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## Marriage Dissatisfaction and the Risk of Sudden Cardiac Death Among Men

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**Marriage Dissatisfaction and the Risk of Sudden Cardiac Death Among Men**

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**Abstract**

Conflicts in marriage have been associated with potential risk of cardiovascular disease; however, there is lack of prospective evidence on the association between marriage satisfaction and sudden cardiac death (SCD). We aimed to assess the association between perceived level of marriage satisfaction and risk of SCD. This study employed the Kuopio Ischemic Heart Disease (KIHD) study, an ongoing prospective population-based study in Finland. Perceived level of marriage satisfaction was assessed in 2262 men using a well-structured self-administered questionnaire. Multivariable adjusted cox regression models were used to estimate hazard ratios (HRs) (95% CI) for SCD. During a median follow-up period of 25.9 years, 239 SCDs were recorded. The mean age of participants was 53 (SD 5.2) years. On adjustment for several conventional cardiovascular risk factors, HR (95% CI) of SCD was 1.90 (CI 1.09-3.32;  $p=0.02$ ) for men who were dissatisfied with their marriage, compared to men who were satisfied with their marriage. The association remained consistent on further adjustment for pre-existing coronary heart disease, socioeconomic status and years of education 1.86 (CI 1.07 - 3.25;  $p=0.03$ ). In conclusion, dissatisfied marriage is associated with an increased risk of SCD among middle-aged Caucasian men, independent of conventional cardiovascular risk factors.

Key words: marriage satisfaction, sudden cardiac death, marital distress, cardiovascular disease.

Marriage is an interesting social context for research in relation to cardiovascular disease (CVD), which is the leading cause of death globally<sup>1</sup>. A substantial part of cardiovascular mortality consists of sudden cardiac death (SCD), with an annual case of about 4 to 5 million globally<sup>2</sup>. Studies have looked at negative (such as irritations and conflict) and positive (such as love and support) perspectives of marriage in relation to health and well-being<sup>3,4</sup>. It has been demonstrated that when conflicts occur regularly in marriages or families and it remains unresolved, there could be potential increased risk of elevated blood pressure and other adverse cardiovascular outcomes due to the activation of the sympathetic nervous system<sup>5</sup>. Many studies on the impact of marital quality on the risk of CVD have often employed cross-sectional, clinical or community samples<sup>6</sup>; therefore, the temporal nature of the association is uncertain, and findings cannot be applied effectively in the general population. To our knowledge, there is no population-based prospective evidence on the risk of SCD among Caucasian men in relation to marriage satisfaction in the general population. Therefore, we aimed to examine the relationship between perceived dissatisfaction in marriage and risk of SCD among middle-aged men.

## Methods

This study employed the Kuopio Ischemic Heart Disease (KIHD) study, which is an ongoing prospective population-based study. The KIHD was designed to investigate the different risk factors for developing CVDs and other chronic diseases among middle-aged and aging men and women in Kuopio and the surrounding communities in Eastern Finland<sup>7</sup>. The study started in 1984 with the baseline sample of 3433 men aged 42 to 60 years, who were randomly selected from the national population register. At baseline examination between March 1984 and December 1989, 2682 men (78.1% of those eligible) volunteered to participate in the study. The

focus of the current study is based on 2262 men from the initial baseline population, who had complete information on relevant covariates and SCD outcomes.

Before visiting the study centre, a self-administered questionnaire was mailed to each participant. The participants were then invited to the study centre for interviews and clinical examination. A trained research nurse was responsible for interviewing all the study participants, who also went through a health examination. Information concerning education, type of occupation, smoking status and duration of regular smoking in years, alcohol consumption, and past medical condition was obtained using detailed questionnaires<sup>7</sup>. Marriage-related questions were also included in this detailed questionnaire. The assessment of the level of perceived marriage satisfaction among the married participants at baseline was based on a single question with a 4-point scale of very satisfied, fairly satisfied, fairly dissatisfied and very dissatisfied. For this study however, 'fairly dissatisfied' and 'very dissatisfied' were combined as 'dissatisfied'.

Risk factors were assessed at baseline. The assessment of smoking, family history of diseases, blood pressure, body mass index (BMI), medical history and socioeconomic status (SES) have been described earlier<sup>7,8</sup>. Alcohol consumption level was assessed using self-administered questionnaire in accordance with the Nordic Alcohol Consumption Inventory, hence calculation of the average weekly alcohol consumption was done. The quantity and frequency of alcohol consumption during the previous year were included in the questions.<sup>9</sup>

The cholesterol contents of serum lipoprotein fractions and triglycerides were measured enzymatically (Boehringer Mannheim). Serum high-density lipoprotein cholesterol (HDL-C) and its subfractions were separated from fresh serum samples using ultracentrifugation and precipitation. Diabetes was defined as a fasting blood glucose level  $\geq 7.0$ mmol/l or clinical

diagnosis of diabetes with dietary, oral or insulin treatment<sup>8</sup>. Chronic disease diagnoses and medication use were checked during a medical examination by the internist.

