



Health Behavior

Does Cost-Related Medication Nonadherence among Cardiovascular Disease Patients Vary by Gender? Evidence from a Nationally Representative Sample



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A B S T R A C T

Introduction: Cardiovascular disease (CVD) is a leading cause of death and disability as well as a major burden on the U.S. healthcare system. Cost-related medication nonadherence (CRN) to prescribed medications is common among patients with CVD. This study examines the gender differences in CRN among CVD patients.

Methods: We used 2011 to 2014 data from the National Health Interview Survey, an annual, cross-sectional, nationally representative household survey of the noninstitutionalized U.S. civilian population (≥ 18 years of age). Based on Andersen's model of health services utilization, multivariate logistic regressions were estimated to examine the effect of gender on the primary composite outcome of CRN which was identified if any of the following types of CRN were reported: 1) skipped medication doses to save money, 2) took less medication to save money, and 3) delayed prescription filling to save money.

Results: Among CVD patients who had used a prescription medication in the last 12 months, 10.0% skipped medication doses, 10.6% took less medication, and 12.8% delayed filling their prescriptions. After adjusting for confounding factors, gender was found to be significantly associated with the composite outcome of CRN among CVD patients. Women were 1.54 times (95% confidence interval, 1.33–1.77) more likely to have any of the types of CRN compared with men.

Conclusion: There are significant gender disparities in CRN among CVD patients. More support for and closer monitoring of CRN is needed for disadvantaged groups, especially women with limited resources.

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With nearly 17.3 million deaths worldwide resulting from cardiovascular disease (CVD) and mortality projections to reach 23.6 million by 2030, CVD conditions are a major public health concern globally and in the United States (Mozaffarian et al., 2015). In fact, CVD is the leading cause of death

and disability in the United States (Cooper et al., 2000; Ford et al., 2007; Mensah & Brown, 2007) and there are currently about 86 million people (>25% of the U.S. population) who have some variability of CVD conditions (Mozaffarian et al., 2015). In 2011, CVD accounted for approximately 32% of deaths in the United States, with one out of every seven CVD-related deaths being attributed to coronary heart disease (Mozaffarian et al., 2015). Without a significant change in the current heart disease prevention environment, the burden of CVD is expected to increase because of the increasingly high rates of obesity, diabetes,

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and other risk factors, coupled with a growing aging population in the United States (Go et al., 2013).

Although many prescription drugs are proven to be effective in the prevention and treatment of CVD, medication nonadherence remains a major barrier to optimum health outcomes. The World Health Organization defines adherence as “the extent to which a person’s behavior—taking medication, following a diet, and/or executing lifestyle changes—corresponds with agreed recommendations from a healthcare provider” (Sabaté, 2003). Patients are generally considered adherent if they are able to take their medication as directed at least 80% of the time (Cramer et al., 2008; Hansen et al., 2009). Medication nonadherence has negative consequences, including increased rates of health care utilization, morbidity, and mortality (Ho, Bryson, & Rumsfeld, 2009). Socioeconomic barriers such as poverty, unemployment, and inadequate health care coverage; health system issues such as gaps in provider–patient communication, lack of motivational factors; conflicting priorities such as food; and concern about the cost of medications contributes to medication nonadherence among CVD patients (Baroletti & Dell’Orfano, 2010). Increasing patient share to the cost of procuring prescription medications is also associated with poor medication adherence (Eaddy, Cook, O’Day, Burch, & Cantrell, 2012).

Cost-related medication nonadherence (CRN), defined as patients not taking medication as prescribed because of their inability to pay, is a common and significant problem among patients with chronic conditions, including CVD (Briesacher, Gurwitz, & Soumerai, 2007). Patients frequently attempt to decrease their medication costs by skipping their medication, delaying the refills of their prescribed medications, or splitting their pills. These cost-driven behaviors have been observed to prevent patients from achieving the full therapeutic benefits of the treatment and put them at risk of poor health (Briesacher et al., 2007; Soumerai et al., 2006). CRN ultimately results in recurrent cardiovascular events, poor health outcomes, and decreased the quality of life for patients with chronic diseases (Iuga & McGuire, 2014).

