Factors associated with racial differences in all-cause 30-day readmission in adults with cardiovascular disease: an observational study of a large healthcare system

Heather R Farmer, Hanzhang Xu, Bradi B Granger, Kevin L Thomas, Matthew E Dupre

ABSTRACT

Objective To examine factors contributing to racial differences in 30-day readmission in patients with cardiovascular disease (CVD).

Design Patients were enrolled from 1 January 2015 to 31 August 2017 and data were collected from electronic health records and a standardised interview administered prior to discharge.

Setting Duke Heart Center in the Duke University Health System.

Participants Patients aged 18 and older admitted for the treatment of cardiovascular-related conditions (n=734).

Main outcome and measures All-cause readmission within 30 days was the main outcome. Multivariate logistic regression models were used to examine whether and to what extent socioeconomic, psychosocial, behavioural and healthcare-related factors contributed to 30-day readmissions in Black and White CVD patients.

Results The median age of patients was 66 years and 18.1% (n=133) were readmitted within 30 days after discharge. Black patients were more likely than White patients to be readmitted (OR 1.62; 95% CI 1.18 to 2.23) and the racial difference in readmissions was largely reduced after taking into account differences in a wide range of clinical and non-clinical factors (OR 1.37; 95% CI 0.98 to 1.91). In Black patients, readmission risks were especially high in those who were retired (OR 3.71; 95% CI 1.71 to 8.07), never married (OR 2.21; 95% CI 1.21 to 4.05), had difficulty accessing their routine care (OR 2.88; 95% CI 1.70 to 4.88) or had been hospitalised in the prior year (OR 1.97; 95% CI 1.16 to 3.37). In White patients, being widowed (OR 2.39; 95% CI 1.41 to 4.07) and reporting a higher number of depressive symptoms (OR 1.07; 95% CI 1.00 to 1.13) were the key factors associated with higher risks of readmission.

Conclusions and relevance Black patients were more likely than White patients to be readmitted within 30 days after hospitalisation for CVD. The factors contributing to readmission differed by race and offer important clues for identifying patients at high risk of readmission and tailoring interventions to reduce these risks.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Electronic health records were linked to patient-reported surveys to examine a wide array of socioeconomic, psychosocial, behavioural, clinical, and healthcare-related factors associated with 30-day readmissions in patients with cardiovascular disease.

⇒ Multivariate logistic regression models were used to identify the major factors contributing to 30-day readmissions in Black and White patients.

⇒ The results of this study provide much-needed evidence for identifying patients at high risk of readmission and tailoring interventions to reduce these risks.

⇒ Additional unmeasured factors may have played a role in the association between patient race and 30-day readmissions.

⇒ Larger and more geographically representative studies are needed to further validate the current findings.

INTRODUCTION

Cardiovascular disease (CVD) remains the leading cause of hospitalisation in the USA. According to recent estimates, approximately one-in-five patients hospitalised with CVD will be readmitted within 30 days after their discharge. Although the implementation of financial penalties and other national campaigns have made small gains over the last decade, high rates of rehospitalisation continue to put enormous strain on the US healthcare system and on those suffering from the disease. In particular, results from several large-scale studies have shown that non-Hispanic Black patients are about 10%–20% more likely to be readmitted within 30 days after discharge compared with non-Hispanic White patients. However, the
reasons for these racial differences in readmission are largely unknown.

Deeply rooted structural factors have been recognised to generate and perpetuate disparities in socioeconomic status, psychosocial resources and engagement in unfavourable health practices between Black and White people. It has also been shown that low levels of socioeconomic status, inadequate social support and other non-clinical factors are associated with poor outcomes in patients discharged with CVD. However, it is unclear whether and to what extent these and other patient-reported factors may be contributing to racial differences in 30-day readmissions among those hospitalised with CVD.

The purpose of this study was to examine a wide range of clinical and non-clinical factors that may be associated with racial differences in 30-day readmission among cardiovascular patients admitted to a large medical centre. The primary objectives of this study were to (1) examine racial differences in rates of 30-day readmission; (2) assess whether socioeconomic, psychosocial, behavioural, and healthcare-related factors contribute to racial differences in readmission and (3) identify the key factors associated with readmission in White and Black patients.

