ORIGINAL RESEARCH

Marital Status and Subclinical Coronary Atherosclerosis in Asymptomatic Individuals

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BACKGROUND: Data are limited on the association between marital status and subclinical coronary atherosclerosis. This study investigated the influence of marital status on subclinical coronary atherosclerosis detected by coronary computed tomographic angiography in an asymptomatic population.

METHODS AND RESULTS: This retrospective study analyzed 9288 asymptomatic individuals (mean age, 53.7±8.0 years; 6041 [65%] men) with no history of coronary artery disease who voluntarily underwent coronary computed tomographic angiography during a general health examination. Marital categories were married (n=8481) versus unmarried (n=807), comprising never married (n=195), divorced (n=183), separated (n=119), and widowed (n=310) individuals. The degree and extent of subclinical coronary atherosclerosis were evaluated by coronary computed tomographic angiography; ≥50% diameter stenosis was defined as significant. Logistic regression and propensity score matching analyses were used to determine the association between marital status and subclinical coronary atherosclerosis. After adjustment for cardiovascular risk factors, no significant differences were observed in the adjusted odds ratio (OR) of unmarried status for any coronary plaque (OR, 1.077; 95% CI, 0.899–1.291), calcified plaque (OR, 1.058; 95% CI, 0.881–1.271), noncalcified plaque (OR, 0.966; 95% CI, 0.691–1.351), mixed plaque (OR, 1.301; 95% CI, 0.884–1.917), and significant coronary artery stenosis (OR, 1.066; 95% CI, 0.771–1.474). Similarly, in the 2:1 propensity-score matched population (n=2398), no statistically significant differences were observed for the OR of marital status for any subclinical coronary atherosclerosis ($P>0.05$ for all).

CONCLUSIONS: In this large cross-sectional study, marital status was not associated with an increased risk of subclinical coronary atherosclerosis.

Key Words: atherosclerosis ■ divorced ■ heart disease risk factors ■ marital status ■ never married ■ separated ■ widowed

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Coronary artery disease (CAD) remains the global leading cause of death.[1] Epidemiologic studies have identified risk factors for CAD, including age, sex, diabetes, hypertension, hyperlipidemia, obesity, current smoking, family history of CAD, and CRP (C-reactive protein).[2–4] The standard of care for patients with CAD was established on the basis of these traditional risk factors.[5,6] Furthermore, the evolving role of nontraditional risk factors, such as socioeconomic and psychosocial factors, has been increasingly recognized.[7,8] Previous studies have acknowledged an association between marital status and not only incidence of CAD but also CAD-related clinical outcomes.[8–11] However, to date, no studies have focused on the association between marital status and subclinical coronary atherosclerosis in asymptomatic individuals. It is still unclear whether specific marital status, defined as married, never married, divorced, separated, or

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CLINICAL PERSPECTIVE

What Is New?

- Marital status is not associated with subclinical coronary atherosclerosis on coronary computed tomographic angiography.
- In addition, each unmarried status (never married, divorced, separated, and widowed) did not have any association with subclinical coronary atherosclerosis.

What Are the Clinical Implications?

- Both married and unmarried individuals may be managed with similar prevention strategies for coronary artery disease.

widowed, is a risk factor for CAD. With the advent of multidetector computed tomography, coronary computed tomographic angiography (CCTA) can provide comprehensive assessment of CAD, including lesion location, disease severity, and plaque characteristics.[1,2] Therefore, this study sought to (1) evaluate the association between marital status and subclinical coronary atherosclerosis and (2) specifically examine the impact of marital status for each unmarried group (never married, divorced, separated, or widowed) on subclinical coronary atherosclerosis in a large cohort of asymptomatic Korean individuals who voluntarily underwent CCTA for early detection of CAD.

METHODS

The data that support the findings of this study are available from the corresponding authors on reasonable request.

Study Population

As a compulsory social insurance, South Korea has a National Health Insurance system that covers the whole population living in the country. The National Health Insurance has actively operated the business of promoting health checkups and health level in an effort to detect diseases early and enhance public health. These general health screenings have been performed to the employee insured with no age limit (annually) and the self-employed insured, such as householders or dependents aged >40 years (biannually). These general checkups are free and covered by the National Health Insurance. In addition, if individuals undergoing general medical checkups paid additional costs, they could take additional tests, such as CCTA. In the present study, we analyzed 10 581 consecutive South Korean individuals, aged ≥20 years, who underwent self-referred CCTA as part of a general health examination at the Health Promotion Center of Ulsan University Hospital from January 2009 to March 2020. At the time of medical checkups, the potential risk of radiation hazards, use of contrast, and higher cost for CCTA were explained to all study participants. A written informed consent for the additional CCTA test was also obtained from each participant. Of the 10 581 enrolled, 1293 individuals were excluded on the basis of these criteria: (1) insufficient medical records (n=581); (2) history of angina or myocardial infarction and/or percutaneous coronary intervention (n=340); (3) no response for marital status (n=171); (4) abnormal 12-lead ECG results, including pathological Q waves, ischemic ST segments or T-wave changes, left bundle-branch blocks, or complete atrioventricular block (n=90); (5) renal insufficiency (creatinine >1.5 mg/dL) (n=47); (6) structural heart diseases (n=41); (7) history of open heart surgery (n=18); (8) history of radiofrequency catheter ablation (n=3); (9) history of patent foramen ovale device closure (n=1); and (10) poor image quality (n=1). Final analysis included 9288 participants (Figure). This retrospective cross-sectional study was approved by the local Institutional Review Board of the Ulsan University Hospital, Ulsan, Korea, which waived the requirement for informed consent because of the retrospective study design (IRB No. UUH 2020-12-033).

Clinical and Laboratory Measurements

Clinical and laboratory data were collected from a clinical data warehouse platform and electronic medical records of Ulsan University Hospital. Any clinical data, including age, sex, and any medical history, were obtained from the systemized self-report questionnaire administered before the general health examination, including the following factors: angina, myocardial infarction, percutaneous coronary intervention, structural heart disease, open heart surgery, previous cardiac procedures, marital status, diabetes, hypertension, hyperlipidemia, smoking status, and family medical history. Participants listed their marital status as married, never married, divorced, separated, or widowed.

Height and weight were obtained with participants wearing light clothing and no shoes. Body mass index was calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2). The waist circumference (cm) was measured midway between the lower costal margin and the iliac crest at the end of a normal expiration by a well-trained nurse. Blood pressure was measured on the right arm after a ≥5-minute rest using an automatic manometer and an appropriate cuff size. A standard 12-lead ECG was obtained from each subject.

After overnight fasting, early morning blood samples were drawn from the antecubital vein into vacuum

tubes and subsequently analyzed at the certified central laboratory of Ulsan University Hospital. The concentrations of glucose, hemoglobin A1c, total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, triglycerides, creatinine, uric acid, and CRP were measured. Left ventricular ejection fraction was measured using echocardiography.