Previous studies have identified CRN across various medical conditions and have recognized patients at specific risk for CRN. In one study of Medicare beneficiaries, increased CRN was observed among low-income diabetes patients and among those taking cholesterol-lowering and hypertension medications (Williams, Steers, Ettner, Mangione, & Duru, 2013). Kidney transplant recipients have difficulty paying for their immunosuppressive medications, with the resultant graft losses directly attributable to CRN (Evans et al., 2010). Similar to other chronic conditions, CRN is equally common among CVD patients. An estimated 50% of nonadherence to medications among patients with CVD was reported to be owing to cost-related factors (Kronish & Ye, 2013). Better CVD medication adherence can improve patient outcomes and, subsequently, reduce total health care costs (Iuga & McGuire, 2014).

Risk factors for medication nonadherence among CVD patients can range from, but are not limited to, depression (Zivin, Ratliff, Heisler, Langa, & Piette, 2010), food insecurity (Bengle et al., 2010), mood and medication beliefs (Kurlander, Kerr, Krein, Heisler, & Piette, 2009; Piette, Rosland, Silveira, Hayward, & McHorney, 2011), doctor–patient discordance (Jackson, Clatworthy, Robinson, & Horne, 2010), and being a woman (Puskas et al., 2011). Puskas et al. (2011) observed a significant disparity in medication adherence between men and women on antiretroviral therapy, with lower adherence being reported among women. In a meta-analysis of gender and racial

disparities in adherence to statin therapy, Lewey et al. (2013) noted that women have a 10% higher odds of nonadherence compared with men (Lewey et al., 2013).

Although CRN is particularly problematic among the uninsured, underinsured, and the elderly (Kennedy & Morgan, 2009; Soumerai et al., 2006), gender is identified as one of the important determinants of CRN (Rolnick, Pawloski, Hedblom, Asche, & Bruzek, 2013). Women with hypertension and hyperlipidemia reported lower adherence compared with men with the same diagnoses (Rolnick et al., 2013). Although gender was not found to be a significant predictor of CRN in the systematic review (Briesacher et al., 2007), other studies reported that women were more likely to experience CRN compared with men (Billimek et al., 2015; Heisler et al., 2004; Kennedy, Coyne, & Sclar, 2004; Zivin et al., 2010). Recently, a large, nationally representative study of U.S. cancer survivors showed that women have higher rates of CRN compared with men, even after controlling for various confounding factors (Lee & Khan, 2015). To our knowledge, no study has examined gender differences in CRN among patients with CVD. Despite the high prevalence of CVD among U.S. populations and high rates of CRN among CVD patients, little is known about CRN among CVD patients, especially the gender differences in CVD-related CRN. The purpose of this study is to narrow these knowledge gaps by exploring the gender-related differences in CRN among CVD patients.

Materials and Methods

Data and Sample

For this study, we used data from the most recently available 2011 to 2014 U.S. National Health Interview Survey (NHIS) maintained by the National Center for Health Statistics. The NHIS is an annual cross-sectional household survey of noninstitutionalized civilian adults (≥ 18 years of age) who were residing in the United States at the time of the interview. The main objective of the NHIS is to monitor the health and the healthcare characteristics of the U.S. population.

A nationally representative survey sample was obtained using a stratified, multistage probability study design with unequal probabilities of selection. Specific subgroups of people including major racial/ethnic minorities were purposefully oversampled in the NHIS. Strategies for sampling and methodologies for data collection were similar throughout the selected years to maintain consistency and to facilitate comparison (available: www.cdc.gov/nchs/nhis.htm). The complex survey design was adjusted to derive nationally representative estimates, with population sampling being applied. The sample in this current study comprised three components of NHIS data: the adult’s sample file, person file, and family file. The three files were linked together using a common identifier. The study sample was further restricted to the current adult population (≥ 18 years of age) who were suffering from CVD and had been prescribed at least one medication in the past 12 months. This resulted in a final sample of 14,226 adults for this study.

