

**Exploratory Description and Longitudinal Modeling of Predictors of Sexual Function and  
Satisfaction Post-Myocardial Infarction**

by

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## **DEDICATION**

This dissertation is dedicated to my parents, Andy and Ellen, and my brother, Sam. Thank you for your constant love and guidance. You three have been an incredible foundation for me through times both good and bad, and you have my utmost gratitude for your unwavering support.

This dissertation is also dedicated to the courageous men and women who were willing to give their time and share their thoughts for this study. Sexuality is a sensitive subject to discuss for many, and without their sacrifices, this dissertation could not have been completed. I am deeply thankful for their contributions.

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## **PREFACE**

Chapters IV, V, and VI of this dissertation were prepared for future submission to academic journals. As such, they contain different content and formatting than the rest of the dissertation in pursuant of each journal's individual guidelines.

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## **LIST OF ABBREVIATIONS**

ANA - American Nurses Association  
CDSR - Cochrane Database of Systematic Reviews  
CINAHL - Cumulative Index of Nursing and Allied Health Literature  
CI - Confidence interval  
CAD - Coronary artery disease  
COPD - Chronic obstructive pulmonary disease  
CSI - Coping Strategy Indicator  
CVD - Cardiovascular disease  
ED - Erectile dysfunction  
FSFI - Female Sexual Function Index  
HIV - Human Immunodeficiency Virus  
HRQOL - Health-related quality of life  
IRB - Institutional Review Board  
ICF - International Classification of Functioning, Disability and Health  
IES-R - Impact of Events Scale - Revised  
IIEF-5 - International Index of Erectile Function – 5 item version  
ISSWSH - International Society for the Study of Women's Sexual Health  
LoWeSS - Locally weighted scatterplot smoothing  
LVEF - Left ventricular ejection fraction  
MI - Myocardial infarction  
MSFI - Male Sexual Function Index  
MSQ - Multidimensional Sexuality Questionnaire  
MSPSS - Multidimensional Scale of Perceived Social Support  
NSHAP - National Social Life, Health, and Aging Project  
NSTEMI - Non ST-segment elevated myocardial infarction  
PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PROMIS - Patient-Reported Outcomes Measurement Information System

RAS - Relationship Assessment Scale

RDAS - Revised Dyadic Adjustment Scale

SD - Standard deviation

STEMI - ST-segment elevated myocardial infarction

WHO - World Health Organization

WSFQ - Watts Sexual Function Questionnaire

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## **ABSTRACT**

Myocardial infarction (MI) negatively impacts many aspects of a patient's quality of life, one of which is sexual function. Though sexual function is a crucial component of quality of life for many individuals, it is critically understudied in the post-MI population. The lack of evidence has left health care providers and patients unsure on how sexual function components change when facing an acute or chronic illness, and what options are available to assist with maintaining optimal sexual function. Identification of modifiable predictors of both increased and decreased function is paramount before effective interventions can be developed. Therefore, the purpose of this dissertation was to illuminate the changes in sexual function over time and apply exploratory modeling to examine potential predictors of function in patients post-MI. The specific aims of this dissertation were three-fold including:

1. Describe sexual function and satisfaction in a population of adults within two weeks and at three months post-MI, and examine changes from two weeks post-MI to three months post-MI.
2. Determine the impact of depression, fear, anxiety, and use of coping strategies on predicting sexual function, satisfaction, and activity at three months post-MI.
3. Describe the relationships between the biopsychosocial domains of sexual function and satisfaction at two weeks post-MI.

A total of 99 patients in a Midwestern hospital were approached out of 395 screened. Of these, 63 provided informed consent (consent/decline rate 63.6%). Participants were mailed surveys at two weeks and three months following discharge from the hospital for an MI. Sexual function data was captured with a multidimensional instrument, the Female/Male Sexual Function Index. Additionally, anxiety, depression, coping strategies, and sexual fear data were gathered using validated survey instruments. Cross-sectional and longitudinal description were performed, and linear and logistic regressions were utilized to examine associations with function and activity at three months. Eighteen participants returned all survey data (response rate 33%). There were three major findings from this dissertation. The first finding was that physical components of function (i.e. erection, orgasm), were poorly correlated with psychosocial components (i.e. sexual satisfaction) at both two weeks and three months post discharge for MI. The second finding was that sexual function scores improved among male participants within the first few months of discharge (18.8%), particularly among those who were sexually active at three months. The third finding was that sexual function was negatively associated with sexual fear, and positively associated with utilization of problem-solving and support-seeking coping strategies at three months. Furthermore, problem-solving and support-seeking strategies revealed a statistically significant association with function at three months, though clinically insignificant. Problem-solving and support-seeking strategies were also identified as positive predictors of sexual function in the models. Altogether, these results, while modest, help to contribute to our understanding of sexual function post-MI, particularly in a short-term capacity post discharge. The studies herein provide some intriguing avenues for predictive research to elucidate the relationship between utilization of coping strategies with sexual function. This study also provided information on functional components at a short time post-MI, which

providers and patients can utilize to understand what to expect after discharge. However, additional research is also needed with a more generalizable population to further explore the potential relationships observed in this dissertation. Additional descriptive work should also include more females and a broader distribution of racial minorities.

## **CHAPTER I**

### **Introduction**

#### **Background**

Coronary artery disease (CAD) remains the most common chronic condition in the United States, affecting approximately 18.2 million adults over the age of 20 (Virani et al., 2020). Embedded within chronic CAD are acute events such as myocardial infarction (MI). Among adults age  $\geq 35$ , 470,000 men and 335,000 women were hospitalized for either a new or recurrent MI between 2005 and 2014 (Virani et al., 2020). A review of recent incidence data reveals an average age for a first-time MI of 65.6 years for males and 72 years for females, with individuals  $>45$  years of age comprising 97% of newly diagnosed events (Benjamin et al., 2019; Virani et al., 2020). While incidence rates of MI are substantial, evidence points to a decline in both short-term and long-term mortality rates over the past 30 years due to improved treatment and preventive strategies following hospital admission. Current in-hospital mortality rates of MI patients have decreased to 5% over the past decade, and 5-year survival rates post discharge range from 80% to 90% (Ko et al., 2020; Coles et al., 2012). The combination of both increased MI incidence rates with improved survival percentages have created a substantial post-MI population of 8.4 million adults over the past two decades (Virani et al., 2020).

MI is associated with profound adverse health outcomes due to the resultant pathophysiology of the disease combined with its relative frequency. Although survival rates

have improved, MI still precipitates destructive effects on the heart and vasculature. An MI is defined as an adverse outcome of obstructive atherosclerotic disease in the coronary arteries (Mehta et al., 2016). MI is primarily caused by either a disruption of a vulnerable plaque or by erosion of the coronary artery wall (Reed, Rossi, & Cannon, 2017). There are three events that can cause coronary occlusions: plaque rupture, plaque erosion, and development of calcific nodules (Mehta et al., 2016). Rupture is the most common cause, which manifests from lesions that damage the cardiovascular wall (Frangiannis, 2015). These lesions can be slow progressing, involving microscopic lesions and small fatty areas, or complicated injuries involving rapid wall deterioration. Most ischemic MIs are caused by lesions that have an eccentric shape with irregular borders, a large, lipid-rich core, a thin fibrous cap, are high in macrophages (which increase inflammation), and are low in smooth muscle cells and collagen (Frangiannis, 2015). Additional factors that affect plaque rupture include mechanical injury to the heart, or inflammation and infection of the cardiac tissue (Cheng, 2001). Stenosis of the coronary arteries can also precipitate turbulent blood flow, which is believed to initiate platelet aggregation and increase the risk of downstream occlusion. There are also two classifications of MI known as type 1 and type 2. While type 1 (ischemic) MIs are related to rupture and occlusion of the coronary wall, type 2 (demand) MIs are caused from an imbalance between blood supply and demand to the myocardial tissue. As a result, type 2 MIs can lead to myocardial ischemia without an associated coronary vessel occlusion (Guimarães et al., 2018).

There are two severity levels of MI based on the subsequent electric activity in the heart following the event. These include ST segment elevated (STEMI) and non-ST elevated (NSTEMI). A STEMI is typically more serious and relates to a worse prognosis both inpatient and upon discharge (Cipriani et al., 2018). In contrast, an NSTEMI does not change the heart's

electrocardiogram readout, and is associated with better outcomes (Cipriani et al., 2018).

Severity of MI is also assessed using high sensitivity troponin T or troponin I levels. Troponin is an enzyme released when cardiac muscle is damaged, and so a higher value indicates a greater injury. Left ventricular ejection fraction (LVEF) is also utilized to assess the amount of blood leaving the heart with each ventricular contraction and indicates basic heart function (Thygesen et al., 2012).

The typical trajectory of patients post-MI first involves stabilization in the inpatient setting, which can range from two to 14 days depending on the severity of the MI and the number of complications post-event. Patients are then either discharged to a subacute rehabilitation facility, nursing home, or with a referral to outpatient rehabilitation, which can last from two to four weeks for inpatient and two to 12 weeks for ambulatory rehabilitation (Piotrowicz & Wolszakiewicz, 2008). The level of care post-event and the outcomes post-discharge largely depend on the severity of the MI along with the patient's unique presentation, comorbidities, and social capacity. Adverse events related to MI include sudden cardiac death, which can occur rapidly and lead to cardiogenic shock in the short-term and heart failure in the long-term. Complications also include bleeding from the antithrombotic and antiplatelet agents used to address the occlusion, mechanical complications including mitral valve regurgitation and septal rupture, and heart rhythm complications (Mehta et al., 2016). In addition to physical complications, MI profoundly effects a patient's health-related quality of life (HRQOL). MI can decrease overall quality of life through its impact on vasculature and cardiac work effort. There is a growing body of evidence that HRQOL domains such as physical function and activity tolerance are reduced after MI and that psychosocial complications post-MI can include marked depression and anxiety (Daniel et al., 2018; Roest, Martens, Denollet, & de Jonge, 2010).

While the pathophysiology of MI is well known, its effects on some components of HRQOL are less understood. One understudied HRQOL domain in this population is sexual health. Sexual health is defined as “a multifaceted concept that encompasses social constructs and individual behaviors, promoting the best possible sexual functioning in physical, psychological and social environments” (Corona, Jannini, & Maggi, p. 236). Sexuality is an integral part of sexual health and is made up of biological (sexual activity, sexual function) and psychosocial components (desire, sexual/relationship satisfaction) (Tierney, 2008). Sexual activity is defined as “a voluntary activity with or without a partner that includes sexual contact, which may or may not include intercourse or orgasm” (Lindau et al., 2012, p. 1440). Sexual function is defined as “sexual activity with transition through the phases from arousal to relaxation with no problems, and with a feeling of pleasure, fulfilment and satisfaction” (Corona, Jannini, & Maggi, 2006). Classical conceptualization of sexual function includes four main phases: excitement, plateau, orgasm, and resolution (Masters & Johnson, 1966). These phases were traditionally presented in a successive or linear progression from excitement to resolution. However, recent revisions were made to address criticisms with the model’s lack of applicability to female sexual function. Following these updates, function was conceptualized as a more circular model in females (Basson, 2001). In addition to sexual function, sexual satisfaction pertains to an individual’s appraisal of the contentedness of their physical and emotional satisfaction within their relationship or overall sex life (Ashdown, Hackathorn, & Clark, 2011).

Many conditions outside of MI can negatively impact sexual health, and as a result research has expanded into chronic illness-associated sexual dysfunction (Basson, Rees, Wang, Montejo, & Incrocci, 2010). Sexual dysfunction is defined as a “heterogeneous group of disorders that are typically characterized by a clinically significant disturbance in a person’s

ability to respond sexually or to experience sexual pleasure” (American Psychiatric Association, 2013). In men, coronary artery disease can impair the endothelium of the penile artery through inflammation, which increases the threshold for vasodilation and subsequent erection (Vlachopoulos, Jackson, Stefanadis, & Montorsi, 2013). In females, vasocongestion and vaginal lubrication are both products of vascular dilation and thus are also hindered by decreased blood supply (Nappi, Albani, Chiovato, & Polatti, 2009).

Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences (World Health Organization, 2006). However, MI threatens the quality of an optimal sexual experience. In particular, sexual dysfunction in patients post-MI is thought to be caused by an impairment of blood flow to sex organs. Decreased blood flow to the heart and periphery increases cardiac effort, fatigue, and chest pain during sexual activity and can be a subsequent source of anxiety and fear, decreasing overall desire for sexual activity (Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). Symptoms in males include erectile dysfunction, orgasmic dysfunction, decreased sexual desire, and decreased satisfaction with intercourse (Puchalski, Szymanski, Kowalik, & Filipiak, 2013). Sexual dysfunction in females post-MI is characterized by decreased vaginal lubrication, decreased libido, orgasmic problems, relationship deterioration, and doubt and fear related to sexual activity (Søderberg, Johansen, Herning, & Berg, 2013; Zeydi, Sharafkhani, Armat, Gould, Soleimani, & Hosseini, 2016; Oskay, Can, & Camci, 2015). Additionally, depression, fatigue, anxiety, and sleep disturbances have been well documented in patients post-MI which can further contribute to male and female sexual dysfunction (Johansson, Karlson, Grankvist, & Brink, 2010; Søderberg, Johansen, Herning, & Berg, 2013; Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). These



changes indicate that sexual health is a commonly affected, yet seldom addressed component of HRQOL (Roest, Martens, Denollet, & de Jonge, 2010; Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010).

## **Significance**

For patients discharged post-MI, the consequences of decreased sexual health are often of serious concern. Throughout the trajectory of stabilization to rehabilitation and discharge, sexual health needs are often neglected, and this leaves post-MI patients uncertain on how to resume sexual activity or adapt to sexual health changes (D'Eath, Byrne, Doherty, McGee, & Murphy, 2013). Current studies affirm that sexual health is rarely discussed because healthcare providers often lack the confidence and knowledge about sexual health issues (Byrne, Doherty, McGee, & Murphy, 2010; Jaarsma et al., 2010). This creates an unmet need in this population, as data suggest that patients are sexually active throughout the lifespan (Clayton, Harsh, & Clayton, 2016), and that adults of all ages desire information about sexual health following hospitalization (Mosack & Steinke, 2009). There is also some preliminary research that has reported a protective effect of sexual activity on prevention of a repeat cardiac event (Liu, Waite, Shen, & Wang, 2016). Assessing sexual health has been defined as an essential component of holistic nursing practice by the American Nurses' Association (ANA) (Dattilo & Brewer, 2005), and is a key recommendation of the American Heart Association (Levine et al., 2012). Therefore, nurses are uniquely positioned to counsel patients about their sexual dysfunction concerns (Vassiliadou et al., 2008). However, while sexual counseling and intervention have been promoted as a standard of care (Steinke, Mosack, & Hill, 2013), providers remain reluctant to discuss sexual health issues with patients (Ivarsson, Fridlund, & Sjöberg, 2010; Jaarsma et al., 2010; D'Eath, Byrne, Doherty, McGee, & Murphy, 2013).

