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# Impact of Marital Stress on Medication Adherence and Physician Follow-Up after Acute Myocardial Infarction

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## Abstract

Introduction: Coronary Heart Disease (CHD) is the leading cause of death worldwide. While different types of stress have been linked to CHD development and prognosis, literature regarding the effect of marital stress on positive health behaviors in the early recovery period following myocardial infarction (MI) is limited.

Objective: The present analysis was undertaken to explore the relationship between marital stress and medication adherence and physician follow up, two important components of early post-MI recovery.

Methods: VIRGO study participants who reported either being married or in a committed relationship at the time of study enrollment or at a 30-day follow-up interview were eligible for assessment of marital stress via the Stockholm Marital Stress Scale. Marital stress was evaluated for its role in patients' medication adherence and physician follow-up 30 days after experiencing an index MI. Bivariate analyses were conducted to examine the relationships between medication adherence, physician follow up, and demographic and medical history variables with marital stress level. Categorical and continuous variables were compared using the chi-square test and analysis of variance, respectively. Multivariate logistic regression models were constructed to examine whether increased marital stress was associated with decreased medication adherence and/or a reduced likelihood of following up with a physician within 30 days post-MI. In secondary analyses, models were stratified by sex to examine whether the relationships between marital stress and these early health behaviors differed among men and women.

Results: Among 1503 individuals enrolled in VIRGO who reported a significant relationship and completed the 30-day follow-up interview, severe marital stress was not significantly associated with medication adherence (OR: 0.94 [95%CI: 0.60-1.48]), follow-up with any physician (OR: 0.84 [95%CI: 0.63-1.12]), or cardiologist-specific follow-up (OR: 0.83 [95%CI: 0.66-1.06]) in multivariate-adjusted models. While severe marital stress was significantly more likely to be reported by women than men ( $p < 0.001$ ), in secondary analyses, sex differences were not observed for the relationships between marital stress and rates of medication adherence, any physician follow-up, or cardiologist follow-up.

Conclusions: Marital stress was not significantly associated medication adherence or physician follow up visits during the early post-MI recovery period, although trends towards lower rates of adherence and physician follow-up were observed in individuals reporting severe marital stress.

## Introduction

Coronary Heart Disease (CHD) occurs secondary to atherosclerosis in the coronary arteries, which results in disruption of coronary circulation, and can lead to angina, and Acute Coronary Syndromes (ACS), such as unstable angina (UA) and myocardial infarction (MI). Among women in particular, CHD is the leading cause of death worldwide,<sup>1</sup> and in the United States alone, since 1984, CHD has accounted for more deaths among women than men.<sup>2</sup> Younger women, while thought to be at reduced CHD risk due to the cardioprotective effects of endogenous estrogen prior to menopause, remain at significant risk for CHD development. In fact, CHD is the leading cause of death among American women over the age of 50,<sup>2</sup> and it is estimated that one in nine women between the ages of 45 and 64 have some manifestation of CHD.<sup>3</sup> Moreover, young women with CHD have an overall worse prognosis than similarly-aged men,<sup>4</sup> women's death rates post-MI are higher than men's, and women are more likely than men to have serious complications subsequent to MI.<sup>5</sup>

Several psychosocial influences have been examined in regard to their relationship with CHD development and prognosis in young women. Stress is one of these factors that has been linked to CHD development in men and to a lesser extent, women, and studies have commonly examined work-related stress. Results have been equivocal, but there is evidence to support an association between job strain and CHD incidence, either among women,<sup>6</sup> or both sexes, with effect being more pronounced among young individuals.<sup>7</sup> An important component of the psychosocial literature that remains under examined is the role of marital stress in CHD.

Among women 65 years old and younger who were followed for three years, marital stress was associated with significant narrowing of coronary artery luminal diameter – a surrogate measure for worsening CHD – whereas lack of stress was associated with artery expansion.<sup>8</sup> Furthermore, over a five-year follow-up, marital stress was associated with a 2.9-fold increased risk for developing a recurrent MI among women sampled from the same cohort.<sup>9</sup> In a pilot, primary prevention study, 150 men were shown to derive a benefit from spousal support in terms of adherence to their medication regimens,<sup>10</sup> however similar data examining this relationship among women is lacking, and this relationship was not examined in patients with documented CHD. The role of marital stress on early positive health behaviors post-MI, which are likely to be factors contributing to poor long-term outcomes, has not been well described in present literature. Examining variations in these behaviors could help identify strategies to mitigate negative long-term clinical outcomes.

The present analysis was undertaken to explore the relationships between marital stress and medication adherence and physician follow-up, which are two important components of early post-MI recovery. The primary goal of the analysis is to determine if a higher level of marital stress is associated with a decrease in medication adherence and physician follow-up, particularly with a cardiologist, in the initial 30-day period post-MI. The secondary goal was to determine whether these relationships varied according to sex.

## Methods

The Variation in Recovery: Role of Gender on Outcomes of Young AMI Patients (VIRGO) study design has been described previously.<sup>11</sup> Briefly, VIRGO is a large observational study of the presentation, treatment and outcomes of young women and men diagnosed with Acute Myocardial Infarction (AMI). The study enrolled 2,990 participants aged 18-55 enrolled at 104 hospitals in the United States between August 21, 2008 and January 5, 2012, using a 2 female: 1 male enrollment strategy. Eligible patients had

elevated cardiac enzymes >99<sup>th</sup> percentile of the upper reference limit of the recruiting hospital and had additional evidence of myocardial ischemia, including symptoms of ischemia, electrocardiogram changes indicative of new ischemia (new ST-T changes, new or presumably new left bundle branch block, or the development of pathological Q waves), or other evidence of myocardial necrosis (imaging or pathology). Patients who were incarcerated, did not speak English or Spanish, were unable to provide informed consent or be contacted for follow-up, developed elevated cardiac markers because of elective coronary revascularization, or had an AMI as the result of physical trauma were not eligible. The primary study aims include determination of sex differences in the distribution and prognostic importance of biological, demographic, clinical and psychosocial risk factors, and to determine how these factors contribute to sex differences in outcomes, including mortality, hospitalization and health status.