Measures

Dependent variables

Our outcome of interest was CRN measured by three survey questions: 1) skipped medication doses to save money, 2) took less medication to save money, and 3) delayed prescription filling to save money. The skipped medication doses variable was

obtained from the response to the question, “During the past 12 months, were any of the following true for you?...You skipped medication doses to save money.” The taking less medication variable was based on the response to the question, “During the past 12 months, were any of the following true for you?...You took less medication to save money.” The variable delay of prescription filling was obtained through responses to the question, “During the past 12 months, were any of the following true for you?...You delayed filling a prescription to save money.” The responses for these three outcome variables representing CRN to prescription drug use were categorized as ‘yes’ or ‘no.’ We also created a primary composite outcome for CRN and coded it as positive if any of three responses to the questions was a “yes.”

Independent variables

We used Andersen's model of health services utilization to guide the selection of the independent variables of interest (Andersen, 1995). Based on Andersen's Model, predisposing, enabling, and need factors explain a person's health-seeking behavior (Andersen, 1995). Predisposing factors include demographic and sociocultural factors, such as respondents' gender, age, marital status, and race. The key independent variable in our study was the gender of the respondent, which was categorized as ‘men’ or ‘women.’ Age was categorized into four groups as 18 to 29, 30 to 44, 45 to 64, and 65 years and greater. Marital status was dichotomized as married or not married. Race/ethnicity of the respondent was grouped into Non-Hispanic White, Non-Hispanic Black, Hispanic, and Non-Hispanic others.

Enabling factors, the resources that are available to a person to be able to seek health care (Andersen, 1995) included the respondents' poverty level, education, health insurance status, and usual source of care. Educational level was categorized into less than high school, high school, and some college and above. We categorized health insurance status into three groups—no insurance, private insurance, and public insurance. Poverty level was measured by the calculation of a poverty-income ratio defined as the ratio of family income to the federal poverty threshold for a family of a given size, with a poverty-income ratio of less than 1 being defined as poor. We grouped this ratio as less than 1 (poor), 1 to 2 (near poor), and greater than 2 (nonpoor). Usual source of care (having a healthcare facility, rather than emergency department, that respondents usually go to when they are sick or need advice about health) was dichotomized as ‘yes’ or ‘no.’

Finally, need factors refer to existing medical problems and unhealthy behaviors (Andersen, 1995). These factors included respondents' self-reported health, body mass index (BMI), smoking status, alcohol use, functional limitation status, and whether or not the respondent had a heart disease or cancer. One prior study examining physician perception of patients' adherence to medications by obesity status reported that BMI is negatively associated with medication adherence (Huizinga, Bleich, Beach, Clark, & Cooper, 2010). There is also evidence to suggest that individuals with functional limitations are more likely to experience CRN compared with individuals with no functional limitations (Zhang, Lee, Pandey, & Meltzer, 2015). Self-reported health was categorized as ‘good and above’ (includes good, very good, and excellent health) and ‘fair and below’ (includes fair and poor health). We classified BMI into “underweight” (BMI <18.5), “normal weight” (BMI between 18.5 and 24.9), “overweight” (BMI between 25 and 29.9), “obese” (BMI between 30 and 39.9), and “severely obese” (BMI ≥40). Self-reported smoking status was categorized as “current smoker”

versus “not a current smoker,” and alcohol use was categorized as “heavy/medium” or “light/none.” The presence or absence of two major diseases—CVD and cancer—were dichotomized as ‘yes’ or ‘no.’

Analysis

The unit of analysis was the individual respondent. We conducted a descriptive analysis comparing the usual source of care for respondents and their predisposing, enabling, and need factors between those with and without any of the three types of medication CRN. We used χ^2 tests to examine bivariate associations between each of the three types of CRN and independent variables. Multivariate logistic regressions were used to model the association between the primary composite CRN outcome and gender, controlling for other covariates. We performed all the statistical analyses using Stata SE 13.0 (StataCorp, College Station, TX).