METHODS
Sample
Data for the study come from patients aged 18 and older admitted due to the Duke Heart Center in the Duke University Health System for treatment of cardiovascular-related conditions. Located in the southeast USA, Duke’s Heart Center is consistently rated among the top heart centres in the country (#1 in North Carolina) and cares for more than 65,000 patients each year. Patients for the current study were recruited from 1 January 2015 to 31 August 2017 among a total of 6860 patients who were admitted to the Duke Heart Center during this study period. Exclusion criteria for this study were limited to admitted patients (18+) who were physically/cognitively able to provide informed written consent. There were 860 patients who were randomly recruited to participate during the study period and 67 patients (7.8%) declined to participate. Additional details of the study design, including subject selection, recruitment processes, survey items and the full study protocol, have been published elsewhere.

The study included 793 patients who were consented, enrolled and asked to complete a standardised self-administered survey prior to discharge. The patients’ survey data were then linked to their electronic health records (EHRs) extracted from the Duke Enterprise Data Unified Content Explorer, which allowed us to gather clinical data on study participants, including whether they were readmitted within the 30 days following discharge. Previous research compared patients enrolled in the study with all eligible patients at Duke Heart Center and showed that the two patient groups had similar demographic and clinical profiles. The final number of patients for analysis included 734 non-Hispanic White and Black patients—excluding 28 patients who reported other race/ethnicity (online supplemental figure 1).

Patient and public involvement
Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research.

Measures
Detailed information on patients’ demographic background, socioeconomic status, psychosocial factors, health behaviours, healthcare access and utilisation and health status was ascertained from the completed surveys and linked EHRs. Details of the study measures are presented in online supplemental table 1. Demographic background included age, sex and race. Socioeconomic factors included educational attainment, employment status, and current health insurance. Psychosocial factors included marital status and several previously validated measures, including levels of social support, life stressors, depressive symptoms and self-efficacy. Behavioural factors included smoking history, alcohol consumption, and medication adherence. Healthcare access and utilisation factors included patient-reported access to routine care, hospital admissions in the previous year, and the length of stay during the index admission. Finally, health status included measures for body mass index, limitations in activities of daily living, and major cardiovascular-related conditions that included hypertension, hyperlipidaemia, diabetes, acute myocardial infarction (MI), heart failure and atrial fibrillation.

Outcome
All-cause readmission within 30 days after discharge from the index admission (yes or no) was the primary outcome. This measure is consistent with the one used by the Centers for Medicare & Medicaid Services, prior research, and many health systems to evaluate hospital performance and patient outcomes in cardiovascular patient populations.

Readmissions were ascertained from the patient’s EHR based on the number of days from the discharge date until a subsequent inpatient admission within the Duke University Health System. Patients who may have been readmitted outside of the Duke University Health System were not included as a readmission in this study. Twenty-four patients died during the study period and five of these patients were readmitted within 30 days of their discharge. Our previous studies have shown that the 30-day readmission and mortality rates in this study were comparable to the rates reported by other hospitals in North Carolina as well as national estimates for cardiovascular patients.

Analysis
The distributions of patient characteristics were compared by race using t-tests, Wilcoxon-rank sum tests and χ² tests as appropriate. A series of logistic regression
Table 1  Characteristics of study participants admitted at Duke Heart Center