A potential explanation for provider reluctance is the general paucity of research on sexuality issues. To date, few studies have been published on the topic of sexual health in patients following an MI. Given that sexual health is a multidimensional construct, improving and maintaining positive sexual health requires a multifaceted approach. However, there are few well validated multidimensional measurements of sexual health post-MI, with the current literature focusing primarily on sexual activity, or on one isolated component of sexual function. This lack of robust multidimensional data is evident when evaluating the contemporary intervention for sexual dysfunction - sexual counseling. A meta-analysis on sexual counseling interventions in patients post-MI found that conducted studies were of generally poor quality and produced mixed effects on return to sexual activity and reduction of sexual problems (Byrne et al., 2016). Therefore, this area of study is in its infancy and further research is warranted before interventions can be developed and care can improve. The current state of the science points to the need for more descriptive information on the effects of MI on sexual health.

## **Purpose**

Given the incidence and survival rates of MI, the physical and psychosocial complications post event, and the importance of sexual health to patients, the assessment and management of sexual health is vital to improving recovery care in this population. However, to date no multidimensional measurement of sexual health exists. Given this disparity, sexual function was selected as the outcome of interest in this dissertation. This outcome was selected given the connection between the pathophysiologic ramifications of MI on sexual function, combined with the need for additional descriptive research and preliminary predictive modeling of sexual function. Therefore, this dissertation examined longitudinal changes in sexual function, operationalized through a validated multidimensional instrument: the Female and Male Sexual

Function Index (FSFI/MSFI) (Rosen et al., 2000; Kalmbach, Ciesla, Janata, & Kingsberg, 2012). Ultimately, identification of predictors of sexual function and satisfaction is a necessary step in the development of effective interventions in post-MI patients.

### **Specific Aims**

**Aim 1).** Describe sexual function and satisfaction in a population of adults within two weeks and at three months post-MI, and examine changes from two weeks post-MI to three months post-MI.

- Hypothesis: Within two weeks of MI, the total score and subscale scores will remain in the dysfunctional range of the FSFI/MSFI but will improve at three months.

**Aim 2).** Determine the impact of depression, fear, anxiety, and use of coping strategies on predicting sexual function, satisfaction, and activity at three months post-MI.

- Hypothesis: Higher levels of sexual fear, depression, anxiety, and lower utilization of positive coping strategies will be associated with reduced sexual activity, function, and satisfaction at three months.

**Aim 3).** Describe the relationships between the biopsychosocial domains of sexual function and satisfaction at two weeks post-MI.

- Hypothesis: Sexual satisfaction will be less closely correlated with the other components of sexual function at two weeks post-MI.

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## **CHAPTER II**

### **Literature Review and Conceptual Framework**

#### **Introduction**

While a growing body of literature has developed regarding post-MI sexual health, the state of the science remains poorly articulated overall. In addition, the differentiation of sexual health in MI compared to chronic CAD is unexplored. As such, two separate reviews of the literature were conducted to gain a broad understanding of sexual health in patients in general CAD and post-MI. This literature search aimed to evaluate theoretical and operational definitions of sexual health and its components, and the capacity in which sexual health was empirically measured in these two populations. Pertinent strengths, weaknesses and gaps in the literature are also presented.

#### **Methods**

The databases included the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, Scopus, PsycINFO, and the Cochrane Database for Systematic Reviews (CDSR). All searches were done by title, and relevant search terms with the appropriate Boolean operators were entered in separated searches for MI and CAD. The search included terms and synonyms for components of sexual health, such as function (libido, orgasm, sexuality, dyspareunia, and erectile dysfunction), activity, intimacy, and pleasure. Synonyms for MI

included heart attack and cardiac event. A 15-year cutoff was selected to only capture recent representative literature. These terms are presented in Table 2.1, 2.2 and 2.3.

Table 2. 1 - Coronary artery disease search terms by database

<p><b>Pubmed</b></p> <p>“cardiovascular disease*” [MeSH Terms] OR (“cardiovascular” [Tiab] AND “disease*” [Tiab]) OR “cardiovascular diseases” [Tiab] OR (“cardiovascular” [Tiab] AND “disease” [Tiab]) OR “cardiovascular disease” [Tiab] OR “CVD” [Tiab] OR “cardiac illness” OR (“heart” [Tiab] AND “disease” [Tiab]) OR “heart disease” [Tiab] OR “coronary artery disease” [Tiab].</p>
<p><b>CINAHL, PsycINFO, CDSR</b></p> <p>“cardiovascular disease” OR (“cardiovascular” AND “disease”) OR “cardiovascular diseases” OR (“cardiovascular” AND “diseases”).</p>

CINAHL: Cumulative Index to Nursing and Allied Health Literature; CDSR: Cochrane Database for Systematic Reviews

Table 2. 2 - Myocardial infarction search terms by database

<p><b>Pubmed</b></p> <p>“myocardial infarction” [MeSH Terms] OR (“myocardial” [Title] AND “infarction” [Title]) OR “myocardial infarction” [Title] OR “MI” [Title] OR “cardiac event” [Title].</p>
<p><b>CINAHL, PsycINFO, CDSR</b></p> <p>“myocardial infarction” OR “myocardial infarction” OR “cardiac event” OR “MI”.</p>

CINAHL: Cumulative Index to Nursing and Allied Health Literature; CDSR: Cochrane Database for Systematic Reviews

Table 2. 3 - Sexual health search terms by database

<p><b>Pubmed</b></p> <p>“sexual dysfunction” [Title] OR (“sexual” [Title] AND “satisfaction” [Title]) OR “sexual satisfaction” [Title] OR “sexual pleasure” [Title] OR (“sexual” [Title] AND “pleasure” [Title]) OR “sexuality” [Title] OR “sexual identity” [Title] OR “sexual function” [Title] OR (“sexual” [Title] AND “function” [Title]) OR “sexual behavior” [MeSH Terms] OR “libido” [MeSH Terms] OR “orgasm” [MeSH Terms] OR “sexuality” [MeSH Terms] OR “intimacy” [Title] OR “intimate” [Title] OR “sexual health” [Title] OR “Partner” [Title] OR “arousal” [Title] OR “desire” [Title] OR “erectile dysfunction” [Title].</p>
<p><b>CINAHL, PsycINFO, CDSR</b></p> <p>“sexual dysfunction” OR (“sexual” AND “satisfaction”) OR “sexual satisfaction” OR “sexual pleasure” OR (“sexual” AND “pleasure”) OR “sexuality” OR “sexual identity” OR “sexual function” OR (“sexual” AND “function”) OR “sexual behavior” OR “libido” OR “orgasm” OR “sexuality” OR “intimacy” OR “intimate” OR “sexual health” OR “Partner” OR “arousal” OR “desire” OR “erectile dysfunction”.</p>

CINAHL: Cumulative Index to Nursing and Allied Health Literature; CDSR: Cochrane Database for Systematic Reviews

The inclusion criteria were descriptive cross-sectional or longitudinal studies using quantitative methods written in English and conducted in either men or women aged 20 years or older. Subgroup analyses of each gender were required if both men and women were included in the same study. Studies of participants who had a marked history of depression, anxiety disorder, schizophrenia, or other mental illness were excluded as these conditions could confound the relationship between CAD/MI and sexual health. Outcomes that were reported by surrogates

(family members, spouses or significant others, providers), and studies of patients with a diagnosis of stroke, congestive heart failure, or congenital heart defects were excluded. Lastly, intervention studies (such as a pharmaceutical, sexual counseling, or marital therapy) were excluded.

Articles were evaluated by their sampling and data collection procedures, their diagnostic criteria for CAD or MI, the theoretical and operational definitions of sexual health presented, and the selection and measurement of individual outcomes. The individual study designs, methods, and results were charted in a synthesis table. The strengths and weaknesses of each study were analysed, and pertinent findings and gaps were synthesized. Statistical factors such as sample size, power analysis, and statistical/clinical significance were also considered.

## **Results**

An initial total of 879 articles were retrieved from the CAD literature. After the removal of duplicates, 485 articles were screened by title and abstract. After title and abstract screening, 446 articles were removed, and the remaining 39 articles were reviewed by full text. From this screening, seven articles were included in the final CAD review. The literature search for sexual health in patients post-MI yielded 471 studies and was reduced to 339 after removal of duplicates. Following initial title and abstract screening, the remaining 22 articles were reviewed by full text. From these, four articles were included in the final MI review. A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram showing the search strategy and the number of articles retrieved, included, and excluded for each search is presented in Figure 2.1 and 2.2.

Figure 2. 1 - PRISMA diagram for sexual health in patients with coronary artery disease.

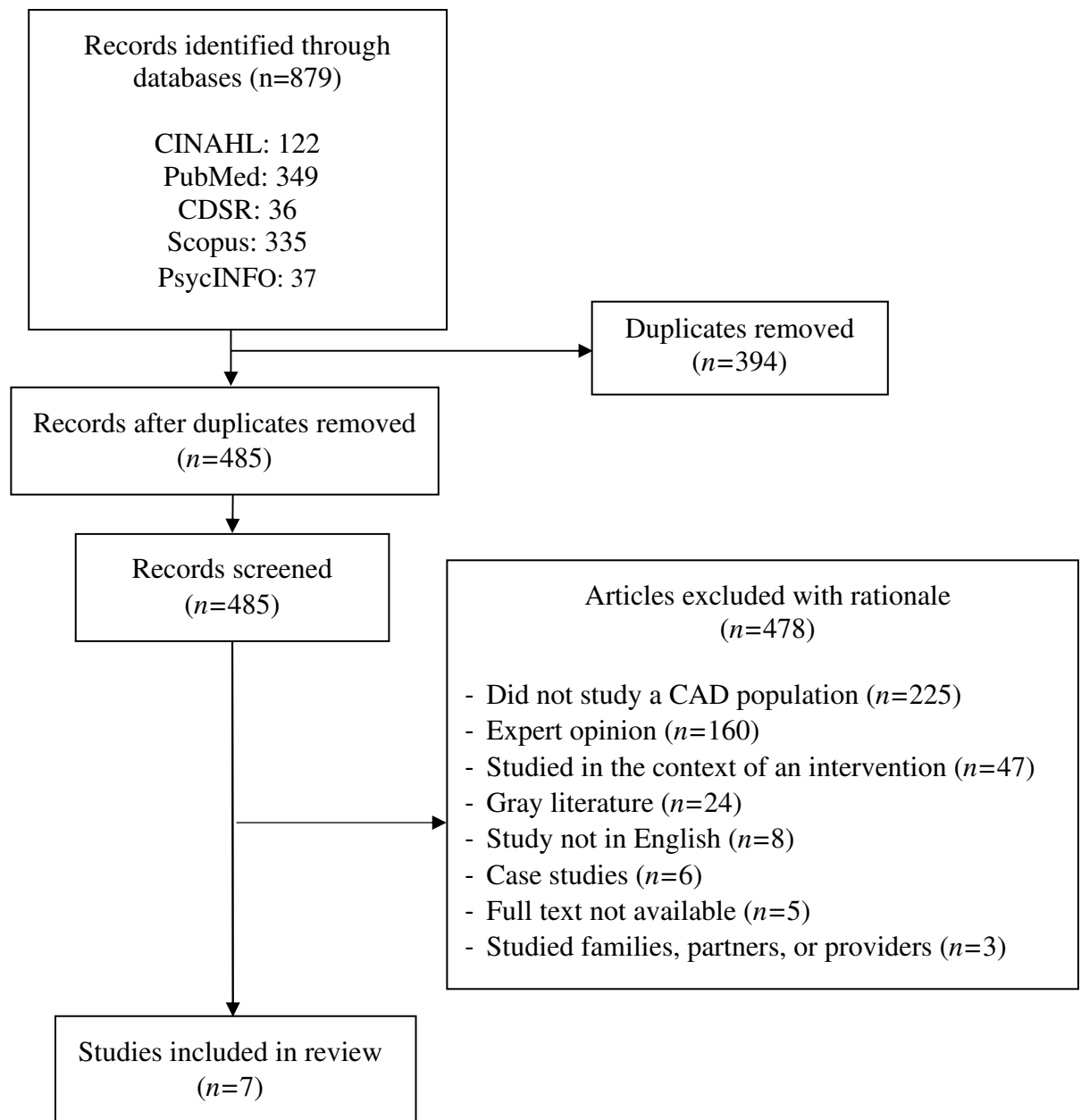
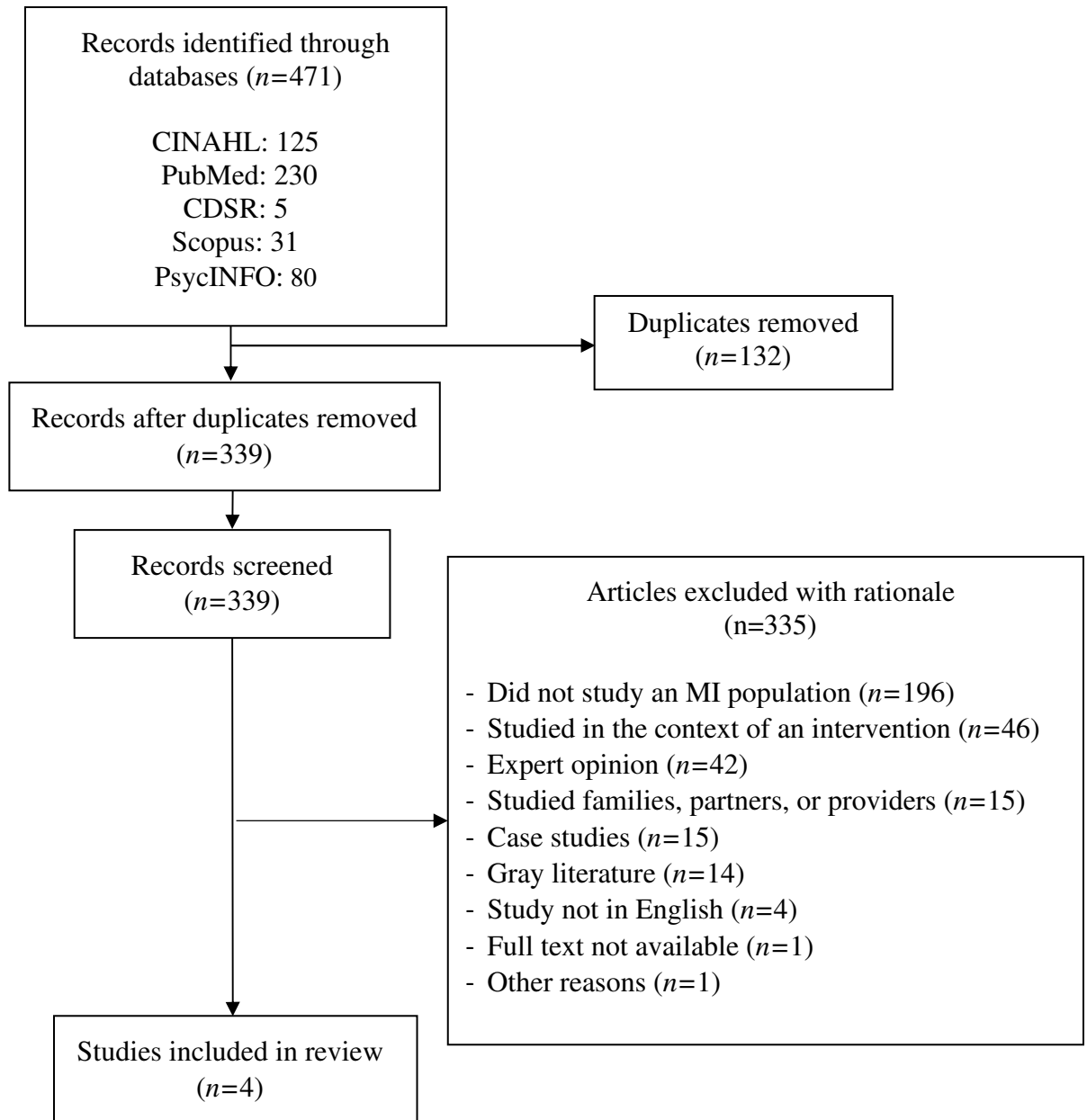