Obesity was defined as a body mass index ≥25 kg/m^2, according to the Asian-specific cutoff recommended by the World Health Organization. Diabetes was defined as a self-reported history of diabetes or current diabetes-specific treatment (either dietary or pharmacologic) on the systemized questionnaire or as a fasting plasma glucose level ≥126 mg/dL or hemoglobin A1c ≥6.5%. Hypertension was defined as blood pressure ≥140/90 mm Hg or a self-reported history of hypertension and/or the use of antihypertensive medication. Hyperlipidemia was defined as total cholesterol ≥240 mg/dL or a self-reported history of hyperlipidemia and/or the use of an antihyperlipidemic medication. A family history of CAD was defined as having a first-degree relative of any age with CAD, as reported on the self-report questionnaire.[13] The 10-year CAD risk score was calculated using the Framingham risk model.[4]

CCTA Image Acquisition and Analysis

Imaging with CCTA was conducted by using single-source, 256-slice computed tomography (CT) (Brilliance iCT; Philips Healthcare, Best, the Netherlands) or dual-source CT (Somatom Definition Flash; Siemens, Erlangen, Germany). Participants with no contraindication to β-adrenergic blocking agents and with a baseline heart rate of >65 beats/min were administrated 100 mg of metoprolol tartrate orally (Betaloc; Yuhan, Seoul, Korea). Participants also took nitroglycerin sublingually before contrast injection. The CT scanning was performed in the prospective ECG-triggering mode or the retrospective ECG-gating mode with ECG-based tube current modulation. During acquisition of CCTA images, 60 to 80 mL of iodinated contrast material (Iomeron 400; Bracco, Milan, Italy) was injected at 4 mL/s, followed by a 40-mL saline flush. A region of interest was placed in the ascending aorta, and image acquisition was initiated automatically once a selected threshold (100 Hounsfield units) had been reached by using bolus tracking. A standard coronary scanning protocol was used, and the tube voltage and tube current-time product were adjusted according to the patient's body size as follows: 80- to 120-kVp tube voltage, 240 to 400 mAs per rotation (dual-source CT), and 400- to 800-mA tube current (256- slice CT).

All CCTA image interpretation and calcium scoring were performed using a dedicated workstation (Syngo.

via [Siemens] or Aquarius iNtuition [Terarecon]) by an experienced cardiovascular radiologist and cardiologist, each with >10 years of experience (S.H.C., W.J.K., and G.M.P.). Final decisions on the findings were reached by consensus. According to the guidelines of the Society of Cardiovascular Computed Tomography, a 16-segment coronary artery tree model was used.[14] The coronary artery calcium score was measured and categorized by scores of 0, 1 to 10, 11 to 100, 101 to 400, and >400.[15] Plaques containing calcified tissue involving >50% of the plaque area (density, >130 Hounsfield units) were classified as calcified, plaques with <50% calcium were classified as mixed, and plaques without calcium were classified as noncalcified.[16] The contrast-enhanced portion of the coronary lumen was semiautomatically traced at the site of maximal stenosis and compared with the mean value of the proximal and distal reference sites.[17] Stenosis ≥50% was defined as significant.

Statistical Analysis

Categorical variables were expressed as frequencies with percentages, and continuous variables were expressed as the mean and SD. Comparisons were performed using the χ^2 test or the Fisher exact test for categorical variables and the unpaired Student t-test or nonparametric Mann-Whitney test for numerical variables, as appropriate. Logistic regression analyses were performed to evaluate the association between marital status and subclinical coronary atherosclerosis detected by CCTA. On the basis of previous epidemiologic studies,[2–4] these clinically important variables were selected: age, sex, diabetes, hypertension, hyperlipidemia, obesity, current smoking, family history of CAD, and CRP. Multivariable logistic regression analyses were performed using these covariates. In addition, to reduce the potential confounding factors in an observational study, propensity score matching analysis was performed on the basis of variables in Table 1. Propensity score matching was conducted by a 2:1 nearest-neighbor matching using a caliper size of 0.2. The balance of covariates in the matched groups was evaluated by measuring their standardized differences in means. All standardized mean differences in the baseline variables were <0.2 (20%) (Figure S1). In the propensity-score matched pairs, the risks of subclinical coronary atherosclerosis were compared by logistic regression using generalized estimating equations for categorical variables or by the linear mixed model for continuous variables that accounted for the clustering of matched pairs. Data manipulation and statistical analyses were performed using the SPSS software, version 24 (SPSS, Chicago, IL) and the R software version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria; www.r-project.org). R "MatchIt"

Table 1. Baseline Characteristics of Individuals, According to Marital Status

Characteristics	Overall population (n=9288)			Propensity score–matched population (2:1)		
	Married (n=8481)	Unmarried (n=807)	P value	Married (n=1594)	Unmarried (n=804)	P value
Age, y	53.5±7.5	55.4±12.0	<0.001	55.3±7.9	55.3±12.0	0.960
Men, n (%)	5663 (66.8)	378 (46.8)	<0.001	791 (49.6)	378 (47.0)	0.239
Body mass index, kg/m^2	24.2±2.9	24.1±3.5	0.082	24.3±3.1	24.1±3.5	0.204
Waist circumference, cm	85.6±7.7	85.5±9.0	0.361	86.1±7.8	85.5±9.0	0.115
Systolic blood pressure, mm Hg	124.6±13.7	126.2±14.7	0.007	127.2±15.1	126.1±14.6	0.068
Diastolic blood pressure, mm Hg	78.5±9.3	78.4±9.7	0.768	78.8±9.7	78.4±9.7	0.307
Diabetes, n (%)	1075 (12.9)	121 (15.2)	0.069	251 (15.7)	120 (14.9)	0.625
Hypertension, n (%)	2788 (33.3)	312 (39.2)	0.001	677 (42.5)	313 (38.9)	0.100
Hyperlipidemia, n (%)	1518 (18.2)	138 (17.4)	0.571	291 (18.3)	140 (17.4)	0.655
Lipid-lowering medication, n (%)	548 (6.6)	46 (5.8)	0.378	95 (6.1)	46 (5.8)	0.807
Current smoker, n (%)	1862 (22.3)	176 (22.3)	0.994	340 (21.3)	176 (21.9)	0.750
Obesity, n (%)	3103 (36.7)	275 (34.2)	0.160	591 (37.1)	276 (34.3)	0.187
Family history of coronary artery disease, n (%)*	753 (9.1)	71 (9.0)	0.922	155 (9.7)	72 (9.0)	0.540
Fasting blood glucose, mg/dL	96.6±22.7	94.8±21.1	0.031	95.4±21.0	94.8±21.1	0.505
Glycated hemoglobin, %	5.7±0.8	5.7±0.8	0.640	5.7±0.8	5.7±0.8	0.527
Total cholesterol, mg/dL	191.3±36.6	191.5±38.3	0.988	192.1±36.7	191.5±38.4	0.719
Low-density lipoprotein cholesterol, mg/dL	127.2±33.9	128.1±35.7	0.625	128.5±34.5	128.1±35.8	0.766
High-density lipoprotein cholesterol, mg/dL	52.7±14.8	53.7±15.1	0.046	52.9±15.5	53.8±15.1	0.162
Triglyceride, mg/dL	117.2±78.0	111.5±72.1	0.047	116.6±79.8	111.5±72.2	0.118
Creatinine, mg/dL	0.9±0.2	0.8±0.2	<0.001	0.8±0.2	0.8±0.2	0.382
Uric acid, mg/dL	5.4±1.4	5.2±1.4	<0.001	5.2±1.3	5.2±1.4	0.342
CRP ≥2 mg/L, n (%)	47 (0.6)	4 (0.5)	0.999	5 (0.3)	4 (0.5)	0.491
Ejection fraction, %	64.4±4.6	64.0±4.7	0.055	64.1±5.0	64.0±4.6	0.497
Framingham risk score	6.8±4.8	8.3±6.3	<0.001	8.5±6.0	8.2±6.2	0.175

