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Author manuscript

J Health Care Poor Underserved. Author manuscript; available in PMC 2018 January 01.

Published in final edited form as:

J Health Care Poor Underserved. 2017 ; 28(1): 499–513. doi:10.1353/hpu.2017.0036.

Financial Strain is Associated with Medication Nonadherence and Worse Self-rated Health among Cardiovascular Patients

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Abstract

Non-traditional indicators of socioeconomic status (SES; e.g., home ownership) may be just as or even more predictive of health outcomes as traditional indicators of SES (e.g., income). This study tested whether financial strain (i.e., difficulty paying monthly bills) predicted medication non-adherence and worse self-rated health. Research assistants administered surveys to 1,527 patients with acute coronary syndromes or acute decompensated heart failure. In adjusted models, a higher income was associated with greater adherence ($p < .001$), but was non-significant when adjusted for financial strain. Education, income, less financial strain, and being employed were each associated with better self-rated health ($p < .001$). Financial strain was associated with less adherence ($\beta = -.17$, $p < .001$) and worse self-rated health ($\beta = -.23$, $p < .001$), and mediated the effect of income on adherence (coeff = .078 [BCa 95% CI: .051 to .108]). Future research should further explore the nuanced link between SES and health behaviors and outcomes.

Keywords

Cardiovascular disease; socioeconomic status; financial strain; medication adherence; self-rated health; disparities

Cardiovascular disease (CVD) studies have identified disparities by age, gender, and race/ethnicity in disease prevalence, management, and outcomes.[1-3] As research has sought to determine what factors may underlie these disparities, socioeconomic status (SES) and

Competing Interests: Dr. Osborn has received a speaker's honorarium and travel reimbursement from Legacy Health, Portland, Oregon, and Dr. Kripalani is a consultant to SAI Interactive and holds equity in Bioscape Digital. Kathryn Goggins and Dr. Wallston declare they have no competing interests.

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medication adherence are particularly interesting. For example, macro indicators of SES (e.g., education, income) and micro indicators of SES (e.g., owning a home, having a checking account) have predicted CVD outcomes and have explained racial/ethnic disparities in CVD outcomes.[4] In addition, medication adherence, the primary self-care behavior for patients with CVD, has explained both disparities in blood pressure control[5] and disparities in emergency room visits for heart failure exacerbation, heart failure and cardiac rehospitalization, and all-cause mortality.[6] For patients with CVD and heart failure, nonadherence to medications is common[7] and has been associated with increased risk of adverse outcomes, including cardiovascular events,[8] hospitalizations[9] or readmission following a myocardial infarction,[10] as well as premature mortality[10-12]. Non-adherence is also associated with increased health care costs.[9, 13]

Certain populations that tend to be at greater risk for non-adherence include people who are younger, [3] female,[3, 14] have health literacy limitations,[15] are racial/ethnic minorities,[16, 17] have less education,[18] or have lower incomes.[19] Among lower-income groups, having a copayment for statin therapy has distinguished between patients who are more or less adherent to their medications,[20] suggesting a more nuanced relationship may exist between indicators of SES and medication adherence, and, separately, health status among people with CVD. However, few studies have operationalized SES using indicators beyond education and income–for example, financial strain.

In 2014, the Institute of Medicine released a report recommending certain social and behavioral domains and measures be captured in the electronic health records (EHR).[21, 22] The committee selected 11 domains and measures based on adequate evidence of associations with health outcomes and the utility of having the information available within the EHR. *Financial resources strain* is to be assessed with a single question asking, “How hard is it for you pay for the very basics like food, housing, medical care, and heating? Would you say it is very hard, somewhat hard or not hard at all?”[23] While there is no common metric for assessing financial resource strain, asking a single question is accepted, freely available, and has a strong association with health status.[23]

Recent research suggests non-traditional, micro indicators of SES such as financial strain and owning a home may be just as or even more predictive of health status as traditional, macro indicators of SES (e.g., education, income).[4] Moreover, depending on both the disparity in question and the outcome of interest, macro and/or micro SES indicators may explain disparities in CVD-related outcomes.[4] In an effort to expand upon this work, this study tested whether a micro indicator of SES, specifically financial strain operationalized as having difficulty paying monthly bills, was associated with non-adherence to home medications and worse self-rated health among patients admitted to the hospital for a CVD-related event while controlling for macro indicators of SES (i.e., education and income). This study also tested whether financial strain explained disparities in medication adherence and self-rated health attributed to traditional, macro SES indicators.

