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

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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% Cl 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% Cl 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 patientreported surveys to examine a wide array of socioeconomic, psychosocial, behavioural, clinical, and healthcare-related factors associated with 30day readmissions in patients with cardiovascular disease.
- \Rightarrow Multivariate logistic regression models were used to identify the major factors contributing to 30-day readmissions in Black and White patients.
- \Rightarrow The results of this study provide much-needed evidence for identifying patients at high risk of readmission and tailoring interventions to reduce these risks
- \Rightarrow Additional unmeasured factors may have played a role in the association between patient race and 30day readmissions.
- \Rightarrow Larger and more geographically representative studies are needed to further validate the current findings.

INTRODUCTION

Protected by copyright, including for uses related to text and data mining, AI training, and Cardiovascular disease (CVD) remains the leading cause of hospitalisation in the USA.¹⁻⁴ According to recent estimates, approximately one-in-five patients hospitalised with CVD will be readmitted within 30 days after their discharge.^{2–5} Although the implementation of financial penalties and other national **og** campaigns have made small gains over the a last decade, high rates of rehospitalisation continue to put enormous strain on the US healthcare system and on those suffering from the disease.^{1 3 6} 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.^{3 7–16} However, the

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Correspondence to Dr Matthew E Dupre; matthew.dupre@duke.edu 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.¹⁷⁻²⁰ 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.^{3 14-16} However, it is unclear whether and to what extent these and other patientreported 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 cardiovascularrelated 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 65000 patients each year.¹⁹ 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 ensure a widely representative patient population and included 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.²¹

The study included 793 patients who were consented, enrolled and asked to complete a standardised selfadministered 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

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showed that the two patient groups had similar demographic and clinical profiles.²¹ 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,^{22 23} life **a** stressors,²⁴ depressive symptoms^{25 26} and self-efficacy.²⁷ Behavioural factors included smoking history, alcohol consumption, and medication adherence.²⁴ 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. ť Finally, health status included measures for body mass index, limitations in activities of daily living, and major . ar cardiovascular-related conditions that included hypertension, hyperlipidaemia, diabetes, acute myocardial infarcō tion (MI), heart failure and atrial fibrillation.

Outcome

data mining 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.^{28–30} Readmissions were ascertained from the patient's EHR based on the number of days from S 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 of their discharge. Our previous studies have shown that is the 30-day readmission and mortality rotes. were comparable to the rates reported by other hospitals in North Carolina as well as national estimates for cardiovascular patients.^{31–34}

Analysis

The distributions of patient characteristics were compared by race using t-tests, Wilcoxon-rank sum tests and χ^2 tests as appropriate. A series of logistic regression

	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					9 (1.2)
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					4 (0.5)
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					5 (0.7)
Married	391 (53.6)	73 (30.9)	318 (64.5)	<0.001	
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					2 (0.3)
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.

Table 2	ORs for racial differences in 30-day readmission in patients with cardiovascular disease, Duke Heart Center (n=734)								
		OR	95% CI	P value					
Race (Bla	ck/White)								
Model ⁻	1: Demographic and health adjustments	1.62	(1.18 to 2.23)	0.003					
Model 2	2: Socioeconomic adjustments	1.59	(1.15 to 2.20)	0.005					
Model 3	3: Psychosocial adjustments	1.47	(1.08 to 2.02)	0.016					
Model 4	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	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.

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 readmission 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,

Protected by copyright, including have fewer psychosocial resources, report more difficulty accessing care, have higher healthcare utilisation, and worse overall health status compared with White patients. ð The overall rate of 30-day readmission was significantly . uses 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 6 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 ā (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 nd 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 **\bar{g}** 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 1.21 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

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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	(0.94 to 1.07)	0.969		_	-
Life stressors	1.00	(0.89 to 1.13)	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

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Table 3 Continued							
	Unadjusted			Adjusted			
	OR	(95% CI)	P value	OR	(95% CI)	P Value	
Acute MI	0.67	(0.32 to 1.44)	0.305		-	-	
Heart failure	0.83	(0.46 to 1.52)	0.550		-	-	
Atrial fibrillation	1.88	(0.95 to 3.75)	0.071		_	_	

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; MI, myocardial infarction.

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 Š 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 ight 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 Z 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 (23%) 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 ھ 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 8 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	u=495)

	Unadiuste	d		Adjuste	d	
	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		-	-
lealth 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		-	-
larital 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
ocial support	0.97	(0.92 to 1.02)	0.229		-	-
fe stressors	1.11	(0.98 to 1.26)	0.100		-	-
ES-D	1.07	(1.01 to 1.13)	0.016	1.07	(1.00 to 1.13)	0.034
elf-efficacy	1.06	(0.89 to 1.26)	0.547		-	-
moking status						
Never smoked	1.00				-	-
Current or former smoker	0.89	(0.56 to 1.42)	0.615		-	-
Icohol consumption	0.77	(0.58 to 1.04)	0.085		-	-
ledication adherence						
Adherence to medication	1.00				-	-
Non-adherence to medication	1.17	(0.59 to 2.31)	0.652		-	-
ccess to routine care						
Adequate access	1.00				-	_
Difficult access	1.61	(0.92 to 2.79)	0.094		-	_
dmissions in the past year						
No admissions	1.00				-	-
1+admissions	1.59	(0.89 to 2.85)	0.118		-	-
ength 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		-	-
ody mass index	0.98	(0.96 to 1.01)	0.190		-	-
DL	1.04	(0.99 to 1.10)	0.102		-	-
iagnosed 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		-	-

Table 4 Continued

	Unadjusted		Adjuste	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.

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.^{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.^{39 46} Again, additional studies are needed to further examine the possible mechanisms linking marital status to rehospitalisation, and how these mechanisms may



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.⁴⁷⁻⁴⁹ 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.^{50 51} There is some evidence to suggest that differences in how individuals cope with stressful experiences may play a role⁵² 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.¹⁷ 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.^{31 32} 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 larger-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 consider 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.^{53 54} Future qualitative studies are also needed to better understand, from both the patient's and provider's perspective, how these factors may contribute **a** to racial differences in 30-day readmissions.

In summary, this study showed that Black patients **5** 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 text that differ in Black and White patients. Together, these findings provide valuable new insights into the potential mechanisms underlying racial differences in 30-day read-missions 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 ⁷Divister 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 accurace of the data analysis and everal contact of the papar. Study exponent after discharge. Strategies addressing these barriers could

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, HX and MED. Acquisition of data: HRF and HX. Analysis and interpretation of data: HRF, HX and MED. Drafting of the manuscript: HRF, HX, BG, KLT and MED. Critical revision of the manuscript for important intellectual content: HRF, HX, BG, KLT and MED. Statistical analysis: HRF, HX and MED. Administrative, technical or material support: HRF.

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