VIRGO study participants who reported being married, living as married or with a partner, or in a committed relationship with a significant other person during the baseline or 30-day follow-up interviews were included in the present analysis. **Figure 1** describes the included patient population. The final population analyzed consisted of 1825 individuals.

Marital stress, the primary explanatory variable, was assessed via the Stockholm Marital Stress Scale,<sup>9</sup> a 17-item scale that includes questions on the quality of the marital relationship (see **Appendix 1**). Responses were scored on a scale from 0-17, where a score of 0 indicates no marital stress and a score of 17 indicates maximum marital stress. Marital stress was categorized based on distribution of responses into “absent/mild” (lowest quartile, scores 0-2), “moderate” (second quartile, score 3) and “severe” (upper two quartiles, scores  $\geq 4$ ).

Medication adherence was assessed at the 30-day follow-up interview using the question, “In the past month, how often did you take your medications as the doctor prescribed?” Responses were categorized as, “all of the time (100%),” “nearly all of the time (90%),” “most of the time (75%),” “about half the time (50%),” and, “less than half the time (<50%).” Due to the distribution of responses, respondents were categorized as either “adherent,” meaning they responded that they took their prescribed medication >90% of the time, or “non-adherent,” meaning that they took their prescribed medication  $\leq 90\%$  of the time.

Follow-up with any physician was assessed at the 30-day interview using the question, “Since your hospitalization for your heart attack or heart problem, how many times have you seen each of the following types of doctors in their office or clinic for your heart condition?” Respondents were grouped into “any” and “none” categories, based on whether or not they had followed up with any physician at least one time in the 30-day interval. A similar strategy was used to develop “any” and “none” categories for cardiologist-specific follow-up.

Distributions of categorical and continuous variables in relation to marital stress were examined using the chi-square test and analysis of variance, respectively. Demographic and medical history factors were examined for their association with marital stress in a bivariate fashion, as were the outcome variables of medication adherence and physician follow-up (**Table 1**). The bivariate analysis was stratified by sex to examine sex differences in associations with marital stress. Logistic regression models were created to assess the relationship between marital stress and medication adherence and physician follow-up. Unadjusted and multivariate-adjusted odds ratios (ORs) were calculated after controlling for potential confounders, and are presented with 95% confidence intervals (CIs). All models were adjusted for sex, age, race, education level, employment status, avoidance of healthcare due to cost, prior MI, presence of angina according to the Seattle Angina Questionnaire (SAQ), hypertension, diabetes mellitus, and

whether or not the individual smoked within the previous 30 days. All analyses were performed using Statistical Analysis Software (SAS) version 9.3.

## Results

A total of 1593 participants reported being married or in a significant relationship, had data regarding marital stress, and were included in bivariate analyses. Of these, 1503 (94.4%) had complete follow up data and were included in the multivariate models. Bivariate analyses are reported in **(Table 1)**. Absent or mild marital stress was reported by 475 individuals (29.8%); 276 individuals (17.3%) reported moderate marital stress; 842 individuals (52.9%) reported severe marital stress. Women were significantly more likely to report severe marital stress than men ( $p < 0.001$ ). Having a history of hypertension, angina, a previous MI, and avoiding healthcare due to cost were associated with more severe marital stress, whereas being employed was associated with less severe marital stress. In analyses stratified by sex, hypertension was associated with more severe marital stress among men, while among women, more severe marital stress was associated with hypercholesterolemia, reporting a previous MI, and avoiding healthcare due to cost. Angina was associated with increased severity of marital stress among both men and women. At the 30-day follow-up interview, 92.5% of individuals reported >90% medication adherence, 77.4% reported having at least one follow-up physician appointment, and 52.8% of individuals reported at least one follow-up cardiologist appointment. Neither medication adherence, follow-up with any physician, nor cardiologist-specific follow-up were significantly associated with marital stress level in bivariate analyses.

The multivariate model examining the association between marital stress and medication adherence is shown in **Table 2**. After adjustment for demographic and medical history variables, neither moderate (OR: 1.15 [95% CI: 0.62-2.13]) nor severe marital stress (OR: 0.94 [95%CI: 0.60-1.48]) were significantly associated with medication adherence. Black race, prior MI, experiencing angina, and reporting smoking within the previous 30 days were associated with decreased medication adherence. The model of association between marital stress and follow-up with any physician is shown in **Table 3**. After adjustment for demographic and medical history variables, neither moderate (OR: 0.96 [95%CI: 0.65-1.40]) nor severe marital stress (OR: 0.84 [95%CI: 0.63-1.12]) were significantly associated with the likelihood of following up with a physician. Female sex, education beyond the high school level, and employment were significantly associated with an increased likelihood of physician follow-up, whereas avoiding healthcare due to cost was associated with a decreased likelihood. In secondary analyses stratified by sex, the association between marital stress and physician follow-up was unchanged. The model of association between marital stress and cardiologist follow-up is shown in **Table 4**. After adjustment for demographic and medical history variables, neither moderate (OR: 1.02 [95%CI: 0.75-1.39]) nor severe marital stress (OR: 0.83 [95%CI: 0.66-1.06]) were significantly associated with the likelihood of following up with a cardiologist. Reporting education beyond the high school level and being employed were significantly associated with an increased likelihood of following up with a cardiologist, whereas having a diagnosis of diabetes mellitus was associated with a decreased likelihood. In secondary analyses stratified by sex, the association between marital stress and cardiologist follow-up was unchanged.

## Discussion

This analysis provides novel insight on the relationship between marital stress and the practice of positive health behaviors during the early recovery period following hospitalization for MI. In the initial 30 days following MI, there was no statistically significant relationship between marital stress and

medication adherence or physician follow-up among men and women aged 18-55. While the results did not reach statistical significance, there was a trend for severe marital stress to be associated with a decreased likelihood of medication adherence and physician follow-up compared to mild or absent marital stress. If these trends persist over time, it is possible that a higher incidence of deleterious clinical outcomes may be observed among individuals reporting severe marital stress, and the practice of these health behaviors could be recognized as an important modifying influence. Indeed, existing literature has shown that severe marital stress is associated with worsening atherosclerosis over a three-year follow-up period,<sup>12</sup> and a nearly three-fold increase in the risk of experiencing a repeat MI over a five-year follow-up period.<sup>9</sup> The present analysis identifies a potential mechanism by which these outcomes could occur, and shows that some effects can be seen almost immediately after experiencing an MI.