Values are shown as mean±SD or number (percentage). CRP indicates C-reactive protein.
*Coronary artery disease in a first-degree relative of any age.

package was used for the propensity score matching. All reported P values are 2 sided, and P<0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

The mean age of the study population was 53.7±8.0 years, and 6041 (65.0%) were men. Marital status classifications were married (n=8481) versus unmarried (n=807), including never married (n=195), divorced (n=183), separated (n=119), and widowed (n=310). Table 1 shows the baseline characteristics of participants by marital status. Mean age, prevalence of women, prevalence of hypertension, systolic blood pressure levels, high-density lipoprotein cholesterol levels, and Framingham risk score were higher in unmarried participants. By contrast, fasting blood glucose, triglyceride, creatinine, and uric acid concentrations were lower in unmarried participants. After 2:1 propensity score matching, there were 2398 matched participants. In the matched cohort, no significant differences were observed in any baseline variable between the married and unmarried groups (Table 1).

CCTA Findings

Table 2 shows the CCTA findings. The mean coronary artery calcium score of the study population was 38.9±156.9. Any coronary plaques were detected in 3118 (33.6%) participants, specifically: calcified in 2882 (31.0%), noncalcified in 544 (5.9%), and mixed plaques in 349 (3.8%) participants. Of all study participants, 568 (6.1%) had significant coronary artery stenosis (≥50% diameter stenosis) in at least one coronary artery on CCTA as follows: left main in 9 (0.1%), left anterior descending in 429 (4.6%), left circumflex

Table 2. Comparison of CCTA Findings, According to Marital Status

Variables	Overall	Married (n=8481)	Unmarried (n=807)	P value
Coronary artery calcium score	38.9±156.9	38.1±154.0	47.8±185.1	0.293
Coronary artery calcium score, n (%)				0.485
0	6298 (68.1)	5757 (68.2)	541 (67.2)	
1–10	798 (8.6)	732 (8.7)	66 (8.2)	
11–100	1306 (14.1)	1191 (14.1)	115 (14.3)	
101–400	626 (6.8)	569 (6.7)	57 (7.1)	
>400	216 (2.3)	190 (2.3)	26 (3.2)	
Any atherosclerotic plaque, n (%)	3118 (33.6)	2837 (33.5)	281 (34.8)	0.431
Plaque characteristics, n (%)				
Calcified plaque	2882 (31.0)	2624 (30.9)	258 (32.0)	0.545
Noncalcified plaque	544 (5.9)	498 (5.9)	46 (5.7)	0.843
Mixed plaque	349 (3.8)	313 (3.7)	36 (4.5)	0.271
Significant stenosis, n (%)	568 (6.1)	513 (6.0)	55 (6.8)	0.385

Values are shown as mean±SD or number (percentage). CCTA indicates coronary computed tomographic angiography.

in 140 (1.5%), and right coronary artery in 207 (2.2%) participants. The prevalence of any coronary, calcified, noncalcified, mixed plaques and significant stenosis did not differ between married and unmarried individuals (*P*>0.05 for all).

Association Between Marital Status and Subclinical Coronary Atherosclerosis

The association between marital status and subclinical atherosclerosis is shown in Table 3. After adjustment for cardiovascular risk factors (age, sex, obesity, diabetes, hypertension, hyperlipidemia, current smoking, family history of CAD, and CRP), logistic regression analyses revealed that unmarried status was not associated with coronary artery calcification, any coronary, calcified, noncalcified, mixed plaques, or significant coronary artery stenosis (*P*>0.05 for all). Furthermore, in the 2:1 propensity score matched population (2398 participants), no statistically significant differences was observed in the odds ratio (OR) for any subclinical coronary atherosclerosis between married and unmarried participants (*P*>0.05 for all) (Table 3).

Subgroup Analyses According to Each Unmarried Status

The study specifically analyzed the married group (n=8481) versus each unmarried group, comprising never married (n=195), divorced (n=183), separated (n=119), and widowed (n=310). According to married versus each unmarried group, baseline characteristics of individuals are shown in Tables S1, S4, S7, and S10. The CCTA findings between married and each unmarried group were also presented in Tables S2, S5, S8, and S11. On multivariable logistic regression analyses,

adjusted with cardiovascular risk factors, the adjusted ORs of each unmarried group relative to married were not associated with coronary artery calcification; any coronary, calcified, noncalcified, mixed plaque; or significant coronary artery stenosis. In each propensity-matched population, the OR of subclinical coronary atherosclerosis did not differ between married and each unmarried group, except for noncalcified plaque in separated participants (OR, 0.279; 95% CI, 0.084–0.934) (Tables S3, S6, S9, and S12).

DISCUSSION

The main finding of this study with asymptomatic individuals assessed by CCTA is that unmarried status was not associated with an increased risk of any subclinical coronary atherosclerosis. Specifically, the risk of subclinical coronary atherosclerosis in each unmarried group, categorized as never married, divorced, separated, or widowed, did not differ from that of the married group. In addition, to the best of our knowledge, this study is the first to assess the association between marital status and subclinical coronary atherosclerosis detected by CCTA in asymptomatic participants.

Marital status has shown a clinical impact on cardiovascular outcomes in patients with CAD.[8] In a previous prospective study of 1401 patients after myocardial infarction, married patients had a significantly better survival benefit with respect to both in-hospital and long-term mortality.[9] In another prospective cohort of 6051 patients undergoing cardiac catheterization for suspected or confirmed CAD, unmarried participants had higher risk for all-cause mortality, cardiovascular death, and cardiovascular death or myocardial infarction compared with married participants.[10]

Table 3. Association Between Marital Status and CCTA Findings

Variables	Univariable		Multivariable		Propensity score–matching analysis	
	Odds ratio (95% CI)	P value	Adjusted odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Coronary artery calcification*						
Unmarried	1.070 (0.904–1.266)	0.432	1.021 (0.835–1.249)	0.839	1.007 (0.830–1.221)	0.947
Married (reference)	1	…	1	…	1	…
Any atherosclerotic plaque						
Unmarried	1.063 (0.913–1.237)	0.431	1.077 (0.899–1.291)	0.419	1.055 (0.882–1.261)	0.558
Married (reference)	1	…	1	…	1	…
Calcified plaque						
Unmarried	1.049 (0.898–1.225)	0.545	1.058 (0.881–1.271)	0.546	1.031 (0.861–1.235)	0.739
Married (reference)	1	…	1	…	1	…
Noncalcified plaque						
Unmarried	0.969 (0.710–1.323)	0.843	0.966 (0.691–1.351)	0.839	0.934 (0.645–1.354)	0.720
Married (reference)	1	…	1	…	1	…
Mixed plaque						
Unmarried	1.218 (0.856–1.734)	0.272	1.301 (0.884–1.917)	0.182	0.935 (0.620–1.410)	0.748
Married (reference)	1	…	1	…	1	…
Significant stenosis						
Unmarried	1.136 (0.852–1.515)	0.385	1.066 (0.771–1.474)	0.697	0.981 (0.704–1.368)	0.910
Married (reference)	1	…	1	…	1	…

Covariates in the multivariable model include age, sex, obesity, diabetes, hypertension, hyperlipidemia, current smoking, family history of coronary artery disease, and CRP (C-reactive protein) ≥2 mg/L. CCTA indicates coronary computed tomographic angiography.