|                           | Overall (n=734) | Black (n=239) | White (n=495) | P value | Missing |
|---------------------------|----------------|--------------|---------------|---------|---------|
| Readmission within 30 days| 133 (18.1)     | 54 (22.6)    | 79 (16.0)     | 0.029   |         |
| **Sociodemographic characteristics** |               |              |               |         |         |
| Age, median (IQR)         | 66 (18)        | 62 (16)      | 68 (18)       | <0.001  |         |
| Female                    | 280 (38.2)     | 104 (43.5)   | 176 (35.6)    | 0.038   |         |
| Less than high school education | 104 (14.4)     | 50 (21.3)    | 54 (11.04)    | <0.001  | 10 (1.4) |
| Employment status         |                |              |               |         |         |
| Currently employed        | 151 (20.8)     | 46 (19.5)    | 105 (21.5)    | <0.001  |         |
| Not employed              | 177 (24.4)     | 84 (35.6)    | 93 (19.0)     |         |         |
| Retired                   | 397 (54.8)     | 106 (44.9)   | 291 (59.5)    |         |         |
| Health insurance coverage |                |              |               |         |         |
| Currently insured         | 671 (91.9)     | 206 (87.3)   | 465 (94.1)    | 0.003   |         |
| Medicaid-only             | 35 (4.8)       | 20 (8.5)     | 15 (3.0)      |         |         |
| No insurance              | 24 (3.3)       | 10 (4.2)     | 14 (2.8)      |         |         |
| **Psychosocial characteristics** |               |              |               |         |         |
| Marital status            |                |              |               | <0.001  |         |
| Married                   | 391 (53.6)     | 73 (30.9)    | 318 (64.5)    |         |         |
| Never married             | 91 (12.5)      | 59 (25.0)    | 32 (6.5)      |         |         |
| Divorced                  | 147 (20.2)     | 66 (28.0)    | 81 (16.4)     |         |         |
| Widowed                   | 100 (13.7)     | 38 (16.1)    | 62 (12.6)     |         |         |
| Social support, mean (SD) | 16.4 (3.9)     | 16.1 (4.0)   | 16.6 (3.9)    | 0.144   | 10 (1.4) |
| Life stressors, mean (SD) | 3.0 (2.0)      | 3.2 (2.2)    | 2.9 (1.9)     | 0.045   | 12 (1.6) |
| CES-D, mean (SD)          | 7.3 (4.3)      | 7.8 (4.4)    | 7.0 (4.2)     | 0.035   | 17 (2.3) |
| Self-efficacy, mean (SD)  | 9.3 (1.6)      | 9.2 (1.6)    | 9.3 (1.6)     | 0.281   | 11 (1.5) |
| **Behavioural characteristics** |               |              |               |         |         |
| Current or former smoker  | 401 (56.0)     | 125 (53.4)   | 276 (57.3)    | 0.331   | 18 (2.5) |
| Alcohol consumption, mean (SD) | 0.52 (0.75)   | 0.47 (0.75) | 0.55 (0.75) | 0.189 | 9 (1.23) |
| Non-adherence to medication | 153 (21.8)   | 72 (31.9)    | 81 (17.0)     | <0.001  | 31 (4.2) |
| **Healthcare access and utilisation** |           |              |               |         |         |
| Difficult access to routine care | 111 (15.3)  | 44 (18.6)    | 67 (13.7)     | 0.084   | 6 (0.8) |
| Hospital admission in the past year | 322 (43.9) | 119 (49.8)  | 203 (41.0)    | 0.025   |         |
| Length of index hospital stay | 37 (5.1)     | 14 (5.9)     | 23 (4.7)      |         |         |
| Short stay (<4 days)      | 179 (24.5)     | 48 (20.2)    | 131 (26.5)    | 0.065   |         |
| Average stay (4 to 7 days) | 267 (36.5)    | 84 (35.3)    | 183 (37.0)    |         |         |
| Long stay (>7 days)       | 286 (39.1)     | 106 (44.5)   | 180 (36.4)    |         |         |
| **Health characteristics** |               |              |               |         |         |
| Body mass index, mean (SD) | 30.8 (8.1)    | 32.8 (9.0)   | 29.9 (7.4)    | <0.001  | 3 (0.4) |
| ADL, mean (SD)            | 2.9 (3.7)      | 3.2 (3.7)    | 2.7 (3.6)     | 0.098   | 15 (2.0) |
| Diagnosed conditions      |               |              |               |         |         |
| Hypertension              | 333 (45.4)     | 112 (46.9)   | 221 (44.7)    | 0.572   |         |
| Hyperlipidaemia           | 374 (51.0)     | 132 (55.2)   | 242 (48.9)    | 0.107   |         |
| Diabetes                  | 173 (23.6)     | 63 (26.4)    | 110 (22.2)    | 0.216   |         |
| Acute MI                  | 103 (14.0)     | 46 (19.3)    | 57 (11.5)     | 0.005   |         |
| Heart failure             | 351 (47.8)     | 141 (59.0)   | 210 (42.4)    | <0.001  |         |
| Atrial fibrillation       | 207 (28.2)     | 43 (18.0)    | 164 (33.1)    | <0.001  |         |
| Died within 30 days       | 24 (3.3)       | 6 (2.5)      | 18 (3.6)      | 0.422   |         |

Note: Values reported as number (percentages) of participants unless noted otherwise. ADL, activities of daily living; CES-D, Centre for Epidemiological Studies Depression Scale; IQR, interquartile range; MI, myocardial infarction; SD, standard deviation.
models were then used to examine racial differences in 30-day readmission. First, we examined the extent to which socioeconomic, psychosocial, behavioural, and healthcare-related factors contributed to racial differences in 30-day readmissions while controlling for age, sex, and health status. Next, we examined whether the factors contributing to racial differences in readmission differed in White and Black patients. Preliminary analyses found significant interactions between study covariates and race when estimating risks of readmission. Therefore, stratified models were used to further investigate the unadjusted and adjusted associations in White and Black patients. For the multivariate (adjusted) models, backward stepwise-selection methods were used to identify the key factors significantly associated (p<0.05) with 30-day readmission in White and Black patients. Preliminary analyses showed that forward stepwise-selection methods produced the same results and identified the same key factors. Predicted probabilities (PP) of 30-day readmissions were estimated from these models and plotted to help illustrate the major findings.