Marital stress has been shown to negatively impact social support mechanisms, such as social integration and sense of belonging, which have been linked to development of CHD and worse prognosis after MI.<sup>12,13</sup> Furthermore, among women, lower emotional support (as marriage would provide) was shown to accelerate the progression of CHD and lead to an overall poorer prognosis.<sup>14,15</sup> Marital stress is hypothesized to influence CHD via similar psychosocial mechanisms. While the pathophysiological mechanisms in which marital stress and other psychosocial factors impact CHD are not completely understood, metabolic abnormalities, sympathetic nervous system activation, systemic inflammation, and, among women, estrogen fluctuation resulting from psychosocial stress combine to provide reasonable biological plausibility that marital stress could influence CHD.<sup>16</sup> Conversely, being a member of a non-stressful marriage could provide a buffering effect on the ability of stress to cause atherosclerosis.<sup>17</sup> The results of the present analysis provide some support to this hypothesis, whereby medication adherence and physician follow-up are potential mediators of the effect of marital stress on poor CHD outcomes, as increased stress was associated with a trend in decreased practice of positive health behaviors. That this trend was seen given the short duration of follow-up in this analysis, it remains entirely possible that the hypothesized relationship between marital stress, positive health behaviors, and poor clinical outcomes after MI exists as described.

In the present analysis, women were much more likely to report severe marital stress than men, although this did not significantly alter positive health behaviors in the short-term. While marital stress has been shown to influence several components of mental health among women,<sup>18</sup> this analysis sought to provide novel insight as to how this translates into the practice of positive health behaviors. It was hypothesized that more severe marital stress would be associated with a decreased likelihood of performing positive health behaviors, which in turn could increase the likelihood of poor CHD prognosis, and that women, who are more prone to psychosocial stress than men, would be affected to a greater extent. This hypothesized relationship is somewhat supported by the observed trend toward poorer medication adherence and physician follow-up overall; however, the short duration of follow-up in this analysis may have precluded the emergence of significant sex-specific differences. It is possible that sex-specific trends will emerge as follow-up continues.

Several demographic and medical history covariates in this analysis may influence the observed relationship between marital stress the practice of early positive health behaviors post-MI, and these factors could be important targets of interventions geared towards mitigating negative clinical consequences downstream. While it has been noted that black individuals tend to have worse adherence rates with cardiovascular medications than whites,<sup>19</sup> in the present analysis, black individuals additionally tended to have more severe marital stress and report lower rates of physician follow-up. This observation may help identify marital stress as a contributor to some of the poorer post-MI

outcomes seen specifically among black individuals. The observed association between marital stress and decreased physician follow-up was also influenced by the two variables in this analysis that came closest to representing socioeconomic status – being employed either full or part-time (associated with better follow-up) and reporting avoidance of medical care due to cost (associated with worse follow-up). Socioeconomic status (SES) is a known barrier to cardiovascular care,<sup>20</sup> and identifying SES as a barrier to the practice of positive health behaviors immediately post-MI can help provide a target for interventions aimed at improving outcomes going forward.

There are several limitations to the present analysis. As data were collected via self-report, participants may have provided biased or incorrect answers based in improper recall. Similarly, participants may have provided socially desirable responses to certain questions instead of providing completely accurate responses. Selection bias may have been a factor in cohort enrollment, as there may have been systematic differences in marital stress level or the practice of health behaviors among the individuals who enrolled in the cohort and the entire population at risk for MI. Bias may also have been manifested in the inability of the cohort to capture potentially eligible individuals who experienced silent or fatal MIs. It is important to note, however, that this is the largest cohort of its kind to assess short-term positive health behaviors following a hospitalization for MI among young patients, and as such, the results contribute greatly to the existing body of literature. Based on the unexpected distribution of medication adherence during the early recovery period (92.5% of respondents were classified as “adherent”), statistical power to detect an association between marital stress and medication adherence was likely limited. Because VIRGO was designed to include individuals aged 18-55, the results may not be generalizable to older populations. Additionally, this analysis comprised only individuals enrolled in the United States; geographic distributions of marital stress, medication adherence and physician follow up may differ significantly, and results must be viewed within this context. Finally, it is important to recognize that marital stress is dynamic, and that levels reported at the 30-day follow-up visit may not be indicative of respondents’ typical marital stress levels, particularly since levels may have fluctuated greatly in response to the occurrence of a significant life event like MI. Thus, care should be exercised when attempting to draw inferences from a single measure of marital stress, and it may be useful to perform repeat assessments as patients are followed over time.

In conclusion, women were more likely to report severe marital stress than men. While marital stress was not significantly associated with medication adherence or physician follow-up in the 30-day post-MI period, there was an observed trend for severe marital stress to be associated with a decreased likelihood of practicing of these behaviors. Further research is needed to examine the relationship between marital stress and positive health behaviors over time, and to determine if differences in the practice of these behaviors can help predict future clinical outcomes.

