Frequency of Sexual Activity and Long-term Survival after Acute Myocardial Infarction

Shlomit Brandis Kepler, MHA,a Tal Hasin, MD,b Yael Benyamini, PhD,c Uri Goldbourt, PhD,a Yariv Gerber, PhDb1

aDepartment of Epidemiology and Preventive Medicine, School of Public Health, Sackler Faculty of Medicine, Tel Aviv University, Israel; bDepartment of Cardiology, Shaare Zedek Medical Center, Jerusalem, Israel; cBob Shapell School of Social Work, Tel Aviv University, Israel; dStanley Steyer Institute for Cancer Epidemiology and Research, Tel Aviv University, Israel.

ABSTRACT

BACKGROUND: Previous studies have shown an inverse relationship between sexual activity and mortality in the general population. We evaluated the association between sexual activity and long-term survival among patients with acute myocardial infarction.

METHODS: Patients aged ≤ 65 years (n=1120; mean age, 53) discharged from 8 hospitals in central Israel after first myocardial infarction from 1992-1993 were followed for mortality through 2015. Frequency of sexual activity was self-reported during the index hospitalization (baseline; referring to the year preceding the infarct) and after 5 and 10-13 years, along with sociodemographic and clinical data. Cox proportional hazards models were constructed to estimate the association with all-cause mortality in time-dependent sexual activity categories.

RESULTS: At baseline, a > once per week frequency of sexual activity was reported by 42% of the patients, whereas no sexual activity was reported by 6%. After 10-13 years, the rates were 21% and 27%, respectively. Lower sexual activity was associated with older age, female sex, lack of a steady partner and more comorbidities. During follow-up, 524 deaths (47%) occurred. An inverse relationship was observed between sexual activity frequency and death, with hazard ratios (95% confidence intervals) of 0.30 (0.23-0.38) for > once per week, 0.36 (0.28-0.46) for once per week, and 0.53 (0.42-0.66) for < once per week, compared with none. After adjusting for relevant confounding factors, the estimates were attenuated to 0.68 (0.50-0.91), 0.63 (0.48-0.83), and 0.72 (0.57-0.93), respectively (P for trend = .004).

CONCLUSIONS: Using repeated assessments of sexual activity after myocardial infarction, an inverse association was demonstrated with mortality, which was only partly accounted for by measured potential confounders.

INTRODUCTION

Sexual activity is an important element of normal human function, well-being, and quality of life.1–3 It is considered a form of physical activity because it requires stretching and physical movement.4,5 Several cohort studies have examined the relationship between sexual activity and mortality risk in the general population, mostly demonstrating an inverse association.6–9

Studies evaluating the association between sexual activity and cardiovascular disease have mostly been case-crossover examinations of the triggering effect of episodic sexual activity on instantaneous risks of acute cardiovascular events.10 A systematic review identified 4 such studies, which generally suggested an increased risk of acute myocardial infarction following sexual activity, with a reduced effect in subjects with higher levels of habitual physical activity.11 Cohort studies investigating the long-term association between frequency of sexual activity and cardiovascular disease development have reported conflicting results. In the Caerphilly study12 involving 914 middle-aged men...
followed up for 20 years, sexual activity frequency was not associated with the incidence of either ischemic stroke or coronary heart disease, but was inversely associated with fatal coronary heart disease. In contrast, higher frequency of sexual activity (≥ once per week vs none) was positively associated with cardiovascular disease event rates over 5 years of follow-up among male subjects from the National Social Life, Health and Aging Project.\textsuperscript{13} Reduced sexual activity frequency is prevalent after myocardial infarction.\textsuperscript{13–16} Myocardial infarction patients, in turn, are at a considerably higher risk of death compared with the general population.\textsuperscript{17,18} To date, however, studies examining sexual activity frequency in relation to long-term mortality in myocardial infarction survivors are not available. Using data from a prospective cohort study of first myocardial infarction patients aged ≤65 years, our goal was to evaluate its longitudinal relationship with overall survival.