Results

Of the 14,226 respondents in our sample who were diagnosed with CVD and were prescribed a medication in the past 12 months, 10.0% reported skipping medications, 10.6% taking less medication and 12.8% delaying filling their prescriptions to save money (Table 1). In terms of demographic characteristics, about one-half of the respondents (47.0%) were women and slightly less than one-half (46.2%) were 65 years of age or older. Non-Hispanic Whites constituted 77.4% of the study sample and only 6.8% of respondents had less than high school education. More than one-half of respondents (55.5%) were married. The most common form of insurance was public insurance (53.2%) and only 7.5% of the respondents reported having no insurance. A majority of the respondents (65.3%) reported a good health status, whereas 34.7% reported a fair and below health status. The incidence of smoking was 18.6% and 69.6% of respondents reported at least one functional limitation. Diabetes and cancer comorbidities along with CVD were reported among 25.3% and 20.3% of respondents, respectively. In terms of gender differences, women were significantly more likely to skip medication doses (12.1% vs. 8.1%), take less medication (13.1% vs. 8.4%), and delay filling prescriptions (15.8% vs. 10.2%) compared with men to save money. Among the CVD patients in this sample, women were likely to be younger, unmarried, non-White, less educated, poorer, underweight or obese, nonsmokers, lighter drinkers, have fair and below health status, and have a usual source of care and functional limitations.

Table 2 presents descriptive statistics for each of the different CRN behaviors such as “skipping medication doses,” “taking less medication,” and delaying filling prescriptions for several relevant independent variables. Based on the predisposing and enabling factors with no adjustment for covariates, CRN behaviors in general were more likely among women, the uninsured, and those who had no usual source of care. Considering the need factors, those who rated their health as fair or poor, had higher BMI, were current smokers, and had a functional limitation were more likely to report CRN behaviors.

Table 3 presents results of the multivariate logistic regressions for CRN and gender, while controlling for other predisposing, enabling, and need factors. Women were approximately 50% more likely (odds ratio [OR], 1.54; 95% confidence interval [CI], 1.33–1.77) to have CRN behaviors than men. For the other predisposing factors, respondents who were

Table 1
Analytical Sample Description (n = 14,226)