Missing data among study covariates was low (0%–4%). To retain the number of patients included in the analyses, we used multiple imputation (by chained equations using mi impute chained) to account for missing data. Information on patient’s county of residence (ascertained from the EHR) was included in all models to account for clustering and to generate robust standard errors. All tests were two tailed and considered statistically significant at p<0.05. Analyses were conducted using Stata V.16.1 (StataCo).

RESULTS

Table 1 presents the distribution of study measures by race. The median age of study participants was 66 years (IQR=18), 38.2% were women, and 32.6% of patients were non-Hispanic Black. Black patients were more likely to be younger, female, have lower socioeconomic status, have fewer psychosocial resources, report more difficulty accessing care, have higher healthcare utilisation, and worse overall health status compared with White patients. The overall rate of 30-day readmission was significantly higher in Black patients than in White patients (22.6% vs 16.0%; p=0.029); and there was no race difference in mortality within 30 days (p=0.422). Approximately 36.7% of patients had an index admission with a principal diagnosis of heart failure (online supplemental table 2), followed by atrial fibrillation (20.6%) and coronary atherosclerosis or other heart disease (20.4%).

Results from multivariate logistic regression models (table 2) showed that Black patients had significantly greater odds of being readmitted within 30 days after discharge compared with White patients (OR 1.62; 95% CI 1.18 to 2.23) after taking into account demographic background and health status. The association was only partially attenuated after further adjustments for socioeconomic factors (OR 1.59; 95% CI 1.15 to 2.20), psychosocial factors (OR 1.47; 95% CI 1.08 to 2.02), behavioural factors (OR 1.60; 95% CI 1.18 to 2.18), and factors related to healthcare access and utilisation (OR 1.53; 95% CI 1.07 to 2.19). The racial differences in 30-day readmissions were largely reduced after adjusting for all covariates (OR 1.37; 95% CI 0.98 to 1.91).

Results from the univariate and multivariate stratified models are presented in table 3 (Black patients) and table 4 (white patients). Overall, the results show that the factors associated with 30-day readmissions differed by race and were largely unchanged in the unadjusted and adjusted regression models. In Black patients, the adjusted models show that the odds for readmission were especially high in those who were retired (OR 3.71; 95% CI 1.71 to 8.07), never married (OR 2.21; 95% CI 1.16 to 4.05), had difficulty accessing their routine medical care (OR 2.88; 95% CI 1.70 to 4.88), and had been hospitalised in the prior year (OR 1.97; 95% CI 1.16 to 3.37). In terms of readmission rates (figure 1), the

| Table 2 | ORs for racial differences in 30-day readmission in patients with cardiovascular disease, Duke Heart Center (n=734) |
|---------|------------------------------------------------------------------------------------------------------------------|
| Race (Black/White) | OR | 95% CI | P value |
| Model 1: Demographic and health adjustments | 1.62 | (1.18 to 2.23) | 0.003 |
| Model 2: Socioeconomic adjustments | 1.59 | (1.15 to 2.20) | 0.005 |
| Model 3: Psychosocial adjustments | 1.47 | (1.08 to 2.02) | 0.016 |
| Model 4: Behavioural adjustments | 1.60 | (1.18 to 2.18) | 0.003 |
| Model 5: Healthcare access and utilisation adjustments | 1.53 | (1.07 to 2.19) | 0.021 |
| Model 6: Fully adjusted | 1.37 | (0.98 to 1.91) | 0.069 |

Model 1 adjusted for age, sex, body mass index, ADLs, and diagnoses of hypertension, hyperlipidaemia, diabetes, acute MI, heart failure, and atrial fibrillation.
Model 2 adjusted for Model 1+educational level, employment status, and health insurance coverage.
Model 3 adjusted for Model 1+marital status, social support, life stressors, depressive symptoms and self-efficacy.
Model 4 adjusted for Model 1+smoking status, alcohol consumption, and non-adherence to medication.
Model 5 adjusted for Model 1+difficult access to care, hospital admissions in the past year, and length of index hospital stay.
Model 6 adjusted for all covariates.
ADLs, activities of daily living; MI, myocardial infarction.
### Table 3  Unadjusted and adjusted ORs of 30-day readmission in Black patients with cardiovascular disease, Duke Heart Center (n=239)