**Table 1 – Patient Characteristics by Marital Stress Level**

|   |            | Total N=1593        |                  |                |         |
|---|------------|---------------------|------------------|----------------|---------|
|   |            | Absent/Mild (N=475) | Moderate (N=276) | Severe (N=842) | p-value |
| <b>Sociodemographic Characteristics</b>         |            |                     |                  |                |         |
| Age, mean ± SD                                  |            | 46.5 ± 6.2          | 47.0 ± 6.4       | 47.2 ± 6.0     | 0.195   |
|   |            | %                   | %                | %              |         |
| Sex   |            |                     |                  |                |         |
|   | Male       | 42.1                | 38.0             | 31.8           | <0.001  |
|   | Female     | 57.9                | 62.0             | 68.2           |         |
| Race  |            |                     |                  |                |         |
|   | White      | 81.7                | 81.9             | 79.1           | 0.683   |
|   | Black      | 11.8                | 12.3             | 14.4           |         |
|   | Other      | 6.5                 | 5.8              | 6.5            |         |
| Hispanic  |            | 5.9                 | 5.5              | 7.9            | 0.228   |
| Education > High School                         |            | 56.6                | 62.0             | 60.2           | 0.282   |
| Working full/part time                          |            | 71.0                | 68.5             | 64.1           | 0.029   |
| Avoid healthcare due to cost                    |            | 24.5                | 28.7             | 34.5           | <0.001  |
| <b>Medical History</b>                          |            |                     |                  |                |         |
| Prior MI  |            | 15.4                | 15.6             | 21.1           | 0.014   |
| Hypertension                                    |            | 58.3                | 57.6             | 67.0           | 0.001   |
| Diabetes  |            | 27.8                | 29.4             | 32.9           | 0.133   |
| Hypercholesterolemia                            |            | 86.1                | 82.6             | 87.7           | 0.106   |
| Renal dysfunction (GFR <60)                     |            | 9.5                 | 8.1              | 7.8            | 0.697   |
| Smoked within past 30 days                      |            | 49.7                | 54.0             | 55.7           | 0.109   |
| Obesity (BMI ≥30 kg/m <sup>2</sup> )            |            | 47.6                | 48.2             | 52.7           | 0.144   |
| SAQ angina frequency                            |            |                     |                  |                |         |
|   | Any angina | 46.0                | 54.3             | 56.4           | 0.001   |
| <b>Clinical Characteristics at Presentation</b> |            |                     |                  |                |         |
| Final MI diagnosis: STEMI                       |            | 54.5                | 53.3             | 48.3           | 0.070   |
| Ejection fraction <40%                          |            | 10.7                | 10.9             | 11.6           | 0.873   |
| <b>Medication Adherence</b>                     |            |                     |                  |                |         |
| Adherent <100% of time                          |            | 7.2                 | 6.5              | 8.4            | 0.501   |
| <b>Physician Follow-Up</b>                      |            |                     |                  |                |         |
| Follow-Up with Any Physician                    |            | 79.4                | 78.3             | 76.0           | 0.350   |
| Follow-Up with Cardiologist                     |            | 55.6                | 55.8             | 50.2           | 0.096   |



|   |            | Men N=573           |                  |                |         | Women N=1017        |                  |                |         |
|---|------------|---------------------|------------------|----------------|---------|---------------------|------------------|----------------|---------|
|   |            | Absent/Mild (N=200) | Moderate (N=105) | Severe (N=268) | p-value | Absent/Mild (N=275) | Moderate (N=171) | Severe (N=574) | p-value |
| <b>Sociodemographic Characteristics</b>         |            |                     |                  |                |         |                     |                  |                |         |
| Age, mean ± SD                                  |            | 46.5 ± 5.8          | 47.5 ± 5.5       | 47.4 ± 5.7     | 0.189   | 46.5 ± 6.4          | 46.8 ± 6.9       | 47.0 ± 6.1     | 0.541   |
|   |            | %                   | %                | %              |         | %                   | %                | %              |         |
| Race  |            |                     |                  |                |         |                     |                  |                |         |
|   | White      | 85.5                | 82.9             | 81.3           | 0.741   | 78.9                | 81.3             | 78.1           | 0.595   |
|   | Black      | 8.5                 | 8.6              | 9.3            |         | 14.2                | 14.6             | 16.7           |         |
|   | Other      | 6.0                 | 8.6              | 9.3            |         | 6.9                 | 4.1              | 5.2            |         |
| Hispanic  |            | 6.0                 | 5.7              | 9.4            | 0.292   | 5.8                 | 5.3              | 7.2            | 0.578   |
| Education > High School                         |            | 58.3                | 68.6             | 61.6           | 0.215   | 55.3                | 57.9             | 59.5           | 0.506   |
| Working full/part time                          |            | 78.4                | 79.1             | 75.7           | 0.695   | 65.8                | 62.0             | 58.7           | 0.135   |
| Avoid healthcare due to cost                    |            | 24.6                | 28.9             | 31.3           | 0.282   | 24.5                | 28.7             | 36.0           | 0.002   |
| <b>Medical History</b>                          |            |                     |                  |                |         |                     |                  |                |         |
| Prior MI  |            | 15.0                | 20.0             | 22.8           | 0.111   | 15.6                | 12.9             | 20.4           | 0.042   |
| Hypertension                                    |            | 57.5                | 57.1             | 70.5           | 0.005   | 58.9                | 57.9             | 65.3           | 0.082   |
| Diabetes  |            | 20.0                | 22.9             | 26.9           | 0.219   | 33.5                | 33.3             | 35.7           | 0.745   |
| Hypercholesterolemia                            |            | 91.5                | 91.4             | 92.5           | 0.897   | 82.2                | 77.2             | 85.4           | 0.038   |
| Renal dysfunction (GFR <60)                     |            | 7.0                 | 5.8              | 7.1            | 0.902   | 11.4                | 9.4              | 11.0           | 0.798   |
| Smoked within past 30 days                      |            | 49.5                | 52.4             | 53.0           | 0.747   | 49.8                | 55.0             | 57.0           | 0.146   |
| Obesity (BMI ≥30 kg/m <sup>2</sup> )            |            | 49.5                | 43.8             | 51.9           | 0.376   | 46.2                | 50.9             | 53.1           | 0.166   |
| SAQ angina frequency                            |            |                     |                  |                |         |                     |                  |                |         |
|   | Any angina | 43.5                | 58.1             | 50.4           | 0.048   | 47.8                | 52.1             | 59.2           | 0.006   |
| <b>Clinical Characteristics at Presentation</b> |            |                     |                  |                |         |                     |                  |                |         |
| Final MI diagnosis: STEMI                       |            | 61.0                | 56.2             | 54.9           | 0.401   | 49.8                | 51.5             | 45.3           | 0.248   |
| Ejection fraction <40%                          |            | 8.7                 | 11.8             | 8.6            | 0.613   | 12.2                | 10.4             | 13.1           | 0.664   |
| <b>Medication Adherence</b>                     |            |                     |                  |                |         |                     |                  |                |         |
| Adherent <100% of time                          |            | 7.0                 | 6.7              | 7.9            | 0.899   | 7.3                 | 6.4              | 8.7            | 0.558   |
| <b>Physician Follow-Up</b>                      |            |                     |                  |                |         |                     |                  |                |         |
| Follow-Up with Any Physician                    |            | 78.5                | 78.1             | 73.1           | 0.344   | 80.0                | 78.4             | 77.4           | 0.681   |
| Follow-Up with Cardiologist                     |            | 57.5                | 56.2             | 53.4           | 0.659   | 54.2                | 55.6             | 48.8           | 0.164   |

