

Marital Status and Outcomes in Patients With Cardiovascular Disease

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Background—Being unmarried is associated with decreased survival in the general population. Whether married, divorced, separated, widowed, or never-married status affects outcomes in patients with cardiovascular disease has not been well characterized.

Methods and Results—A prospective cohort (inception period 2003–2015) of 6051 patients (mean age 63 years, 64% male, 23% black) undergoing cardiac catheterization for suspected or confirmed coronary artery disease was followed for a median of 3.7 years (interquartile range: 1.7–6.7 years). Marital status was stratified as married (n=4088) versus unmarried (n=1963), which included those who were never married (n=451), divorced or separated (n=842), or widowed (n=670). The relationship between marital status and primary outcome of cardiovascular death and myocardial infarction was examined using Cox regression models adjusted for clinical characteristics. There were 1085 (18%) deaths from all causes, 688 (11%) cardiovascular-related deaths, and 272 (4.5%) incident myocardial infarction events. Compared with married participants, being unmarried was associated with higher risk of all-cause mortality (hazard ratio [HR]: 1.24; 95% confidence interval [CI], 1.06–1.47), cardiovascular death (HR: 1.45; 95% CI, 1.18–1.78), and cardiovascular death or myocardial infarction (HR: 1.52; 95% CI, 1.27–1.83). Compared with married participants, the increase in cardiovascular death or myocardial infarction was similar for the participants who were divorced or separated (HR: 1.41; 95% CI, 1.10–1.81), widowed (HR: 1.71; 95% CI, 1.32–2.20), or never married (HR: 1.40; 95% CI, 0.97–2.03). The findings persisted after adjustment for medications and other socioeconomic factors.

Conclusions—Marital status is independently associated with cardiovascular outcomes in patients with or at high risk of cardiovascular disease, with higher mortality in the unmarried population. The mechanisms responsible for this increased risk require further study. (*J Am Heart Assoc.* 2017;6:e005890. DOI: 10.1161/JAHA.117.005890.)

Key Words: cardiovascular disease • divorce • marital status • mortality • never married • socioeconomic position • unmarried • widowed

Divorced individuals have increased all-cause mortality in the general population. In contrast, evidence for increased risk of adverse cardiovascular outcomes in

unmarried populations remains conflicting.^{1–5} Although survival according to marital status has been reported in patients presenting with acute coronary syndromes, few studies have evaluated the relationship between adverse cardiovascular outcomes and marital status in patients with known or suspected coronary artery disease (CAD).^{6–8} In addition, the definition of unmarried status is not always clear despite noted differences in the divorced or separated, widowed, and never-married groups.^{9–13} Va et al, for example, reported higher all-cause mortality rates for divorced men and for widowed or never-married women but not for never-married or widowed men.¹² To further investigate the impact of marital status on cardiovascular outcomes, we analyzed the relationship between marital status and adverse outcomes in patients with known CAD or who were at high-risk for CAD. We specifically examined outcomes of each unmarried group (divorced or separated, widowed, and never married) with the hypothesis that, compared with married patients, unmarried patients will be at increased risk for adverse cardiovascular outcomes.

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Clinical Perspective

What Is New?

- Being unmarried is associated with adverse cardiovascular outcomes in patients with coronary artery disease.
- This study is the first to show adverse outcomes in separate unmarried groups (divorced or separated, widowed, and never married).
- The increased risk of cardiovascular events remained significant even after extensive adjustment for clinical characteristics including coronary artery disease severity, socioeconomic risk factors, and medication use.

What Are the Clinical Implications?

- Individuals with coronary artery disease who are at high risk for adverse cardiovascular outcomes should be identified.
- Further investigation is needed to determine whether more aggressive treatment strategies can positively alter outcomes for unmarried patients.

Methods

The data, analytic methods, and study materials will not be made available to other researchers for purposes of reproducing the results or replicating the procedure.