|                                   | Unadjusted |          | Adjusted |          |
|-----------------------------------|------------|----------|----------|----------|
|                                   | OR (95% CI)| P value  | OR (95% CI)| P Value  |
| Age                               | 0.98 (0.95 to 1.01) | 0.293 | -- | -- |
| Female                            | 0.78 (0.45 to 1.36) | 0.385 | -- | -- |
| Educational level                 |            |          |          |          |
| High school education or more     | 1.00       |          | -- | -- |
| Less than high school education   | 0.83 (0.41 to 1.70) | 0.614 | -- | -- |
| Employment status                 |            |          |          |          |
| Currently employed                | 1.00       |          | 1.00     |          |
| Not employed                      | 1.98 (0.77 to 5.10) | 0.158 | 2.24 (0.80 to 6.24) | 0.124 |
| Retired                           | 1.70 (0.91 to 3.16) | 0.096 | 3.71 (1.71 to 8.07) | 0.001 |
| Health insurance coverage         |            |          |          |          |
| Currently insured                 | 1.00       |          | -- | -- |
| Medicaid-only                     | 1.19 (0.55 to 2.60) | 0.662 | -- | -- |
| No insurance                      | 1.36 (0.42 to 4.42) | 0.604 | -- | -- |
| Marital status                    |            |          |          |          |
| Currently married                 | 1.00       |          | 1.00     |          |
| Never married                     | 1.64 (0.89 to 3.00) | 0.111 | 2.21 (1.21 to 4.05) | 0.010 |
| Divorced                          | 0.67 (0.29 to 1.53) | 0.341 | 0.56 (0.23 to 1.38) | 0.206 |
| Widowed                           | 0.63 (0.26 to 1.54) | 0.310 | 0.44 (0.16 to 1.21) | 0.110 |
| Social support                    | 1.00       |          | 0.969 | -- | -- |
| Life stressors                    | 1.00       |          | 0.972 | -- | -- |
| CES-D                             | 1.03 (0.98 to 1.07) | 0.240 | -- | -- |
| Self-efficacy                     | 1.11 (0.95 to 1.29) | 0.196 | -- | -- |
| Smoking status                    |            |          |          |          |
| Never smoked                      | 1.00       |          | -- | -- |
| Current or former smoker          | 0.92 (0.55 to 1.53) | 0.745 | -- | -- |
| Alcohol consumption               | 0.85 (0.58 to 1.23) | 0.379 | -- | -- |
| Medication adherence              |            |          |          |          |
| Adherence to medication           | 1.00       |          | -- | -- |
| Non-adherence to medication       | 0.86 (0.49 to 1.53) | 0.601 | -- | -- |
| Access to routine care            |            |          |          |          |
| Adequate access                   | 1.00       |          | 1.00     |          |
| Difficult access                  | 2.64 (1.61 to 4.35) | <0.001 | 2.88 (1.70 to 4.88) | <0.001 |
| Admissions in the past year       |            |          |          |          |
| No admissions                     | 1.00       |          | 1.00     |          |
| 1+admissions                      | 1.81 (1.09 to 3.02) | 0.023 | 1.97 (1.16 to 3.37) | 0.013 |
| Length of index hospital stay (days) |            |          |          |          |
| Average stay                      | 1.00       |          | -- | -- |
| Short stay                        | 0.40 (0.18 to 0.89) | 0.024 | -- | -- |
| Long stay                         | 0.91 (0.49 to 1.67) | 0.754 | -- | -- |
| Body mass index                   | 0.97 (0.93 to 1.01) | 0.133 | -- | -- |
| ADL                               | 0.99 (0.92 to 1.06) | 0.796 | -- | -- |
| Diagnosed conditions              |            |          |          |          |
| Hypertension                      | 1.29 (0.85 to 1.96) | 0.222 | -- | -- |
| Hyperlipidaemia                   | 0.84 (0.42 to 1.66) | 0.613 | -- | -- |
| Diabetes                          | 0.86 (0.38 to 1.94) | 0.710 | -- | -- |