	n	All	Men	Women	p Value
Dependent variables					
Skipped medication doses to save money	1,450	10.0 (9.3–10.7)	8.1 (7.2–9.0)	12.1 (11.0–13.3)	<.001
Took less medication to save money	1,562	10.6 (9.9–11.4)	8.4 (7.5–9.4)	13.1 (12.1–14.3)	<.001
Delayed filling prescription to save money	1,853	12.8 (12.1–13.6)	10.2 (9.2–11.2)	15.8 (14.6–17.1)	<.001
Overall medication nonadherence owing to costs	2,166	14.9 (14.1–15.8)	12.2 (11.2–13.3)	18.0 (16.8–19.3)	<.001
Predisposing factors					
Gender					
Men	6,923	53.0 (51.9–54.1)	N/A	N/A	N/A
Women	7,303	47.0 (45.9–48.1)	N/A	N/A	N/A
Age (y)					
18–29	627	5.1 (4.6–5.7)	4.9 (4.3–5.7)	5.3 (4.7–6.1)	.004
30–44	1,266	10.2 (9.5–10.9)	9.0 (8.2–10.0)	11.5 (10.4–12.7)	
45–64	5,026	38.4 (37.3–39.7)	39.2 (37.5–40.8)	37.6 (36.0–39.2)	
≥65	7,307	46.2 (45.0–47.5)	46.8 (45.1–48.5)	45.6 (43.9–47.3)	
Marital status					
Married	5,988	55.5 (54.4–56.6)	64.7 (63.3–66.0)	45.2 (43.7–46.8)	<.001
Not married	8,238	44.5 (43.4–45.5)	35.3 (34.0–36.7)	54.8 (53.2–56.3)	
Race/ethnicity					
Non-Hispanic White	10,100	77.4 (76.5–78.3)	79.7 (78.5–80.9)	74.8 (73.5–76.1)	<.001
Non-Hispanic Black	1,974	10.1 (9.5–10.8)	8.3 (7.5–9.2)	12.1 (11.2–13.2)	
Hispanic	1,337	7.6 (7.0–8.2)	7.3 (6.5–8.1)	7.9 (7.2–8.7)	
Non-Hispanic Other	815	4.9 (4.5–5.4)	4.6 (4.1–5.3)	5.2 (4.5–5.9)	
Enabling factors					
Education attainment					
Less than high school	1,227	6.8 (6.2–7.3)	6.6 (5.9–7.3)	7.0 (6.3–7.8)	.039
High school	5,686	38.9 (37.7–40.0)	37.8 (36.2–39.4)	40.1 (38.6–41.7)	
Some college and above	7,313	54.3 (53.1–55.5)	55.6 (53.9–57.3)	52.9 (51.3–54.5)	
Health insurance					
Private	6,949	53.2 (52.0–54.4)	54.1 (52.4–55.7)	52.3 (50.7–53.8)	.143
Public	6,232	39.3 (38.2–40.5)	38.3 (36.8–39.9)	40.5 (38.9–42.0)	
No coverage	1,045	7.5 (6.9–8.1)	7.6 (6.8–8.6)	7.3 (6.6–8.1)	
Poverty ratio					
<1	2,765	14.7 (13.9–15.5)	11.8 (10.8–12.8)	18.0 (16.9–19.1)	<.001
1–2	3,381	20.6 (19.7–21.4)	18.9 (17.7–20.1)	22.4 (21.3–23.6)	
>2	8,080	64.7 (63.6–65.9)	69.4 (67.8–70.9)	59.6 (58.0–61.1)	
Usual source of care					
Yes	13,371	93.9 (93.3–94.4)	93.0 (92.1–93.8)	94.8 (94.2–95.4)	<.001
No	855	6.1 (5.6–6.7)	7.0 (6.2–7.9)	5.2 (4.6–5.8)	
Need factors					
Self-reported health					
Excellent, very good, or good	8,896	65.3 (64.3–66.4)	66.8 (65.3–68.3)	63.7 (62.2–65.1)	.003
Fair or poor	5,330	34.7 (33.6–35.7)	33.2 (31.7–34.7)	36.3 (34.9–37.8)	
BMI					
Underweight (<18.5)	266	1.9 (1.6–2.3)	1.3 (0.9–1.7)	2.7 (2.2–3.3)	<.001
Normal weight (18.5–24.9)	3,787	26.6 (25.6–27.6)	22.8 (21.6–24.1)	30.8 (29.4–32.3)	
Overweight (25–29.9)	4,892	34.6 (33.5–35.7)	39.6 (38.1–41.2)	28.9 (27.5–30.4)	
Obese (30–39.9)	4,306	30.3 (29.3–31.3)	31.3 (29.9–32.8)	29.1 (27.6–30.6)	
Severely obese (≥40)	975	6.6 (6.1–7.1)	4.9 (4.4–5.5)	8.4 (7.6–9.4)	
Current smoker					
Yes	2,620	18.6 (17.7–19.6)	19.8 (18.5–21.1)	17.3 (16.2–18.5)	.005
No	11,606	81.4 (80.4–82.3)	80.2 (78.9–81.5)	82.7 (81.5–83.8)	
Alcohol use					
Heavy or medium	2,257	17.4 (16.6–18.4)	23.4 (22.0–24.8)	10.8 (9.8–11.9)	<.001
Light or none	11,969	82.6 (81.6–83.4)	76.6 (75.2–78.0)	89.2 (88.1–90.2)	
Functional limitation					
Not limited in any way	3,894	30.4 (29.3–31.5)	35.9 (34.3–37.4)	24.2 (22.9–25.6)	<.001
Has a functional limitation	10,332	69.6 (68.5–70.7)	64.1 (62.6–65.7)	75.8 (74.4–77.1)	
Diabetes					
Yes	3,802	25.3 (24.3–26.2)	26.1 (24.7–27.5)	24.3 (23.1–25.6)	.053
No	10,424	74.7 (73.8–75.7)	73.9 (72.5–75.3)	75.7 (74.4–76.9)	
Cancer					
Yes	2,976	20.3 (19.4–21.2)	20.3 (19.2–21.5)	20.2 (19.1–21.4)	.908
No	11,250	79.7 (78.8–80.6)	79.7 (78.5–80.8)	79.8 (78.6–80.9)	

Abbreviations: BMI, body mass index; N/A, not applicable.