Study Design

We enrolled 6051 participants in the Emory Cardiovascular Biobank, a prospective cohort of patients who underwent cardiac catheterization for suspected or known CAD at Emory Healthcare hospitals between 2003 and 2015.^{14,15} Participants with severe valvular heart disease, congenital heart disease, severe anemia, recent blood transfusion, myocarditis, active inflammatory diseases, and active cancer were excluded. Adults (aged >18 years) were interviewed to collect information on demographic characteristics, medical history, medication use, behavioral habits, and socioeconomic factors including employment status and education level. Median household income was defined by the 2009–2013 American Community Survey 5-Year Estimates according to the ZIP code of primary residence reported by study participants.¹⁶ Marital status was derived from a self-administered questionnaire at enrollment. Patients listed their marital status as married, divorced, separated, widowed, or never married. Divorced and separated statuses were combined into 1 group for this analysis and will be referred to as the *divorced/separated* group. Risk factor prevalence was determined by physician diagnosis and/or treatment for hypertension, hyperlipidemia, or diabetes mellitus. Smoking was classified as *nonsmoker* or *ever smoked* if there was a lifetime history of smoking at least 100 cigarettes. Medical records were

reviewed to confirm self-reported history of myocardial infarction (MI). All coronary angiograms were scored for luminal narrowing using a modified American Heart Association/American College of Cardiology classification.¹⁷ Obstructive coronary artery disease was defined as the presence of at least 1 major epicardial vessel with $\geq 50\%$ stenosis. After excluding individuals with <30 days of follow-up or incomplete angiographic or questionnaire data, 6051 participants were eligible. The study was approved by the institutional review board at Emory University. All participants provided written informed consent.

Follow-up and Outcomes

Follow-up was conducted by telephone and medical chart abstraction to determine adverse outcomes. The primary outcome was the combined incidence of cardiovascular death and MI, and the secondary outcomes included all-cause death and cardiovascular death. Cardiovascular death was defined as death attributable to an ischemic cardiovascular cause like fatal MI, ischemic stroke, or sudden death secondary to presumed cardiovascular cause in this high-risk CAD population. Medical records were accessed or requested to validate all self-reported events including MI, which was defined using standard criteria, as described. The classification of events and follow-up data was made on the basis of phone interview, electronic medical record review, social security death index, and state records. Adjudication was conducted by 3 independent physicians who were blinded to the study.

Statistical Analyses

Continuous variables are presented as mean \pm SD, and categorical variables are presented as proportion (percentage). The Student *t* test, 1-way ANOVA, and the χ^2 test were used to compare patient characteristics among marital status groups. The Mann-Whitney *U* nonparametric test was performed on nonnormally distributed variables. The relationship between marital status and outcomes was determined using Cox proportional hazards regression in models (using age as the time scale) adjusted for sex, race (black versus nonblack), diagnosis of hypertension, diabetes mellitus, low- and high-density lipoprotein levels, heart failure, history of MI, estimated glomerular filtration rate (eGFR; calculated using the Chronic Kidney Disease Epidemiology Collaboration equation), body mass index, obstructive coronary artery disease, smoking history, medications (statins, aspirin, beta blockers, angiotensin receptor blockers or angiotensin-converting enzyme inhibitors), education (dichotomized by college degree), and employment status (employed versus not employed).

For outcomes including all-cause death, cardiovascular death, and MI, we used the Fine and Gray competing risk

analysis and reported subdistribution hazard ratio (HR) by treating noncardiovascular death and all-cause death as competing risk events.

The first model included only characteristics to evaluate clinical outcomes. Model 2 included all variables in Model 1 and the dichotomous marital status. Model 3 was similar to model 2, with marital status further divided into unmarried, divorced/separated, widowed, and never married. Models 4 and 5 were similar to model 2 with the addition of medication prescriptions and socioeconomic factors (employment status and college education), respectively.

Sensitivity analyses were performed in models to examine interactions among marital status, outcomes, and each of the following: age, sex, race, and employment. We checked the proportional hazards assumption (by testing time-covariate interactions) and covariate functional forms for all the final Cox models and found no significant violations. Analyses were performed using SAS 9.4 (SAS Institute) and R 3.2.2.¹⁸ *P* values <0.05 were considered statistically significant.

Results

Study Population

Baseline characteristics of the 6051 participants (aged 63±11 years) are shown in Table 1. The cohort was 64% male and 23% black (Table 1). Obstructive CAD was present in 4256 (70.3%) participants, and 490 (8%) participants presented with acute MI. More than two thirds of participants (n=4088, 68%) were married, 842 (14%) were divorced or separated, 670 (11%) were widowed, and 451 (7%) were never married.