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Methods

Participants

The Vanderbilt Inpatient Cohort Study (VICS) is a prospective cohort study of patients with CVD admitted to Vanderbilt University Hospital (VUH) in Nashville, Tennessee or Williamson Medical Center (WMC) in Franklin, Tennessee. Recruited patients were 18 years of age or older and hospitalized with a diagnosis of acute coronary syndrome (ACS) and/or acute decompensated heart failure (ADHF), as determined by medical record review conducted by a physician. Exclusion criteria consisted of severe cognitive impairment or altered mental status, unstable psychiatric illness, the inability to communicate in English, previously enrolled in the study, or being on hospice, too ill to participate in the interview (e.g. were intubated or were on severely sedative medications), or discharged following eligibility screening. Patients enrolled in VICS from October 2011 to January 2014 were included in this analysis.

Procedures

Details of the VICS design and procedures have been described elsewhere.[24] In short, after providing written informed consent, participants completed a series of interviewer-administered baseline measures in their hospital room. The interview lasted 45 minutes. Trained research assistants (RAs) who performed these interviews collected data on a range of patient and social factors, including financial strain, medication adherence, self-rated health, and demographic characteristics, prior health status, and socioeconomic status. All data were then entered directly into the Research Electronic Data Capture (REDCap).[25] All study procedures were approved by the Vanderbilt University Institutional Review Board prior to participant enrollment.

Measures

Predictor variable

Financial strain: Financial strain was assessed with a single item that asked participants, “How difficult is it for you (and your family) to pay your monthly bills?” Response options were 1 = not at all difficult, 2 = not very difficult, 3 = somewhat difficult, or 4 = very difficult.

Criterion variables

Medication adherence: Adherence to the home medication regimen was measured using a shortened, 7-item version of the 12-item Adherence to Refills and Medications Scale.[26] The ARMS-7 has a correlation coefficient of .95 with the full-length measure (ARMS-12[26]), allowing us to decrease interview length while accurately assessing this concept. The ARMS measure asks patients to report adherence to refilling prescriptions and taking their home medications in the past year. Response options were 1= none of the time, 2 = some of the time, 3 = most of the time, or 4= all of the time. The total ARMS-7 score is a continuous value ranging from 7 to 28, with higher scores indicating more problems with adherence. For ease of interpretation, we reverse scored the ARMS items so higher scores indicated better adherence. If participants answered six, but not all seven of the questions, their overall

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score was scaled up using an average of the valid responses, allowing us to recapture missing values. The ARMS-7 was not administered to participants who reported not taking any medications (prescription or over-the-counter) prior to hospital admission.

Self-rated health: The first five items from the 10-item Patient-Reported Outcome Measurement Information System (PROMIS) Global Health Scale[27] constitutes our measure of self-rated health, and assesses physical, mental, and social health status as well as quality of life on a 5-point Likert response scale. Response options were 1 = poor, 2 = fair, 3 = good, 4 = very good, or 5 = excellent. The last five items assess domains (e.g., pain) that are likely to fluctuate among acutely ill hospitalized patients and were not administered in the baseline survey. The mean of all five items was calculated, and higher scores indicated better self-rated health.

A priori covariates

Demographic characteristics: Age and gender data were collected from the electronic medical record prior to the interview, and self-reported race/ethnicity was collected during the interview. Self-reported race/ethnicity was dichotomized (0=non-Hispanic White [NHW], 1=Black, Hispanic, or other).

Prior health: Hospitalizations in the past year served as the proxy for prior health. Participants were asked, “How many times have you been hospitalized in the last 12 months, not counting this time?” To address this variable's non-normality, it was dichotomized into 0=no hospitalizations and 1= at least one hospitalization.