**METHODS**

**Study Design and Sample**

Data were drawn from the Israel Study of First Acute Myocardial Infarction, a longitudinal, prospective cohort study investigating the role of sociodemographic, medical, and psychosocial variables in long-term clinical outcomes and quality of life in younger patients hospitalized after first acute myocardial infarction.\textsuperscript{19–21} Consecutive patients aged ≤65 years (n = 1626) admitted to 8 medical centers located in central Israel were enrolled from February 15, 1992, through February 15, 1993. Five percent of those admitted (n = 81) died during initial hospitalization, leaving 1545 eligible candidates for the study, among whom 1521 consented to participate. Patients who provided data regarding sexual activity frequency at the index hospitalization (n = 1120) were included in the present analysis (Figure 1). All aspects of the study were approved by the appropriate institutional ethics committees.

**Data Collection**

Individual sociodemographic, medical, and psychosocial data were collected from medical records and structured interviews conducted during the index hospitalization (T0). Two follow-up interviews that included information on sexual activity frequency were subsequently conducted 5 years (T1) and 10-13 years (T2) after myocardial infarction.

**Sexual Activity**

Information was self-reported. At the first interview (T0), patients were asked about their sexual activity frequency during the year preceding the index myocardial infarction; at follow-up interviews (T1 and T2), patients were asked about their current sexual activity frequency. At each interview, patients were requested to rate their sexual activity frequency, using a 7-item scale, as follows: “3 times per week or more,” “twice per week,” “once per week,” “2 to 3 times per month,” “once per month,” “less than once per month,” and “not at all.” A “Refuse to answer” category was included in the questionnaire. Only sexual intercourse was considered in the above scale and not masturbation. For analytical purposes, patients were grouped into 4 categories, at each interview, as follows: 1) more than once per week; 2) once per week; 3) less than once per week; and 4) no sexual activity. At the last follow-up interview (T2), patients not engaging in sexual activity were requested to state the main reason for abstinence, using the following options: “lack of interest in sexual activity,” “lack of a partner,” “heart condition,” “other medical problem,” “partner’s medical problem,” “sexual dysfunction,” “partner’s sexual dysfunction,” or “other reason.”

**Other Covariates**

Cardiovascular risk factors and disease characteristics were recorded at the index hospitalization. Diabetes mellitus, hypertension, and dyslipidemia were defined according to standard criteria based on clinical and laboratory data. Height and weight were recorded at all 3 interviews; body mass index (BMI, kg/m\textsuperscript{2}) was calculated. Leisure time physical activity was self-reported at all interviews and grouped into regularly active, irregularly active, or inactive.\textsuperscript{19} Cigarette use was also reported during all interviews and was categorized as current, past, or never.\textsuperscript{20} Also assessed were the Charlson index,\textsuperscript{22} analyzed categorically (no comorbidity for 0 points, moderate comorbidity for 1-2 points, and severe comorbidity for 3 points or more), and Killip class, categorized as ≥2 vs 1. Socioeconomic variables were self-reported and included education (years of schooling) and living with a steady partner, which was reported at both T0 and T2.

**Outcome Measure**

Mortality was assessed through various sources, including the Israeli Population Registry, participants’ medical records, death certificates, family physicians, and family members. Follow-up lasted through December 31, 2015.
The Israeli Population Registry has complete ascertainment of death.\textsuperscript{21}