A death was considered as SCD if it occurred within 1 hour of the onset of an abrupt change in symptoms or within 24 hours after the onset of symptoms when clinical findings did not reveal a noncardiac cause of sudden death. Deaths that occurred unwitnessed during the night-time, such as being found dead in bed, were classified as those whose death occurred 24 hours from the symptoms. Patients who were successfully resuscitated from ventricular tachycardia and/or ventricular fibrillation were also defined. The deaths due to aortic aneurysm rupture, cardiac rupture or tamponade, and pulmonary embolism, cancer, or other noncardiac comorbidities were not included as SCDs. The diagnostic classification of events was based on symptoms, ECG findings, cardiac enzyme elevations, autopsy findings (80%) and history of coronary heart disease, together with the clinical and ECG findings of the paramedic staff. Out-of-hospital SCDs and non-SCDs were documented. Out-of-hospital SCDs was defined based on the available data from the clinical status and recent symptoms. All hospital documents, including medical records, laboratory and ECG findings from hospital and paramedical staff, and the use of medications and defibrillators, were available to use.<sup>10</sup> All deaths that occurred by the end of 2014 were checked against the hospital documents, health center wards, and death certificates. There were no losses to follow-up. All the documents related to the death were crosschecked in detail by 2 physicians. The Independent Events Committee, masked to clinical data, performed classification of deaths.

Descriptive statistics were used to summarise the baseline characteristics of the participants. Baseline characteristics were presented as means (standard deviation, SD) or median (interquartile range, IQR) for continuous variables and absolute counts (percentages) for

categorical variables (Table 1). Multivariate cox regression models were used to estimate the hazard ratios (HRs) of the exposures for the main outcome after confirmation of no major departure from the proportionality assumptions using Schoenfeld residuals<sup>11</sup>. Married men were categorized into 3 groups based on their response to marriage satisfaction – very satisfied, fairly satisfied and dissatisfied.

The HR and 95% confidence intervals (CI) were calculated after adjustment for several potential confounding factors using the Cox multivariable models. Three models were specified: (model 1) age; (model 2) model 1 plus BMI, smoking, alcohol intake, systolic blood pressure, history of type 2 diabetes mellitus, serum total cholesterol, and HDL-C; and (model 3) model 2 plus history of ischemic heart disease (IHD), SES and years of education. These covariates were selected based on their previously established roles as predictive factors for the outcome and based on the available data as well as their potential role as confounding factors. All analyses employed Microsoft windows software, IBM SPSS Statistics 25 (SPSS Inc., Chicago, IL, USA 9). Two-sided *p*-value <0.05 was considered statistically significant.

The study protocol (KIHD) was approved by the Research Ethics Committee of the University of Eastern Finland, Kuopio with reference number 143/97. Each participant also gave written informed consent. The study protocol conforms to the ethical guidelines of the Declaration of Helsinki.

## Results

**Table 1** shows the baseline characteristics of the 2262 participants. The mean age of the men at recruitment was 53 years (SD 5.2). A total of 239 cases of SCD were reported within the median follow-up period of 25.9 (IQR 18.9 - 28.0) years. An overview of the characteristics of

the participants showed that men that were fairly satisfied with their marriages accounted for the highest percentage (55.2%).

**Table 2** reports the association between perceived marriage satisfaction and the risk of SCD. In analysis that adjusted for several conventional risk factors, comparing men who were dissatisfied with their marriage to men who were satisfied with their marriage, HR (95% CI) for SCD was 1.90 (CI 1.09-3.32;  $p=0.02$ ). The association remained consistent on further adjustment for history of IHD, SES and years of education 1.86 (CI 1.07 - 3.25;  $p=0.03$ ). A combination of fairly satisfied and dissatisfied marriage was also associated with an increased risk of SCD (HR 1.43, 95 % CI 1.10-1.88,  $p=0.01$ ) when compared with a very satisfied marriage, after adjustment for covariates (model 3).

## Discussion

In this population-based cohort study, the relationship between marriage satisfaction and risk of SCD was determined among Caucasian men. Compared with a very satisfied marriage, perceived dissatisfaction in marriage was associated with an increased risk of SCD among men and this was independent of several conventional and emerging risk factors. Similarly, even a fairly satisfied marriage was also related to a higher risk of SCD, compared to those who were very satisfied of their marriage. These findings are consistent with earlier studies that have shown a link between marriage satisfaction and cardiovascular health<sup>6, 12, 13</sup>.