Comparison of Married and Unmarried Participants

Unmarried participants were more likely to be female and black; less likely to be smokers; and more likely to have hypertension, heart failure, reduced eGFR, or elevated low- or high-density lipoprotein levels compared with the married cohort. Married participants were more likely to have been prescribed an angiotensin-converting enzyme inhibitor or angiotensin receptor blocker, aspirin, statin, or clopidogrel (Table 1). In multivariable analyses stratified by sex, marriage for men was associated with older age, being white, higher body mass index, and lower prevalence of hypertension and heart failure. In women, being married was associated only with younger age and white race (Table 2).

During a median follow-up period of 3.7 years (interquartile range: 1.7–6.7 years), there were 1085 (18%) deaths from all causes, 688 (11%) cardiovascular-related deaths, and 272 (4.5%) incident MI events (Table 1, Figure 1). In a Cox

proportional hazards regression model that included all cardiovascular risk factors, significant predictors of all-cause mortality were body mass index, heart failure history, diabetes mellitus, current or prior smoking, obstructive CAD, and eGFR (Table 3, Model 1). The same factors and black race were independent predictors of cardiovascular mortality and the combined outcome of cardiovascular death or MI.

All-cause and cardiovascular mortality as well as the combined cardiovascular death/MI rates were higher in unmarried participants compared with married participants (Table 1). In a Cox regression model that included all aforementioned risk factors, the unmarried group compared with the married group had HRs of 1.24 (95% confidence interval [CI], 1.06–1.47) for all-cause mortality, 1.45 (95% CI, 1.18–1.78) for cardiovascular death, and 1.52 (95% CI, 1.27–1.83) for cardiovascular death/MI (Table 3, Figure 1). The association between marital status and adverse outcomes remained significant after adjusting for socioeconomic status (employment and education) and medications (Table 3). Similar to the rates observed in the entire unmarried population, cardiovascular death and cardiovascular death/MI were higher in each of the unmarried subgroups of divorced/separated, widowed, and never-married participants, without significant interaction among these 3 groups (*P*>0.05 for interaction), although the association was stronger in the widowed group.

Sensitivity Analysis

Sensitivity analyses were performed to examine whether age, sex, race, or unmarried subgroups affected the association between marital status and outcomes. We found no interaction between marital status and cardiovascular death or cardiovascular death/MI with respect to age, sex, or race. However, there was a significant interaction among age, marital status, and all-cause death (interaction, *P*=0.04). Notably, unmarried participants aged <65 years (n=1072) experienced higher risk of all-cause death (HR: 1.43; 95% CI, 1.09–1.89), whereas unmarried status was not associated with all-cause death (sHR: 0.99; 95% CI, 0.79–1.24) in participants aged ≥65 years (n=891).

Comparison of Married and Divorced or Separated Participants

Compared with married participants, divorced or separated participants were more likely to be younger, female, and black; to have higher low- and high-density lipoprotein cholesterol levels; and to be diagnosed with hypertension, obstructive CAD, or heart failure (Table 1).

Cox proportional hazards regression models adjusting for the aforementioned covariates demonstrated that, compared