Continued
predicted rates of readmission in Black patients were 39% (PP 0.39; 95% CI 0.26 to 0.57) among the retired, 60% (PP 0.60; 95% CI 0.35 to 1.03) among the never married, 59% (PP 0.59; 95% CI 0.36 to 0.97) among those with difficult access to care, and 35% (PP 0.35; 95% CI 0.25 to 0.49) among those who were admitted in the past year. In White patients, widowhood (OR 2.39; 95% CI 1.41 to 4.07) and having depressive symptoms (OR 1.07; 95% CI 1.00 to 1.13) were the factors associated with higher risks of readmission. Approximately 40% (PP 0.40; 95% CI 0.25 to 0.62) of white patients who were widowed were readmitted within 30 days; whereas only 17% of White patients who were currently married were readmitted. In terms of Centre for Epidemiological Studies Depression Scale (CES-D), the risks of readmission increased with the number of reported depressive symptoms. Approximately 11% of White patients who reported no depressive symptoms (CES-D score=0) were readmitted within 30 days (PP 0.11; 95% CI 0.06 to 0.20); whereas, approximately 24% of White patients who reported a high number of depressive symptoms (CES-D score=12) were readmitted within 30 days (PP 0.24; 95% CI 0.17 to 0.34).

**DISCUSSION**

This study examined the factors associated with racial differences in 30-day readmissions among patients hospitalised with CVD. We found that Black patients were more likely to be readmitted within 30 days after discharge compared with White patients (23% vs 16%; OR=1.62). We also found that the racial differences in readmission were attributable to a wide range of socioeconomic, psychosocial, behavioural and healthcare-related factors. Furthermore, our results showed that the key factors contributing to 30-day readmission differed in Black and White patients.

In Black patients, we found that difficulty in accessing healthcare and more healthcare utilisation was associated with significantly higher risks of readmission. Most notably, approximately 59% of Black patients who reported difficulty accessing their routine medical care were readmitted compared with only 21% of Black patients who reported adequate access to their medical care. These findings are consistent with a number of studies showing that inadequate access to healthcare is a major barrier associated with high rates of adverse events requiring rehospitalisations.11 35 36 Our findings further suggest that inadequate access to routine care may have more negative consequences for Black patients than for White patients. Additional research is needed to better understand at a more pragmatic level what specific obstacles (eg, costs, transportation) may be limiting Black patients’ access to routine care and why such barriers may have contributed to higher risks of readmission in Black patients but not in White patients. In turn, more effective interventions are needed to help mitigate these obstacles to reduce the excess risks of readmission in Black patients.

The results also showed that key social roles, including marital status and employment status, were associated with increased risks of rehospitalisation in Black patients. We found that Black patients who were employed had significantly lower risks of readmission (10%) than those who were not employed (25%) or retired (39%). Independent of age and health status, retirees may have a particularly higher risk of readmission because they may be more socially isolated than their non-retired peers, which can contribute to loneliness, lack of social/physical engagement and/or other risk factors for readmission.37 38 Relatedly, we found that Black patients who never married were at especially high risks of readmission (60%) compared with those who were currently married (27%). Possible explanations for the strong association between marital status and 30-day readmission in Black patients may include the number/quality of supportive social ties, availability of and type of coping mechanisms and/or other unmeasured resources associated with marriage (eg, differential income, assets).39-45 Indeed, our study showed that Black patients were much more likely to have never married (25% vs 7%) and possess fewer socioeconomic resources compared with White patients. For example, 21% of Black patients had less than a high school education compared with 11% of White patients. However, more studies are needed to explore why marital status—as well as employment status—has a greater impact on rehospitalisation in Black patients than in White patients. This knowledge will help guide the development of interventions to reduce the risk of readmission among Black patients.

In White patients, we found that marital status was a key factor associated with risks of 30-day readmission. The results showed that approximately 40% of White patients...
Table 4  Unadjusted and adjusted ORs of 30-day readmission in White patients with cardiovascular disease, Duke Heart Center (n=495)