Socioeconomic status: Socioeconomic information, such as educational attainment, employment status, and annual household income was also collected during the interview. Participants were asked to report the highest grade or year of school they had completed. Employment status was recorded as employed for wages (part-time or full-time), self-employed, retired, unable to work (disabled), out of work for more than one year, out of work for less than one year, or a homemaker. These categories were later collapsed into 0=unemployed (retired, disabled, out of work, or homemaker) and 1=employed (for wages or self-employed). Annual household income was self-reported and coded into one of nine possible categories, ranging from less than $10,000 to more than $100,000.

Analyses

Analyses were performed using SPSS 21.0. Cronbach's α assessed the internal consistency of the ARMS-7 and PROMIS Global-5. Means and standard deviations or frequencies summarized our observed variables. Spearman's rho correlation coefficients and a single Mann-Whitney test examined the bivariate relationships between financial strain and medication adherence, medication adherence and self-rated health, financial strain and self-rated health, and financial strain and each macro indicator of SES (i.e., education, employment status, income). Finally, two four-step multiple linear regression models with pairwise deletion (to maximize all available data) tested the unique contribution of financial strain in determining home medication adherence and self-rated health after adjusting for *a priori* covariates at one of three steps. In our largest model, we estimated eight predictors

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with N=1,527. Power is optimized to detect even a small effect with 30 participants per predictor,[28] and we had a ratio of 190.87 per predictor. First, ARMS-7 scores were regressed on demographic characteristics (age, gender, race/ethnicity) in Step 1, prior health in Step 2, macro SES indicators (education, employment status, income) in Step 3, and financial strain in Step 4. Second, PROMIS Global-5 scores were regressed on the same variables entered into the model at each of the four steps previously described. Finally, when the introduction of financial strain in Step 4 reduced the effect of variables entered in Steps 1-3 on the outcome of interest, tests for indirect effects with bootstrapped (5,000 samples) bias-corrected and accelerated (BCa) confidence intervals[29, 30] were performed to test whether financial strain mediated the relationship between the predictor and the outcome.

Results

Of the 6,719 patients admitted for ACS and/or ADHF from October 2011 to January 2014, 3,645 (54.2%) were not eligible for enrollment for reasons such as being discharged, too ill, previously enrolled, or having impaired cognition. Trained RAs approached the 3,074 eligible patients and 1,132 declined additional screening. Of the 1,942 fully eligible patients, RAs enrolled 1,545 (79.6%), as 397 patients were either discharged after they had been screened or elected to not participate after the details of informed consent. Finally, 18 patients were withdrawn because they did not complete the baseline interview or asked to be removed from the study, resulting in 1,527 participants included in this analysis. As shown in Table 1, participants were on average 59.97 ± 12.79 years old and predominately non-Hispanic White (81.7%). The majority of participants were male (56.2%), had some college education (54.6%), and had an annual household income greater than 35K (50.1%). Two-thirds of participants were not employed (67%), and nearly two thirds had a diagnosis of ACS (63.3%). More than half (52.8%) of participants reported being hospitalized at least once in the past year. Participants were relatively adherent to their home medications (a median of 26 on a 7-28 scale), and rated their health as average (a mean of 2.92 on a 1 – 5 scale). In our sample, the ARMS-7 was both unidimensional and internally consistent with a Cronbach's alpha of .93. Additionally, the PROMIS Global-5 was also unidimensional and internally consistent with a Cronbach's α of .83.

Spearman's rho and Mann-Whiney U examined bivariate relationships. Having more financial strain was significantly associated with being less adherent to home medications (Spearman's $\rho = -.24$, $p < .001$). Medication adherence was significantly associated with better self-rated health (Spearman's $\rho = .21$, $p < .001$), but medication adherence did not mediate the relationship between financial strain and self-rated health in unadjusted (indirect effect = -.022 [BCa 95% CI: -.034 to -.013]) or adjusted analyses (indirect effect = -.016 [BCa 95% CI: -.027 to -.009]). In addition, having more financial strain was significantly associated with worse self-rated health (Spearman's $\rho = -.37$, $p < .001$). Finally, having more financial strain was also associated with having less education (Spearman's $\rho = -.26$, $p < .001$), being unemployed (2.44±1.13 vs. 2.18±1.03, $p < .001$), and having a lower income (Spearman's $\rho = -.47$, $p < .001$).