30 to 44 years of age were about 1.9 (OR, 1.90; 95% CI, 1.35–2.66) times more likely, whereas those who were 65 years and older were 60% less likely to have CRN behaviors compared with those who were 19 to 29 years of age. In terms of the enabling factors, those with no insurance were 3.7 times more likely (OR, 3.67;

95% CI, 2.95–4.57) to have CRN behaviors compared with those with private insurance. Furthermore, those with a poverty ratio of greater than 2 were 33% less likely (OR, 0.67; 95% CI, 0.55–0.82) to have CRN behaviors compared with poverty ratios of less than 1 (poor). For need factors, respondents with a self-reported

Table 2
Descriptive Statistics of Independent Variables by Types of Cost-related Medication Nonadherence for Patients with Cardiovascular Disease (n = 14,226)

	Skipped Medication Doses (Weighted %)	Took Less Medication (Weighted %)	Delayed Filling Prescription (Weighted %)	Overall Medication Nonadherence (Weighted %)
Predisposing factors				
Gender				
Men	8.1	8.4	10.2	12.2
Women	12.1	13.1	15.8	18.0
Age (y)				
18–29	10.5	11.6	14.8	16.4
30–44	19.6	20.9	26.0	28.1
45–64	14.8	15.4	18.0	20.9
≥65	3.7	4.3	5.4	6.9
Marital status				
Married	8.3	8.8	10.8	12.6
Not married	12.1	12.9	15.3	17.9
Race/ethnicity				
Non-Hispanic White	9.1	9.6	12.0	13.8
Non-Hispanic Black	15.4	16.4	18.4	22.3
Hispanic	13.1	14.1	15.3	18.3
Non-Hispanic Other	8.0	9.1	10.5	12.4
Enabling factors				
Education				
Less than high school	9.2	10.1	12.2	14.1
High school	10.7	11.5	13.9	16.2
Some college and above	9.6	10.1	12.1	14.2
Health insurance				
Private	6.6	7.0	9.1	10.7
Public	9.8	10.7	12.7	15.0
No coverage	34.5	36.0	39.8	45.4
Poverty ratio				
<1	19.2	20.6	22.6	25.7
1–2	14.3	15.3	19.0	21.8
>2	6.5	6.9	8.6	10.3
Usual source of care				
Yes	9.1	9.7	11.9	13.9
No	23.0	25.4	26.8	31.1
Need factors				
Self-reported health				
Excellent, very good, or good	6.6	7.0	8.7	10.4
Fair or poor	16.4	17.6	20.6	23.5
BMI				
Underweight (<18.5)	9.9	10.4	13.4	14.5
Normal weight (18.5–24.9)	9.1	10.0	11.3	13.1
Overweight (25–29.9)	7.5	8.1	10.2	11.9
Obese (30–39.9)	12.1	12.7	15.1	18.0
Severely obese (≥40)	16.7	16.9	22.5	24.7
Current smoker				
Yes	18.9	20.7	24.2	27.1
No	7.9	8.3	10.2	12.2
Alcohol use				
Heavy or medium	9.4	9.5	10.9	13.3
Light or none	10.1	10.9	13.2	15.3
Functional limitation				
Not limited in any way	5.0	5.1	6.8	8.1
Has a functional limitation	12.1	13.0	15.5	17.9
Diabetes				
Yes	12.3	12.7	16.0	18.6
No	9.2	9.9	11.8	13.7
Cancer				
Yes	8.6	9.6	11.9	13.6
No	10.3	10.9	13.1	15.3

Abbreviation: BMI, body mass index.

health of excellent, very good or good were 0.4 times less likely (OR, 0.57; 95% CI, 0.49–0.67), and current smokers were 1.6 times more likely (OR, 1.57; 95% CI, 1.35–1.82) to have CRN behaviors to save money. Those with diabetes and functional limitations were also more likely to have CRN behaviors. We performed additional analyses to examine if there were any significant interactions between gender, age, marital status, and poverty status, but none were significant (results not shown). We performed a further

sensitivity analysis by restricting the sample to the CVD patients with functional limitations, the results remained the same (results not shown).