Table 1. Demographics and Clinical Characteristics Stratified by Marital Status

Variables	Marital Status Subgroups							
	Married (n=4088)	Unmarried (n=1963)	P Value*	Divorced/ Separated (n=842)	Widowed (n=670)	P Value†	Never Married (n=451)	P Value‡
Age, y	63 (11)	63 (14)	0.15	60 (11)	73 (11)	<0.001	53 (14)	<0.001
Male, n (%)	2961 (72)	918 (47)	<0.001	440 (52)	211 (32)	<0.001	267 (59)	<0.001
Black race, n (%)	690 (17)	711 (36)	<0.001	317 (38)	157 (23)	<0.001	237 (53)	<0.001
Body mass index, kg/m ²	30 (6)	30 (7)	0.22	30 (7)	29 (7)	0.32	31 (8)	0.009
Employed, n (%)	1539 (38)	511 (26)	<0.001	273 (32)	97 (15)	0.004	141 (31)	0.008
College education, n (%) [#]	2474 (61)	1002 (51)	<0.001	446 (53)	296 (44)	<0.001	260 (58)	0.24
Median income, estimated**	51 620 (17 833)	47 644 (16 219)	<0.001	48 138 (16 208)	47 969 (16 896)	<0.001	46 290 (15 195)	<0.001
Clinical characteristics								
History of smoking, n (%)	2710 (66)	1245 (63)	0.028	554 (66)	430 (64)	0.78	261 (58)	<0.001
Hypertension, n (%)	3130 (77)	1583 (82)	<0.001	675 (81)	571 (86)	0.003	337 (76)	0.38
Diabetes mellitus, n (%)	1414 (35)	709 (37)	0.25	297 (36)	263 (39)	0.72	149 (34)	0.71
Low-density lipoprotein, mg/dL	93 (36)	97 (39)	<0.001	100 (39)	95 (41)	<0.001	96 (37)	0.38
High-density lipoprotein, mg/dL	42 (13)	45 (20)	<0.001	44 (15)	46 (14)	<0.001	46 (31)	<0.001
MI on admission, n (%)	324 (8)	166 (9)	0.48	53 (6)	72 (11)	0.12	41 (9)	0.41
History of MI, n (%)	955 (24)	468 (25)	0.45	201 (25)	174 (27)	0.56	93 (22)	0.26
Obstructive CAD, n (%) ^{††}	2916 (76)	1340 (74)	0.07	554 (70)	501 (82)	0.001	285 (68)	<0.001
Heart failure, n (%)	842 (21)	519 (27)	<0.001	221 (27)	177 (27)	<0.001	121 (27)	0.002
eGFR, mL/min/1.73 m ²	73 (23)	71 (27)	0.024	74 (26)	63 (22)	0.64	78 (30)	<0.001
ACE/ARB use, n (%)	2297 (56)	1023 (52)	0.003	440 (52)	379 (57)	0.040	204 (45)	<0.001
Beta-blocker use, n (%)	2689 (66)	1317 (67)	0.32	550 (65)	487 (73)	0.81	280 (62)	0.12
Aspirin use, n (%)	3168 (78)	1422 (72)	<0.001	595 (71)	532 (79)	<0.001	295 (65)	<0.001
Statin use, n (%)	2945 (72)	1296 (66)	<0.001	535 (64)	483 (72)	<0.001	278 (62)	<0.001
Clopidogrel use, n (%)	1812 (44)	789 (40)	0.002	344 (41)	309 (46)	0.07	136 (30)	<0.001
Clinical outcomes								
All-cause death (n=1085)	681 (16.66)	404 (20.58)	<0.001	153 (18.17)	184 (27.46)	0.29	67 (14.86)	0.33
Cardiovascular death (n=688)	412 (10.08)	276 (14.06)	<0.001	102 (12.11)	126 (18.81)	0.07	48 (10.64)	0.71

Continued

Table 1. Continued

Variables	Marital Status Subgroups						P Value [§]	
	Married (n=4088)	Unmarried (n=1963)	P Value*	Divorced/ Separated (n=842)	P Value [†]	Widowed (n=670)		P Value [‡]
MI (n=272)	170 (4.16)	102 (5.2)	0.07	48 (5.7)	0.047	33 (4.93)	0.36	21 (4.66)
Cardiovascular death/MI (n=824)	506 (12.38)	336 (17.12)	<0.001	135 (16.03)	0.004	142 (21.19)	<0.001	59 (13.08)

Values are mean (SD) unless otherwise noted. ACEI/ARB indicates angiotensin-converting enzyme inhibitor or angiotensin receptor blocker; CAD, coronary artery disease; eGFR, estimated glomerular filtration rate; MI, myocardial infarction.

*P value denotes statistical significance for comparison between married and all unmarried participants.

†P value denotes statistical significance for comparison between married and divorced or separated participants.

‡P value denotes statistical significance for comparison between married and widowed participants.

§P value denotes statistical significance for comparison between married and never-married individuals.

||Statistically significant P values.

¶Includes part-time employment.

#Includes any college education, even if incomplete.

