (0.6)
Flu shot in previous year	729 (81.3)
Missing	15 (1.7)
Access to Health Care Factors	
Family income	
< $25,000	348 (38.8)
≥ $25,000	487 (54.3)
Missing	62 (6.9)
Needs met by income	
P	43 (4.8)
FW/VW	816 (91.0)
Missing	38 (4.2)
Home ownership	665 (74.1)
Missing	168 (18.7)
Other assets	
0	199 (22.2)
1-2	268 (29.9)
3-7	350 (39.0)

Variable, n (%)	
Missing	80 (8.9)
Health insurance	750 (83.6)
Missing	8 (0.9)
Prescription medication insurance	775 (86.4)
Missing	71 (7.9)
Usual place to go for health care	
Private doctor	800 (89.2)
Other[a]	89 (9.9)
Missing	8 (0.9)
Hospitalization in previous 6 months	113 (12.6)
Missing	8 (0.9)

Abbreviations: 3MS: modified mini-mental state exam; BMI: body mass index; CES-D: Center for Epidemiologic Studies Depression scale; CVA: cerebrovascular accident; E: excellent; F: fair; FW: fairly well; G: good; LDL: low density lipoprotein; P: poor; SD: standard deviation; VG: very good; VW: very well

[a]"Other" included: public clinic, HMO, hospital outpatient clinic, emergency room, or other

Table 2

Bivariate logistic regression analyses of medication nonadherence correlates in older adults with Coronary Heart Disease, Diabetes Mellitus, and Hypertension (n=897)

Potential Correlate	Nonadherence Outcome			
	MMAS-4		CRN-2	
	Odds Ratio (95% CI)	p-Value	Odds Ratio (95% CI)	p-Value
Demographic Factors				
Age	0.95 (0.91-1.00)	0.05	0.98 (0.90-1.07)	0.65
Sex: Male vs Female	0.99 (0.76-1.30)	0.96	0.69 (0.42-1.14)	0.15
Race: Black vs White	1.48 (1.12-1.95)	0.005	2.23 (1.36-3.65)	0.002
Education				
Postsecondary	1.00 (*Reference*)	--	1.00 (*Reference*)	--
Less than high school	1.35 (0.94-1.91)	0.10	2.27 (1.24-4.16)	0.008
High school	1.15 (0.85-1.55)	0.38	1.38 (0.76-2.49)	0.29
Literacy level				
≥ 9th grade	1.00 (*Reference*)	--	1.00 (*Reference*)	--
≤ 6th grade	1.13 (0.79-1.62)	0.50	2.35 (1.32-4.21)	0.004
7^{th}–8^{th} grade	1.15 (0.80-1.66)	0.44	1.62 (0.85-3.10)	0.14
Memphis site	1.32(1.01-1.72)	0.04	1.63 (0.98-2.70)	0.06
Married	0.95 (0.73-1.24)	0.70	0.37(0.21-0.65)	0.001
Health Status Factors				
Number of regularly scheduled medications				
0-4	1.00 (*Reference*)	--	1.00 (*Reference*)	--
5-8	1.26 (0.93-1.69)	0.13	1.08 (0.61-1.91)	0.17
≥9	1.16 (0.79-1.69)	0.45	1.78 (0.93-3.37)	0.18
Number of chronic cardiovascular conditions (DM, CHD, HTN)				
1	1.00 (*Reference*)	--	1.00 (*Reference*)	--
2	1.19 (0.89-1.59)	0.23	1.51 (0.89-2.57)	0.13
3	0.62 (0.39-0.99)	0.04	1.63 (0.77-3.45)	0.20
Osteoporosis	1.27 (0.84-1.93)	0.26	1.21 (0.58-2.52)	0.61
Cancer	0.82 (0.60-1.13)	0.22	0.71 (0.38-1.32)	0.27
Depression (CES-D > 15)	1.12 (0.73-1.72)	0.60	1.30 (0.62-2.72)	0.49
Cognitive impairment (3MS < 80)	0.99 (0.68-1.47)	0.98	0.94 (0.45-1.94)	0.86
CVA	1.34 (0.89-2.03)	0.17	1.18 (0.57-2.47)	0.65
Dyslipidemia (LDL >130)	1.19 (0.85-1.66)	0.31	1.17 (0.64-2.16)	0.61
BMI (kg/m^2)				
>30	1.00 (*Reference*)	--	1.00 (*Reference*)	--
<25	0.94 (0.66-1.34)	0.74	0.68 (0.36-1.26)	0.22