Figure 2. 2 - PRISMA diagram for sexual health in patients post myocardial infarction



## **Study Characteristics**

Seven articles from the CAD literature were included in this review. One study was conducted in Denmark (Rundblad et al., 2017), three in Iran (Assari, Lankarani, Ahmadi, & Kazemi Saleh, 2014; Ghanbari Afra, Taghadosi, & Gilasi, 2015; Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008), one in Israel (Justo et al., 2010), one in Turkey (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007), and one in Norway (Træen & Olsen, 2007). Five different questionnaires were used among five of the seven studies. These included the Larson's Sexual Satisfaction Questionnaire (LSSQ) (Larson, Anderson, Holman, & Niemann, 1998), the Sexual Health Inventory for Males (SHIM) (Rosen, Cappelleri, Smith, Lipsky & Pena, 1999), the Female Sexual Function Index (FSFI) (Rosen et al., 2000), the Relation and Sexuality Scale (RSS) (Berglund et al., 2001), and the Revised Dyadic Adjustment Scale (RDAS) (Busby et al., 1995). The remaining two articles used investigator developed questionnaires (Træen & Olsen, 2007; Rundblad et al., 2017).

Of the four articles included from the MI literature, one was conducted in Bosnia and Herzegovina (Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić, 2019), one in Turkey (Oskay, Can, & Camci, 2015), one in the United States (Lindau et al., 2012), and one in the United States and Spain concurrently (Lindau et al., 2016). Two of the studies utilized previously developed and validated questionnaires including the Female Sexual Function Index (FSFI) (Rosen et al., 2000) and the International Index Of Erectile Function 5-item (IIEF-5) (Rosen, Cappelleri, Smith, Lipsky & Pena, 1999), while the remaining two used investigator developed questionnaires (Lindau et al., 2012; Lindau et al., 2016). Table 2.4 compares the characteristics of the included CAD and MI studies including study designs, sample sizes, genders included, and measurements utilized.



Table 2. 4 - Characteristics among CAD and MI studies

	CAD ( <i>n</i> =7)	MI ( <i>n</i> =4)
Gender, No. (%)		
Men only	1 (14.3)	1 (25)
Women only	1 (14.3)	1 (25)
Both genders	5 (71.4)	2 (50)
Sample sizes, Mean		
Average	597	1,193
Range	20 - 1,664	45 - 2,802
Study design, No. (%)		
Cross-sectional	7 (100)	3 (75)
Longitudinal	0 (0)	1 (25)
Outcomes, No. (%)*		
Sexual activity	0 (0)	2 (50)
Sexual function	6 (85.7)	3 (75)
Sexual satisfaction	3 (42.9)	1 (25)
Measurements, No. (%)		
FSFI:	1 (14.3)	1 (25)
LSSQ:	1 (14.3)	-
RSS:	1 (14.3)	-
RDAS:	1 (14.3)	-
SHIM:	1 (14.3)	-
IIEF-5:	-	1 (25)
Investigator-developed:	2 (28.6)	2 (50)

FSFI: Female Sexual Function Index; IIEF-5: International Index of Erectile Function; LSSQ: Larson's Sexual Satisfaction Questionnaire; RDAS: Revised Dyadic Adjustment Scale; RSS: Relation and Sexuality Survey; SHIM: Sexual Health Inventory for Men.

\*Some studies measured more than one outcome

### **Sampling, Inclusion, and Exclusion**

The sampling techniques, diagnostic techniques, and inclusion criteria varied in the CAD literature. Three studies sampled from a retrospective cohort (Ghanbari Afra, Taghadosi, & Gilasi, 2015; Træen & Olsen, 2007; Rundblad et al., 2017). Four studies compared patients with CAD to a control population (Ghanbari Afra, Taghadosi, & Gilasi, 2015; Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007; Træen & Olsen, 2007; Justo et al., 2010). Studies applied various diagnostic techniques for inclusion. Four studies utilized selective coronary angiography with a threshold of either 40% occlusion or 50%-70% stenosis (Assari, Lankarani, Ahmadi, & Kazemi Saleh, 2014; Justo et al., 2010; Ghanbari Afra, Taghadosi, & Gilasi, 2015; Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007), while two studies screened using a diagnosis from the medical record (Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008; Rundblad et al., 2017). The remaining study did not provide diagnostic criteria (Træen & Olsen, 2007).

The selected studies also varied in exclusion criteria. Three studies did not provide any criteria (Rundblad et al., 2017; Træen & Olsen, 2007; Justo et al., 2010), while one excluded based on withdrawal from the study or hospitalization (Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008). Conversely, the remaining three studies applied extensive exclusion criteria including systemic and psychologic disease, comorbidity scores, and medications that could interfere with sexual health (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007; Ghanbari Afra, Taghadosi, & Gilasi, 2015; Assari, Lankarani, Ahmadi & Kazemi Saleh, 2014). The inclusion of a comorbidity score in these studies reduced potential confounders significantly. However, two studies required that patients be married to participate, which decreased generalizability to unpartnered individuals (Ghanbari Afra, Taghadosi, & Gilasi, 2015; Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008).

Study designs, sampling techniques, inclusion criteria, and exclusion criteria for the MI literature also varied across studies. Two studies applied active data collection, while the remaining two were secondary data analyses. The length of time that patients were surveyed post-MI were 1 month, three months, and longitudinally from 1 month to 1 year (Lindau et al., 2016). One study included a range of timepoints post-event from 1 month to more than one year (Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić, 2019). Three studies recruited patients who were hospitalized for an MI, while one study recruited patients admitted to an outpatient heart health clinic (Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić, 2019). Only one study provided their diagnostic criteria for MI, which consisted of an increased troponin above the 99th percentile (>18 ng/mL) with at least one symptom of ischemia or electrocardiogram changes (Lindau et al., 2016). One study did not provide exclusion criteria, while another only excluded based on presence of endocrine diseases and endocrine cancers (Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić, 2019). One study excluded patients who were incarcerated or had an MI from outside factors (Lindau et al., 2016). The most comprehensive exclusion criteria were for previous history of MI, presence of advanced disease, reproductive surgery, depression, or taking an antidepressant or hormone replacement (Oskay, Can, & Camci, 2015).

### **Coronary Artery Disease Literature**

The broad outcomes of function and satisfaction were theoretically defined and operationalized in different capacities across the selected CAD studies. Theoretical definitions of sexual function ranged from “a complex process coordinated by the neurological, vascular and endocrine systems” (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007, p. 236), to “distressing disturbances in the sexual response cycle” (Rundblad et al., 2017, p. 786), to specifically erectile

dysfunction defined as “the inability to attain and/or maintain penile erection sufficient for satisfactory sexual performance” (Justo et al., 2010, p. 41). Two studies did not provide a theoretical definition (Assari, Lankarani, Ahmadi, & Kazemi Saleh, 2014; Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008). Sexual function was operationalized as either severity of functional problems, or the percentage of individuals who experienced a subcomponent of sexual dysfunction (e.g. erectile dysfunction, dyspareunia). Satisfaction was operationalized as either overall degree of satisfaction, or the frequency of individuals satisfied with their sex lives. Two studies operationalized both sexual function and satisfaction concurrently (frequency and severity) (Træen & Olsen, 2007, Justo et al., 2010). Two studies measured a broad theoretical outcome of sexuality and sexual well-being, although one was operationalized through a narrow focus on satisfaction with sex life (Træen & Olsen, 2007), while the second was focused sex life, frequency of penetrative and non-penetrative intercourse, change in ability to orgasm, and sexual fear (Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008).

Sexual function was studied more frequently compared to satisfaction and aligned into two categories - frequency of sexual problems, and severity of sexual dysfunction. While both men and women experienced a broad range of functional issues across the continuum of the sexual response cycle, a higher percentage of men reported having at least one sexual issue compared to women (M: 53-57.7%; F: 31.3-43%) (Træen & Olsen, 2007; Rundblad et al., 2017). However, women experienced dysfunction more profoundly than men. The most common sexual problems were ejaculation difficulties (M: 91.4%), erectile difficulties (M: 74-85.8%), premature or delayed orgasm (M: 11-49%; F: 13-37.3%), arousal difficulties (M: 21.4-44%; F: 24-74%), lubrication difficulties (F: 15.5-37%), and pain with intercourse (F: 4-6%) (Træen & Olsen,

2007; Rundblad et al., 2017; Assari, Lankarani, Ahmadi, & Kazemi Saleh, 2014; Justo et al., 2010). When examining severity of sexual problems, women experienced more severe dysfunction compared to both men and healthy controls. Function scores in women with CAD were lower compared to healthy controls for desire, arousal, lubrication, orgasm, and pain with intercourse (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007), and were lower compared to men in overall function scores (Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008).

The confidence in these data is strengthened by the broad range of well validated measurements for sexual function with robust sampling techniques and inclusion criteria. The inclusion of comorbidity scoring prior to inclusion improved the internal validity of the study findings (Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008; Assari, Lankarani, Ahmadi, & Kazemi Saleh, 2014). However, the studies conducted by Træen and colleagues and Rundblad and colleagues implemented inadequately validated measurements without prior evidence of psychometric testing. In addition, Træen and Olsen did not provide any diagnostic criteria for inclusion from their sampled registry, which produces questions on whether the target population was adequately chosen. Furthermore, the authors also do not state whether the control registry was free of people without CAD, only stating that it was a representative sample (Træen & Olsen, p. 195).

Comparably to sexual function, sexual satisfaction was also aligned into severity and frequency. Studies measured the overall level of sexual satisfaction, and the percentage of participants satisfied with their overall sex life. Across the three articles included in this review, sexual satisfaction was consistently higher in patients despite reduced sexual function. Furthermore, sexual satisfaction scales were not statistically higher in women with CAD when

compared to healthy controls, which was observed across different measurements (FSFI and LSSQ) (Ghanbari Afra, Taghadosi, & Gilasi, 2015; Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007). In terms of frequencies, 47% of men and 64% of women older than 49 years of age were satisfied with their sex life, which was also comparable to a general population (Træen & Olsen, 2007).

The confidence in these results is strengthened as each study utilized different measurements yet all appreciated the same outcome. In addition, both studies utilized well validated measurements for sexual satisfaction, albeit with different topics and phrasing. Two studies applied rigorous sampling and exclusion criteria to control for potential confounding factors. However, one study reported significant differences between the CAD and control group in terms of gender, education, employment, medical history and use of cardiac medications, which affects the internal validity of the study findings (Ghanbari Afra, Taghadosi, & Gilasi, 2015). Furthermore, as with the sexual function measurements, Træen & Olsen did not use a validated tool for sexual satisfaction. Table 2.5 details the individual study characteristics including sample sizes, study designs, dependent variables, and measurements. Table 2.6 provides the key findings, strengths, and weaknesses of the included articles.

Table 2. 5 - Individual CAD study characteristics

Study	Sample	Study design	Dependent Variables	Measurement and validation
Assari, Lankarani, Ahmadi, & Kazemi Saleh, 2014	Sample size: 551 with CAD (155F, 396M). Average age: F:56.3, M: 57.2. Racial makeup was not reported.	Cross-sectional  (active data collection)	Sexual function	RDAS, 14 items, entire scale used.  Validation not provided.  RSS, 10 items, entire scale used.  Validated in target population (Tavallai et al., 2007).
Ghanbari Afra, Taghadosi, & Gilasi, 2015	Sample size: 150 with CAD (44F, 106M), 150 controls (83F, 67M). Average age and racial makeup were not reported.	Cross-sectional  (retrospective cohort)	Sexual satisfaction	LSSQ, 25 questions, entire scale used. Validated in study population (a=0.98) (Bahrami, Yaghoob zadeh, Sharif Nia, Soliemani, & Haghdoost, 2016).

Justo et al., 2010	Sample size: 112M with CAD, 12 controls. Average age: 74.6 in entire sample, 78.2 in controls. Racial makeup was not reported.	Cross-sectional (active data collection)	Sexual function	SHIM, 5 questions, entire scale used. Validation not provided.
Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007	Sample size: 20F with CAD, 15 controls. Average age: 38.2 in CAD, 37.9 in control. Racial makeup was not reported.	Cross-sectional (active data collection)	Sexual function, sexual satisfaction	FSFI, 19 questions, entire scale used. Validated in target population ( $\alpha=0.95$ ) (Oksuz & Malhan, 2006).
Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008	Sample size: 635 with CAD (171F, 464M). Average age: F: 56.3, M: 57.1. Racial makeup was not reported.	Cross-sectional (active data collection)	Sexual function	RDAS, 14 items, entire scale used. Validation not provided. RSS, 10 items, entire scale used. Validated in target population (Tavallaii et al., 2007).



Rundblad et al., 2017	Sample size: 1,036 with CAD (344F, 692M). Average age and racial makeup were not reported.	Cross-sectional (retrospective cohort)	Sexual function	Investigator developed questionnaires. Validation not provided.
Træen & Olsen, 2007	Sample size: 1,093 with CAD (612F, 481M). Average age and racial makeup were not reported.	Cross-sectional (retrospective cohort)	Sexual function, sexual satisfaction	Investigator developed questionnaires. Validation not provided.