According to a four-step hierarchical linear regression model, being younger and being a racial/ethnic minority was significantly associated with being less adherent to home

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medications in all four steps, whereas being female was significantly associated with being more adherent to home medications in the last two steps, after macro and micro SES indicators were in the model. Prior health, education, and employment status were not associated with home medication adherence at any step. In Step 3, having more income was significantly associated with being more adherent to home medications ($p < .001$), but that relationship was reduced to non-significance when financial strain was introduced in Step 4. In Step 4, having more financial strain was significantly associated with being less adherent to home medications ($\beta = -.17$, $p < .001$), explaining 2.1% of unique variance in ARMS-7 scores (Total $R^2 = 11.5\%$).

Table 3 presents the indirect effects of income on medication adherence via financial strain. Having more income was associated with being more adherent (total effect, $p < .001$), but this relationship was attenuated to non-significance when adjusted for financial strain (direct effect, p = ns), such that income was related to adherence via financial strain (indirect effect = .078 [BCa 95% CI: .051 to .108]).

According to a second four-step hierarchical linear regression model (see Table 4), male gender was associated with worse self-rated health in Steps 1 and 2, but this relationship was no longer significant when SES variables were introduced in Step 3. Race/ethnicity was not related to self-rated health at any step. By Step 4, reporting worse prior health was associated with worse self-rated health, and older age and higher SES were each associated with better self-rated health (all $p < .001$). Furthermore, having more financial strain was significantly associated with worse self-rated health ($\beta = -.23$, $p < .001$), explaining 3.8% of unique variance in self-rated health scores (Total $R^2 = 26.2\%$). The introduction of financial strain in Step 4 did not change the relationships between variables entered into the equation at Steps 1-3 and self-rated health, so indirect effect tests were not performed to test for financial strain as a mediator of those relationships.

Discussion

This study examined the relationships between financial strain, medication adherence, and self-rated health in a large sample of patients hospitalized for acute coronary syndrome and/or heart failure. Participants reporting more financial strain were significantly less adherent to their home medications, and this effect persisted after adjustment for demographic characteristics, prior health care utilization, and traditional, macro indicators of SES. Financial strain was also independently associated with worse self-rated health, after adjustment for the same covariates. This research both supports the IOM's recent recommendation to measure *financial resource strain* in EHRs[21, 22] and sheds light on the importance of perceived financial circumstances, in this case difficulty paying bills, above and beyond traditional markers of SES such as education, employment status and income.

Furthermore, financial strain mediated the relationship between income and medication adherence, but did not mediate the relationships between income (employment status or education) and self-rated health. In this latter instance, the traditional markers for SES, education, employment status and income, remained significantly associated with self-rated health along with financial strain. When it comes to adhering to one's medication regimen,

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the actual amount of annual income a person has is apparently not as critical as whether or not that amount is sufficient to meet one's monthly expenses. To our knowledge, this is one of the first reports of the critical role that discrepancies between income and expenses (i.e., *financial strain*) plays in understanding why patients with heart disease might not take their medication as prescribed.

There were other findings related to medication adherence worth noting. Older age was associated with better adherence to home medications, a finding consistent with other studies.[3, 14] Female gender was associated with better adherence, which is inconsistent with a few others that have found the opposite relationship.[3, 17, 18, 31] However, this relationship did not become significant until SES indicators were entered into the model. In addition, being a racial/ethnic minority was significantly associated with being less adherent, as reported consistantly in the literature.[16, 17] Interestingly, in this sample of cardiovascular patients, race/ethnicity was unrelated to self-rated health, as was gender, once prior health was entered in the model in Step 3. Without controlling for prior health, however, males rated their health more favorably than females did.