Potential Correlate	Nonadherence Outcome			
	MMAS-4		CRN-2	
	Odds Ratio (95% CI)	p-Value	Odds Ratio (95% CI)	p-Value
25-30	1.01 (0.74-1.39)	0.94	0.60 (0.34-1.07)	0.08
Moderate/high intensity exercise	0.88 (0.65-1.19)	0.40	0.68 (0.37-1.25)	0.21
Fair/poor self-rated health (vs. excellent/very good/good)	1.40(1.02-1.92)	0.04	2.03 (1.21-3.40)	0.008
Physical function limitation	1.25 (0.92-1.69)	0.15	1.94 (1.17-3.23)	0.011
Falls	1.51 (1.14-2.01)	0.004	0.78 (0.45-1.36)	0.38
Sleep disturbances	1.48 (1.12-1.96)	0.005	1.45 (0.86-2.43)	0.16
Vision problems	1.03 (0.49-2.18)	0.94	0.42 (0.06-3.13)	0.40
Hearing problems	0.86 (0.46-1.62)	0.63	0.57 (0.14-2.42)	0.45
Current smoker	1.06 (0.48-2.33)	0.89	2.24 (0.75-6.71)	0.15
Flu shot in previous year	0.70 (0.49-0.99)	0.04	0.72 (0.40-1.32)	0.29
Access to Health Care Factors				
Family income < $25,000	1.27 (0.96-1.68)	0.09	2.62 (1.54-4.46)	<0.001
Needs poorly met by income (vs. very well/fairly well)	1.39 (0.75-2.57)	0.29	4.36 (2.04-9.33)	<0.001
Home ownership	1.07 (0.63-1.80)	0.80	0.94 (0.36-2.44)	0.89
Other assets				
3-7	1.00 (*Reference*)	--	1.00 (*Reference*)	--
0	1.25 (0.88-1.78)	0.21	4.09 (2.11-7.95)	<0.0001
1-2	1.18 (0.85-1.63)	0.33	2.25 (1.14-4.47)	0.02
Health insurance	1.03 (0.71-1.49)	0.86	1.08 (0.54-2.17)	0.83
Prescription medication insurance	1.01 (0.57-1.79)	0.97	0.95 (0.33-2.73)	0.92
Private doctor as the usual place to go for health care (vs. Other[a])	0.93 (0.60-1.44)	0.74	2.58 (0.79-8.37)	0.12
Hospitalization in previous 6 months	1.43 (0.96-2.13)	0.08	1.05 (0.51-2.18)	0.89

Abbreviations: 3MS: modified mini-mental state exam; BMI: body mass index; CES-D: Center for Epidemiologic Studies Depression scale; CHD: coronary heart disease; CRN-2: 2-item cost-related nonadherence; CVA: cerebrovascular accident; DM: diabetes mellitus; HTN: hypertension; LDL: low density lipoprotein; MMAS-4: 4-item Morisky Medication Adherence Scale

[a]"Other" included: public clinic, HMO, hospital outpatient clinic, emergency room, or other

Table 3

Multivariable logistic regression of backward-selected correlates of MMAS-4 and CRN-2 (n=897)