*Coronary artery calcification is defined as coronary artery calcium score >10.

An observational study with 11 216 patients undergoing percutaneous coronary intervention also demonstrated higher cardiac event rates in unmarried versus married patients.[11] The support social network, early recognition for health changes, improved adherence, and financial resources afforded by spouses may be important benefits in married patients with CAD.[7,8] On the basis of these benefits, protective role of marriage on cardiovascular outcomes is well established in patients with CAD.[7]

Previously, some studies grouped individuals with an unmarried status together, whereas other studies differentiated unmarried participants into never married, divorced, separated, or widowed groups, which may reflect heterogeneity among studies.[8,10,18–20] In a meta-analysis, the risk of all-cause and CAD-related mortality increased in the divorced individuals, but this increase was not seen in widowed participants in the general population.[8] In the US National Health Interview Survey, never married individuals were less likely to be smokers, alcohol consumers, or overweight and more likely to exercise compared with married individuals, suggesting that those who never married may have better health habits.[21] These findings suggest that clinical impact on CAD may be different even among the unmarried groups. Moreover, it remains unknown whether each marital status is associated with subclinical coronary atherosclerosis, which suggests a need for in-depth analysis of observational data from a sizable population. Therefore, the present study aimed to evaluate the association between marital status and the risk of subclinical coronary atherosclerosis through analysis from a large CCTA registry.

In the multivariable analysis of this study, traditional risk factors, including age (OR, 1.106; 95% CI, 1.098–1.114), men (OR, 3.511; 95% CI, 3.106–3.969), obesity (OR, 1.237; 95% CI, 1.117–1.371), diabetes (OR, 1.856; 95% CI, 1.614–2.133), hypertension (OR, 1.913; 95% CI, 1.724–2.122), hyperlipidemia (OR, 1.418; 95% CI, 1.614–2.133), current smoking (OR, 1.283; 95% CI, 1.136–1.450), and family history of CAD (OR, 1.262; 95% CI, 1.065–1.496), were significantly associated with any coronary plaque on CCTA. However, unmarried status was not associated with an increased
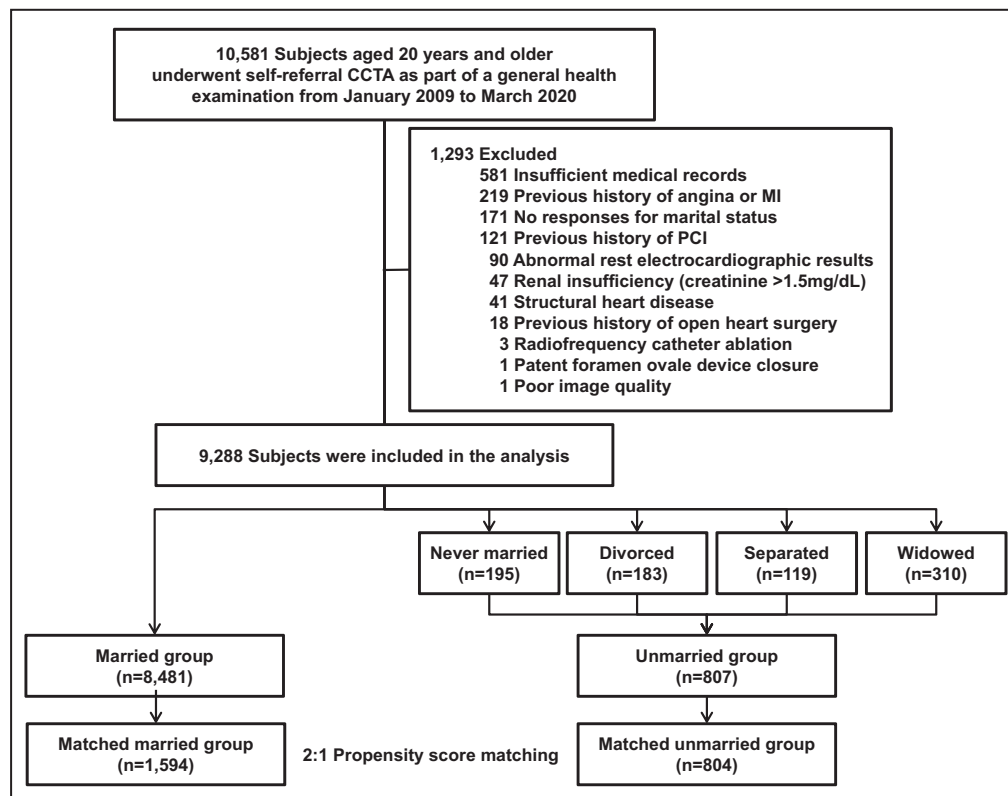
Figure. **Overview of the study population.**
CCTA indicates coronary computed tomographic angiography; MI, myocardial infarction; and PCI, percutaneous coronary intervention.

risk of subclinical coronary atherosclerosis detected by CCTA. Furthermore, the risk of each unmarried group, such as never married, divorced, separated, or widowed, did not differ from married group. Previous multicenter studies have reported a high diagnostic accuracy of CCTA for CAD in various populations.[22] In addition, CCTA has a proven long-term prognostic value for patients with suspected CAD, even for asymptomatic participants.[23–25] Thus, considering the findings of the present study, the association between unmarried status and subclinical disease before CAD events is not more influential than traditional risk factors. Therefore, in unmarried individuals without CAD events, the modification of traditional cardiovascular risk factors and lifestyles should be prioritized to reduce the risk of CAD. In contrast, in those with established CAD, evidence showed that marital status played a role influencing CAD-related morbidity and mortality.[8–11] Therefore, to prevent future cardiac events in unmarried patients with CAD, an increased focus on these patients may be warranted.

Our study had several limitations. First, the current study was conducted at a single center. Our study population was at relatively low risk for CAD

(mean 10-year Framingham risk score, 6.9%). In addition, because all study participants voluntarily underwent CCTA for a general health examination, it is possible that the study enrolled many participants who were more interested in their health than may be represented in the general population. Therefore, selection bias is possible. In addition, because the different groups of unmarried population are relatively limited in number, prospective studies with larger populations are needed to confirm these findings. Second, calcified plaques and higher coronary artery calcium score may have led to an overestimation of significant coronary artery stenosis. Third, the study participants were exclusively Korean, which may limit the applicability of findings to other ethnic groups. Fourth, despite using propensity score analysis to control for measured confounders, hidden or unmeasured confounders might have influenced our findings. In addition, because our study relied on self-reported medical history, there was a possibility of recall bias. Finally, CCTA has potential shortcomings, such as radiation hazards, use of contrast, and high cost. Therefore, although this study population only included volunteers, the

performance of CCTA in asymptomatic individuals cannot be justified. Despite these limitations, we believe that our study may have important clinical implications in revealing the association between marital status and subclinical coronary atherosclerosis in asymptomatic individuals.

In conclusion, this large cross-sectional study with asymptomatic individuals undergoing CCTA showed that unmarried status was not associated with subclinical coronary atherosclerosis. In addition, the risk of subclinical coronary atherosclerosis in each unmarried group, such as never married, divorced, separated, or widowed, did not differ from that of the married group. These findings should be further investigated and validated in prospective studies.