|                                | Unadjusted |                  | Adjusted |                  |
|--------------------------------|------------|------------------|----------|------------------|
|                                | OR (95% CI)| P value          | OR (95% CI)| P value          |
| Age                            | 1.00 (0.99 to 1.02) | 0.555 | – | – |
| Female                         | 1.76 (0.97 to 3.19) | 0.064 | – | – |
| Educational level              |            |                  |          |                  |
| High school education or more  | 1.00       | –                | –        | –                |
| Less than high school education| 1.44 (0.69 to 3.01) | 0.325 | – | – |
| Employment status              |            |                  |          |                  |
| Currently employed             | 1.00       | –                | –        | –                |
| Not employed                   | 1.86 (0.90 to 3.83) | 0.092 | – | – |
| Retired                        | 1.56 (0.88 to 2.77) | 0.131 | – | – |
| Health insurance coverage      |            |                  |          |                  |
| Currently insured              | 1.00       | –                | –        | –                |
| Medicaid-only                  | 0.36 (0.04 to 2.97) | 0.343 | – | – |
| No insurance                   | 0.38 (0.05 to 2.86) | 0.350 | – | – |
| Marital status                 |            |                  |          |                  |
| Currently married              | 1.00       |                  | 1.00     |                  |
| Never married                  | 1.35 (0.56 to 3.26) | 0.500 | 1.26 (0.52 to 3.05) | 0.605 |
| Divorced                       | 0.76 (0.27 to 2.13) | 0.604 | 0.68 (0.25 to 1.90) | 0.466 |
| Widowed                        | 2.69 (1.60 to 4.54) | <0.001 | 2.39 (1.41 to 4.07) | 0.001 |
| Social support                 | 0.97 (0.92 to 1.02) | 0.229 | – | – |
| Life stressors                 | 1.11 (0.98 to 1.26) | 0.100 | – | – |
| CES-D                          | 1.07 (1.01 to 1.13) | 0.016 | 1.07 (1.00 to 1.13) | 0.034 |
| Self-efficacy                  | 1.06 (0.89 to 1.26) | 0.547 | – | – |
| Smoking status                 |            |                  |          |                  |
| Never smoked                   | 1.00       | –                | –        | –                |
| Current or former smoker       | 0.89 (0.56 to 1.42) | 0.615 | – | – |
| Alcohol consumption           | 0.77 (0.58 to 1.04) | 0.085 | – | – |
| Medication adherence           |            |                  |          |                  |
| Adherence to medication        | 1.00       | –                | –        | –                |
| Non-adherence to medication    | 1.17 (0.59 to 2.31) | 0.652 | – | – |
| Access to routine care         |            |                  |          |                  |
| Adequate access                | 1.00       | –                | –        | –                |
| Difficult access               | 1.61 (0.92 to 2.79) | 0.094 | – | – |
| Admissions in the past year    |            |                  |          |                  |
| No admissions                  | 1.00       | –                | –        | –                |
| 1+admissions                   | 1.59 (0.89 to 2.85) | 0.118 | – | – |
| Length of index hospital stay (days) |            |                  |          |                  |
| Average stay                   | 1.00       | –                | –        | –                |
| Short stay                     | 0.54 (0.25 to 1.16) | 0.113 | – | – |
| Long stay                      | 1.18 (0.72 to 1.94) | 0.512 | – | – |
| Body mass index                | 0.98 (0.96 to 1.01) | 0.190 | – | – |
| ADL                            | 1.04 (0.99 to 1.10) | 0.102 | – | – |
| Diagnosed conditions           |            |                  |          |                  |
| Hypertension                   | 0.87 (0.53 to 1.42) | 0.578 | – | – |
| Hyperlipidaemia                | 0.76 (0.52 to 1.10) | 0.144 | – | – |
| Diabetes                      | 0.79 (0.45 to 1.39) | 0.417 | – | – |

Continued
who were widowed were readmitted; whereas only 17% of those who were married were readmitted. Numerous studies have shown that marital loss, particularly widowhood, can have negative consequences on health and well-being.\textsuperscript{39} 41 42 46 Furthermore, studies have shown that widowhood is especially impactful to the cardiovascular health and survival of White older adults; whereas Black adults have been shown to be less impacted by widowhood.\textsuperscript{39} 46 Again, additional studies are needed to further examine the possible mechanisms linking marital status to rehospitalisation, and how these mechanisms may

### Table 4 Continued

|                  | Unadjusted |                  | Adjusted |                  |
|------------------|------------|------------------|----------|------------------|
|                  | OR (95% CI)| P value          | OR (95% CI)| P value          |
| Acute MI         | 0.47 (0.20 to 1.13) | 0.091 | – | – |
| Heart failure    | 1.40 (0.92 to 2.13) | 0.120 | – | – |
| Atrial fibrillation | 0.92 (0.57 to 1.49) | 0.741 | – | – |

Note: P values are based on logistic regression models for both unadjusted and adjusted ORs. Results from the adjusted model were derived using backward stepwise-selection procedures.

ADL, activities of daily living; CES-D, Centre for Epidemiological Studies Depression Scale; CI, confidence interval; MI, myocardial infarction; OR, odds ratio.

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**Figure 1** Predicted probabilities of 30-day readmission in Black and White patients with cardiovascular disease. Note: Predicted probabilities were estimated from multivariate models in table 3 (Black patients) and table 4 (White patients). Significance levels for two-tailed tests: *p<0.05, **p<0.01, ***p<0.001. CES-D, Centre for Epidemiological Studies Depression Scale.
differ by race in order to reduce excess risks of readmission among White patients.