CAD: Coronary artery disease; LSSQ: Larson's Sexual Satisfaction Questionnaire; FSFI: Female Sexual Function Index; RDAS: Revised Dyadic Adjustment Scale; RSS: Relation and Sexuality Survey; SHIM: Sexual Health Inventory for Men

Table 2. 6 - Sexual function and satisfaction in patients with CAD with study strengths and limitations

Authors	Effects on function and satisfaction	Strengths	Limitations
Assari, Lankarani, Ahmadi, & Kazemi Saleh, 2014	<p><b>Sexual function:</b> Women had more frequent issues with libido and orgasm compared to men. Arousal disorders scores were similar among men and women. In men, 91.4% had an ejaculation disorder, and 15.5% of women had lubrication difficulties.</p> <p>The study found a mild to moderate association between function and marital quality.</p>	<p>A broad multidimensional measurement of sexual function was applied in this study and fit the theoretical definitions. The study controlled for several key covariates including a comorbidity scale used during screening.</p>	<p>The study results may not be applicable to CAD participants outside of Israel. The study’s predictor analysis is limited given the cross-sectional nature of the data. Time since diagnosis of CAD was not reported. Other components of sexual health were not examined.</p>

<p>Ghanbari Afra, Taghadosi, &amp; Gilasi, 2015</p>	<p><b>Sexual satisfaction:</b> Sexual satisfaction scores were similar (101.5 compared to 101) even after controlling for confounding factors. 70.7% of patients with CAD and 64% of healthy subjects respectively were “highly satisfied” with their sexual relationships. There was a significant correlation with satisfaction and gender and use of cardiac medications.</p>	<p>The study recruited a large sample size and used a validated tool for sexual satisfaction. The use of diagnostics via an artery occlusion threshold strengthened the internal validity of the study. The study controlled for cardiac medications in their analysis which was an important confounder.</p>	<p>The study only measured sexual satisfaction and is missing additional components of sexual health. There were significant differences between the two groups in gender, education, employment, medical history, and use of medications. The study only recruited partnered individuals which limits the study’s external validity.</p>
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<p>Justo et al., 2010</p>	<p><b>Sexual function:</b> Erectile dysfunction was more common among men with CAD compared to men without CAD, although there was not a significant difference between the two groups (85.7 vs.72.7%). Age was the only variable associated with increased scores on the SHIM outside of cardiovascular risk factors, and severity of CAD.</p>	<p>The theoretical and operational definitions fit with the measurements chosen. The SHIM is a well validated instrument for sexual function. The study used angiography and a stenosis threshold to control for severity of CAD. The high compliance rate with the surveys mitigates bias in the sample. The study controlled for cardiac comorbidities and medications as well, which reduced issues of internal validity.</p>	<p>The SHIM only assesses erectile quality and as such other components of sexual function are absent, including orgasm, arousal, and desire. Exclusion criteria were not provided. Patients were interviewed after completing the survey, but the content of this survey was not disclosed, and it is unclear if it might have biased survey responses.</p>
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<p>Kaya, Yilmaz, Nurkalem, Ilktac, &amp; Karaman, 2007</p>	<p><b>Sexual function:</b> Women with CAD were diagnosed with female sexual dysfunction 60% of the time compared to healthy women (33%). The domain scores for arousal, lubrication, orgasm, and pain were all statistically decreased in women with CAD.</p> <p><b>Sexual satisfaction:</b> Satisfaction was not statistically significant between women with CAD and healthy controls (3.9 vs.4.8).</p>	<p>The FSFI is an appropriate, well validated multidimensional tool for sexual dysfunction. The theoretical and operational definitions fit with the measurement chosen. The study utilized a control group for comparison of function and satisfaction scores. The study measured both function and satisfaction within the same cohort.</p>	<p>The sample size was small, and the study was only conducted with female participants, limiting the translatability of the results across other genders. The only exclusion criteria were those who wanted to withdraw from the study or were re-hospitalized, which does not account for additional comorbid conditions or cardiac medications.</p>
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<p>Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, &amp; Naseri, 2008</p>	<p><b>Sexual function:</b> Men had significantly lower scores on sexual function (10.4 vs.11), sexual frequency (5.5 vs.6.5), and total RSS scores, indicating that men had better overall sexual function. Men had significantly higher sexual fear scores (0.8 vs.0.3). Total RSS scores were also correlated with marital quality.</p>	<p>The study used validated measurements with a robust sample size. The RSS measures function, activity, and fear, which is multidimensional. The addition of a comorbidity measurement upon recruitment to ensure that patients did not present with other comorbid conditions that could influence the sexual health data was valuable.</p>	<p>It is unclear how they diagnosed people with CAD or how the inclusion criteria were determined. The study was only limited to married individuals and the study acknowledges that cultural differences may impact the study's applicability to other populations. The RSS does not measure sexual satisfaction, which is a key component of sexual health. time since diagnosis of CAD and use of cardiac medications was not reported.</p>
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<p>Rundblad et al., 2017</p>	<p><b>Sexual function:</b> The total percentage of participants with sexual difficulties was 46.4%. The most common problem in men was arousal or orgasmic difficulties (45.9%), while in women desire was the most reported (23.4%). Furthermore, 21.2% of men and 12.3% of women had hesitancy towards having sex.</p>	<p>The study leveraged a large nationally representative dataset. The study captured frequencies of sexual function and fear which approached a comprehensive sexual health measurement. The collection of multiple chronic conditions outside of CAD allowed for interesting comparisons across diagnoses.</p>	<p>The study questionnaires were developed by the investigators with limited disclosure on how these measurements were validated. Sexual arousal and orgasm were assessed with one question but are separate components of the sexual response cycle. The study reported a response rate of 51% for men and 41.2% for women which could indicate response bias or selection bias.</p>
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<p>Træen &amp; Olsen, 2007</p>	<p><b>Sexual function:</b> More patients with CAD had sexual issues (26%) compared to healthy controls (11%). However, the healthy controls had greater difficulty achieving orgasm than the cardiac group.</p> <p><b>Sexual satisfaction:</b> A total of 66% of healthy controls reported being satisfied with their sex life while this was 53% in the CAD group.</p>	<p>The study was conducted in a large nationally representative sample using a multidimensional measurement of sexual health. The study measured both function and satisfaction within the same cohort which allowed for comparison across the two components of sexual health.</p>	<p>While somewhat multidimensional, the measurements used were not previously validated. Patients had to be enrolled in a heart or lung registry before their data could be included in the study, but this process was not discussed. There were statistically significant differences between the population and control groups at the beginning of the survey. This means that changes in prevalence of sexual problems in the Norwegian population may have occurred between 1997 and 2005.</p>
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CAD: Coronary artery disease; LSSQ: Larson's Sexual Satisfaction Questionnaire; FSFI: Female Sexual Function Index; RDAS: Revised Dyadic Adjustment Scale; RSS: Relation and Sexuality Survey; SHIM: Sexual Health Inventory for Men



## **Myocardial Infarction Literature**

While sexual function was the most common outcome, none of the included studies provided a theoretical definition. Sexual activity was the second most common outcome and was theoretically defined as “any mutually voluntary activity with another person that involves sexual contact, whether or not intercourse or orgasm occurs” in two studies (Lindau et al., 2012, p. 1440; Lindau et al., 2016, p. 756). Sexual satisfaction was also not theoretically defined in the one study it was measured in. Similarly to the CAD literature, sexual function was operationalized as either the percentage of patients reporting a specific problem (Lindau et al., 2016), or severity scores of a particular function problem (Oskay, Can, & Camci, 2015; Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić, 2019). In the study of only men, sexual function was only operationalized as erectile function (Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić, 2019). Sexual activity was operationalized as the presence of any sexual activity in the time since their MI (either one month or one year post event).

Sexual activity was studied in half of the selected articles. After an MI, 34.6-73% of women and 46.8-85% of men were sexually active (Lindau et al., 2012; Lindau et al., 2016). Most sexually active participants were engaging at a frequency of 2-3 times per month or less (Lindau et al., 2016). Among patients who were sexually active before their event, 48% of men and 59% of women reduced sexual activity post-MI, and men were more likely than women to have resumed sexual activity by one month (Lindau et al., 2012; Lindau et al., 2016). Approximately 13% of patients never returned to sexual activity post-event (Lindau et al., 2016). Only 9.1% of men and 4.0% women who were previously inactive attempted sexual activity in the year after their MI (Lindau et al., 2012). Based on retrospective data collection on pre-MI sexual activity rates, predictors of return to sexual activity in men included no discharge

instructions, no discussion with a physician, and lower physical function (Lindau et al., 2012). There were conflicting findings surrounding age as a predictor for sexual activity; age was reported as a significant predictor of sexual activity resumption in the Lindau 2016 article but was not significant in the Lindau 2012 article. This may have been due to the different population ages in each study.

Three articles measured sexual function, with one reporting severity of sexual function problems and two reporting frequency of problems. The sexual problems reported were lack of interest (F: 40%, M: 19%); inability to climax (F: 19%, M: 13%); experienced orgasm too quickly (M: 14%); trouble with erection (M: 22%), or lubrication (F: 22%), or experienced physical pain (F: 10%, M: 4%). Regarding erection difficulties, one study found that 77.1% of patients with MI reported at least some erectile dysfunction, compared to 51% in the control group (Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić, 2019). The overall prevalence of sexual dysfunction according to the criteria of the FSFI was 75.6% (Oskay, Can, & Camci, 2015), compared to a separate study which found that 59% of women and 46% of men reporting at least one sexual problem (Lindau et al., 2016). The total FSFI scores were  $16.41 \pm 8.04$ , compared to  $23.13 \pm 3.95$  in healthy controls, out of a total score of 36 points. The domains of desire, lubrication, arousal, orgasm, and pain were all decreased in the MI group compared to healthy controls, indicating worse sexual function. Interestingly, 88.4 % of patients were worried about another MI upon resuming sexual activity, which was also present in 58% of the patients' husbands (Oskay, Can, & Camci, 2015).

Only one article measured sexual satisfaction using a validated measure. Satisfaction was the one domain that remained high in the MI population as scores were  $4.03 \pm 1.13$  compared to  $4.11 \pm 1.07$  in the control group (Oskay, Can, & Camci, 2015). There were no statistical

significances between the two groups. Both satisfaction scores approached the maximum score of 6 for the scale. In addition, Lindau et al., (2016) found that 85.8% of women and 88.6% of men still felt sexual satisfaction with their significant other despite the decreased frequency; however, the operationalization of this outcome was not provided.

The strengths of the MI literature were the strong number of large-sample, multi-site studies. Some studies used well validated measurements, including the FSFI and the IIEF-5. However, as seen in the CAD literature, many studies did not define or operationalize their outcomes using validated measures, and most studies did not apply a multidimensional perspective to sexual health. The operationalization of sexual activity within the articles was often based over an entire year, which reduced sensitivity on when individuals returned to intercourse. Definitions of “early resumer” and “late resumer” for activity used in the Lindau articles do not possess enough capacity to determine what a normal or expected timeframe would be for resumption of sexual activity. As such, the attempts to estimate predictors of sexual activity is hampered by this vague outcome variable. Furthermore, these studies only predicted resumption of sexual activity, without considering sexual function or satisfaction with sex, which are important variables to consider. One study excluded patients older than 55 years of age which only constitutes 20% of all patients post-MI, and as such limited applicability to the majority of post-MI patients. Lastly, the data are also hindered on reliance on retrospective data collection over a year, which introduces a significant risk of recall bias. Table 2.7 presents the individual study characteristics of the MI articles including sample sizes, study designs, dependent variables, and measurements utilized. Table 2.8 provides the pertinent sexual health findings from each article, along with the strengths and limitations.

Table 2. 7 - Individual MI study characteristics

Study	Sample	Study design	Dependent Variable	Measurement and validation
Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić, 2019	Sample size: 48M post-MI, 51 controls. Average age: 57.1 in MI sample, 55.2 in controls. Racial makeup was not reported.	Cross-sectional (active data collection)	Sexual function	IIEF, 5 scale version used entire scale used. Validation not provided.
Lindau et al., 2012	Sample size: 1,879 post-MI (605F, 1,274M). Average age: F: 61.1, M: 58.6. Racial makeup: 71% white, 21.6% black, 7.4% other.	Cross-sectional (secondary analysis)	Sexual activity	Investigator developed questionnaires. Validation not provided.
Lindau et al., 2016	Sample size: 2,802 post-MI (1889F, 913M). Median age: F: 49, M: 48. Racial makeup: 79.6% white, 14.7% black, 6.7% other.	Longitudinal (secondary analysis)	Sexual activity, Sexual function	Investigator developed questionnaires. Validation not provided.

Oskay, Can, & Camci, 2015	Sample size: 45F post-MI, 50 controls. Average age: 62.7 in MI sample, 63.68 in controls. Racial makeup was not reported.	Cross-sectional (active data collection)	Sexual function, sexual satisfaction	FSFI, 19 questions, entire scale used. Validated in target population ( $\alpha=0.95$ ) (Oksuz & Malhan, 2006).
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FSFI: Female Sexual Function Index; MI: Myocardial Infarction; IIEF-5: International Index of Erectile Function; ED: Erectile dysfunction

Table 2. 8 - Sexual function and satisfaction in patients with MI with study strengths and limitations

Authors	Effects on function and satisfaction	Strengths	Limitations
Hodžić, Durek, Begić, Šabanović Bajramović, & Durak- Nalbantić, 2019	<b>Function:</b> Approximately 77% of patients with MI reported at least some ED, compared to 51% in the control group. In the post-MI group, 33.33% had mild ED, 20.83% had mild to moderate ED, 12.5% had moderate, and 10.42% had severe ED.	The study applied a strong measurement of sexual function, though it is only focused on erectile function. The use of a control group allowed comparisons to a health population.	Validation for the IIEF in a post-MI population was not provided. Collapsing the scores on the IIEF into categories (i.e. without ED, mild ED, moderate ED) masks the broad range of scores post-event, which are discussed minimally in the manuscript. The study did not appear to control for any confounding variables. The theoretical definition of sexual function was not provided.