ARTICLE INFORMATION

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Disclosures

None.

Supplemental Material

Tables S1–S12
Figure S1

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SUPPLEMENTAL MATERIAL

Table S1. Baseline characteristics of individuals between married and never-married groups

Characteristics	Overall population (n=8,676)			Propensity score matched population (2:1)		
	Married(n=8,481)	Never-married (n=195)	P Value	Married (n=334)	Never-married (n=170)	P Value
Age, years	53.5 ± 7.5	42.9 ± 11.1	<0.001	45.4 ± 8.9	45.4 ± 9.5	0.949
Men, no. (%)	5,663 (66.8)	139 (71.3)	0.186	234 (70.1)	118 (69.4)	0.891
Body mass index, kg/m^2	24.2 ± 2.9	24.2 ± 4.4	0.094	24.2 ± 3.2	24.2 ± 3.9	0.815
Waist circumference, cm	85.6 ± 7.7	85.2 ± 11.7	0.089	85.0 ± 8.5	85.1 ± 10.3	0.807
Systolic blood pressure, mmHg	124.6 ± 13.7	125.3 ± 14.5	0.481	123.9 ± 14.4	124.9 ± 14.5	0.474
Diastolic blood pressure, mmHg	78.5 ± 9.3	78.9 ± 9.7	0.520	78.4 ± 10.5	78.9 ± 10.0	0.600
Diabetes mellitus, no. (%)	1,075 (12.9)	13 (6.7)	0.010	22 (6.6)	13 (7.6)	0.659
Hypertension, no. (%)	2,788 (33.3)	53 (27.5)	0.089	97 (29.0)	48 (28.2)	0.841
Hyperlipidemia, no. (%)	1,518 (18.2)	31 (16.0)	0.425	53 (15.9)	29 (17.1)	0.736
Lipid-lowering medication, no. (%)	548 (6.6)	6 (3.1)	0.051	11 (3.4)	6 (3.6)	0.910
Current smoker, no. (%)	1,862 (22.3)	62 (32.3)	0.001	96 (28.7)	55 (32.4)	<0.001
Obesity, no. (%)	3,103 (36.7)	65 (33.3)	0.328	129 (38.6)	59 (34.7)	<0.001
Family history of coronary artery disease*, no. (%)	753 (9.1)	23 (11.9)	0.181	31 (9.3)	22 (12.9)	0.208
Fasting blood glucose, mg/dL	96.6 ± 22.7	90.0 ± 18.5	<0.001	91.3 ± 19.5	90.8 ± 19.5	0.776
Glycated hemoglobin, %	5.7 ± 0.8	5.5 ± 0.7	<0.001	5.5 ± 0.6	5.5 ± 0.7	0.716
Total cholesterol, mg/dL	191.3 ± 36.6	192.4 ± 41.5	0.944	193.9 ± 39.0	197.3 ± 40.1	0.367
Low-density lipoprotein cholesterol, mg/dL	127.2 ± 33.9	127.8 ± 38.3	0.825	129.0 ± 36.1	131.9 ± 37.7	0.395
High-density lipoprotein cholesterol, mg/dL	52.7 ± 14.8	53.0 ± 16.1	0.719	53.7 ± 15.2	53.2 ± 16.2	0.734
Triglyceride, mg/dL	117.2 ± 78.0	124.1 ± 90.0	0.741	121.1 ± 95.0	129.8 ± 91.5	0.320
Creatinine, mg/dL	0.9 ± 0.2	0.9 ± 0.2	0.890	0.9 ± 0.2	0.9 ± 0.2	0.923
Uric acid, mg/dL	5.4 ± 1.4	5.7 ± 1.6	0.007	5.6 ± 1.4	5.7 ± 1.5	0.808
C-reactive protein ≥2mg/L, no. (%)	47 (0.6)	2 (1.0)	0.304	0 (0.0)	1 (0.6)	0.999
Ejection fraction, %	64.4 ± 4.6	63.0 ± 4.0	0.001	63.8 ± 4.4	63.3 ± 3.5	0.249

Framingham risk score	6.8 ± 4.8	3.9 ± 4.0	<0.001	4.1 ± 3.9	4.5 ± 4.0	0.347

Values are shown as mean ± standard deviation or number (%).

*Coronary artery disease in a first-degree relative of any age

Table S2. Comparison of coronary computed tomography angiographic findings between married and never-married groups

Variables	Overall	Married (n=8,481)	Never-married (n=195)	P Value
Mean coronary artery calcium score	37.6 ± 152.5	38.1 ± 154.0	15.8 ± 63.1	<0.001
Coronary artery calcium score, no. (%)				0.002
0	5,917 (68.5)	5,757 (68.2)	160 (82.1)	
1-10	743 (8.6)	732 (8.7)	11 (5.6)	
11-100	1,204 (13.9)	1,191 (14.1)	13 (6.7)	
101-400	578 (6.7)	569 (6.7)	9 (4.6)	
>400	192 (2.2)	190 (2.3)	2 (1.0)	
Any atherosclerotic plaque, no. (%)	2,873 (33.1)	2,837 (33.5)	36 (18.5)	<0.001
Plaque characteristics, no. (%)				
Calcified plaque	2,659 (30.6)	2,624 (30.9)	35 (17.9)	<0.001
Non-calcified plaque	500 (5.8)	498 (5.9)	2 (1.0)	0.004
Mixed plaque	315 (3.6)	313 (3.7)	2 (1.0)	0.049
Significant stenosis, no. (%)	519 (6.0)	513 (6.0)	6 (3.1)	0.084

Values are shown as mean ± standard deviation or number (%).

Table S3. Association between marital status and coronary computed tomography angiographic findings

Variables	Univariable		Multivariable		Propensity score matching analysis	
	Odds ratio (95% CI)	P Value	Adjusted odds ratio (95% CI)	P Value	Odds ratio (95% CI)	P Value
Coronary artery calcification*						
Never-married	0.460 (0.299-0.708)	<0.001	1.127 (0.699-1.818)	0.623	1.032 (0.627-1.696)	0.902
Married (reference)	1	-	1	-	1	-
Any atherosclerotic plaque						
Never-married	0.450 (0.313-0.649)	<0.001	1.032 (0.685-1.554)	0.881	0.997 (0.632-1.574)	0.990
Married (reference)	1	-	1	-	1	-
Calcified plaque						
Never-married	0.488 (0.338-0.706)	<0.001	1.124 (0.744-1.698)	0.580	1.056 (0.665-1.677)	0.816
Married (reference)	1	-	1	-	1	-
Non-calcified plaque						
Never-married	0.166 (0.041-0.671)	0.012	0.301 (0.074-1.229)	0.094	0.320 (0.078-1.306)	0.112
Married (reference)	1	-	1	-	1	-
Mixed plaque						
Never-married	0.270 (0.067-1.094)	0.067	0.584 (0.142-2.405)	0.457	0.783 (0.149-4.120)	0.773
Married (reference)	1	-	1	-	1	-
Significant stenosis						
Never- married	0.493 (0.218-1.117)	0.090	1.176 (0.503-2.746)	0.708	1.489 (0.500-4.434)	0.475
Married (reference)	1	-	1	-	1	-

CI = confidence interval

*Coronary artery calcification is defined as coronary artery calcium score >10.

Covariates in the multivariable model include age, sex, obesity, diabetes mellitus, hypertension, hyperlipidemia, current smoking, family history of coronary artery disease, and C-reactive protein ≥2 mg/L.