**Statistical Analysis**

Patient characteristics across baseline sexual activity frequency categories are presented as means and standard deviations for continuous variables and as frequencies for categorical variables; differences between groups were examined using analysis of variance or the $\chi^2$ test, as appropriate. Cox proportional hazards models\textsuperscript{23} were constructed to estimate the associations between baseline sexual activity frequency categories and time to death. Cox regression models with time-dependent covariates were subsequently used; this method is suitable for longitudinal studies as it considers changes in exposures over time.\textsuperscript{24} Initial adjustment was made for age and sex, followed by a model additionally adjusting for cardiovascular risk factors (smoking, hypertension, dyslipidemia, BMI, and diabetes), disease severity indices (Killip class and comorbidity index), and socioeconomic measures (education and living with a steady partner). Sexual activity frequency, smoking, leisure time physical activity, and living with a steady partner were treated as time-dependent variables, when appropriate. Missing data on sexual activity frequency at follow-up interviews (6\% at T1 and 11\% at T2) were handled by the last observation carried forward method. Missing values for other covariates did not exceed 5\%. The proportionality assumption was tested with the Schoenfeld residuals, with no violations detected. Analyses were performed with SPSS version 25 (IBM Corp, Armonk, NY).

**RESULTS**

Data from 1120 participants (mean $\pm$ SD age, 53 $\pm$ 8 years; 86\% males) who provided information on sexual activity frequency at baseline were included in the analysis. Four hundred one patients (26\%) did not respond to the sexual activity frequency question at baseline. On average, non-respondents were older (57 $\pm$ 7 vs 53 $\pm$ 8), had a lower proportion of men (68\% vs 86\%), and were less likely to live with a steady partner (80\% vs 89\%). Median survival estimate was lower for non-respondents (13.9 years) than for respondents (21.6 years).

Nine hundred ninety-five (94\%) and 835 (89\%) patients provided data on sexual activity frequency (Figure 1) at T1 and T2, respectively. The distribution of sexual activity frequency throughout the follow-up is presented in Figure 2. Lack of sexual activity was increasingly reported during successive interviews. Conversely, a $>$ once per week frequency was decreasingly reported. The Spearman correlation coefficients of sexual activity frequency between follow-up visits were 0.56 between T0 and T1, 0.55 between T0 and T2, and 0.79 between T1 and T2.

Patient characteristics by baseline sexual activity frequency are summarized in Table 1. Generally, patients with higher sexual activity frequency were younger, had a larger percentage of males, and were more educated than patients reporting lower frequency. The former were also more likely to smoke, to engage in leisure time physical activity, and to live with a steady partner, and had lower Killip class and comorbidity burden as measured by the Charlson index.

During a median follow-up time of 22.3 years (interquartile range, 15.0-22.8), 524 (47\%) deaths occurred. In a Cox regression model with baseline sexual activity frequency as primary exposure, a strong graded inverse association was observed with mortality. However, the association was attenuated after sequential adjustment for 1) age and sex, and 2) clinical and socioeconomic variables (Table 2).
With sexual activity frequency modeled as a time-dependent variable, a stronger relationship was revealed. Multivariable adjustment for demographic, clinical, and socioeconomic variables (with smoking, leisure time physical activity, and living with a steady partner treated as time-dependent covariates) demonstrated a substantial risk difference between inactive and active patients, whereas the risk among the sexually active categories varied only slightly, with no clear dose response (Table 3).

In a sensitivity analysis, despite the small number of participants in some of the classes, the time-dependent association with mortality was assessed for the original 7-category sexual activity frequency scale. In the fully adjusted Cox model, the

![Table 1](image)

Table 1: Baseline Characteristics by Reported Frequency of Sexual Activity at Study Entry