Cost-related underuse of medications is a widespread problem regardless of the health context. In a representative sample of older adults in the U.S., 20% reported cost-related nonadherence, and financial stress, operationalized as having a higher out-of-pocket payment for medications and a lower net worth, and each were significantly associated with nonadherence.[32] People reporting cost-related underuse of medications are also more likely to be hospitalized than those who do not report cost-related underuse.[33] However, providing full drug coverage improves medication adherence among both racial/ethnic minorities and Whites, but the health benefits for minorities are profound, with a reduction in major cardiovascular events or revascularization by 35% and reduced health care spending by 70%.[34]

There are several study limitations to acknowledge. First, participants were recruited from an academic medical center and an affiliated community hospital and had a relatively high SES on average, and only 18% of participants were members of racial/ethnic minority groups. The nature of the study population may limit generalizability, particularly to settings with patients that have lower SES or a high percentage of racial/ethnic minorities. Second, though validated measures were employed, outcome variables were self-reported and may be subject to social desirability. We also shortened the ARMS, and our results may be limited by skewed responses to this measure for participants who did not answer all questions (i.e., a dilution effect). Third, the variable no hospitalizations versus as least one hospitalization in the past year was used as a proxy for health status, and, for patients with multiple admissions, interviewing at the first admission impacts this outcome. Finally, while or RAs were trained on data entry and management, as with all studies, data entry errors may have affected our results.

Balancing out those limitations, however, were a number of strengths. Our sample size was relatively large and, in this referral center, consisted of patients from over 15 different states, spanning 150 different counties. There was a high rate of enrollment from eligible patients. Our self-report measures of medication adherence and health status were from previously

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validated instruments that were administered by highly trained RAs who entered the data directly into the REDCap data management system. Finally, the survey includes patients hospitalized with two different, but prevalent conditions, ACS or ADHF, thus increasingly the likelihood the findings apply broadly to cardiovascular patients.

In summary, having difficulty paying monthly bills determined medication nonadherence and worse self-rated health beyond age, gender, race/ethnicity, education, employment status and income. Our findings are consistent with recent literature suggesting nontraditional indicators of SES such as whether someone has a checking account[4] or lives in a higher SES community[35] (e.g., determined by proportion of car and home owners, welfare recipients) are important predictors of CVD outcomes. Our study particularly adds to a limited literature examining the link between nontraditional SES indicators, specifically financial strain, and health behaviors[36] and self-rated health.[37] Linking *financial strain* to CVD outcomes and their disparities highlights the need for socio-medical interventions such as improving access to affordable medications and upstream social policies to promote equity. Research to further this agenda must adequately measure the more nuanced aspects of SES.

Acknowledgments

This research was supported by the National Heart Lung and Blood Institute (R01 HL109388), and in part by the National Center for Research Resources (UL1 RR024975-01), now at the National Center for Advancing Translational Sciences (UL1 TR000445-06). Dr. Osborn is supported by the National Institute of Diabetes and Digestive and Kidney Diseases (K01 DK087894 and R01 DK100694-01A1). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. The funding agencies were not involved in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript. Drs. Osborn and Wallston had full access to all study data and take responsibility for data integrity and the accuracy of data analysis. Finally, we would like to thank Dr. Christianne Roumie for her critique of this manuscript.