Table S4. Baseline characteristics of individuals between married and divorced groups

Characteristics	Overall population (n=8,664)			Propensity score matched population (2:1)		
	Married(n=8,481)	Divorced (n=183)	P Value	Married (n=360)	Divorced (n=182)	P Value
Age, years	53.5 ± 7.5	53.6 ± 6.9	0.826	54.1 ± 7.9	53.6 ± 6.9	0.420
Men, no. (%)	5,663 (66.8)	102 (55.7)	0.002	196 (54.4)	102 (56.0)	0.732
Body mass index, kg/m^2	24.2 ± 2.9	24.1 ± 3.0	0.528	24.2 ± 2.9	24.1 ± 3.0	0.720
Waist circumference, cm	85.6 ± 7.7	85.6 ± 7.9	0.996	85.8 ± 8.1	85.7 ± 7.9	0.874
Systolic blood pressure, mmHg	124.6 ± 13.7	125.0 ± 14.1	0.684	125.6 ± 14.8	124.9 ± 14.0	0.572
Diastolic blood pressure, mmHg	78.5 ± 9.3	78.0 ± 9.7	0.555	78.7 ± 9.5	78.0 ± 9.7	0.516
Diabetes mellitus, no. (%)	1,075 (12.9)	25 (13.7)	0.762	51 (14.2)	25 (13.7)	0.893
Hypertension, no. (%)	2,788 (33.3)	62 (34.1)	0.828	128 (35.6)	62 (34.1)	0.570
Hyperlipidemia, no. (%)	1,518 (18.2)	31 (17.1)	0.708	48 (13.3)	31 (17.0)	0.388
Lipid-lowering medication, no. (%)	548 (6.6)	10 (5.5)	0.566	23 (6.5)	10 (5.6)	0.052
Current smoker, no. (%)	1,862 (22.3)	61 (34.3)	<0.001	110 (30.6)	60 (33.0)	0.563
Obesity, no. (%)	3,103 (36.7)	67 (36.6)	0.970	136 (37.8)	67 (36.8)	0.833
Family history of coronary artery disease*, no. (%)	753 (9.1)	16 (8.8)	0.919	29 (8.1)	16 (8.8)	0.769
Fasting blood glucose, mg/dL	96.6 ± 22.7	97.3 ± 21.1	0.659	98.2 ± 30.7	97.3 ± 21.1	0.663
Glycated hemoglobin, %	5.7 ± 0.8	5.7 ± 0.8	0.626	5.8 ± 0.9	5.7 ± 0.8	0.735
Total cholesterol, mg/dL	191.3 ± 36.6	193.1 ± 34.6	0.517	189.6 ± 33.6	193.0 ± 34.7	0.275
Low-density lipoprotein cholesterol, mg/dL	127.2 ± 33.9	129.7 ± 32.8	0.321	125.8 ± 30.5	129.9 ± 32.8	0.164
High-density lipoprotein cholesterol, mg/dL	52.7 ± 14.8	54.2 ± 17.2	0.166	54.3 ± 16.7	53.9 ± 16.8	0.802
Triglyceride, mg/dL	117.2 ± 78.0	115.4 ± 72.1	0.764	118.9 ± 74.5	115.4 ± 72.3	0.457
Creatinine, mg/dL	0.9 ± 0.2	0.8 ± 0.2	0.001	0.8 ± 0.2	0.8 ± 0.2	0.777
Uric acid, mg/dL	5.4 ± 1.4	5.3 ± 1.3	0.168	5.2 ± 1.4	5.3 ± 1.3	0.622
C-reactive protein ≥2mg/L, no. (%)	47 (0.6)	0 (0.0)	0.627	1 (0.3)	0 (0.0)	0.999
Ejection fraction, %	64.4 ± 4.6	64.1 ± 4.8	0.435	64.3 ± 4.3	63.9 ± 5.2	0.531

Framingham risk score	6.8 ± 4.8	7.6 ± 5.2	0.022	7.6 ± 5.5	7.6 ± 5.2	0.983

Values are shown as mean ± standard deviation or number (%).

*Coronary artery disease in a first-degree relative of any age

Table S5. Comparison of coronary computed tomography angiographic findings between married and divorced groups

Variables	Overall	Married (n=8,481)	Divorced (n=183)	P Value
Mean coronary artery calcium score	38.0 ± 153.0	38.1 ± 154.0	33.5 ± 99.4	0.692
Coronary artery calcium score, no. (%)				0.759
0	5,885 (68.3)	5,757 (68.2)	128 (70.3)	
1-10	747 (8.7)	732 (8.7)	15 (8.2)	
11-100	1,212 (14.1)	1,191 (14.1)	21 (11.5)	
101-400	584 (6.8)	569 (6.7)	15 (8.2)	
>400	193 (2.2)	190 (2.3)	3 (1.6)	
Any atherosclerotic plaque, no. (%)	2,896 (33.4)	2,837 (33.5)	59 (32.2)	0.731
Plaque characteristics, no. (%)				
Calcified plaque	2,678 (30.9)	2,624 (30.9)	54 (29.5)	0.678
Non-calcified plaque	511 (5.9)	498 (5.9)	13 (7.1)	0.484
Mixed plaque	321 (3.7)	313 (3.7)	8 (4.4)	0.629
Significant stenosis, no. (%)	526 (6.1)	513 (6.0)	13 (7.1)	0.554

Values are shown as mean ± standard deviation or number (%).

Table S6. Association between marital status and coronary computed tomography angiographic findings

Variables	Univariable		Multivariable		Propensity score matching analysis	
	Odds ratio (95% CI)	P Value	Adjusted odds ratio (95% CI)	P Value	Odds ratio (95% CI)	P Value
Coronary artery calcification*						
Divorced	0.894 (0.625-1.279)	0.541	0.965 (0.644-1.446)	0.862	1.076 (0.699-1.656)	0.738
Married (reference)	1	-	1	-	1	-
Any atherosclerotic plaque						
Divorced	0.947 (0.692-1.295)	0.731	1.010 (0.708-1.441)	0.956	1.180 (0.815-1.709)	0.380
Married (reference)	1	-	1	-	1	-
Calcified plaque						
Divorced	0.934 (0.678-1.288)	0.678	0.992 (0.690-1.425)	0.963	1.127 (0.777-1.636)	0.528
Married (reference)	1	-	1	-	1	-
Non-calcified plaque						
Divorced	1.226 (0.692-2.170)	0.485	1.327 (0.723-2.434)	0.361	1.653 (0.804-3.400)	0.172
Married (reference)	1	-	1	-	1	-
Mixed plaque						
Divorced	1.193 (0.582-2.445)	0.630	1.455 (0.692-3.061)	0.323	2.312 (0.876-6.101)	0.090
Married (reference)	1	-	1	-	1	-
Significant stenosis						
Divorced	1.188 (0.671-2.102)	0.555	1.377 (0.743-2.552)	0.310	1.380 (0.656-2.906)	0.396
Married (reference)	1	-	1	-	1	-

CI = confidence interval

*Coronary artery calcification is defined as coronary artery calcium score >10.

Covariates in the multivariable model include age, sex, obesity, diabetes mellitus, hypertension, hyperlipidemia, current smoking, family history of coronary artery disease, and C-reactive protein ≥ 2 mg/L.