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>None (n=70)</th>
<th>&lt;1/week (n=301)</th>
<th>1/week (n=277)</th>
<th>&gt;1/week (n=472)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean±SD, years</td>
<td>57.5±6.6</td>
<td>56.2±7.3</td>
<td>53.9±7.8</td>
<td>49.2±8.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>31 (44)</td>
<td>230 (76)</td>
<td>250 (90)</td>
<td>448 (95)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Education, mean±SD, years</td>
<td>8.9±4.2</td>
<td>10.4±4.2</td>
<td>12.0±3.9</td>
<td>12.0±3.8</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Living with a steady partner, n (%)</td>
<td>31 (44)</td>
<td>263 (87)</td>
<td>264 (95)</td>
<td>443 (94)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Leisure time physical activity, n (%)</td>
<td>47 (67)</td>
<td>152 (50)</td>
<td>123 (44)</td>
<td>212 (45)</td>
<td>.002</td>
</tr>
<tr>
<td>Smoking, n (%)</td>
<td>30 (43)</td>
<td>86 (29)</td>
<td>70 (25)</td>
<td>95 (20)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>30 (43)</td>
<td>129 (43)</td>
<td>115 (42)</td>
<td>136 (29)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>29 (41)</td>
<td>87 (29)</td>
<td>58 (21)</td>
<td>76 (16)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hyperlipidemia, n (%)</td>
<td>28 (40)</td>
<td>121 (40)</td>
<td>100 (36)</td>
<td>168 (36)</td>
<td>.561</td>
</tr>
<tr>
<td>Body mass index, mean±SD</td>
<td>27.1±5.0</td>
<td>26.3±4.0</td>
<td>26.9±3.7</td>
<td>27.0±3.6</td>
<td>.076</td>
</tr>
<tr>
<td>Killip class &gt;1, n (%)</td>
<td>21 (30)</td>
<td>79 (24)</td>
<td>46 (17)</td>
<td>71 (15)</td>
<td>.001</td>
</tr>
<tr>
<td>Charlson comorbidity index, n (%)</td>
<td>32 (46)</td>
<td>172 (57)</td>
<td>181 (65)</td>
<td>328 (69)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No comorbidity</td>
<td>33 (47)</td>
<td>112 (37)</td>
<td>91 (32)</td>
<td>137 (29)</td>
<td></td>
</tr>
<tr>
<td>Mild comorbidity</td>
<td>5 (7)</td>
<td>17 (6)</td>
<td>5 (2)</td>
<td>7 (1)</td>
<td></td>
</tr>
</tbody>
</table>

*Refers to the year preceding the index myocardial infarction.
hazard ratios (95% confidence intervals) for death were 0.93 (0.69-1.27) for < once per month, 0.65 (0.43-0.93) for once per month, 0.65 (0.48-0.89) for 2 to 3 times per month, 0.61 (0.46-0.82) for once per week, 0.64 (0.45-0.90) for twice per week, and 0.62 (0.40-0.97) for 3 times per week or more, compared with none (P for trend < .001).

The distribution of the main reasons for sexual abstinence at T2 is depicted in Figure 3 and illustrates a variety of potential causes. Lack of partner and non-cardiac medical problem were the most commonly reported reasons. Sexual dysfunction and the heart condition itself were less common reasons for abstaining from sexual activity.

**DISCUSSION**

In this study, sexually active myocardial infarction patients had a better clinical and socioeconomic profile compared with less active patients. The survival advantage associated with baseline sexual activity frequency was attenuated after multivariable adjustment for relevant confounding factors. With sexual activity frequency modeled as a time-dependent variable, accounting for changes occurring during follow-up, a sizeable risk-adjusted survival advantage was observed among participants engaging in any sexual activity level vs none, with only small differences between the active categories (except the < once per month category).
Comparison with Other Research