**Table 2. Multivariate Model of Association between Marital Stress and Medication Adherence**

|   | N=1503 | Unadjusted OR (95% CI) | Adjusted ORs (95% CIs) |                  |                  |                  |                  |
|---|--------|------------------------|------------------------|------------------|------------------|------------------|------------------|
| <b>Marital Stress Level</b>             |        |                        |                        |                  |                  |                  |                  |
| Absent/Mild                             |        | 1.00                   | 1.00                   | 1.00             | 1.00             | 1.00             |                  |
| Moderate                                |        | 1.08 (0.59-1.99)       | 1.08 (0.59-1.99)       | 1.07 (0.58-1.96) | 1.07 (0.58-1.98) | 1.10 (0.60-2.04) | 1.15 (0.62-2.13) |
| Severe                                  |        | 0.85 (0.55-1.32)       | 0.85 (0.55-1.33)       | 0.85 (0.54-1.32) | 0.86 (0.55-1.35) | 0.92 (0.59-1.45) | 0.94 (0.60-1.48) |
| <b>Sociodemographic Characteristics</b> |        |                        |                        |                  |                  |                  |                  |
| <b>Sex</b>                              |        |                        |                        |                  |                  |                  |                  |
| Male                                    |        | 1.00                   | 1.00                   | 1.00             | 1.00             | 1.00             | 1.00             |
| Female                                  |        | 0.96 (0.64-1.43)       | 0.97 (0.65-1.46)       | 1.05 (0.70-1.58) | 1.07 (0.71-1.61) | 1.08 (0.71-1.63) | 1.07 (0.70-1.63) |
| <b>Age</b>                              |        |                        |                        |                  |                  |                  |                  |
|   |        | 1.02 (0.99-1.05)       |                        | 0.01 (0.98-1.05) | 1.01 (0.98-1.05) | 1.02 (0.99-1.05) | 1.01 (0.98-1.05) |
| <b>Race</b>                             |        |                        |                        |                  |                  |                  |                  |
| White                                   |        | 1.00                   |                        | 1.00             | 1.00             | 1.00             | 1.00             |
| Black                                   |        | 0.49 (0.31-0.79)       |                        | 0.50 (0.31-0.81) | 0.51 (0.31-0.82) | 0.54 (0.33-0.87) | 0.51 (0.31-0.83) |
| Other                                   |        | 1.59 (0.57-4.43)       |                        | 1.61 (0.58-4.50) | 1.61 (0.58-4.50) | 1.51 (0.54-4.23) | 1.38 (0.49-3.90) |
| <b>Education</b>                        |        |                        |                        |                  |                  |                  |                  |
| ≤ High School                           |        | 1.00                   |                        | 1.00             | 1.00             | 1.00             | 1.00             |
| >High School                            |        | 1.12 (0.76-1.65)       |                        | 1.12 (0.76-1.66) | 1.08 (0.72-1.62) | 1.05 (0.70-1.58) | 0.96 (0.63-1.46) |
| <b>Working full/part time</b>           |        |                        |                        |                  |                  |                  |                  |
|   |        | 1.22 (0.82-1.82)       |                        |                  | 1.12 (0.73-1.70) | 1.07 (0.70-1.63) | 1.03 (0.67-1.58) |
| <b>Avoid healthcare due to cost</b>     |        |                        |                        |                  |                  |                  |                  |
|   |        | 0.86 (0.57-1.23)       |                        |                  | 0.91 (0.60-1.38) | 1.00 (0.66-1.53) | 1.03 (0.67-1.58) |
| <b>Medical History</b>                  |        |                        |                        |                  |                  |                  |                  |
| <b>Prior MI</b>                         |        |                        |                        |                  |                  |                  |                  |
|   |        | 0.54 (0.35-0.83)       |                        |                  |                  | 0.62 (0.39-0.98) | 0.57 (0.35-0.91) |
| <b>SAQ angina frequency</b>             |        |                        |                        |                  |                  |                  |                  |
| None                                    |        | 1.00                   |                        |                  |                  | 1.00             | 1.00             |
| Any                                     |        | 0.49 (0.33-0.74)       |                        |                  |                  | 0.53 (0.35-0.81) | 0.52 (0.34-0.80) |
| <b>Hypertension</b>                     |        |                        |                        |                  |                  |                  |                  |
|   |        | 0.96 (0.65-1.43)       |                        |                  |                  |                  | 1.24 (0.79-1.92) |
| <b>Diabetes</b>                         |        |                        |                        |                  |                  |                  |                  |
|   |        | 1.02 (0.67-1.55)       |                        |                  |                  |                  | 1.13 (0.72-1.76) |
| <b>Smoked within past 30 days</b>       |        |                        |                        |                  |                  |                  |                  |
|   |        | 0.58 (0.39-0.86)       |                        |                  |                  |                  | 0.60 (0.39-0.91) |