**Median income estimated from ZIP code-derived median income.

††Obstructive CAD is defined as the presence of a ≥50% obstructive lesion in any of the major vessels on coronary angiogram at enrollment.

with married participants, divorced or separated participants had a nonsignificant increased risk of all-cause death (HR: 1.23; 95% CI, 0.98–1.55) and cardiovascular death (sHR: 1.27; 95% CI, 0.95–1.69) and a significant increased risk of cardiovascular death/MI (sHR: 1.41; 95% CI, 1.10–1.81; Table 3, Figure 2).

Comparison of Married and Widowed Participants

Compared with married participants, widowed participants were more likely to be older, female, and black and have reduced eGFR and a history of hypertension, diabetes mellitus, obstructive CAD, heart failure, presentation with acute MI, or higher high-density lipoprotein level (Table 1).

Cox proportional hazards regression models adjusting for the aforementioned covariates demonstrated that, compared with married participants, widowed participants had a nonsignificant increased risk of all-cause death (HR: 1.24; 95% CI, 0.99–1.54) but a significant increased risk of cardiovascular death (sHR: 1.62; 95% CI, 1.23–2.13), and cardiovascular death/MI (sHR: 1.71; 95% CI, 1.32–2.20).

Comparison of Married and Never-Married Participants

Compared with married participants, those who never married were more likely to be younger, female, and black; to have lower rates of smoking and obstructive CAD; and to have higher body mass index, high-density lipoprotein and eGFR levels, and greater prevalence of heart failure (Table 1).

Cox regression models adjusting for the aforementioned covariates demonstrated that, compared with married participants, never-married individuals had a nonsignificant increased risk of all-cause death (HR: 1.28; 95% CI, 0.92–1.79), cardiovascular death (sHR: 1.47; 95% CI, 0.98–2.21), and cardiovascular death/MI (sHR: 1.40; 95% CI, 0.97–2.03; Table 3, Figure 2).

Discussion

In this article, we described the association between marital status and adverse outcomes in a patient population at high risk for CAD or with known CAD. This study is the first, to our knowledge, to evaluate hard cardiovascular disease outcomes in separate unmarried groups in a high-risk cardiovascular disease population, with extensive adjustment for clinical characteristics including CAD severity and socioeconomic risk factors. Compared with married participants, we found that unmarried individuals had 45% higher rates of cardiovascular death and 52% higher cardiovascular death/MI. Adverse cardiovascular outcomes were higher in each of the unmarried subgroups of divorced/separated, widowed, and

Table 2. Characteristics Independently Associated With Marriage

Variables	Men		Women	
	OR (95% CI)	P Value*	OR (95% CI)	P Value*
Age, per 10 y	1.26 (1.16–1.38)	<0.001	0.75 (0.68–0.83)	<0.001
Black race	0.39 (0.31–0.48)	<0.001	0.26 (0.2–0.35)	<0.001
Body mass index, per 5 kg/m ²	1.13 (1.04–1.24)	0.004	0.98 (0.91–1.06)	0.68
Smoking history	1.09 (0.98–1.21)	0.12	1.01 (0.9–1.13)	0.91
Hypertension	0.78 (0.61–1)	0.05	1.01 (0.74–1.36)	0.96
Diabetes mellitus	1.08 (0.88–1.33)	0.44	0.99 (0.77–1.27)	0.95
Low-density lipoprotein, per 10 mg/dL	1 (0.97–1.03)	0.90	1 (0.98–1.03)	0.77
High-density lipoprotein, per 10 mg/dL	0.95 (0.89–1.02)	0.15	0.96 (0.89–1.04)	0.32
MI history	0.88 (0.71–1.09)	0.26	0.83 (0.63–1.1)	0.20
Obstructive CAD	0.88 (0.69–1.13)	0.33	0.89 (0.69–1.15)	0.38
Heart failure	0.78 (0.63–0.98)	0.03	0.82 (0.63–1.06)	0.13
eGFR rate, per 10 mL/min/1.73 m ²	1.02 (0.98–1.07)	0.27	1.04 (0.99–1.09)	0.11

CAD indicates coronary artery disease; CI, confidence interval; eGFR, estimated glomerular filtration rate; MI, myocardial infarction; OR, odds ratio. *P value reflects comparison between married and unmarried groups.

never-married participants, similar to the rates observed in the entire unmarried population. The findings persisted after adjustment for medication prescriptions and socioeconomic risk factors, including employment and education.