Table S7. Baseline characteristics of individuals between married and separated groups

Characteristics	Overall population (n=8,600)			Propensity score matched population (2:1)		
	Married(n=8,481)	Separated (n=119)	P Value	Married (n=234)	Separated (n=118)	P Value
Age, years	53.5 ± 7.5	54.5 ± 8.7	0.175	54.0 ± 8.2	54.4 ± 8.7	0.701
Men, no. (%)	5,663 (66.8)	72 (60.5)	0.150	144 (61.5)	72 (61.0)	0.978
Body mass index, kg/m^2	24.2 ± 2.9	24.3 ± 3.0	0.775	24.5 ± 3.4	24.2 ± 3.0	0.358
Waist circumference, cm	85.6 ± 7.7	85.9 ± 7.5	0.684	86.3 ± 8.8	85.8 ± 7.4	0.522
Systolic blood pressure, mmHg	124.6 ± 13.7	123.7 ± 14.5	0.497	122.7 ± 13.3	123.9 ± 14.4	0.448
Diastolic blood pressure, mmHg	78.5 ± 9.3	78.7 ± 10.3	0.765	78.5 ± 9.6	78.8 ± 10.2	0.784
Diabetes mellitus, no. (%)	1,075 (12.9)	22 (18.6)	0.065	48 (20.5)	22 (18.6)	0.677
Hypertension, no. (%)	2,788 (33.3)	39 (33.1)	0.955	82 (35.0)	39 (33.1)	0.666
Hyperlipidemia, no. (%)	1,518 (18.2)	25 (21.2)	0.407	61 (26.1)	24 (20.3)	0.278
Lipid-lowering medication, no. (%)	548 (6.6)	8 (6.8)	0.936	21 (9.1)	7 (6.0)	0.311
Current smoker, no. (%)	1,862 (22.3)	31 (26.5)	0.282	56 (23.9)	31 (26.3)	0.629
Obesity, no. (%)	3,103 (36.7)	40 (34.5)	0.615	91 (38.9)	40 (33.9)	0.351
Family history of coronary artery disease*, no. (%)	753 (9.1)	8 (6.8)	0.391	17 (7.3)	7 (5.9)	0.640
Fasting blood glucose, mg/dL	96.6 ± 22.7	95.3 ± 22.0	0.536	97.1 ± 19.7	95.5 ± 21.9	0.520
Glycated hemoglobin, %	5.7 ± 0.8	5.6 ± 0.6	0.298	5.7 ± 0.7	5.6 ± 0.7	0.175
Total cholesterol, mg/dL	191.3 ± 36.6	188.4 ± 38.4	0.390	190.7 ± 41.3	189.3 ± 37.4	0.984
Low-density lipoprotein cholesterol, mg/dL	127.2 ± 33.9	129.3 ± 35.0	0.494	131.5 ± 39.1	130.0 ± 34.3	0.742
High-density lipoprotein cholesterol, mg/dL	52.7 ± 14.8	50.6 ± 12.7	0.176	50.6 ± 12.1	50.7 ± 12.6	0.806
Triglyceride, mg/dL	117.2 ± 78.0	111.0 ± 54.6	0.389	108.0 ± 52.7	111.7 ± 54.4	0.529
Creatinine, mg/dL	0.9 ± 0.2	0.8 ± 0.2	0.136	0.8 ± 0.2	0.8 ± 0.2	0.868
Uric acid, mg/dL	5.4 ± 1.4	5.3 ± 1.3	0.332	5.3 ± 1.3	5.3 ± 1.3	0.979
C-reactive protein ≥2mg/L, no. (%)	47 (0.6)	0 (0.0)	0.999	2 (0.9)	0 (0.0)	0.999
Ejection fraction, %	64.4 ± 4.6	64.4 ± 4.9	0.976	64.9 ± 4.4	64.6 ± 4.5	0.566

| Framingham risk score | 6.8 ± 4.8 | 7.4 ± 4.7 | 0.163 | 7.0 ± 4.0 | 7.4 ± 4.7 | 0.462 |

Values are shown as mean ± standard deviation or number (%).

*Coronary artery disease in a first-degree relative of any age

Table S8. Comparison of coronary computed tomography angiographic findings between married and separated groups

Variables	Overall	Married (n=8,481)	Separated (n=119)	P Value
Mean coronary artery calcium score	38.0 ± 153.9	38.1 ± 154.0	34.8 ± 151.6	0.819
Coronary artery calcium score, no. (%)				0.917
0	5,839 (68.2)	5,757 (68.2)	82 (68.9)	
1-10	744 (8.7)	732 (8.7)	12 (10.1)	
11-100	1,208 (14.1)	1,191 (14.1)	17 (14.3)	
101-400	575 (6.7)	569 (6.7)	6 (5.0)	
>400	192 (2.2)	190 (2.3)	2 (1.7)	
Any atherosclerotic plaque, no. (%)	2,874 (33.4)	2,837 (33.5)	37 (31.1)	0.588
Plaque characteristics, no. (%)				
Calcified plaque	2,661 (30.9)	2,624 (30.9)	37 (31.1)	0.971
Non-calcified plaque	501 (5.8)	498 (5.9)	3 (2.5)	0.121
Mixed plaque	319 (3.7)	313 (3.7)	6 (5.0)	0.456
Significant stenosis, no. (%)	520 (6.0)	513 (6.0)	7 (5.9)	0.940

Values are shown as mean ± standard deviation or number (%).

Table S9. Association between marital status and coronary computed tomography angiographic findings

Variables	Univariable		Multivariable		Propensity score matching analysis	
	Odds ratio (95% CI)	P Value	Adjusted odds ratio (95% CI)	P Value	Odds ratio (95% CI)	P Value
Coronary artery calcification*						
Separated	0.872 (0.560-1.360)	0.546	0.803 (0.485-1.330)	0.394	0.913 (0.528-1.580)	0.745
Married (reference)	1	-	1	-	1	-
Any atherosclerotic plaque						
Separated	0.898 (0.607-1.327)	0.588	0.864 (0.554-1.348)	0.520	0.846 (0.522-1.373)	0.499
Married (reference)	1	-	1	-	1	-
Calcified plaque						
Separated	1.007 (0.681-1.489)	0.971	1.002 (0.642-1.561)	0.995	0.968 (0.595-1.576)	0.896
Married (reference)	1	-	1	-	1	-
Non-calcified plaque						
Separated	0.415 (0.131-1.309)	0.133	0.413 (0.129-1.321)	0.136	0.279 (0.084-0.934)	0.038
Married (reference)	1	-	1	-	1	-
Mixed plaque						
Separated	1.386 (0.605-3.174)	0.441	1.156 (0.455-2.938)	0.761	1.338 (0.453-3.949)	0.598
Married (reference)	1	-	1	-	1	-
Significant stenosis						
Separated	0.971 (0.450-2.094)	0.940	0.794 (0.337-1.874)	0.599	0.608 (0.247-1.498)	0.279
Married (reference)	1	-	1	-	1	-

CI = confidence interval

*Coronary artery calcification is defined as coronary artery calcium score >10.

Covariates in the multivariable model include age, sex, obesity, diabetes mellitus, hypertension, hyperlipidemia, current smoking, family history of coronary artery disease, and C-reactive protein ≥2 mg/L.