Discussion

In this nationally representative sample of individuals with a CVD condition who were prescribed at least one medication in

Table 3Adjusted Multivariate Logistic Regression for Differences in Cost-related Medication Nonadherence for Patients with Cardiovascular Disease ($n = 14,226$)

	Medication Nonadherence
Predisposing factors	
Women (Ref = men)	1.54*** (1.33–1.77)
Age, y (Ref = 19–29 years)	
30–44	1.90*** (1.35–2.66)
45–64	1.14 (0.83–1.56)
≥65	0.40*** (0.29–0.56)
Married (Ref = not married)	1.02 (0.89–1.17)
Race/ethnicity (Ref = Non-Hispanic White)	
Non-Hispanic Black	1.12 (0.91–1.37)
Hispanic	0.95 (0.73,1.22)
Non-Hispanic other	0.73 (0.53,1.01)
Enabling factors	
Education attainment (Ref = less than high school)	
High school	1.14 (0.90–1.46)
Some college and above	1.42** (1.09–1.84)
Health insurance (Ref = private insurance)	
Public	0.99 (0.84–1.16)
No coverage	3.67*** (2.95–4.57)
Poverty ratio (Ref = <1)	
1–2	1.24* (1.03–1.49)
>2	0.67*** (0.55–0.82)
Having usual source of care (Ref = no)	0.75* (0.58–0.98)
Need factors	
Self-reported health (Ref = fair or poor)	
Excellent, very good, or good	0.57*** (0.49–0.67)
BMI (Ref = underweight [<18.5])	
Normal weight (18.5–24.9)	1.16 (0.76–1.78)
Overweight (25–29.9)	1.09 (0.71–1.69)
Obese (30–39.9)	1.43 (0.92–2.24)
Severely obese (≥ 40)	1.37 (0.84,2.23)
Current smoker (Ref = not a current smoker)	1.57*** (1.35–1.82)
Alcohol use (Ref = light or none)	
Heavy or medium use	1.14 (0.92–1.41)
Functional limitation (Ref = not limited in any way)	
Has a functional limitation	2.34*** (1.89–2.91)
Diabetes	1.42*** (1.21–1.65)
Cancer	1.15 (0.97–1.36)

Abbreviations: BMI, body mass index.

Note: Exponentiated coefficients; 95% confidence intervals in brackets. Adjusted for survey years.

* $p < .05$, ** $p < .01$, *** $p < .001$.

the last 12 months, the study results showed that 10.0% skipped medication doses, 10.6% took less medication, and 12.8% delayed filling their prescriptions. After adjusting for several confounding factors, women with CVD were more likely to experience CRN compared with men. Additionally, among all CVD patients, having no insurance, being in a poorer health, and being a current smoker were associated with CRN. With the high and increasing costs of CVD medications, this study to examine gender differences in CRN among patients with CVD adds to the literature and has the potential for clinical intervention. The study results show significant gender differences in CRN among CVD patients.

These findings are consistent with the previous literature on CRN. Gender differences in medication nonadherence had been observed in a few studies. For example, a meta-analysis of gender and racial disparities in adherence to statin therapy showed that women had a 10% higher odd of nonadherence compared with men (Lewey et al., 2013). Billimek et al. (2015) found that medication nonadherence was an important contributor to poorer lipid control among women with diabetes. Puskas et al. (2011) observed a significant disparity in the medication adherence between men and women on antiretroviral therapy, with lower adherence being reported among women. Similarly,

Rolnick et al. (2013) showed that women with hypertension and hyperlipidemia had lower adherence compared with men with the same diagnoses.

In a multicenter, cross-sectional study of adult patients across 11 countries who had undergone heart transplants, Schoenfeld et al. (2015) reported that CRN was higher among women participants compared with men. Similarly, Lee and Khan (2015) demonstrated a significant gender disparity in CRN among cancer survivors, with more women reporting CRN compared with men even after controlling for several possible confounding factors, such as health status, insurance status, and other socioeconomic variables. Although it is not clear why women with CVD are likely to experience CRN compared with men with CVD, women tend to have major social and family roles and might feel some responsibility for the care of their families (Revenson et al., 2016). It is also reasonable to speculate that they skip medications or delay their prescription refills to save money that could be used to take care of their other family responsibilities. If true, our results showing gender disparities in CRN have major implications for the design of interventions, policies, and programs to support and monitor women CVD patients who may be at risk for poorer health and worse CVD outcomes because they want to prioritize their social and family role functions.