A study performed 2 decades ago in patients undergoing bypass surgery reported that married patients were 2.5 times more likely to be alive after 15 years compared with unmarried patients.⁶ A more recent study in patients undergoing percutaneous revascularization also demonstrated higher cardiovascular event rates in unmarried patients compared with married patients.⁷ Although these studies

are in agreement with our findings, which were obtained from a wide spectrum of patients who had CAD or were at high risk for CAD, our study further examined outcomes in never-married, widowed, and divorced/separated groups.

Divorce portends a worse prognosis compared with the married status in the general population.^{19–21} Evidence also suggests that divorced individuals experience increased cardiovascular events and mortality, although these data are conflicting.^{2,4,9,22–24} For example, in men without known CAD but with above-average risk factor prevalence, increased mortality was observed in divorced individuals, but in a study

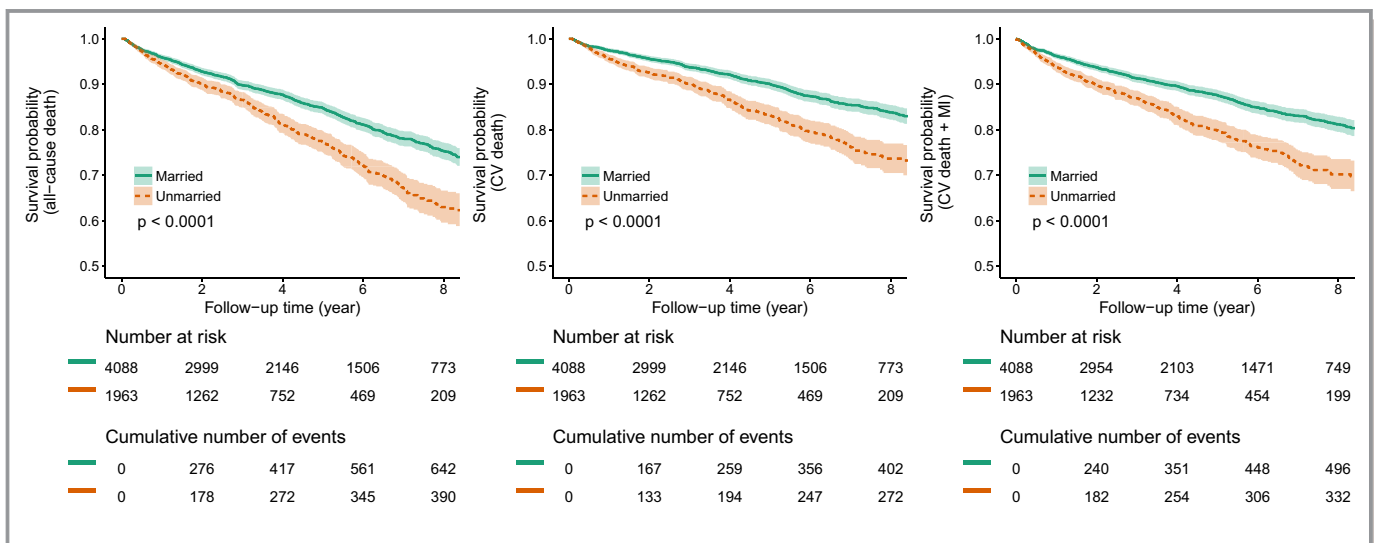


Figure 1. Kaplan–Meier survival curves for (A) all-cause death, (B) cardiovascular (CV) death, and (C) CV death or myocardial infarction, stratified by marital status for the whole cohort.