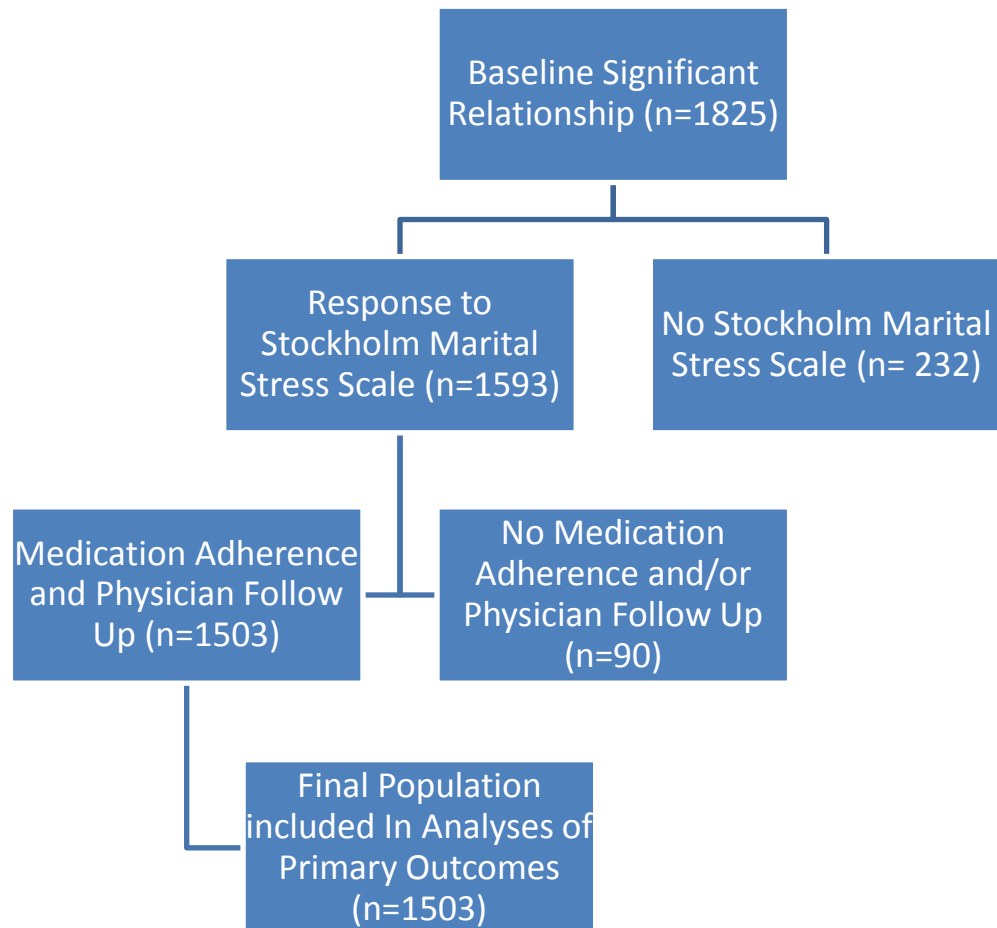
**Table 3. Multivariate Model of Association between Marital Stress and Any Physician Follow-Up**

|   | N=1503 | Unadjusted OR (95% CI) | Adjusted ORs (95% CIs) |                  |                  |                  |
|---|--------|------------------------|------------------------|------------------|------------------|------------------|
| <b>Marital Stress Level</b>             |        |                        |                        |                  |                  |                  |
| Absent/Mild                             |        | 1.00                   | 1.00                   | 1.00             | 1.00             | 1.00             |
| Moderate                                |        | 0.97 (0.66-1.41)       | 0.96 (0.66-1.40)       | 0.93 (0.64-1.36) | 0.95 (0.65-1.39) | 0.96 (0.65-1.40) |
| Severe                                  |        | 0.81 (0.61-1.07)       | 0.79 (0.60-1.05)       | 0.77 (0.58-1.03) | 0.82 (0.61-1.09) | 0.84 (0.63-1.12) |
| <b>Sociodemographic Characteristics</b> |        |                        |                        |                  |                  |                  |
| <b>Sex</b>                              |        |                        |                        |                  |                  |                  |
| Male                                    |        | 1.00                   | 1.00                   | 1.00             | 1.00             | 1.00             |
| Female                                  |        | 1.16 (0.90-1.49)       | 1.19 (0.92-1.53)       | 1.24 (0.96-1.60) | 1.30 (1.01-1.69) | 1.30 (1.00-1.69) |
| <b>Age</b>                              |        |                        |                        |                  |                  |                  |
|   |        | 1.01 (0.99-1.03)       |                        | 1.01 (0.99-1.03) | 1.01 (0.99-1.03) | 1.01 (0.99-1.03) |
| <b>Race</b>                             |        |                        |                        |                  |                  |                  |
| White                                   |        | 1.00                   |                        | 1.00             | 1.00             | 1.00             |
| Black                                   |        | 0.74 (0.52-1.04)       |                        | 0.73 (0.52-1.04) | 0.76 (0.53-1.08) | 0.77 (0.54-1.10) |
| Other                                   |        | 1.02 (0.60-1.73)       |                        | 1.06 (0.63-1.80) | 1.06 (0.62-1.80) | 1.04 (0.61-1.77) |
| <b>Education</b>                        |        |                        |                        |                  |                  |                  |
| ≤ High School                           |        | 1.00                   |                        | 1.00             | 1.00             | 1.00             |
| >High School                            |        | 1.51 (1.18-1.92)       |                        | 1.53 (0.20-1.96) | 1.36 (1.05-1.75) | 1.34 (1.04-1.74) |
| Working full/part time                  |        | 1.53 (1.19-1.97)       |                        |                  | 1.37 (1.05-1.79) | 1.35 (1.03-1.76) |
| Avoid healthcare due to cost            |        | 0.61 (0.47-0.79)       |                        |                  | 0.68 (0.52-0.89) | 0.70 (0.54-0.92) |
| <b>Medical History</b>                  |        |                        |                        |                  |                  |                  |
| Prior MI                                |        | 0.69 (0.51-0.93)       |                        |                  |                  | 0.80 (0.58-1.09) |
| <b>SAQ angina frequency</b>             |        |                        |                        |                  |                  |                  |
| None                                    |        | 1.00                   |                        |                  |                  | 1.00             |
| Any                                     |        | 0.78 (0.61-1.00)       |                        |                  |                  | 0.86 (0.67-1.10) |
| Hypertension                            |        | 0.80 (0.62-1.03)       |                        |                  |                  | 0.96 (0.73-1.28) |
| Diabetes                                |        | 0.79 (0.61-1.02)       |                        |                  |                  | 0.88 (0.67-1.15) |
| Smoked within past 30 days              |        | 0.85 (0.66-1.09)       |                        |                  |                  | 1.00 (0.77-1.30) |