Marital strain and hostility have been shown to cause an elevation in both systolic and diastolic blood pressures in some clinical studies<sup>5, 14</sup>. Research has shown how good relationship quality and satisfaction can lower the ambulatory blood pressure (ABP)<sup>15</sup>. There has been no previous investigation on the association between marriage satisfaction and SCD among general

population. This shows the uniqueness of the present study that reveals the relationship between perceived dissatisfaction in marriage and risk of SCD among men. The study revealed that men who are dissatisfied with their marriages have even 86% higher risk of SCD when compared to those that are very satisfied in their marriages. Considering that an element of dissatisfaction can exist in 'fairly satisfied' marriage, a combined group of the 'fairly satisfied' and 'dissatisfied' marriage was also associated with a 43% increased risk of SCD when compared with very satisfied marriage.

This finding could be attributed to some factors. Marital factors have been noted to be a source of stress<sup>16</sup>. Dissatisfaction in marriage can lead to unhappiness, as well as increased stress, which can inadvertently affect cardiovascular function and health in general. The autonomic nervous system can be activated within a short period of time following an exposure to a stressor. This induces both sympathetic and parasympathetic response causing the release of catecholamines with a resultant increase in heart rate, decrease heart rate variability and raised core body temperature<sup>17</sup>. Therefore, the possible mechanisms for dissatisfied marriages leading to SCD, could possibly be via the stress pathways; and elevated ABP, increased heart rates and platelet aggregation have been associated with increased sympathetic activity caused by psychological stress<sup>18, 19</sup>.

Another possible mechanism is changes in behavioral or social patterns. Men who are dissatisfied in their marriages, may have the tendency to indulge in unhealthy habits, such as alcoholism, unhealthy diets, smoking and extramarital affairs. They also could be on antidepressants. Studies have shown cross-sectional associations between marital dissatisfaction and alcohol use disorders (alcohol abuse/dependence)<sup>20, 21</sup>. Binge alcohol consumption (more than 6 drinks per day) has been associated with increased risk for SCD<sup>22</sup>. However, it is

important to know to what extent marital dissatisfaction can lead to alcohol use disorders and vice versa<sup>23</sup>. Although marriage dissatisfaction can possibly encourage smoking habits, however, there is a possibility that discrepancies in smoking among couples can decrease marital satisfaction<sup>24</sup>. These two unfavorable habits, heavy drinking and smoking, are known risk factors for SCD<sup>25</sup>. Although low rates of sudden deaths occurrence during sexual activity have been reported in autopsy findings, most of the sudden deaths occurred in men who engaged in extramarital activity<sup>26</sup>. Therefore, it is possible the underlying cause of SCD in dissatisfied marriages among men is related to their social behavior, such as heavy drinking, cigarette smoking and extramarital affairs.

This study provides further insight on the need for marriage satisfaction, in addition to marital status, to be included among the list of questions to be asked by healthcare professionals, especially among men with pre-existing CVD or those who have an increased risk of CVD. Also, it provides an insight on the need to consider therapy in addition to other treatment options for people who are dissatisfied in their marriages. This will potentially reduce their risk of SCD.

This present study is not without limitations, which deserves mention. First, the measure of marriage satisfaction was based on a single question which assessed the perceived level of marriage satisfaction by the men, giving room for reporter's bias. Other methods that are not based only on a single question have preferably been used for measuring marital satisfaction<sup>27</sup>.<sup>28</sup> The second limitation is the inability to adjust for other confounding factors that were not available in the study. For instance, there was no data on type of marriage (heterosexual or same-sex<sup>13</sup>), changes in marriage status (e.g. divorce or remarriage), and medication use (such as antidepressants<sup>25</sup>). Third, the number of participants and events in the "dissatisfied" category was relatively small, evidenced by the wide confidence intervals of HR. Fourth, the study included

only middle-aged Caucasian men, thus the result cannot be generalized to other populations, such as women, elderly, young adults and other races. Women are shown to be at greater risk of stress compared to men<sup>29</sup>, although it has been reported that they have lower incidence of SCD<sup>30</sup>. The incidence of SCD has also been shown to increase with age<sup>30</sup>, making the elderly to be more vulnerable, despite the higher proportion of sudden deaths occurring among the younger age groups<sup>30</sup>.

The strength of the study is in the recruitment of a fairly large number of participants for this prospective study with well-documented data available for use. From existing studies, this is the first report from a prospective study revealing a relationship between marriage satisfaction and risk of SCD among middle-aged men.

In conclusion, this present study provides epidemiological evidence that dissatisfaction in marriage is associated with an increased risk of SCD among middle-aged men. Men who are dissatisfied in their marriages should be regarded as a high-risk group when compared to men in very satisfied marriages. Although the exact mechanism underlying this association is not well understood, stress and adaptive negative behavioural factors (such as smoking and alcoholism) can be potential triggers for the increased risk of SCD among this group.