<p>Lindau et al., 2012</p>	<p><b>Activity:</b> Patients who were sexually active before their MI, 48% of men and 59% of women engaged in sexual activity at a lower frequency, and 11% of men and 13 of women did not engage in sexual activity at all.</p> <p>Predictors of better sexual activity included having a discussion with a physician, having a partner, and being male.</p>	<p>The study recruited and measured a large sample of men and women.</p> <p>Oversampling women helped to answer some understudied questions surrounding activity in women post-MI. The study was also able to measure individuals of different races, which are also understudied.</p> <p>Capturing of depression allowed for controlling by some psychological conditions.</p>	<p>Asking patients to rate sexual activity over a period of 12 months severely hampers sensitivity of the data as it raises questions on how early or late patients actually resumed activity. All questions were investigator developed and are not validated or psychometrically tested. The inclusion criteria for the sample used in this secondary analysis was not discussed. Pre-MI sexual activity data was collected retrospectively which introduces recall bias.</p>
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<p>Lindau et al., 2016</p>	<p><b>Activity:</b> A total of 13% of patients never returned to sexual activity post-event. However, while patients decreased their overall frequency, 85% of men and 72.6% of women were still sexually active after 1 year. In addition, 85.8% of women and 88.6% of men still felt sexual satisfaction with their significant other despite the decreased frequency.</p> <p><b>Function:</b> The sexual problems reported were lack of interest (Female: 40%, Male: 19%); inability to climax (Female: 19%, Male: 13%); experienced orgasm too quickly (Male: 14%); trouble with erection (Male: 22%), or lubrication (Female: 22%), or experienced physical pain (Female: 10%, Male: 4%).</p>	<p>The study recruited and measured a large sample of men and women. The study oversampled women compared to men which aims to answer understudied questions regarding sexual function and activity. The study was able to measure individuals of different races. The study captured a wide range of sexual function problems in their survey, though they only measured prevalence rather than severity.</p>	<p>The capturing of frequency of sexual problems produces questions about the actual severity of those problems. The questions were investigator developed and their psychometric properties were not provided. The exclusion of patients older than 55 years of age limits applicability to older populations. The study classifies expected resumption of sexual activity for its analysis but does not provide any justification or evidence for their presented operationalization.</p>
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<p>Oskay, Can, &amp; Camci, 2015</p>	<p><b>Function:</b> Patients post-MI had statistically significantly lower scores on all subscales of the FSFI except for pain (<math>16.41 \pm 8.04</math> vs. <math>23.13 \pm 3.95</math>). Approximately 88% of patients were worried about another MI.</p> <p><b>Satisfaction:</b> Satisfaction scores were not statistically significant between patients post-MI and healthy controls (<math>4.03 \pm 1.13</math> vs. <math>4.11 \pm 1.07</math>).</p>	<p>The study utilized the FSFI, which is a strong multidimensional measurement of sexual function and satisfaction. The study compared the findings to healthy controls, which reduced concerns regarding internal validity. The study controlled for several covariates including depression and comorbidities.</p>	<p>The study required participants to be married and have a regular sex life before taking the surveys, but a “regular” sex life is not defined by the study authors. Patients were asked about worries regarding their sex life, but these questions were not validated. The researcher provided guidance during survey collection which may have introduced bias or influenced respondents. Theoretical definition of sexual function and satisfaction was not provided.</p>
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FSFI: Female Sexual Function Index; MI: Myocardial Infarction; IIEF-5: International Index of Erectile Function; ED: Erectile dysfunction

## **Discussion**

In this limited set of studies, a diverse range of sexual function issues were reported by patients with CAD and MI including orgasmic, erectile, arousal, and lubrication difficulties, in rates as high as 80-90%. The selected MI and CAD studies examined a constellation of outcomes that were operationally defined with numerous measures, most consistent with the theoretical definitions but not all adequately validated. Only three studies across the CAD and MI literature measured function and satisfaction concurrently. The overall dearth of literature in this population carries important implications for treatment and intervention, particularly given the large number of CAD and post-MI patients who experience sexual health issues. Given that sexual dysfunction and dissatisfaction is frequently seen in other chronic illness populations but receive considerably more study (Basson, Rees, Wang, Montejo, & Incrocci, 2010), more research is needed in CAD and post-MI populations to create a complete representation of sexual health that can be addressed with subsequent intervention.

While men reported sexual problems more frequently, limited evidence suggests that women with CAD experience dysfunction more profoundly than men. However, despite marked sexual dysfunction, a consistent finding was that sexual satisfaction remained high in both CAD and MI populations and was comparable to healthy controls. This may indicate that in coping with CAD or MI, patients redefine new expectations and perceptions of sexual health while their physical sexual function worsens. Previous literature has found that coping strategies were pivotal for maintenance of general well-being with adjusting to cardiovascular disease, and so this could also apply to maintenance of sexual health issues (Mahrer-Imhof, Hoffmann, & Froelicher, 2007).

Among all the outcomes in the MI literature, sexual activity was studied the most often. Lindau et al. (2016) reported that despite a significant decrease in sexual activity at one month after MI, sexual activity rates rebounded in the timeframe between one month and one year for both men and women. In an earlier study, Lindau et al. (2012) also reported that among patients who had been sexually active, both men and women reported less frequent sexual activity in the year post-event. Based on the evidence presented above, it can be reasonably concluded that sexual activity is decreased or not resumed at all in 50-60% of previously sexually active patients following an MI, and that the most common sexual health problems include erectile dysfunction in men, and a general loss of interest and desire in both genders.

While some predictors can be hypothesized from the evidence presented, the lack of appropriate statistical methods in the current literature precludes definitively identifying these important variables. While there was stronger evidence of predictors in the MI literature, the two articles that were methodologically rigorous enough to identify predictors only targeted sexual activity, and relied on retrospective data collection. While there is one previously conducted study that has modeled predictors of function and activity, the study was conducted with a mixture of MI, heart failure, angina, acute coronary syndrome, peripheral bypass, pacemaker implantation, implantable cardiac defibrillator, and coronary bypass patients, and also included patients with emphysema and stroke, while declining to separate by cardiac condition and so results were not transferrable to post-MI patients (Mosack, Hill, & Steinke, 2015). This study was not included in this review given its lack of cardiac condition-specific results.

Despite the identified evidence, there were several methodologic inadequacies in the available MI and CAD literature. Seven of 11 studies provided unclear or unreported diagnostic

and sampling procedures, and four studies utilized poorly validated measurements. Overall, studies overwhelmingly targeted specific outcomes of sexual health, with few focusing on a broad biopsychosocial representation. An explanation for this could be that sexual function is a complex multidimensional construct, and as such it remains an empirical challenge to study. As a result, synthesizing the impact of MI or CAD on sexual function is made difficult when multiple different measurements are used to operationalize the same theoretical outcome. This review highlights the complex operationalization of sexual function into multiple components that are not consistent across studies. This was made evident by the six different measurements that were used for individual components of sexual function and satisfaction, with only two studies capturing a complete multidimensional representation using the FSFI (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007; Oskay, Can, & Camci, 2015). Furthermore, studies utilizing investigator developed questionnaires were unclear on how they were developed and did not provide evidence for their validity or reliability (Træen & Olson, 2007; Rundblad et al., 2017; Lindau et al., 2012; Lindau et al., 2016).

This review also revealed numerous gaps in the current literature alongside the general observation of how little robust research has been published in both areas. Overall, the studies identified were primarily descriptive and cross-sectional. In addition, no study examined patients past one year, so it is uncertain how these trends could change over a longer timeframe. The lack of data on racial and sexual minorities in the CAD literature indicate that additional studies with diverse populations would be needed to stratify by sexual orientation, sexual identity, and race. Second, five studies excluded non-married individuals, citing their sample's culturally based reluctance to disclose sexual health information. Cultural differences in expression of sexuality may provide important direction when counseling, assessing, and aiding patients with sexual

issues, so further research is indicated to provide culturally sensitive sexual care to these populations (Goossens et al., 2011). Lastly, few studies compared patients post-MI to a general healthy population, which reduces the internal validity of those findings.

Overall, the literature provided a limited definition of sexual health, particularly in patients post-MI. This indicates that the landscape of sexual health in this population remains fragmented and under-supported. In summary, the key gaps identified from this review of the literature are the lack of a consistent definition of “sexual health” in this population, little consensus on the definition of sexual health components, the absence of robust MI-specific predictor research, and a lack of longitudinal data on sexual health changes over time, particularly at a short term-post discharge. The absence of robust longitudinal models is a key gap to address in order to advance the state of the science. Thus, the next step is to apply a prospective longitudinal study to both identify sexual health over time and to evaluate modifiable predictors of positive and negative sexual health.

### **Conceptual Framework**

The results of the literature review identified a need for multidimensional longitudinal sexual health data in the post-MI population. Expanding the current understanding of the relationship between MI and sexual health is vital to improving patient-centered care and HRQOL. As such, a conceptual framework was developed to visualize the components of sexual health that are affected by an MI in the context of relevant moderators and mediators, while also applying a longitudinal lens.

The conceptual framework that served as the basis for this dissertation research was the International Classification of Functioning, Disability, and Health (ICF). The ICF was introduced by the World Health Organization (WHO) in 2001 after extensive testing across multiple

disciplines to provide a standard tool for measuring health and disability across a variety of conditions. The model serves as a conceptual basis for the definition and measurement of any pathologic or physical disability and is operationalized to apply across the entire lifespan (WHO, 2001, p. 7). The ICF model creates a dynamic interaction between a person's health condition by providing a research tool for measuring outcomes and quality of life, with both environmental factors and personal factors moderating outcomes. The ICF was created to provide a scientific basis for understanding and studying both health and disease, and so is appropriate for this application to patients post-MI (WHO, 2001, p. 5). To date, the ICF has not been used in the context of sexual health with cardiac patients, but is applicable given the original model was designed to capture many disease-specific effects on function and disability (WHO, 2001, p. 5; McDougall, Wright, and Rosenbaum, 2010). Thus, a theory synthesis was conducted to explicate the key concepts, external and internal drivers, and visualize the overall effects of MI on sexual health.

The aim of a synthesis is to construct a theory of interrelated ideas from available evidence, integrating concepts and statements into an organized network (Walker & Avant, p. 140). The steps of theory synthesis are as follows: 1) to specify the focal concepts as the foundation for the synthesized theory; 2) review the literature to identify factors related to the focal concepts; and 3) organize concepts and statements into a representation of the phenomena of interest that is both efficient and detailed (Walker & Avant, p. 140). For this synthesis, the ICF is applied as the foundation for extrapolating the relationships between sexual health and MI. An MI represents a critical event that produces changes to sexual health, and as such will represent the health condition at the top of the model. From this, revised versions of the ICF model from other literature - and an additional sexual health conceptual model - are integrated to

fully represent the concepts relevant in post-MI sexual health. Table 2.9 details the steps of a theory synthesis as outlined by Walker and Avant.

Table 2. 9 - Steps of a theory synthesis (Walker & Avant, 2011)

Step	Description	Page
1	Designation of a topic of interest	52
2	Identify the factors related to focal concepts	55
3	Create and visualize the relationships among variables and focal concepts (moderators and mediators)	59
4	Construct an integrated representation	62

### **Specification of Focal Concepts**

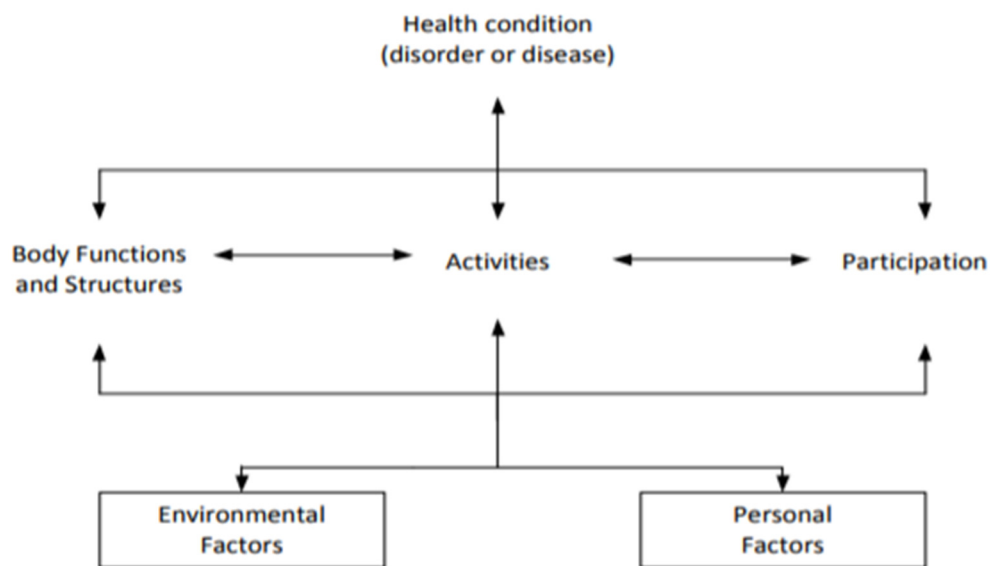
According to Walker and Avant, a theory synthesis begins with designating a topic of interest (Walker & Avant, p. 140). In this exercise, the topic of interest is conceptualizing the effects of MI on sexual health. The first step is to define the focal concepts germane to the parent model or theory. The focal concepts from the original ICF are “body functions and structures” “activities” and “participation” (WHO, 2001, see figure 2.3), which are explained in greater detail below. First, the general model is briefly discussed, then the model’s applicability to MI-induced sexual dysfunction is elaborated.

### **International Classification of Functioning, Disability and Health Model**

The ICF model is appropriate for a focus on sexual health given that individuals are sexual beings throughout the lifespan, even into older age (WHO, 2001, p. 7). First, the basic premise of the original ICF model was intentionally kept neutral to capture a comprehensive spectrum of the effects of MI on sexual functioning (WHO, 2001, p. 8). This is applicable

because treatment for sexual dysfunction post-MI means identifying both positive and negative influencers of sexual health to be reinforced or addressed, respectively. The ICF also details an interaction between function and disability, conceptualized as collective terms stemming from a biological, individual, and social perspective.

Figure 2. 3 - Original ICF model and components (WHO, 2001) p. 18



### **Body Functions and Structures**

The components of “body functions and structures” are classified according to their response to a disease. Function is defined in a broad capacity, as the “...positive or neutral aspects of the interaction between a person’s health condition and that individual’s contextual factors and environmental factors” (WHO, 2001, p. 8). Body functions and structures encompass



anatomical systems including mental, sensory, speech, cardiovascular, immunological, respiratory, neurological, musculoskeletal, and integumentary. Importantly, they also include reproductive systems, which are especially relevant given the subject matter of sexual health. In this synthesis exercise, function was given more attention than structure. This is because the original ICF operationalizes structure loss in terms of total or partial absence of body parts, such as loss of limbs, which are less relevant in this population (WHO, 2001, p. 24).

### **Activities and Participation**

The original conceptual model groups “activities and participation” into one domain. This encompasses how patients learn and apply knowledge, communication, general mobility, and self-care for participation in major and minor life endeavors (WHO, 2001). This domain also includes interpersonal interactions and relationships in community, social, and civic life (WHO, 2001).

### **Personal and Environmental Factors**

The “personal and environmental factors” play an important role in the ICF model and may vary from patient to patient (WHO, 2001). They are external to the individual and can exert either a positive or negative influence on the components of function, activities, and participation. Personal factors can include age, sex, marital status, number of children, occupation, upbringing, culture, and religious beliefs (WHO, 2001). This also includes behavioral factors such as coping styles, behavioral patterns, gender roles, and the individual’s psychological makeup (WHO, 2001, p. 17). These factors represent the complete background of the individual at the personal level, separate from the health condition or health state (WHO, 2001).

The environmental factors can include products, technologies, relationships, attitudes, services, systems, and policies (WHO, 2001). In addition, they are further divided into the immediate environment factors, which includes the home, workplace, or school, while the societal factors include higher-level systems such as community and government networks. (WHO, 2001).