References

1. Mensah GA, Mokdad AH, Ford ES, et al. State of disparities in cardiovascular health in the United States. Circulation. 2005; 111(10):1233–1241. [PubMed: 15769763]
2. Hertz RP, Unger AN, Cornell JA, et al. Racial disparities in hypertension prevalence, awareness, and management. Archives of internal medicine. 2005; 165(18):2098–2104. [PubMed: 16216999]
3. Kyanko KA, Franklin RH, Angell SY. Adherence to chronic disease medications among New York City Medicaid participants. Journal of urban health: bulletin of the New York Academy of Medicine. 2013; 90(2):323–328. [PubMed: 22722919]
4. Osborn CY, de Groot M, Wagner JA. Racial and ethnic disparities in diabetes complications in the northeastern United States: the role of socioeconomic status. Journal of the National Medical Association. 2013; 105(1):51–58. [PubMed: 23862296]
5. Bosworth HB, Powers B, Grubber JM, et al. Racial differences in blood pressure control: potential explanatory factors. Journal of general internal medicine. 2008; 23(5):692–698. [PubMed: 18288540]
6. Wu JR, Lennie TA, De Jong MJ, et al. Medication adherence is a mediator of the relationship between ethnicity and event-free survival in patients with heart failure. Journal of cardiac failure. 2010; 16(2):142–149. [PubMed: 20142026]
7. Ho PM, Bryson CL, Rumsfeld JS. Medication adherence: its importance in cardiovascular outcomes. Circulation. 2009; 119(23):3028–3035. [PubMed: 19528344]
8. Gehi AK, Ali S, Na B, et al. Self-reported medication adherence and cardiovascular events in patients with stable coronary heart disease: the heart and soul study. Archives of internal medicine. 2007; 167(16):1798–1803. [PubMed: 17846400]

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9. Dragomir A, Cote R, White M, et al. Relationship between adherence level to statins, clinical issues and health-care costs in real-life clinical setting. Value in health: the journal of the International Society for Pharmacoeconomics and Outcomes Research. 2010; 13(1):87–94. [PubMed: 19695008]
10. Tuppin P, Neumann A, Danchin N, et al. Evidence-based pharmacotherapy after myocardial infarction in France: adherence-associated factors and relationship with 30-month mortality and rehospitalization. Archives of cardiovascular diseases. 2010; 103(6-7):363–375. [PubMed: 20800800]
11. Rasmussen JN, Chong A, Alter DA. Relationship between adherence to evidence-based pharmacotherapy and long-term mortality after acute myocardial infarction. JAMA: the journal of the American Medical Association. 2007; 297(2):177–186. [PubMed: 17213401]
12. Ho PM, Magid DJ, Shetterly SM, et al. Medication nonadherence is associated with a broad range of adverse outcomes in patients with coronary artery disease. American heart journal. 2008; 155(4):772–779. [PubMed: 18371492]
13. Dilokthornsakul P, Chaiyakunapruk N, Nimpitakpong P, et al. The effects of medication supply on hospitalizations and health-care costs in patients with chronic heart failure. Value in health: the journal of the International Society for Pharmacoeconomics and Outcomes Research. 2012; 15(1 Suppl):S9–14. [PubMed: 22265074]
14. Mochari H, Ferris A, Adigopula S, et al. Cardiovascular disease knowledge, medication adherence, and barriers to preventive action in a minority population. Preventive cardiology. 2007; 10(4):190–195. [PubMed: 17917515]
15. Gazmararian JA, Kripalani S, Miller MJ, et al. Factors associated with medication refill adherence in cardiovascular-related diseases: a focus on health literacy. Journal of general internal medicine. 2006; 21(12):1215–1221. [PubMed: 17105519]
16. Zhang Y, Baik SH, Chang CC, et al. Disability, race/ethnicity, and medication adherence among Medicare myocardial infarction survivors. American heart journal. 2012; 164(3):425–433 e424. [PubMed: 22980311]
17. Lewey J, Shrank WH, Bowry AD, et al. Gender and racial disparities in adherence to statin therapy: a meta-analysis. American heart journal. 2013; 165(5):665–678, 678 e661. [PubMed: 23622903]
18. Bohm M, Schumacher H, Laufs U, et al. Effects of nonpersistence with medication on outcomes in high-risk patients with cardiovascular disease. American heart journal. 2013; 166(2):306–314 e307. [PubMed: 23895814]
19. Lemstra M, Blackburn D, Crawley A, et al. Proportion and risk indicators of nonadherence to statin therapy: a meta-analysis. The Canadian journal of cardiology. 2012; 28(5):574–580. [PubMed: 22884278]
20. Kazerooni R, Bounthavong M, Watanabe JH. Association of copayment and statin adherence stratified by socioeconomic status. The Annals of pharmacotherapy. 2013; 47(11):1463–1470. [PubMed: 24259605]
21. IOM (Institute of Medicine). Capturing social and behavioral domains in electronic health records: Phase 1. The National Academies Press; Washington, D.C.: 2014.
22. IOM (Institute of Medicine). Capturing social and behavioral domains in electronic health records: Phase 2. 2014.
23. Kahn JR, Pearlin LI. Financial strain over the life course and health among older adults. Journal of health and social behavior. 2006; 47(1):17–31. [PubMed: 16583773]
24. Meyers AG, Salanitro A, Wallston KA, et al. Determinants of health after hospital discharge: rationale and design of the Vanderbilt Inpatient Cohort Study (VICS). BMC health services research. 2014; 14:10. [PubMed: 24397292]
25. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. Journal of biomedical informatics. 2009; 42(2):377–381. [PubMed: 18929686]
26. Kripalani S, Risser J, Gatti ME, et al. Development and evaluation of the Adherence to Refills and Medications Scale (ARMS) among low-literacy patients with chronic disease. Value in health: the journal of the International Society for Pharmacoeconomics and Outcomes Research. 2009; 12(1): 118–123. [PubMed: 19911444]