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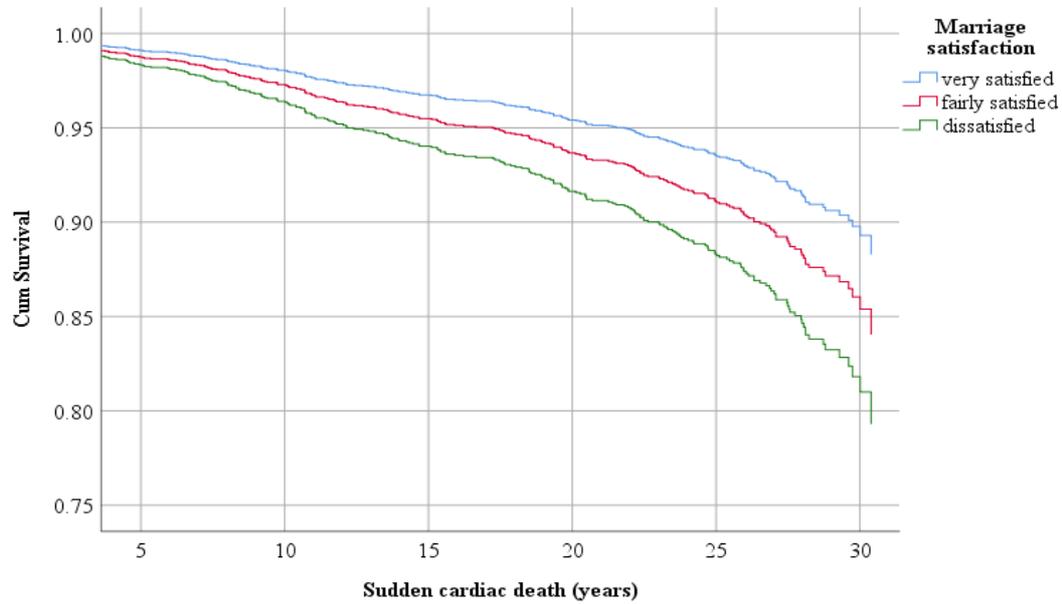
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**Figure 1:** Survival plot showing the association between marriage satisfaction and sudden cardiac death



ACCEPTED MANUSCRIPT

**Table1: Baseline characteristics of 2262 participants**

<b>Characteristics</b>	<b>Mean (SD) or median (IQR) or n (%)</b>
<b>Age (years)</b>	53.0 (5.2)
<b>Body mass index (kg/m<sup>2</sup>)</b>	26.9 (3.5)
<b>Total cholesterol (mmol/l); (mg/dl)*</b>	5.9 (1.1); 228.2 (42.5)
<b>High-density lipoprotein cholesterol (mmol/l); (mg/dl)*</b>	1.3 (0.3); 50.3 (11.6)
<b>Mean systolic blood pressure (mmHg)</b>	134.0 (17.1)
<b>Years of education</b>	8.8 (3.5)
<b>Socioeconomic status</b>	12.2 (5.3)
<b>Alcohol /week (g)</b>	31.8 (6.4-90.2)
<b>Smokers</b>	687 (30.3%)
<b>Type 2 diabetes mellitus</b>	141 (6.2%)
<b>Ischaemic heart disease</b>	567 (25.1%)
<b>Marriage satisfaction</b>	
<b>Very satisfied</b>	896 (39.6%)
<b>Fairly satisfied</b>	1249 (55.2%)
<b>Dissatisfied</b>	117 (5.2%)

\*For conversion to mg/dl, mmol/l is multiplied by 38.67.

**Table 2: Relationship between marital satisfaction and risk of sudden cardiac death**

	Perceived marriage satisfaction		
	Very satisfied	Fairly satisfied	Dissatisfied
<b>Sudden cardiac death</b>			
<b>Events/total</b>	78/896	146/1249	15/117
<b>HR (95% CI):</b>			
<b><i>p</i>-value</b>			
Model 1	1.0	1.37 (1.04 - 1.81): 0.03	1.73 (1.00 - 3.00): 0.05
Model 2	1.0	1.41 (1.07 - 1.86): 0.02	1.90 (1.09 - 3.32): 0.02
Model 3	1.0	1.39 (1.06 - 1.84): 0.02	1.86 (1.07-3.25): 0.03

CI, confidence interval

Model 1= Adjusted for age

Model 2= Model 1 plus body mass index, smoking, alcohol consumption, systolic blood pressure, diabetes mellitus, total cholesterol, high-density lipoprotein cholesterol

Model 3= Model 2 plus ischemic heart disease, socioeconomic status and education(years). The hazard ratios (HR) compared for the marriage, 'fairly satisfied' and 'dissatisfied' vs 'very satisfied'