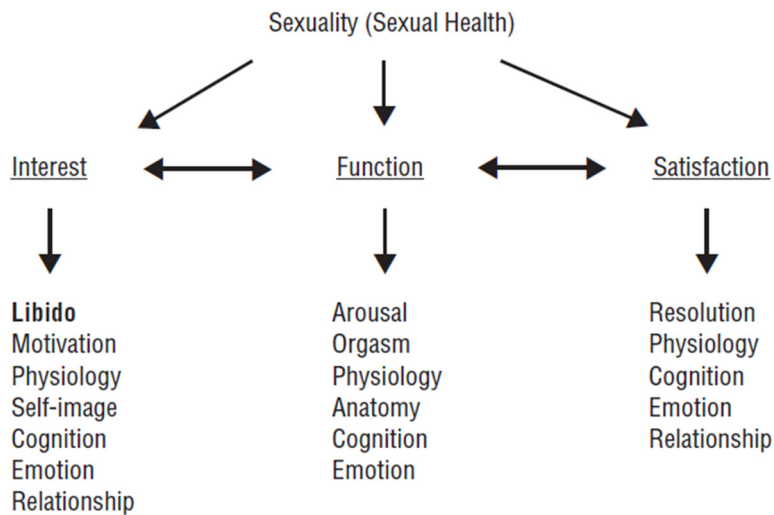
### **Factors Related to Focal Concepts**

The second step in a theory synthesis is to identify the related factors, which involves reviewing the literature to identify the key focal points or concepts in the original framework (Walker & Avant, p. 145). First, the construct of sexual health is elaborated upon in greater detail. The World Health Organization defines sexual health as “a state of physical, emotional, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination, and violence. For sexual health to be attained and maintained, the sexual rights of all persons must be respected, protected and fulfilled.” (World Health Organization (WHO), 2017 p. 3).

A review of outside conceptual models published in the literature was conducted to identify previously created representations of sexual health. In breast cancer, Barton and colleagues (2004) detail a schematic depicting the three major components of sexual health and sexuality (p. 600). The concepts of function, interest and satisfaction influence each other and consist of their own sub-components. Interest is made up of libido, motivation, physiology, self-image, cognition, emotion, and relationship. Function consists of arousal, orgasm, physiology, anatomy, cognition, and emotion. Lastly, satisfaction is made up of resolution, physiology,

cognition, emotion, and relationship. This conceptualization represents a multidimensional construct of sexual health, which was incorporated into the resulting conceptual framework in the subsequent paragraphs. Figure 2.4 details this schematic of sexuality and sexual functioning (Barton, Wilwerding, Carpenter, & Loprinzi, 2004).

Figure 2. 4 - Schematic of Concepts Involved in Sexuality and Sexual Functioning (Barton, Wilwerding, Carpenter, & Loprinzi, 2004)



The first focal concept of the ICF is body functions, defined as the “physiological and psychological functions of body systems” (WHO, 2001, p. 12). There are also impairments to body functions, defined as the “problems that stem from a significant loss or deviation from the norm” (WHO, 2001 p. 12). The presented body function definitions are applicable to sexual health in how physiological damage from MI affects the completion or initiation of the sexual response cycle. The functional changes experienced by patients post-MI are conceptually similar to how “reproductive systems” are impacted from a disease or condition as described in the original ICF (WHO, 2001, p. 29). There is a growing body of evidence on the effect of MI on sexual function that directly impairs the completion of this cycle, matching the conceptual

definition in the ICF. Latent class analysis of sexual dysfunction has found groupings of symptoms in sexual arousal, desire, and pain, which are all relevant phenomena observed in post-MI patients (Laumann, Paik, & Rosen, 1999). Erectile dysfunction and vaginal dryness are common symptoms in patients post-MI that affects sexual organs and limits their function (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007). Furthermore, cross-sectional studies have reported that sexual function scores, including orgasm and lubrication, are lower in women with MI compared with control groups (Oskay, Can, & Camci, 2015).

One key psychological component of sexual health is sexual fear. There is a growing body of evidence on sexual fear as a common complication of MI development and has been documented in as high as 88% of women and in 58% of their husbands (Oskay, Can, & Camci, 2015). In another study, fear of resuming sexual activity was expressed by 51% of patients and 44% of partners, and negatively impacted sexual activity (Eyada & Atwa, 2007). Patients post-MI are fearful about returning to sexual activity, and desire discussion with providers about the topic (Kaya et al, 2007). However, only 3% of men and 18% of women are adequately educated prior to discharge (Bedell, Duperval, & Goldberg, 2002). Furthermore, a cross-sectional study of 302 patients across 3 separate hospital samples found that communication issues stemmed from a lack of information from providers, and a reduced shared intimacy between the individual and their partner (Mosack & Steinke, 2009).

The second focal concept, activity, is defined in the original ICF model as “the execution of a task or action by an individual... and the activity limitations they experience” (WHO, 2001 p. 29). This is appropriate to sexual health given that sexual activity constitutes a primary act of sexual expression taken either individually or with one or more partners. Sexual activity can also encompass a variety of activities including penetrative and non-penetrative intercourse such as

masturbation, fondling, kissing, and hugging (Steinke et al., 2013). Sexual activity has been the dependent variable in several previous sexual health studies with patients post-MI. A secondary data analysis conducted in the United States and Spain found that 48% of men and 59% of women had reduced sexual activity post-MI, while 11% of men and 13% of women never resumed sexual activity in the following year (Lindau et al., 2014).

The third focal concept of participation is defined as “involvement in a life situation” ingrained in individual, community, social, and civic life (WHO, 2001). This can include interpersonal interactions, relationships, learning, or applying knowledge (WHO, 2001, p. 14). Participation in the context of sexual health was conceptualized as sexual satisfaction, which ties into emotional involvement of the individual as a sexual being. The literature has indicated that partnered individuals retain high satisfaction, but that MI can cause poorer dyadic satisfaction and overall marital relations (Kazemi Saleh, Pishgou, Farrokhi, Fotros, & Assari, 2008). A second cross-sectional study of 462 men and women found that both groups reported less satisfaction with sexual activity post-MI, directly related to perceived health pre-event compared to post-event (Drory, Kravetz, & Weingarten, 2000).

### **Personal and Environmental Factors**

The contextual factors of person and environment in the ICF act as both moderators and mediators of the relationship between MI development and sexual health. In the chronic disease literature, the ICF model has been modified to further detail the outside influences on quality of life at both the internal and external level (Rivers et al., 2017). Sexual health components are also influenced by moderators, which include personal and environmental factors. The moderators and mediators in this conceptual model are explained in further detail.

Personal factors include age, race, gender, education, employment status, MI severity, partner status, and comorbidities. Pertinent cardiac comorbidities include cancer, diabetes, chronic obstructive pulmonary disease (COPD), and neurologic disorders. There is a growing body of evidence to suggest that these comorbidities can also negatively impact sexual function through either impaired genital response from cancer treatment and hormonal changes (Basson, Rees, Wang, Montejo, & Incrocci, 2010; Westermann, Wolford, & Krychman, 2016), the physiological and psychologic challenges of breathlessness that comes with COPD (Vincent & Singh, 2007), the damage to the vasculature caused by diabetes (Steinke, Mosack, & Hill, 2014), and the psychological and functional deficits from neurological impairment such as multiple sclerosis, spinal cord injury, or stroke (Basson, Rees, Wang, Montejo, & Incrocci, 2010). MI severity can have varying effects on patient outcomes depending on if their MI was STEMI or NSTEMI, or was classified as type 1 or type 2. Environmental factors exist outside the individual but could nonetheless moderate the relationship between an MI and sexual health. One such factor includes rehabilitation status. Cardiac rehabilitation is an intervention that approximately half of post-MI patients undergo upon discharge from the hospital (Fang, Ayala, Luncheon, Ritchey, & Loustalot, 2017). Rehabilitation may improve functional status and tolerance, in turn influencing tolerance for sexual activity.

### **Moderators**

Based on the currently available literature, several factors were considered as moderators of the relationship between MI and sexual function. These included depression, anxiety, familial support, relationship dynamics, religion, spirituality, and cultural backgrounds. These act as moderators of the strength and/or direction of the association between MI and sexual health (Bennett, 2000). They are split between personal and environmental factors in the final model,

though some listed above were not included in the final model as elaborated below (see figure 2.5).

First, depression is common in patients post-MI and can play a major role in recovery and subsequently impact participation in sexual activity (Eyada & Atwa, 2007). Depression rates are higher in post-MI patients (35%) compared to general populations (9%) (Daniel et al., 2018). Given that depression was identified in 20% of 10,785 MI patients over eight studies, depression could also play a key role in sexual satisfaction, as depression reduces desire for many activities, including sexual activity. A cohort study of 493 patients found that depressive symptoms played a significant factor in the relationships between sexual function and quality of life (Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). An additional systematic review and meta-analysis also found a bidirectional relationship between sexual dysfunction and depression (Atlantis & Sullivan, 2012).

Another important psychosomatic symptom that often presents alongside depression is anxiety. Like depression, anxiety rates in post-MI patients are larger than a general population. A recent cohort study of 99 reported that of 37% of patients post-MI had anxiety, which was considerably larger compared to the 7% rates among healthy participants (Daniel et al., 2018). Additional studies have reported that anxiety can persist upwards of five months post recovery for MI (Steinke & Swan, 2004). Previous studies have found associations between anxiety and sexual function. In a cohort study of 64 patients, sexual satisfaction was inversely related to anxiety with an odds ratio of -2, and sexual satisfaction also accounted for 42% of the variance in anxiety scores (Steinke & Wright, 2006).

Third is familial support, which may play a role in how individuals rely on family members outside of their spouse for management of stressful situations. Social and familial

support is directly related to self-efficacy and hopelessness following MI (Garcia, Denardin Budó, Schwartz, Simon, & da Silva, 2015; Smallheer & Dietrich, 2019). A cohort study found that social support played a key role in coping strategies with post-MI anxiety and this could extend to sexual function (Son, Friedmann, Thomas, & Son, 2016).

Some moderators were not included in this conceptual model due to a lack of concrete evidence or a well validated measurement. Cultural backgrounds have been studied in both cardiac and post-MI patients and are known to influence how patients discuss sexual concerns with providers (Goossens et al., 2011; Altıok & Yılmaz, 2011). In addition, patient spirituality has been found to play a role in improving quality of life in patients post-MI, and so may also exhibit an effect on management of sexual dysfunction (Wachelder, Moulaert, van Heugten, Gorgels, Wade, & Verbunt, 2016). In cardiac illness, religiosity or spirituality was linked with improved HRQOL and illness adjustment and so may be an important interaction to study in patients post-MI (Trevino & McConnell, 2014). However, measuring and quantifying cultural, religious, or spiritual preferences may be too complicated and nuanced, and the evidence as a whole remains underdeveloped. Community and employment support (outside of employment status) were also not measured as their effects are difficult to capture due to the broad range of possible responses and the lack of robust measurements. Furthermore, relationship dynamics assumes the presence of a partner, and may not be the case for single patients, and so was not directly measured as a predictor, although marital status was collected as a covariate. Lastly, the influence of the medical professional or hospital network was not explored due to the lack of robust surveys.



## **Mediators**

One variable was conceptualized as a mediator of the relationship between MI and sexual function: utilization of coping styles. The methods through which an individual adjusts and copes with life events is also an internal pathway for which sexual health adjusts after an event. There is some preliminary evidence to support the effect of coping strategies by regulating distress and mediating the changes in well-being post event (Kroemeke, 2016). For example, a longitudinal study of 460 patients post-MI found that education, anxiety, and social support also played key roles in coping strategies which may in turn affect how sexual dysfunction is managed by the patient (Son, Friedmann, Thomas, & Son, 2016).

## **Construction of an Integrated Representation**

The third step in a theory synthesis is to create and visualize the relationships among variables and focal concepts (Walker & Avant, p. 145). First, the overall relationship is described. The event of MI causes changes to a multidimensional construct of sexual health and is as such placed at the top of the model in similar fashion to the ICF. Personal factors that are unique to the individual and outside factors related to the environment both moderated the relationship between the disease progression and the outcome of sexual health. Coping was depicted as a mediator along the trajectory from MI to sexual health. Sexual health was split into the concepts of physical, psychological, and social as organized by the ICF model and Barton, Wilwerding, Carpenter, & Loprinzi (2004).

Second, the nature of each relationship in the proposed model is described in further detail. The illness condition (MI) was placed at the top of the model to designate a unidirectional relationship with the outcome of sexual health. The ICF model places the external factors outside of the system, playing a unidirectional influence on the transition process. In this synthesis, these

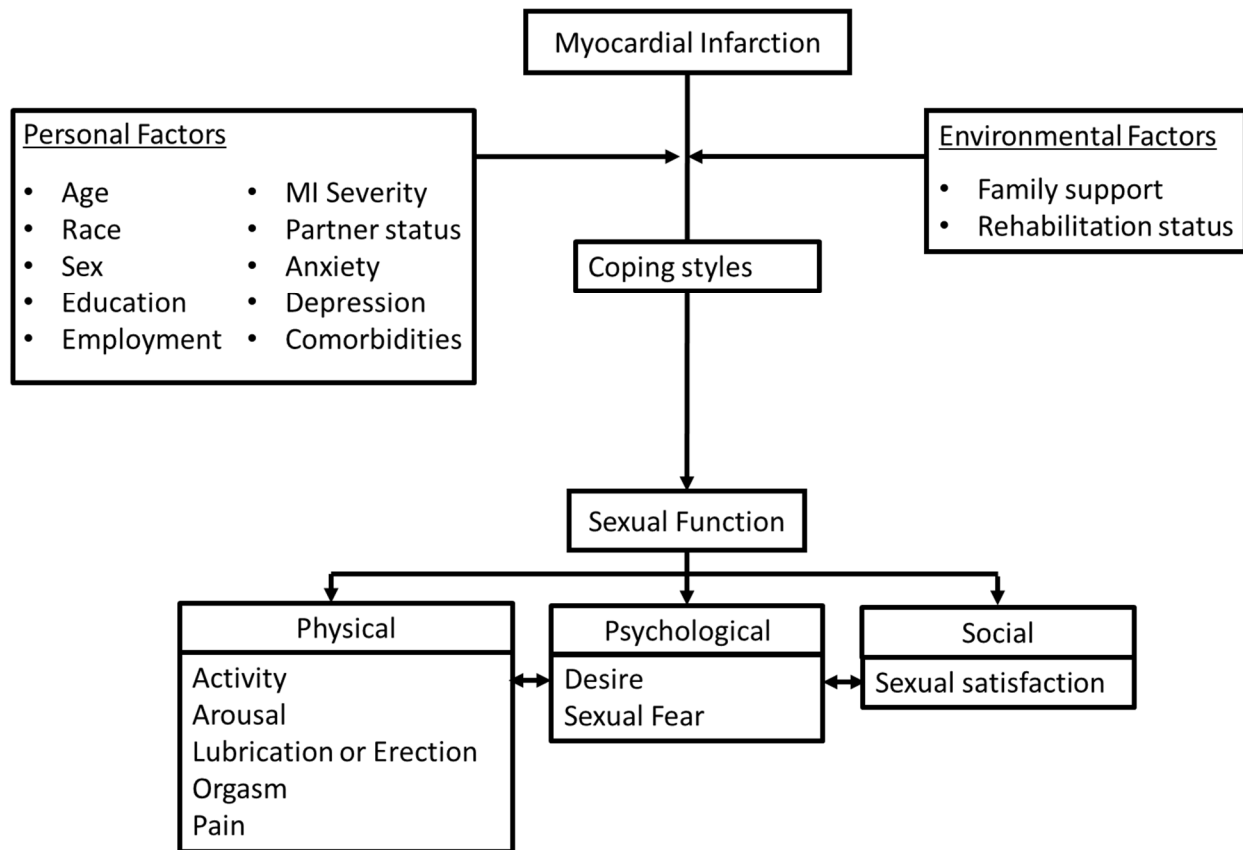
are moved alongside the condition at the top of the sexual health system to symbolize the upstream role they play on influencing sexual health over time. The bottom of the model is where the construct of sexual health was placed and contained three components including physical, psychological, and social. The bidirectional relationships between the components illustrates the multifaceted and complex nature of sexual health as visualized in Barton, Wilwerding, Carpenter, & Loprinzi (2004) as well as other sexual health literature (Basson, 2001). The domains of physical, psychological, and social were distinguished as separate entities, but were still interconnected to illustrate the interaction between the different domains. This representation is appropriate as the ICF model allows for either partial overlap or utilization of all domains under all the subheadings (WHO, 2001, p. 16).