**Table 4. Multivariate Model of Association between Medication Adherence and Cardiologist Follow-Up**

|   | N=1503 | Unadjusted OR (95% CI) | Adjusted ORs (95% CIs) |                  |                  |                  |                  |                  |
|---|--------|------------------------|------------------------|------------------|------------------|------------------|------------------|------------------|
| <b>Marital Stress Level</b>             |        |                        |                        |                  |                  |                  |                  |                  |
| Absent/Mild                             |        | 1.00                   | 1.00                   | 1.00             | 1.00             | 1.00             | 1.00             | 1.00             |
| Moderate                                |        | 1.03 (0.76-1.40)       | 1.04 (0.76-1.41)       | 1.00 (0.73-1.37) | 1.02 (0.75-1.39) | 1.02 (0.74-1.39) | 1.02 (0.75-1.39) | 1.02 (0.75-1.39) |
| Severe                                  |        | 0.81 (0.64-1.02)       | 0.82 (0.65-1.03)       | 0.80 (0.63-1.01) | 0.83 (0.65-1.05) | 0.83 (0.65-1.05) | 0.83 (0.65-1.05) | 0.83 (0.66-1.06) |
| <b>Sociodemographic Characteristics</b> |        |                        |                        |                  |                  |                  |                  |                  |
| <b>Sex</b>                              |        |                        |                        |                  |                  |                  |                  |                  |
| Male                                    |        | 1.00                   | 1.00                   | 1.00             | 1.00             | 1.00             | 1.00             | 1.00             |
| Female                                  |        | 0.87 (0.71-1.08)       | 0.89 (0.72-1.10)       | 0.92 (0.74-1.14) | 0.96 (0.77-1.20) | 0.96 (0.77-1.20) | 0.96 (0.77-1.20) | 0.98 (0.79-1.22) |
| <b>Age</b>                              |        |                        |                        |                  |                  |                  |                  |                  |
|   |        | 0.99 (0.98-1.01)       |                        | 0.99 (0.98-1.01) | 0.99 (0.98-1.01) | 0.99 (0.98-1.01) | 0.99 (0.98-1.01) | 0.99 (0.98-1.01) |
| <b>Race</b>                             |        |                        |                        |                  |                  |                  |                  |                  |
| White                                   |        | 1.00                   |                        | 1.00             | 1.00             | 1.00             | 1.00             | 1.00             |
| Black                                   |        | 0.91 (0.67-1.23)       |                        | 0.93 (0.68-1.27) | 0.97 (0.71-1.32) | 0.97 (0.71-1.33) | 0.97 (0.71-1.33) | 1.00 (0.73-1.37) |
| Other                                   |        | 1.28 (0.83-1.97)       |                        | 1.30 (0.83-2.02) | 1.31 (0.84-2.04) | 1.31 (0.84-2.04) | 1.31 (0.84-2.04) | 1.32 (0.85-2.07) |
| <b>Education</b>                        |        |                        |                        |                  |                  |                  |                  |                  |
| ≤ High School                           |        | 1.00                   |                        | 1.00             | 1.00             | 1.00             | 1.00             | 1.00             |
| >High School                            |        | 1.82 (1.47-2.24)       |                        | 1.82 (1.48-2.24) | 1.65 (1.33-2.05) | 1.65 (1.33-2.05) | 1.65 (1.33-2.05) | 1.62 (1.30-2.03) |
| <b>Working full/part time</b>           |        |                        |                        |                  |                  |                  |                  |                  |
|   |        | 1.62 (1.30-2.01)       |                        |                  | 1.38 (1.10-1.74) | 1.38 (1.10-1.74) | 1.38 (1.10-1.74) | 1.34 (1.07-1.70) |
| <b>Avoid healthcare due to cost</b>     |        |                        |                        |                  |                  |                  |                  |                  |
|   |        | 0.69 (0.55-0.85)       |                        |                  | 0.79 (0.63-1.00) | 0.79 (0.63-1.00) | 0.79 (0.63-1.00) | 0.81 (0.64-1.02) |
| <b>Medical History</b>                  |        |                        |                        |                  |                  |                  |                  |                  |
| <b>Prior MI</b>                         |        |                        |                        |                  |                  |                  |                  |                  |
|   |        | 0.85 (0.65-1.11)       |                        |                  |                  | 0.97 (0.74-1.29) | 0.97 (0.74-1.29) | 1.03 (0.78-1.37) |
| <b>SAQ angina frequency</b>             |        |                        |                        |                  |                  |                  |                  |                  |
| None                                    |        | 1.00                   |                        |                  |                  | 1.00             | 1.00             | 1.00             |
| Any                                     |        | 0.95 (0.77-1.16)       |                        |                  |                  | 1.03 (0.84-1.28) | 1.03 (0.84-1.28) | 1.04 (0.84-1.29) |
| <b>Hypertension</b>                     |        |                        |                        |                  |                  |                  |                  |                  |
|   |        | 0.80 (0.65-0.99)       |                        |                  |                  |                  |                  | 0.95 (0.76-1.20) |
| <b>Diabetes</b>                         |        |                        |                        |                  |                  |                  |                  |                  |
|   |        | 0.71 (0.57-0.88)       |                        |                  |                  |                  |                  | 0.78 (0.61-0.98) |
| <b>Smoked within past 30 days</b>       |        |                        |                        |                  |                  |                  |                  |                  |
|   |        | 0.79 (0.64-0.97)       |                        |                  |                  |                  |                  | 0.94 (0.76-1.17) |

Figure 1



---

\*Of the individuals identified as being in a significant relationship, 1593 had response data for the marital stress variable and were thus included in the analyses. Of these, 1503 had response data for medication adherence and physician follow-up.