Several longitudinal studies of varying duration have demonstrated an inverse relationship between sexual activity (sexually active, yes or no)\(^6,7\) or sexual activity frequency\(^8,9\) and mortality risk in the general population. The Duke First Longitudinal Study of Aging\(^8\) included 252 men and women aged 60-94 years. Over 25 years of follow-up, sexual activity was a significant predictor of longevity in men, but not in women. The Caerphilly study\(^9\) included 918 men aged 45-59 years. At 10 years of follow-up, the multivariable adjusted odds ratios (95% confidence intervals) for all-cause mortality were 1.9 (1.0-3.4) in low frequency of orgasm and 1.6 (1.0 to 2.8) in medium frequency of orgasm, compared with high frequency of orgasm. A 14-year follow-up study involving 2453 Taiwanese aged ≥65 years also suggested an inverse relationship between sexual activity and mortality risk. The adjusted hazard ratios (95% confidence intervals) for mortality in sexually active vs inactive subjects were 0.67 (0.56-0.80) in men and 0.84 (0.65-1.09) in women. When grouped into sexual activity frequency categories, the adjusted hazard ratios (95% confidence intervals) for all-cause mortality in the entire cohort were 0.87 (0.72-1.04) for high frequency (≥ once per week) and 0.77 (0.66-0.91) for medium frequency (once per month to once per week), compared with a lower frequency or none.\(^8\) Sexual activity was assessed repeatedly over 7 years of follow-up among 1705 community-dwelling Australian men aged 70 years and over.\(^7\) It was observed that men not having sexual activity had a twofold increase in mortality compared with sexually active men. However, the association was attenuated after multivariable adjustment that included age and depression.

The present analysis thus supports previous reports, but extends their findings to myocardial infarction patients. Post-myocardial infarction patients differ from healthy adults with regard to both sexual activity frequency\(^14-16\) and mortality risk.\(^17,18\) Our findings reveal that, in a cohort of first acute myocardial infarction patients aged ≥65 years followed up for more than 2 decades, a strong inverse relationship existed between sexual activity and death. The present study has a distinct advantage of performing repeated assessments of sexual activity frequency over a long period, in addition to obtaining data on multiple confounding variables at different time points in a large representative acute myocardial infarction patient sample.

Potential Mechanisms

Several biological mechanisms involved in the association between sexual activity frequency and survival have been previously suggested. One study by de Baca et al\(^26\) examined self-reported partnered relationship satisfaction, perceived stress, partner support, partner conflict, physical intimacy, and telomere length in a sample derived from the Stress, Aging, and Emotions (SAGE) study. The authors found a positive association between sexual intimacy and telomere length. Telomeres are repeated nucleoprotein sequences (TTAGGG) that provide protection against replication and degradation in DNA material by stabilizing the ends of chromosomes. Another possible mechanism may be related to secreted levels of testosterone hormone. Low levels of testosterone were found to be associated with risk of cardiovascular disease events.\(^27\) Generally, low levels of testosterone were previously linked to lower sexual desire. Indeed, studies examining castrated Cynomolgus male monkeys, who lose their source of testosterone, have shown a reduction in sexual initiation. However, administering synthetic testosterone regained their sexual interest.\(^28\) In humans, menopausal women who suffer from lower levels of testosterone reported lower sexual desire, which was also regained with the help of testosterone replacement therapy.\(^29\) Studies in healthy young adults have yielded inconclusive results.\(^30\)

The association between erectile dysfunction, which is negatively related to sexual activity frequency,\(^31\) and cardiovascular disease has been studied extensively.\(^32\) Erectile dysfunction shares many risk factors with cardiovascular disease, such as advanced age, hypertension, diabetes mellitus, smoking, obesity, and dyslipidemia. Erectile dysfunction and cardiovascular disease are considered different manifestations of the same systemic disorder and, therefore, may partly account for our findings. Although erectile dysfunction was not assessed routinely in this study, sexual dysfunction was reported by 14% of the patients as the main reason for abstinence at T2.

Sexual activity is a form of physical activity because it increases heart rate and blood pressure\(^4,5\) and—just like physical activity—it has been identified as a trigger for myocardial infarction.\(^11\) Regarding long-term effects, an inverse association was repeatedly shown between physical activity and mortality, both in the general population and in patients with cardiovascular disease.\(^33,34\) In a previous investigation of the same cohort of patients studied here, regular engagement in leisure time physical activity was associated with about half the mortality risk compared with sedentary lifestyle.\(^19\) Importantly, however, in the present analysis, adjustment for physical activity did not dramatically change the observed association between sexual activity frequency and survival.