The personal and environmental factors that were measured in this proposal are included in the final conceptual framework. However, for the purposes of this dissertation, only some variables were included and measured. First, only sexual activity, sexual function, sexual satisfaction, and sexual fear was included in this framework and measured in the study. To date, there is no validated measure that captures a complete representation of sexual health. While sexual health is a multidimensional construct that contains many biopsychosocial components unmentioned in this conceptual framework including intimacy, body image, partner sexual function and role engagement, there is no validated measurement that captures every component of sexual health. As a result, sexual health was operationalized by measuring desire, arousal, lubrication/erection, satisfaction, and pain with intercourse through two well validated measures: the Male/Female Sexual Function Index (MSFI/FSFI). Sexual fear was added to capture an additional psychological domain.

The moderators included in the final framework were anxiety, and depression. As previously mentioned, these variables were supported by the current evidence, and as such were recognized as potential predictors that were assessed in the second aim of this dissertation. Furthermore, coping is an important potential mediator of the relationship between the event of MI and the outcome of sexual health, and so was also included and measured in the final model.

In summary, the final synthesized theory details the external and internal relationships and integrates a multidimensional representation of sexual health based on current evidence. Overall, the presentation of sexual health post-MI is understudied, as the effect of many external and internal factors are poorly articulated. While there has been a recent call for outside interventions including sexual counseling as a component of standard care (Steinke et al., 2013), sexual counselling has not been well implemented and the effects of rehabilitation on sexual health in patients post cardiac event are largely unknown (Byrne et al., 2016). Exploring the impact of predictors through this conceptual model will help to illuminate targets to evaluate for potentially effective interventions. Ultimately, it is crucial to apply this model empirically in a patient sample, as overall a theory cannot provide explanations, predictions, or control for phenomena on their own without being tested (Walker & Avant, p. 80).

Figure 2. 5 - Conceptual model



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## **CHAPTER III**

### **Methods**

#### **Study Design**

This study employed a prospective cohort design. The study aims were to 1). describe sexual function and satisfaction within two weeks and at three months post-MI; 2). determine if depression, anxiety, and utilization of coping strategies are associated with changes in sexual function and satisfaction from two weeks to three months post-MI; 3). describe the relationships between the multiple domains of sexual function within two weeks post-MI. The study was approved by the Institutional Review Board (IRBMED) regulatory body (HUM00147371).

#### **Study Participants**

##### **Sample Size and Power Analyses**

Power analyses were conducted for all three aims using SAS software version 9.4 (SAS Institute, Cary, NC). Power analysis for a paired samples t-test was conducted for the first aim. The standard deviations and means for this power analysis were adopted from a previous study that applied the FSFI in a cohort of patients post-MI (Oskay, Can, & Camci, 2015). The previous mean of FSFI scores in women post-MI at three months was 16.41, while a hypothesized mean of FSFI scores at two weeks was conjectured at 12.35. Applying an alpha level of 0.05 and a power of 0.8, 14 participants (with two time points) were needed to determine a statistically

significant correlation with a magnitude of at least 0.5 from two weeks to three months. The final sample size of 21 pairs with these conjectured scores equated to 0.957 power.

Power analysis for the second aim was conducted using a treatment by time approach with two groups of covariate scores (low and high) in SAS. An exemplary data set with means for each group of a selected predictor variable (depression) across the two timepoints was created (Castelloe, 2014). The conjectured standard deviation in depression scores used was 2.5. The correlation between timepoints and decay between timepoints within a LEAR correlation was 0.6 and 0.8 respectively. Applying an alpha of 0.05 and power of 0.8 equated to 10 required participants with two data points. The primary aim of increased sexual function with a sample size of 13 male participants equated to a power of 0.936. The secondary aim of sexual activity with a sample size of 18 males equated to 0.993 with these hypothesized score changes.

Power analysis for the third aim was conducted in SAS. The number of variables adjusted for in the correlation between MSFI domains of sexual function and sexual fear was set at 0 given the smaller sample size. The correlation coefficient (alpha) was set at 0.5 and power of 0.8. Applying these settings produced a total required sample size of 29. The final sample of 28 achieved a power of 0.799.

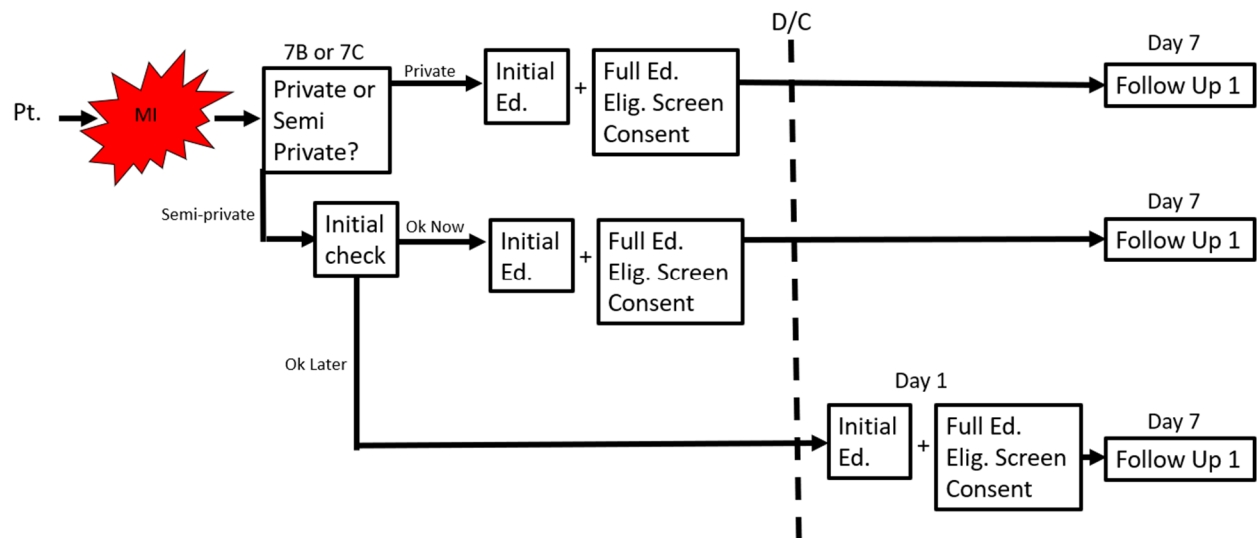
## **Study Procedure**

### **Recruitment and Consent**

Recruitment of adult participants was conducted on inpatient units 7B (Cardiology and General Medicine Telemetry) and 7C (Cardiac Step-Down) at the University of Michigan Health System (Michigan Medicine) in Ann Arbor, Michigan. Eligible participants were first approached on these inpatient units to promote face-to-face interaction when discussing the details of the study. The study's purpose, risks, benefits, and the right to decline participation

were explained to the patient. Given the sensitive nature of the study questionnaires, patients were offered a follow up phone call post-discharge to discuss the study in a more private setting. If a patient declined participation, they were asked to complete a brief 4-item survey which measured age, gender, race, and ethnicity, in order to compare demographics of those who agreed vs. declined to participate. If an individual agreed to participate, he or she signed informed consent at the bedside. The patient’s address and phone number were also reviewed with the patient at the bedside from the medical record to ensure accuracy. A schematic of the entire recruitment process is detailed in figure 3.1.

Figure 3. 1 - Recruitment schematic



### Eligibility Criteria

The primary investigator screened for eligible subjects by identifying the patient’s admitting diagnosis on the inpatient floor census. Inclusion and exclusion criteria were verified using the patient’s medical record. The inclusion and exclusion criteria were as follows:

**Inclusion Criteria**

- Adult male and female patients (over 21 years of age).
- Diagnosed with a myocardial infarction within the past 7 days.
- Troponin T or I value exceeding the 99th percentile of a normal reference population (Thygesen et al., 2012).
- Able to read and write English.

**Exclusion Criteria**

- Patients with a pertinent medical or mental condition that would interfere with survey data (breast/gynecologic cancer, prostate cancer, COPD, or HIV infection).
- Patients who were intubated or otherwise medically or psychologically unstable (alcohol withdrawal, suicide precautions).
- Patients with co-morbidities or terminal disease which limited life expectancy to less than 1 year.

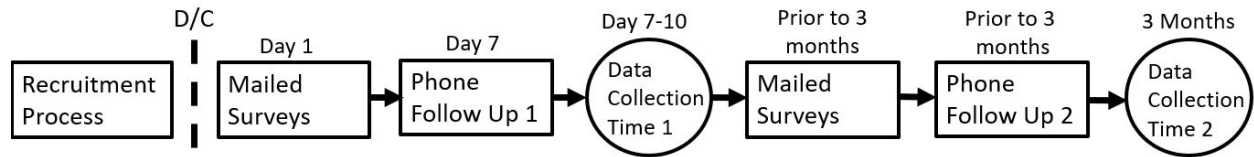
**Data Collection**

Following consent, data from validated self-report questionnaires were collected at two timepoints (baseline-post-MI [two weeks post discharge from the hospital], and [three months post discharge from the hospital]). Consented participants were mailed survey questionnaires within one week of discharge, generally within the first day. These questionnaires were then completed at the participant's residence and returned to the investigator in a pre-addressed, stamped envelope. A mailed photocopy of the signed consent form including the investigator's phone number was provided with the first round of questionnaires. The return envelope did not include a return address to protect confidentiality. Follow up phone calls were made at both timepoints following the mailing of the questionnaires to assess for potential questions and inform the patient of upcoming questionnaire completion. As an incentive, only individuals who



completed both timepoints received a 30-dollar gift card provided by the Human Subject Incentives Program (HSIP). The full data collection schematic is detailed in figure 3.2.

Figure 3. 2 - Data collection schematic



Days represent time after discharge date

### Data Management

Names and addresses were collected on printed labels used to mail the surveys. Participants were identified with a unique research identification number. All forms were labeled with this unique research number and were stored in a locked cabinet. The mailing labels and consent forms were kept in separate locked cabinets from the data. Access to all electronic data were password encrypted and accessible to only the primary investigator and the primary mentor behind the University of Michigan’s firewall.

All study data were entered using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the University of Michigan (Harris, Taylor, Thilke, Payn, Gonzalez, & Conde, 2009; Harris et al., 2019). This was done to utilize an intuitive data capture interface, and to provide a direct export platform into common statistical software packages. Data were first entered in REDCap data management software before export to Microsoft Excel for cleaning. All data was double entered and cross-referenced to check for errors. The subsequent processed data was then downloaded into SAS software version 9.4 (SAS Institute, Cary, NC) for analysis.

## **Measures**

The theoretical definitions and operationalization of the dependent variables are summarized in table 3.1, while the predictors and covariates are summarized in table 3.2. In this study, the dependent variable was sexual function and satisfaction, while potential predictors were selected from the developed conceptual framework detailed in chapter two (Fig. 2.5, p. 65). These predictors included depression, anxiety, and use of coping strategies, and were based on relevant literature surrounding sexual health in the MI population. The measurements are described in further detail in accordance with each study aim.

### **Dependent Variables**

Sexual health is a multidimensional construct made up of physical, psychological, and social components. However, to date there is no validated measure that captures a complete representation of sexual health. As a result, function and satisfaction were measured instead of sexual health due to wider availability of validated measures. Sexual function was operationalized using the Female Sexual Function Index (FSFI) (Rosen et al., 2000), and the Male Sexual Function Index (MSFI) (Kalmbach, Ciesla, Janata, & Kingsberg, 2012). The FSFI is the best available measurement to capture sexual function as a multidimensional construct and is considered the gold standard by the International Society for the Study of Women's Sexual Health (ISSWSH). The FSFI is a well-validated measure with 19 items in six subscales covering the entire sexual response cycle. These include desire, arousal, lubrication, orgasm, satisfaction, and pain during intercourse. Questions on the FSFI are answered on Likert-type scales which are then transformed into a continuous outcome for each scale. Raw scores are multiplied by a factor before totaling, with desire being multiplied by a factor of 0.6, orgasm, satisfaction, and pain by a factor of 0.4, and arousal and lubrication by a factor of 0.3 (see appendix A). Scores can range

from 2-36, with a higher score indicating better sexual function. The measurement also has a cut off score of 26.55 which clinically indicates sexual dysfunction (Wiegel, Meston, & Rosen, 2005). The internal consistency of the measures is 0.93–0.97 for the total score, and 0.89–0.92, 0.90–0.95, 0.93–0.96, 0.91–0.94, 0.82–0.91, and 0.92–0.94 for each subscale (Rosen et al., 2000). The test-retest reliability of the measures is 0.88 for the total score and 0.83, 0.85, 0.86, 0.80, 0.83, and 0.79 for each subscale, validated in a population of adult women (Rosen et al., 2000). The measurement has been used in patients post-MI (Oskay, Can, & Camci, 2015). Appendix A contains the FSFI questionnaires and the domain scoring algorithm.

In male post-MI participants, sexual function was measured using the Male Sexual Function Index (MSFI). This measurement consists of 16 items and was adapted from the FSFI using the same domains of desire, arousal, and orgasm. The MSFI was selected to provide a consistent operationalization of sexual function and satisfaction with the FSFI. Thus, in areas that are conceptually and operationally similar in both males and females, such as satisfaction, orgasm, and arousal, item structure and the number of questions are the same to maintain consistency. In subscales that are different, such as lubrication/erection and pain, the measures were revised to capture the physiological differences in male and female sexual function. In the MSFI, lubrication was exchanged with erectile function, and pain was removed (Kalmbach, Ciesla, Janata, & Kingsberg, 2012). The other questions remained unaltered from the original phrasing in the FSFI. Like the FSFI, desire is multiplied by a factor of 0.6, orgasm and satisfaction a factor of 0.4, and erection and arousal a factor of 0.3 when calculating the final scores (see appendix B). The measurement can range from 2-30, with a higher score indicating better sexual function. A clinical cut off score for dysfunction has not been established for this measurement. The internal consistencies for the MSFI were 0.85, 0.82, 0.76, 0.66 and 0.82 for

each of the subscales. (Kalmbach et al., 2015). Appendix B contains the MSFI questionnaire and scoring algorithm.