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27. Cella D, Riley W, Stone A, et al. The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005-2008. Journal of clinical epidemiology. 2010; 63(11):1179–1194. [PubMed: 20685078]

28. Wilson VanVoorhis CR, Morgan BL. Understanding power and rules of thumb for determiing sample sizes. Tutorials in Quantitative Methods for Psychology. 2007; 3(2):43–50.

29. Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behavior research methods. 2008; 40(3):879–891. [PubMed: 18697684]

30. Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. Behavior research methods, instruments, & computers: a journal of the Psychonomic Society, Inc. 2004; 36(4):717–731.

31. Granger BB, Ekman I, Granger CB, et al. Adherence to medication according to sex and age in the CHARM programme. European journal of heart failure. 2009; 11(11):1092–1098. [PubMed: 19875409]

32. Zivin K, Ratliff S, Heisler MM, et al. Factors influencing cost-related nonadherence to medication in older adults: a conceptually based approach. Value in health: the journal of the International Society for Pharmacoeconomics and Outcomes Research. 2010; 13(4):338–345. [PubMed: 20070641]

33. Heisler M, Choi H, Rosen AB, et al. Hospitalizations and deaths among adults with cardiovascular disease who underuse medications because of cost: a longitudinal analysis. Medical care. 2010; 48(2):87–94. [PubMed: 20068489]

34. Choudhry NK, Bykov K, Shrank WH, et al. Eliminating medication copayments reduces disparities in cardiovascular care. Health affairs. 2014; 33(5):863–870. [PubMed: 24799585]

35. Shimony A, Zahger D, Ilia R, et al. Impact of the community's socioeconomic status on characteristics and outcomes of patients undergoing percutaneous coronary intervention. International journal of cardiology. 2010; 144(3):379–382. [PubMed: 19446896]

36. Macy JT, Chassin L, Presson CC. Predictors of health behaviors after the economic downturn: a longitudinal study. Social science & medicine. 2013; 89:8–15. [PubMed: 23726210]

37. Tucker-Seeley RD, Harley AE, Stoddard AM, et al. Financial hardship and self-rated health among low-income housing residents. Health education & behavior: the official publication of the Society for Public Health Education. 2013; 40(4):442–448. [PubMed: 23104979]

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Table 1

Participant characteristics ($N = 1527$).