The results also showed that depressive symptoms were associated with increased risks of 30-day readmission among White patients. This finding is largely consistent with previous research showing that depressive symptoms are independently associated with risks for readmissions among patients with CVD. To date, however, the evidence has been mixed on the extent to which depressive symptoms are associated with cardiovascular outcomes among White and Black patients. There is some evidence to suggest that differences in how individuals cope with stressful experiences may play a role. Nevertheless, more research is clearly warranted to better understand why depressive symptoms were associated with increased risks of 30-day readmission among White patients but not Black patients.

The results from this study have potentially important implications. Our results suggest that screening patients for social determinants of health, such as marital status, employment status, and access to healthcare may be critical in identifying patients at increased risk of rehospitalisation after discharge. Our results also suggest that the most effective strategies for reducing readmissions will require patient-centred screening and discharge planning that is tailored to White and Black patients with CVD. For example, Black patients are more likely to come from socioeconomically disadvantaged backgrounds, live in segregated neighbourhoods with fewer health-promoting resources and face significant barriers in accessing their medical care—all of which have been linked to structural inequities and racism that impact care transitions after discharge and risks of rehospitalisation. Therefore, effectively reducing the excess burden of readmissions among Black patients will need to address these and other social determinants of health and structural barriers to care. By screening patients for such factors on admission, providers may be better equipped to reduce racial differences in readmissions by providing earlier and more targeted care to prevent adverse outcomes.

Several limitations of the study should also be acknowledged. The results from this study are limited to patients admitted to the Duke Heart Center for cardiovascular care; therefore, the findings may not be generalisable to the overall population of patients with CVD. Larger and more geographically representative studies are needed to further validate the current findings and provide additional insights into racial disparities in 30-day readmissions. Relatedly, patients who may have been readmitted outside of the Duke University Health System were not represented in this study, and therefore, some readmissions may have been undercounted. To help address this issue, our analyses accounted for potential area-level biases by clustering on patients’ county of residence. Moreover, as noted above, the observed readmission rate in this study was comparable to other local and national estimates of 30-day readmission in cardiovascular patients. Furthermore, we recognise that failing to account for possible discharges to skilled-nursing facilities and related health facilities may potentially underestimate the overall rates of readmission among our study participants. We recognise that while we found strong associations between social determinants of health and risks for readmission, in order to ascertain causality, additional factors need to be accounted for. Finally, we recognise that additional individual-level and institutional-level factors may have played a role in the associations. Therefore, we encourage future large-scale observational studies to consider other important factors, such as additional measures of socioeconomic status (eg, income, wealth), interpersonal discrimination and structural/institutional racism (in the community or healthcare settings), as well as specific patient groups, such as those with past clinical procedures (eg, revascularisation) and/or specific diagnoses of CVD (eg, heart failure, atrial fibrillation, acute MI, stroke) and the processes of care related to these diagnoses. Future qualitative studies are also needed to better understand, from both the patient’s and provider’s perspective, how these factors may contribute to racial differences in 30-day readmissions.

In summary, this study showed that Black patients with CVD were more likely to be readmitted within 30 days after discharge compared with White patients. The primary factors contributing to these differences are complex and involve a combination of socioeconomic, psychosocial, behavioural and healthcare-related factors that differ in Black and White patients. Together, these findings provide valuable new insights into the potential mechanisms underlying racial differences in 30-day readmissions and offer important clues to help screen and identify patients who may be at risk of poor outcomes after discharge. Strategies addressing these barriers could reduce rates of readmission among Black patients with CVD at risk for poor outcomes.

Author affiliations
1Department of Human Development and Family Sciences, University of Delaware, Newark, Delaware, USA
2Duke University School of Nursing, Durham, North Carolina, USA
3Division of Cardiology, Department of Medicine, Duke University, Durham, North Carolina, USA
4Duke Clinical Research Institute, Durham, North Carolina, USA
5Department of Population Health Sciences, Duke University, Durham, North Carolina, USA
6Department of Sociology, Duke University, Durham, North Carolina, USA

Twitter Heather R Farmer @heatherfarmer__ and Bradi B Granger @bradigranger

Contributors HRF had full access to the data in the study and takes responsibility for the accuracy of the data analysis and overall content of the paper. Study concept and design: HRF, HK and MED. Acquisition of data: HRF, HK and MED. Analysis and interpretation of data: HRF, HK and MED. Drafting of the manuscript: HRF, HK, KLT and MED. Critical revision of the manuscript for important intellectual content: HRF, HK, BG, KLT and MED. Statistical analysis: HRF, HK and MED. Administrative, technical or material support: HRF.

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