Appendix 1

| Questions  |  |
|--|--|
| 1. Is the relationship with your spouse (significant other) loving?                                    | <input type="radio"/> Yes <input type="radio"/> No |
| 2. Is the relationship with your spouse (significant other) friendly?                                  | <input type="radio"/> Yes <input type="radio"/> No |
| 3. Is the relationship with your spouse (significant other) routine-like?                              | <input type="radio"/> Yes <input type="radio"/> No |
| 4. Is the relationship with your spouse (significant other) problematic?                               | <input type="radio"/> Yes <input type="radio"/> No |
| 5. Do you engage in leisure activities together with your spouse (significant other)?                  | <input type="radio"/> Yes <input type="radio"/> No |
| 6. Do you have your own private life outside the relationship with your spouse (significant other)?    | <input type="radio"/> Yes <input type="radio"/> No |
| 7. Is your spouse (significant other) your closest confidant?  | <input type="radio"/> Yes <input type="radio"/> No |
| 8. Does your spouse (significant other) consider you his closest confidant?                            | <input type="radio"/> Yes <input type="radio"/> No |
| 9. Are there things you can't talk openly about with each other?                                       | <input type="radio"/> Yes <input type="radio"/> No |
| 10. Have you had serious problems in the relationship with your spouse (significant other) previously? | <input type="radio"/> Yes <input type="radio"/> No |
| 11. Have you had serious problems in the relationship with your spouse (significant other) currently?  | <input type="radio"/> Yes <input type="radio"/> No |
| 12. Have you had serious crises in your relationship?  | <input type="radio"/> Yes <input type="radio"/> No |
| 13. Have you solved problems actively together?  | <input type="radio"/> Yes <input type="radio"/> No |
| 14. Do you have a sexual relationship with your spouse (significant other)?                            | <input type="radio"/> Yes <input type="radio"/> No |
| 15. Do you find the sexual relationship with your spouse (significant other) satisfactory?             | <input type="radio"/> Yes <input type="radio"/> No |
| 16. Has your sexual relationship been affected by your heart disease?                                  | <input type="radio"/> Yes <input type="radio"/> No |
| 17. Has your sexual relationship ceased due to your heart disease?                                     | <input type="radio"/> Yes <input type="radio"/> No |

## Scoring

A marital stress score of 1 is assigned if the respondent answered “no” to items 1, 2, 5, 7, 8, 13, 14, and 15; and assign score of 1 if respondent answered “yes” to the items 3, 4, 6, 9, 10, 11, 12, 16, and 17.

Another score of 1 is assigned for each problem (infidelity, substance use/abuse, economic problems, health problems, or other unspecified problems) as shown by answers to questions 10 and 11. The total scores is the sum of all scores. The scale score can range from 0-19\*. See example below.

|  |   |
|--|---|
| 1. Is the relationship with your spouse (significant other) loving?                                    | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 2. Is the relationship with your spouse (significant other) friendly?                                  | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 3. Is the relationship with your spouse (significant other) routine-like?                              | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 4. Is the relationship with your spouse (significant other) problematic?                               | <input type="radio"/> Yes <input checked="" type="radio"/> No |
| 5. Do you engage in leisure activities together with your spouse (significant other)?                  | <input type="radio"/> Yes <input checked="" type="radio"/> No |
| 6. Do you have your own private life outside the relationship with your spouse (significant other)?    | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 7. Is your spouse (significant other) your closest confidant?  | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 8. Does your spouse (significant other) consider you his closest confidant?                            | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 9. Are there things you can't talk openly about with each other?                                       | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 10. Have you had serious problems in the relationship with your spouse (significant other) previously? | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 11. Have you had serious problems in the relationship with your spouse (significant other) currently?  | <input type="radio"/> Yes <input checked="" type="radio"/> No |
| 12. Have you had serious crises in your relationship?  | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 13. Have you solved problems actively together?  | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 14. Do you have a sexual relationship with your spouse (significant other)?                            | <input checked="" type="radio"/> Yes <input type="radio"/> No |
| 15. Do you find the sexual relationship with your spouse (significant other) satisfactory?             | <input type="radio"/> Yes <input checked="" type="radio"/> No |

16. Has your sexual relationship been affected by your heart disease?  Yes  No

17. Has your sexual relationship ceased due to your heart disease?  Yes  No

Items 1, 2, 5, 7, 8, 13, 14, and 15 (in green) – Assign a score of 1 if answered “No”: score = 2.

Items 3, 4, 6, 9, 10, 11, 12, 16, and 17 (in yellow) – Assign a score of 1 if answered “Yes”: score = 6.

For each item 10 and 11 give an additional score of 1 if answered “Yes”: score = 1. Hence, the total score is (2 + 6 + 1) = 9.

\*Scoring/range seem to vary by studies. Check the detailed scoring for items 10 and 11.

### Reliability / Validity

| Study Population                                    | Reliability / Validity                 |
|---|--|
| General female population in Stockholm <sup>1</sup> | Cronback $\alpha$ (reliability) = 0.77 |
| CAD Patients in the SFCA Study <sup>2</sup>         | Cronback $\alpha$ (reliability) = 0.74 |

### References:

- 1) Orth-Gomer K, Wamala SP, et al. (2000). “Marital Stress Worsens Prognosis in Women With Coronary Heart Disease.” JAMA 284(23): 3008-3014.
- 2) Wang HX, Leineweber C, et al. (2006). “Psychosocial stress and atherosclerosis: family and work stress accelerate progression of coronary disease in women. The Stockholm Female Coronary Angiography Study.” J Intern Med 261: 245-254.

### Prior Studies using Stockholm Marital Stress Scale

| Cutpoints  | Study Population | Avg Age        | Reference                |
|--|------------------|----------------|--------------------------|
| Marital stress was categorized as:<br>-Mild/Absent (lowest quartile, scores 0-1)<br>-Moderate (second quartile, scores 2-3)<br>-Severe (upper 2 quartiles, scores > 3) | CAD Patients     | 56 (30-65) yrs | Orth-Gomer et al. (2000) |



|  |              |                |                          |
|--|--------------|----------------|--------------------------|
| Marital stress was categorized as:<br>-Mild/Absent (lower tertile, score 0-1)<br>-Moderate (middle, 2-3)<br>-High (upper tertile, 4-14)        | CAD Patients | 56 (30-65) yrs | Wang et al. (2006)       |
| High marital stress > median score<br>Low marital stress < median score<br>(range: 0-30)   | CAD patients | 56 (30-65) yrs | Blom et al. (2003)       |
| Marital stress was categorized as:<br>-Mild/Absent (lowest quartile; scores 0-1)<br>-Moderate (3 upper quartiles, scores > 1)<br>(range: 0-30) | CAD Patients | 56 (30-65) yrs | Orth-Gomer et al. (2005) |

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- 1) Orth-Gomer K, Wamala SP, et al. (2000). "Marital Stress Worsens Prognosis in Women With Coronary Heart Disease." JAMA 284(23): 3008-3014.
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