Potential Correlate	Nonadherence Outcome					
	Model of backward-selected correlates of MMAS-4[a]		Model of *significant* backward-selected correlates of MMAS-4 forced on CRN-2[b]		Model of backward-selected correlates of CRN-2[c]	
	Adjusted Odds Ratio (95% CI)	p-Value	Adjusted Odds Ratio (95% CI)	p-Value	Adjusted Odds Ratio (95% CI)	p-Value
Demographic Factors						
Age	0.96 (0.91-1.02)	0.20	--	--	--	--
Sex: Male vs. Female	1.30 (0.91-1.87)	0.15	--	--	--	--
Race: Black vs. White	1.85 (1.25-2.74)	0.002	2.14 (1.26-3.62)	0.005	--	--
Education						
Postsecondary	1.00 (*Reference*)	--	--	--	--	--
< high school	0.92 (0.55-1.54)	0.75				
High school	1.14 (0.78-1.65)	0.50				
Literacy level						
≥ 9th grade	1.00 (*Reference*)	--	--	--	1.00 (*Reference*)	--
≤ 6th grade	1.12 (0.59-2.10)	0.74			1.87 (0.97-3.63)	0.06
7th – 8th grade	0.82 (0.51-1.29)	0.39			1.51 (0.75-3.06)	0.25
Married	0.84 (0.59-1.19)	0.33	--	--	0.53 (0.28-0.99)	0.049
Health Status Factors						
Number of chronic cardiovascular conditions (DM, CHD, HTN)						
1	1.00 (*Reference*)	--	--	--	--	--
2	1.21 (0.86-1.69)	0.27				
3	0.56 (0.32-0.97)	0.04				
Cancer	0.68 (0.47-0.99)	0.04	0.73 (0.38-1.41)	0.35	--	--
Fair/poor self-rated health (vs. excellent/very good/good)	--	--	--	--	1.80 (1.02-3.19)	0.04

Potential Correlate	Nonadherence Outcome					
	Model of backward-selected correlates of MMAS-4[a]		Model of *significant* backward-selected correlates of MMAS-4 forced on CRN-2[b]		Model of backward-selected correlates of CRN-2[c]	
	Adjusted Odds Ratio (95% CI)	p-Value	Adjusted Odds Ratio (95% CI)	p-Value	Adjusted Odds Ratio (95% CI)	p-Value
Physical function limitation	1.13 (0.79-1.63)	0.51	--	--	--	--
Falls	1.49 (1.07-2.07)	0.02	0.73 (0.40-1.32)	0.29	--	--
Sleep disturbances	1.38 (1.01-1.88)	0.04	1.43 (0.84-2.43)	0.18	--	--
Flu shot in previous year	0.77 (0.51-1.17)	0.22	--	--	--	--
Access to Health Care Factors						
Family income <$25,000	--	--	--	--	1.58 (0.85-2.92)	0.15
Needs poorly met by income (vs. very well/fairly well)					2.77 (1.22-6.29)	0.02
Other assets			--	--	--	--
3-7	1.00 (*Reference*)	--				
0	0.88 (0.54-1.42)	0.59				
1-2	1.04 (0.71-1.53)	0.84				
Private doctor as the usual place to go for health care (vs. Other[a])					3.24 (0.96-10.93)	0.06
Hospitalization in previous 6 months	1.97 (1.22-3.17)	0.005	0.77 (0.30-1.99)	0.59	--	--

Abbreviations: CHD: coronary heart disease; CRN-2: 2-item cost-related nonadherence; DM: diabetes mellitus; HTN: hypertension; MMAS-4: 4-item Morisky Medication Adherence Scale

[a]Hosmer and Lemeshow Goodness-of-Fit Test: p=0.95; $x2$=2.75; df=8

[b]Hosmer and Lemeshow Goodness-of-Fit Test: p=0.94; x^2=2.33; df=8

[c]Hosmer and Lemeshow Goodness-of-Fit Test: p=0.59; x^2=4.63; df=8

[d]"Other" included: public clinic, HMO, hospital outpatient clinic, emergency room, or other