	n*(%) or *M* ± *SD
Age	59.97 ± 12.79
Gender, female	669 (43.8)
Race/ethnicity, non-White	279 (18.3)
Education, years	13.48 ± 2.94
0-8 years	67 (4.4)
9-11 years	155 (10.2)
12/GED years	472 (30.9)
13-15years	456 (29.9)
16 years	197 (12.9)
17+ years	180 (11.8)
Employment status, employed	504 (33.0)
Annual household income, dollars	
0 to 9,999	114 (7.7)
10,000 to 14,999	118 (8.0)
15,000 to 19,999	108 (7.3)
20,000 to 24,999	170 (11.5)
25,000 to 34,999	228 (15.4)
35,000 to 49,000	252 (17.0)
50,000 to 74,999	203 (13.7)
75,000 to 99,999	142 (9.6)
100,000 +	145 (9.8)
Prior hospitalizations[‡]	801 (52.8)
Primary diagnosis	
Acute coronary syndromes (ACS)	967 (63.3)
Acute decompensated heart failure (ADHF)	452 (29.6)
Both ACS and ADHF	108 (7.1)
Medication adherence, 7-item ARMS score[†] (range 7-28)	25.6 ± 2.52
Self-rated health, 5-item PROMIS score (range 1-5)	2.93 ± 0.85

Notes. M = mean; SD = standard deviation; GED = general education development;

[‡]dichotomized as 0 = no hospitalizations or 1 = at least one hospitalization in the past year;

[†]the ARMS score was reversed, so high scores mean better adherence;

ARMS = Adherence to Refills and Medications Scale

PROMIS = Patient-Reported Outcome Measurement Information System

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Table 2

Hierarchical multiple regression models presenting the unique contribution of financial strain on medication adherence.

Predictors		Step 1 Demographics	Step 2 + Prior health	Step 3 + SES	Step 4 + Financial strain
	Step 1 ΔR^2	.08***			
Age	β	.22***	.22***	.19***	.16***
Gender (1 = female)	β	.03	.03	.06*	.06*
Race/ethnicity (1 = non-White)	β	-.14***	-.14***	-.12***	-.14***
	Step 2 ΔR^2		.00		
Prior health‡ (1 = ≥1 hospitalizations)	β		-.01	.01	.02
	Step 3 ΔR^2			.02***	
Education	β			.05	.04
Employment status (1 = employed)	β			-.04	-.03
Income	β			.12***	.05
	Step 4 ΔR^2				.02***
Financial strain	β				-.17***
	Total R^2	.08	.08	.09	.11

Notes. SES = socioeconomic status;

‡dichotomized as 0 = no hospitalizations or 1 = at least one hospitalization in the past year.

*$p < .05$;

**$p < .01$;

***$p < .001$

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Table 3

Indirect effect test of income on medication adherence via financial strain.

	Income
Predictor to financial strain (a path)	-.20***
Financial strain to medication adherence (b path)	-.39***
Total effect of predictor on medication adherence (c path)	.13***
Direct effect of predictor on medication adherence (c′ path)	.05
Partial effect of control variables on medication adherence	
Age	.03***
Gender (1 = female)	.32*
Race/ethnicity (1 = non-White)	-.85***
Prior health‡ (1 = ≥1 hospitalizations)	.14
Education	-.21
Employment status(1 = employed)	.04
Indirect effect of predictor on medication adherence via financial strain (ab paths)	.078† (.051, .108)

Notes.

‡dichotomized as 0 = no hospitalizations or 1 = at least one hospitalization in the past year.

†point estimate (95% BCa bootstrap CI).

*$p < .05$;

***$p < .001$

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Table 4

Hierarchical multiple regression models presenting the unique contribution of financial strain on self-rated health.

Predictors		Step 1 Demographics	Step 2 + Prior health	Step 3 + SES	Step 4 + Financial strain
	Step 1 ΔR^2	.03***			
Age	β	.10***	.10***	.13***	.09**
Gender (1 = female)	β	-.13***	-.11***	-.03	-.03
Race/ethnicity (1 = non-White)	β	-.04	-.02	.02	.00
	Step 2 ΔR^2		.08***		
Prior health‡			-.28***	-.21***	-.19***
	Step 3 ΔR^2			.12***	
Education	β			.10***	.08***
Employment status (1 = employed)	β			.18***	.18***
Income	β			.21***	.11***
	Step 4 ΔR^2				.04***
Financial strain	β				-.23***
	Total R^2	.03	.11	.22	.26

Notes. SES = socioeconomic status;

‡dichotomized as 0 = no hospitalizations or 1 = at least one hospitalization in the past year.

*$p < .05$;

**$p < .01$;

***$p < .001$