Table 3. Marital Status and Outcomes

Variables	All-Cause Death, HR (95% CI)	Cardiovascular, Death sHR (95% CI)	Cardiovascular Death/MI, sHR (95% CI)
Model 1: Clinical characteristics			
Male	1.03 (0.87–1.21)	0.92 (0.74–1.15)	0.94 (0.77–1.14)
Black race	1.13 (0.93–1.37)	1.27 (1.00–1.62)	1.39 (1.13–1.72)
Body mass index, per 5 kg/m ²	0.86 (0.81–0.93)	0.89 (0.81–0.98)	0.92 (0.84–0.99)
Smoking history	1.28 (1.09–1.50)	1.33 (1.09–1.64)	1.39 (1.15–1.68)
Hypertension	1.00 (0.84–1.21)	1.08 (0.85–1.37)	1.13 (0.91–1.41)
Diabetes mellitus	1.26 (1.08–1.48)	1.12 (0.92–1.38)	1.21 (1.01–1.45)
Low-density lipoprotein, per 10 mg/dL	1.00 (0.98–1.02)	0.99 (0.97–1.02)	0.99 (0.97–1.02)
High-density lipoprotein, per 10 mg/dL	0.99 (0.93–1.05)	0.94 (0.86–1.02)	0.96 (0.89–1.03)
eGFR rate, per 10 mL/min/1.73 m ²	0.86 (0.83–0.89)	0.86 (0.82–0.90)	0.88 (0.84–0.91)
MI history	1.01 (0.86–1.18)	0.97 (0.79–1.19)	1.19 (0.99–1.43)
Obstructive CAD	1.28 (1.06–1.55)	1.38 (1.08–1.76)	1.64 (1.31–2.07)
Heart failure	2.06 (1.76–2.41)	2.54 (2.09–3.10)	2.03 (1.69–2.43)
Model 2: Clinical characteristics plus marital status			
Unmarried vs married	1.24 (1.06–1.47)	1.45 (1.18–1.78)	1.52 (1.27–1.83)
Model 3: Clinical characteristics plus marital status groups			
Divorced/separated vs married	1.23 (0.98–1.55)	1.27 (0.95–1.69)	1.41 (1.10–1.81)
Widowed vs married	1.24 (0.99–1.54)	1.62 (1.23–2.13)	1.71 (1.32–2.20)
Never married vs married	1.28 (0.92–1.79)	1.47 (0.98–2.21)	1.40 (0.97–2.03)
Model 4: Clinical characteristics plus marital status plus medications			
Unmarried vs married	1.24 (1.05–1.46)	1.45 (1.18–1.78)	1.52 (1.26–1.83)
Model 5: Clinical characteristics plus marital status plus socioeconomic factors (employment and education)			
Unmarried vs married	1.14 (0.95–1.37)	1.33 (1.06–1.68)	1.46 (1.22–1.76)

CAD indicates coronary artery disease; CI, confidence interval; eGFR, estimated glomerular filtration rate; HR, hazard ratio; MI, myocardial infarction; sHR, subdistribution hazard ratio.

of individuals with no prior history of CAD, divorce was not associated with increased cardiovascular mortality.^{2,22} We found an increased rate of cardiovascular mortality and MI in divorced or separated participants compared with the married group, even after extensive adjustment for covariates. The mechanisms underlying the adverse prognosis in divorced individuals are not completely understood. Studies have demonstrated that remarriage may attenuate the increased risk observed after divorce, suggesting that immediate emotional and financial aspects of divorce play a smaller role than the long-term effects of remaining divorced.²⁵ A lack of social support has also been hypothesized to worsen outcomes after divorce.²⁶ Unhappy marriages, which likely have lower levels of social support, are associated with poor outcomes compared with happily married couples.²⁷ Similarly, divorce has been associated with worse outcomes compared with never marrying, suggesting that the acute stress of divorce may play a role in adverse outcomes.²⁸ It is also possible that individuals remain unmarried because of psychosocial factors that put them at greater risk for CAD.²⁹

Widowhood has been previously associated with increased risk of adverse cardiovascular events and mortality.^{9,12,30,31} Our study confirms this increased cardiovascular mortality risk in widowed compared with married individuals in a population with CAD, even after adjustment for covariates. Proposed explanations for this disparity include living alone and reduced social support.³²

Data on never-married individuals and outcomes are limited. A population-based study of men and women in Japan found a significant increase in cardiovascular and all-cause mortality in men and an increase in all-cause mortality in women who had never married compared with the married group.² Other studies have demonstrated conflicting results.^{10,13,24} In the present study, we found an elevated risk of cardiovascular mortality in the never-married cohort similar to the other unmarried groups. Although it did not reach statistical significance, the rate observed in the never-married group was not different from the entire unmarried population, without significant interaction among the 3 unmarried groups. The increased risk may be due to lack of social support or self-selection of never-married