Table S10. Baseline characteristics of individuals between married and widowed groups

Characteristics	Overall population (n=8,791)			Propensity score matched population (2:1)		
	Married(n=8,481)	Widowed (n=310)	P Value	Married (n=532)	Widowed (n=287)	P Value
Age, years	53.5 ± 7.5	64.5 ± 7.6	<0.001	62.7 ± 7.8	63.7 ± 7.3	0.073
Men, no. (%)	5,663 (66.8)	65 (21.0)	<0.001	130 (24.4)	65 (22.6)	0.552
Body mass index, kg/m²	24.2 ± 2.9	24.1 ± 3.2	0.485	24.0 ± 8.1	24.1 ± 3.2	0.616
Waist circumference, cm	85.6 ± 7.7	85.4 ± 8.3	0.691	85.0 ± 8.1	85.4 ± 8.2	0.507
Systolic blood pressure, mmHg	124.6 ± 13.7	128.3 ± 14.9	<0.001	126.8 ± 15.3	127.7 ± 14.6	0.397
Diastolic blood pressure, mmHg	78.5 ± 9.3	78.1 ± 9.5	0.465	77.7 ± 9.3	77.9 ± 9.3	0.771
Diabetes mellitus, no. (%)	1,075 (12.9)	61 (20.2)	<0.001	89 (16.7)	53 (18.5)	<0.001
Hypertension, no. (%)	2,788 (33.3)	158 (52.1)	<0.001	250 (47.0)	1445 (50.5)	0.334
Hyperlipidemia, no. (%)	1,518 (18.2)	51 (17.0)	0.592	103 (19.4)	50 (17.4)	0.499
Lipid-lowering medication, no. (%)	548 (6.6)	22 (7.3)	0.613	42 (8.1)	20 (7.2)	0.642
Current smoker, no. (%)	1,862 (22.3)	22 (7.3)	<0.001	41 (7.7)	21 (7.3)	0.841
Obesity, no. (%)	3,103 (36.7)	103 (33.3)	0.221	164 (30.8)	95 (33.1)	0.497
Family history of coronary artery disease*, no. (%)	753 (9.1)	24 (8.0)	0.530	46 (8.6)	25 (8.7)	0.974
Fasting blood glucose, mg/dL	96.6 ± 22.7	96.1 ± 21.9	0.722	95.4 ± 21.3	96.3 ± 22.5	0.583
Glycated hemoglobin, %	5.7 ± 0.8	5.9 ± 0.8	<0.001	5.8 ± 0.8	5.9 ± 0.8	0.651
Total cholesterol, mg/dL	191.3 ± 36.6	191.1 ± 38.4	0.934	192.8 ± 37.7	191.0 ± 38.8	0.523
Low-density lipoprotein cholesterol, mg/dL	127.2 ± 33.9	126.8 ± 36.1	0.840	128.8 ± 34.4	126.7 ± 36.5	0.421
High-density lipoprotein cholesterol, mg/dL	52.7 ± 14.8	55.1 ± 13.7	0.004	54.9 ± 14.5	55.1 ± 13.9	0.851
Triglyceride, mg/dL	117.2 ± 78.0	101.5 ± 63.8	<0.001	98.4 ± 53.5	101.7 ± 64.8	0.314
Creatinine, mg/dL	0.9 ± 0.2	0.7 ± 0.2	<0.001	0.7 ± 0.2	0.7 ± 0.2	0.350
Uric acid, mg/dL	5.4 ± 1.4	4.8 ± 1.2	<0.001	4.8 ± 1.2	4.8 ± 1.2	0.936
C-reactive protein ≥2mg/L, no. (%)	47 (0.6)	2 (0.6)	0.692	3 (0.6)	2 (0.7)	0.816
Ejection fraction, %	64.4 ± 4.6	64.4 ± 4.9	0.924	64.4 ± 4.8	64.4 ± 4.6	0.987

| Framingham risk score | 6.8 ± 4.8 | 11.7 ± 6.6 | <0.001 | 10.6 ± 6.0 | 11.2 ± 6.4 | 0.264 |

Values are shown as mean ± standard deviation or number (%).

*Coronary artery disease in a first-degree relative of any age

Table S11. Comparison of coronary computed tomography angiographic findings between married and widowed groups

Variables	Overall	Married (n=8,481)	Widowed (n=310)	P Value
Mean coronary artery calcium score	39.6 ± 159.4	38.1 ± 154.0	81.2 ± 265.3	<0.001
Coronary artery calcium score, no. (%)				<0.001
0	5,928 (67.8)	5,757 (68.2)	171 (55.3)	
1-10	760 (8.7)	732 (8.7)	28 (9.1)	
11-100	1,255 (14.3)	1,191 (14.1)	64 (20.7)	
101-400	596 (6.8)	569 (6.7)	27 (8.7)	
>400	209 (2.4)	190 (2.3)	19 (6.1)	
Any atherosclerotic plaque, no. (%)	2,986 (34.0)	2,837 (33.5)	149 (48.1)	<0.001
Plaque characteristics, no. (%)				
Calcified plaque	2,756 (31.4)	2,624 (30.9)	132 (42.6)	<0.001
Non-calcified plaque	526 (6.0)	498 (5.9)	28 (9.0)	0.021
Mixed plaque	333 (3.8)	313 (3.7)	20 (6.5)	0.012
Significant stenosis, no. (%)	542 (6.2)	513 (6.0)	29 (9.4)	0.017

Values are shown as mean ± standard deviation or number (%).

Table S12. Association between marital status and coronary computed tomography angiographic findings

Variables	Univariable		Multivariable		Propensity score matching analysis	
	Odds ratio (95% CI)	P Value	Adjusted odds ratio (95% CI)	P Value	Odds ratio (95% CI)	P Value
Coronary artery calcification*						
Widowed	1.813 (1.428-2.300)	<0.001	1.094 (0.814-1.471)	0.551	1.072 (0.798-1.441)	0.642
Married (reference)	1	-	1	-	1	-
Any atherosclerotic plaque						
Widowed	1.841 (1.467-2.311)	<0.001	1.223 (0.925-1.616)	0.158	1.227 (0.921-1.635)	0.162
Married (reference)	1	-	1	-	1	-
Calcified plaque						
Widowed	1.655 (1.315-2.083)	<0.001	1.073 (0.810-1.421)	0.623	1.131 (0.847-1.511)	0.403
Married (reference)	1	-	1	-	1	-
Non-calcified plaque						
Widowed	1.592 (1.068-2.372)	0.022	1.293 (0.821-2.038)	0.268	1.157 (0.671-1.996)	0.600
Married (reference)	1	-	1	-	1	-
Mixed plaque						
Widowed	1.800 (1.128-2.871)	0.014	1.506 (0.876-2.588)	0.139	1.225 (0.645-2.327)	0.535
Married (reference)	1	-	1	-	1	-
Significant stenosis						
Widowed	1.603 (1.083-2.374)	0.018	1.003 (0.637-1.579)	0.989	1.058 (0.628-1.783)	0.831
Married (reference)	1	-	1	-	1	-

CI = confidence interval

*Coronary artery calcification is defined as coronary artery calcium score >10.

Covariates in the multivariable model include age, sex, obesity, diabetes mellitus, hypertension, hyperlipidemia, current smoking, family history of coronary artery disease, and C-reactive protein ≥2 mg/L.

Figure S1. Covariate balances in propensity-score matched populations between married and unmarried groups.