From a practical standpoint, given that 1) sexuality and sexual activity are markers of well-being, and 2) prevalent causes for sexual abstinence, including medical (eg, erectile dysfunction and some cardiovascular disease medications) and psychological (eg, lack of interest, depression, and fear) barriers, are—at least in part—modifiable,\(^35\) sex and sexuality after myocardial infarction should be targeted for intervention.

Methodological Considerations

The present investigation has several strengths. Previous studies of sexual activity frequency and mortality were conducted in the general population, and, therefore, may not be generalizable to myocardial infarction patients. Our study included consecutive myocardial infarction survivors in a defined
geographic region. A wide range of variables was obtained at baseline and during follow-up, allowing adjustment for multiple confounding factors. Sexual activity frequency was reported at 3 time points over 10-13 years. This provides a more accurate picture of true sexual activity habits than would be possible from evaluating a single point. Methodologically, modeling sexual activity frequency (as well as other important confounding factors) as time-varying variables in the regression models reduces misclassification bias.

Some limitations of our study should be acknowledged to aid data interpretation. Exposure data were not available in 26% of the original cohort, partly due to the sensitive nature of the study question. Still, this rate is set at the low end of the expected range reported previously. Patients who provided sexual activity frequency data were, on average, younger, had a higher male proportion, and were more likely to live with a steady partner than the patients who did not provide these data. It is expected that the more intrusive a survey, the higher the barrier to intimacy, and the more likely one is to encounter participation bias. Our study was observational, therefore any observed survival benefits associated with sexual activity frequency could be attributable to other, unmeasured variables, such as erectile dysfunction or depression. Our sample includes a low percentage of women (14%), mainly resulting from the age restriction (≤65) of this myocardial infarction patient cohort. Sexual activity frequency was self-reported and, therefore, may be misrepresented by some patients. The reliability of self-reported sexual behavior varies with a variety of factors including age, ethnicity, number of sexual partners, and time frame for recall.

CONCLUSIONS

In a longitudinal investigation of Israeli patients after first myocardial infarction, an inverse association was observed between reported frequency of sexual activity and mortality. Further elucidation of the mechanisms involved in the association is warranted.

ACKNOWLEDGMENTS

The following investigators and institutions took part in the Israel Study of First Acute Myocardial Infarction: Yaacov Drory, MD, Principal Investigator, Department of Rehabilitation, Sackler Medical School, Tel Aviv University, Tel Aviv; Yeheskel Kishon, MD, Michael Kriwisky, MD, and Joseph Rosenman, MD, Wolfson Medical Center, Holon; Uri Goldbourt, PhD, Hanoch Hod, MD, Eliezer Kaplanlisky, MD, and Michael Eldar, MD, Sheba Medical Center, Tel Hashomer, Itzhak Shapira, MD, Amos Pines, MD, Margalit Drory, MSW, Arie Roth, MD, Shlomo Laniado, MD, and Gad Keren, MD, Tel Aviv Sourasky Medical Center, Tel Aviv; Daniel David, MD, Morton Leibowitz, MD, and Hana Pausner, MD, Meir Medical Center, Kfar Sava; Zvi Schlesinger, MD, and Zvi Vered, MD, Assaf Harohef Medical Center, Zerifin; Alexander Battler, MD, Alejandro Solodky, MD, and Samuel Sclarovsky, MD, Beilinson Medical Center, Petach Tikvah; Izhak Zehavi, MD, and Rachel Marom-Klibansky, MD, Hasharon Medical Center, Petah Tikvah; and Ron Leor, MD, Laniado Medical Center, Netanya.

This work was performed in partial fulfillment of the requirements for the M.Sc. degree of Shlomit Brandis Kepler, Sackler Faculty of Medicine, Tel Aviv University, Israel.

References