Similar to the Lee and Khan (2015) study, we used Andersen's model of health services uses to explain the gender disparities in CRN for CVD. Following this framework, we accounted for the predisposing, enabling, and need factors that may influence patients' CRN behavior. Although this model allows us to account for the multiple influences on health services use and health care use, it also shows that outcomes could in turn affect a patient's perceived need for a health service as well as their predisposing factor. For example, although being in poor health (a perceived need/need factor) may increase the risk for CRN, being non-adherent to a medication could also increase the risk for poor health (Andersen, 1995). Future research should explore the mechanisms, directionality, and causal pathways that link patient-related factors to their behavior in medication use or health service use.

In previous research, CRN was reported to be more likely among the elderly, individuals without insurance and ethnic minorities (Ho et al., 2009; Kennedy & Morgan, 2009; Soumerai et al., 2006). These findings are partly consistent with our study; a lack of insurance and poverty were significantly associated with CRN. Soumerai et al. (2006) noted that CRN was more likely in elderly patients. A similar CRN experience among younger age groups was reported by Schoenfeld et al. (2015). These age-related differences could possibly be due to the availability of Medicare to individuals who are 65 years of age or older who might have prescription drug insurance through their health plan, making the cost of their medications less expensive and possibly lessening the report of CRN among the older population.

Having no insurance, being in a poorer health, and being a current smoker were associated with CRN. Williams et al. (2013) showed that individuals with a lower income ($< \$25,000$) had an increased risk for CRN compared with individuals with more income ($> \$40,000$). It is likely that the low-income group also had no insurance, thereby increasing their risk for CRN. A recent study using the NHIS data showed that having Medicare Part D did not eliminate the problem of CRN among stroke survivors (Levine et al., 2013). Similar to our study, this study showed an increased risk for CRN among women and those with lower health status, high comorbidity score, greater poverty, no health insurance, and more functional limitations. With the results of

this study showing the continued prevalence of CRN among patients with CVD, it is concerning that having insurance may not alleviate the problem or reduce the risk of CRN. As is evident by the gender differences in CRN, it is possible that addressing the problem of CRN needs to evolve beyond having health insurance and better income, and extend to other sociodemographic-related and behavioral risk factors and/or psychosocial reasons for CRN.

Despite using a nationally representative sample of individuals, there are several limitations of this study that must be considered. First, the use of a cross-sectional study design means that only associations can be detected and no causality can be established. This research design issue should be considered before making causal conclusions reported in this study. Second, we only focused on the CRN and could not measure other important contextual factors such as patient–provider communication, organizational factors, or patient psychosocial factors such as patient beliefs in medicines and illness that may influence medication adherence. Women have a higher propensity to use health services and complete health-related surveys. Hence, men might have been less forthcoming in admitting to CRN during survey data collection. Finally, this study's questions about CRN were asked with regard to the past 12 months medication behavior. This introduces a high possibility for recall bias, which could lead to overestimated or underestimated CRN. Additionally, the measure of CRN that was used in this study did not capture the extent of nonadherence, nor did it evaluate specifically nonadherence for other reasons such as concerns about side effects, lack of self-efficacy, or confusion about instructions.

Implications for Practice and/or Policy

Monitoring CRN among certain population subgroups, especially for women with CVD and individuals with poor health, is needed, especially as adherence research moves toward the development of tailored patient-centered interventions. Support needs to be provided to these disadvantaged groups to improve their medication adherence. The higher rates of CRN in women compared with men may also help to explain gender-related disparities in health outcomes for women. Our study also suggests that the current programs or interventions aimed at improving adherence in women should particularly focus on cost-related barriers.

Conclusions

This study showed significant gender disparities in CRN to prescription medications by CVD patients in a national sample after controlling for predisposing, enabling, and need factors. Future research should focus on CRN outcomes, and examine whether these outcomes differ with varying levels of CRN among various subgroups.

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