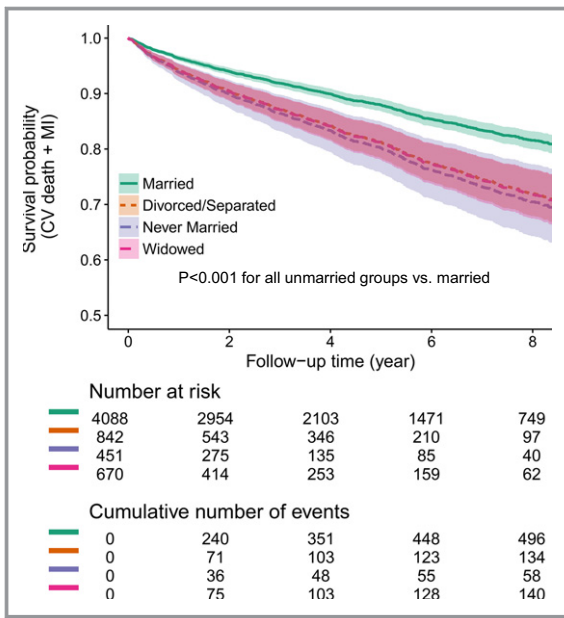


Figure 2. Age-adjusted survival curves for cardiovascular death or myocardial infarction, stratified by marital status groups (never married, widowed, and divorced/separated).

individuals due to poor socioeconomic and psychosocial status. Although the never-married cohort was much younger and had a higher prevalence of smoking, the baseline risk factor profile did not differ significantly from the divorced/separated or widowed groups.

We demonstrated a significant interaction between age and all-cause mortality in the unmarried group, but no interaction was found with cardiovascular death or cardiovascular death/MI. Younger (aged <math><65</math> years) unmarried individuals were at higher risk for all-cause mortality than those aged ≥ 65 years, although the rates of cardiovascular death or cardiovascular death/MI were higher in unmarried individuals regardless of age.

Prior studies evaluating the effect of sex on cardiovascular outcomes in divorced individuals are conflicting. A large meta-analysis of 29 studies found that, compared with the married group, all-cause mortality was higher for both divorced men and women, with minimal difference between groups.¹⁹ Other studies have reported that either men are at higher risk after divorce than their female counterparts^{2,24,33} or that divorced women have higher risk compared with men.^{4,5} In the present study, there was no interaction between sex and outcomes in the unmarried groups.

The association between unmarried status and adverse cardiovascular events persisted after adjustment for medications and socioeconomic factors including education and employment status, suggesting that additional factors play a role in the disparity faced by unmarried individuals. Lifestyle and medication adherence are positively influenced by being married. Lack of social support, a more sedentary lifestyle,

and lack of motivation to be receptive to lifestyle changes and to follow prescriptions are potential explanations for the association between being unmarried and nonadherence³⁴; however, adherence—a likely confounder—was not captured in this database.

The strengths of our study include its large sample size, a diverse multiethnic population, adequate representation of both sexes and black and white races, detailed delineation of CAD status, and careful long-term follow-up. To our knowledge, this study is the first to demonstrate an association between marital status and all-cause and cardiovascular mortality in a high-risk cardiovascular patient population. Limitations include the retrospective analysis, single-center study, and lack of follow-up regarding continued marital status. However, studies evaluating the effects of remarriage on outcomes are conflicting, and our mean follow-up of 3 years indicates that few participants are likely to have had a change in marital status.^{23,25,35} Our cohort is not representative of the general population without CVD, and thus our results are not generalizable. Finally, we do not have information regarding the temporal relationship between the duration from divorce or widowhood and enrollment, and cohabitation was not captured in this data set.^{3,5}

Conclusions

Unmarried patients with known or suspected CAD have an increased risk of all-cause and cardiovascular mortality compared with married individuals, even after extensive adjustment for differences in demographic and cardiovascular risk factors. The risk of adverse outcomes was attenuated with age. Accounting for unmarried status in the management of patients with CAD, consideration of associated psychological conditions, and potentially more aggressive follow-up and therapy need to be considered in future studies.

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Disclosures

None.

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