In addition to the above functional measures, a psychological component of sexual health, sexual fear, was measured using the sexual fear subscale of the Multidimensional Sexuality Questionnaire (MSQ). The original measurement consists of 100 questions with 20 subscales with Cronbach’s alphas ranging from 0.72 to 0.91 (Snell, Fisher, & Walters, 1993). The sexual fear subscale is five questions and is graded from 1-4, with a Cronbach’s alpha of 0.82 (Snell, Fisher, & Walters, 1993). The score can range from 0-20, with higher scores indicating more sexual fear. The reliability score of the sexual fear subscale is 0.67 (Snell, Fisher, & Walters, 1993). The measurement was developed in an adult English-speaking population but has not been used in cardiac patients, meaning that the questions are not gauged specifically towards MI (Snell, Fisher, & Walters, 1993). To address this, a header was added to the questionnaire that asked the patient to think about sexual fear in the context of since they had their MI. This clause was adopted from the Impact of Events Scale-Revised (IES-R) (Weiss, 2007). The sexual fear subscale with this additional header is presented in appendix C.

Table 3. 1 - Theoretical definitions and operationalization of outcomes

Outcome	Theoretical Definition	Operationalization
Overall function	“Normal sexual functioning comprises sexual activity with transition through the phases from arousal to relaxation with no problems, and with a feeling of pleasure, fulfilment and satisfaction” (Corona, Jannini, & Maggi, 2006).	Total Female Sexual Function Index or Male Sexual Function Index scores

Desire	Sexual interest, sexual thoughts or fantasies, and motivations for attempting to become sexually aroused (Lewis et al., 2010).	Desire subscale of the Female Sexual Function Index or Male Sexual Function Index Questions 1-2
Arousal	“The feeling of being ‘turned on’ or ‘excited’” (Corona, Jannini, & Maggi, 2006, p. 245).	Arousal subscale of the Female Sexual Function Index or Male Sexual Function Index Questions 3-6
Erection	The process in which penile tissues become engorged due to increased blood flow (Hill, 2008, p. 252).	Erection subscale of the Male Sexual Function Index Questions 7-10
Lubrication	The process in which the labia majora and minora become engorged with moisture seeping through vaginal walls due to increased blood pressure (Hill, 2008, p. 252).	Lubrication subscale of the Female Sexual Function Index Questions 7-10
Orgasm	“Subjective feelings of intense sensation and pleasure, including a sudden discharge of accumulated erotic tension at sexual climax and a temporarily altered state of consciousness” (Garcia, Lloyd, Wallen, & Fisher, 2014, p. 2).	Orgasm subscale of the Female Sexual Function Index or Male Sexual Function Index Questions 11,12,13

Pain	Pain during sexual intercourse that is not otherwise attributable to other sexual dysfunction problems (McCabe et al., 2016, p. 137).	Pain subscale of the Female Sexual Function Index Questions 17, 18, 19
Sexual satisfaction	“The response and feeling that one’s sexual needs are being met as well as the needs of their partner” (Ashdown, Hackathorn, & Clark, 2011).	Satisfaction subscale of the Female Sexual Function Index or Male Sexual Function Index Questions 14, 15, 16
Sexual fear	“A fear of engaging sexually with an individual” (Snell, Fisher, & Walters, 1993, p. 31)	Sexual fear subscale of the Multidimensional Sexuality Questionnaire

**Predictors**

The hypothesized predictors included depression, anxiety, and utilization of coping strategies. First, depression and anxiety were assessed with the Patient-Reported Outcomes Measurement Information System (PROMIS) for depression and anxiety-short forms (Cella et al., 2007). These measurements consist of four questions each for anxiety and depression and possess strong evidence for clinical validity in multiple chronic conditions; however, from a cardiac perspective, only heart failure has been currently analyzed. Construct validity was assessed through qualitative item review via focus groups and cognitive interviewing (DeWalt, Rothrock, Yount, & Stone, 2007). The Cronbach’s alphas for these measurements were 0.89 for anxiety and 0.93 for depression (Kroenke, Yu, Wu, Kean, & Monahan, 2014). Both scales are scored from 0-20, with higher scores indicating worse anxiety or depression. The items of the short form anxiety 4a and depression 4a are presented in appendix D and E, respectively.

Coping styles were measured using the Coping Strategy Indicator (CSI) a 33-item questionnaire with three subscales with a response scale of 1-3 (total score range 33-99). Higher scores indicate an increased use of coping strategies. The subscales are Problem Solving, or an individual's active attempts to manipulate or manage an outside stressor (i.e. a fight response); Seeking Social Support, or an individual's attempt utilized outside social resources for addressing a stressor, and Avoidance, which are attempts to separate from the stressor typically entailing a withdrawal or "flight" response (Amirkhan, 1990). The measurement was developed with a population of 1000 English-speaking adults (Amirkhan, 1990). The internal consistency of the subscales ranged from 0.84 to 0.93, and the test-retest reliability of the subscales varied from 0.77 to 0.86 (Amirkhan, 1990). The items in this scale are presented in appendix F.

### **Covariates**

In addition to the identified predictors, several potential confounding factors were considered for this study. These included gender, age, race, severity of MI (left ventricular ejection fraction, and troponin levels), education attainment (some high school, high school degree, some college, college, graduate degree), rehabilitation status, (currently enrolled, previously enrolled, not enrolled, planning to enroll), employment status (employed [full time, part time], unemployed, retired, and medical leave), partner status (single, in a relationship [living/not living together], married, divorced, widowed), and familial support. These variables were collected from either the demographic questionnaire or medical record. A complete list of these covariates and their source (operationalization) is described in table 3.2.

One covariate, familial support, was measured with a unique instrument, the family subscale of the Multidimensional Scale of Perceived Social Support (MSPSS) (Zimet, Dahlem, Zimet, & Farley, 1998). The MSPSS was originally developed in students but has also been

validated in older adults. A total of four questions were used from this measure. The total score can range from 4-28, with higher scores indicating better familial support. The measurement has strong evidence for internal consistency (Cronbach’s alpha ranged from 0.87 to 0.94), and test-retest reliability (total score: 0.73, family subscale: 0.74) in older adults (Stanley, Beck, & Zebb, 1988). The Cronbach’s alpha for the family subscale was 0.85. The items of the MSPSS are presented in appendix G.

Table 3. 2 - Predictors and covariates

Predictor	Operationalization	Data Source
Anxiety	Patient-Reported Outcomes Measurement Information System - Anxiety 4a	TP1, TP2 survey
Depression	Patient-Reported Outcomes Measurement Information System - Depression 4a	TP1, TP2 survey
Coping strategies	Coping Strategy Indicator	TP1, TP2 survey
Covariate	Operationalization	Data Source
Age		Demographic survey
Sex	Male, Female	Demographic survey
Race	Caucasian, Black/African Descent, Asian, Other	Demographic survey
Education	Some high school, high school degree, some college, college, graduate degree	Demographic survey
Employment status	Employed (full or part time), unemployed, retired, on medical leave	Demographic survey
Partner status	Single, in a relationship (living/not living together), married, divorced, widowed	Demographic survey



Rehabilitation status	Currently enrolled, previously enrolled, not enrolled, planning to enroll	Demographic survey
Family support	Family Subscale - Multidimensional Scale of Perceived Social Support	Demographic survey
MI severity	STEMI or NSTEMI, left ventricular ejection fraction, HS troponin T levels, troponin I levels	Medical record

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STEMI/NSTEMI: ST(Non)-Elevated Myocardial Infarction, TP1(2): Timepoint 1(2)

### **Analyses**

The measures were summarized as frequencies, means (SD), and ranges for the dependent variable, predictors, and covariates at each data point. Approximately 98% of demographic survey questions were completed, 99% of dependent variable questions were completed for timepoint 1, and 98% were completed for timepoint 2. Approximately 99% of covariate questions were completed for both timepoints. Thus, imputation was deemed not appropriate, given that most missing data were from biomarkers in the demographic survey (i.e. LVEF and troponin values), and not the dependent variable nor covariates. There was some missing data among the satisfaction subscale of the FSFI and MSFI, and so those missing data were excluded when tabulating total and satisfaction subscale scores, as these data were likely missing not at random.

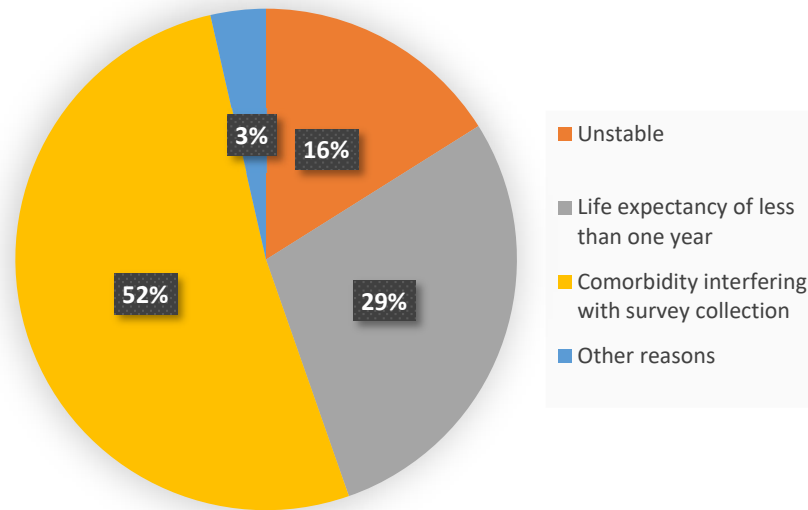
Demographic data between consented and declined participants were compared with independent samples t-tests for continuous variables and chi-square tests for the categorical variables. Given the attrition rates across the first timepoint, demographic data were compared between those who had sent in at least one packet of surveys and those who were lost to follow up (defined as returning no data). In addition to demographic analysis, univariate statistics were

applied to examine the outcomes and changes in covariates across the two timepoints and assess whether the underlying distributional assumptions of statistical tests were met. The normality of the MSFI/FSFI and covariates were checked using a Shapiro-Wilk test. For distributions that did not meet an assumption of normality, nonparametric methods were used where appropriate. A more detailed description of the analyses utilized for the dissertation aims are described in subsequent chapters.

## **Results**

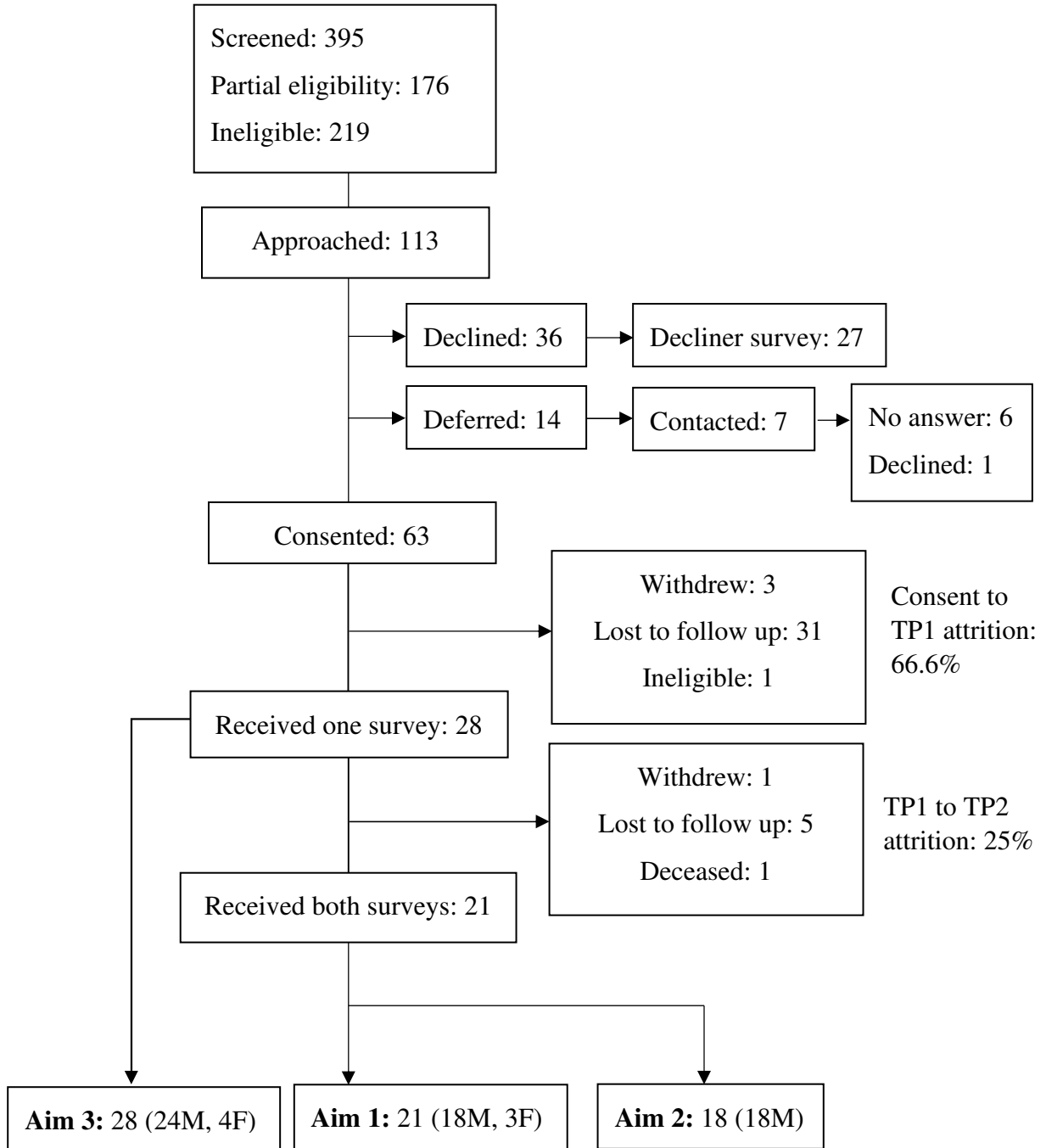
Recruitment took place over 14 months, in which 395 participants were initially screened from the inpatient record. Of these, 44.5% were only partially eligible ( $n=176$ ). These reasons included an unclear differential diagnosis in the medical record, the patient was in a follow-up admission from a MI diagnosis made more than 7 days ago, or inconclusive lab results combined with a lack of conclusive clinical symptoms noted in the history and physical. The remaining 219 (55.6%) patients were excluded based on several criteria. Half of those excluded (52%) were for pertinent medical conditions (i.e. dementia, problems with writing or seeing) or comorbidities which are known to directly influence sexual health and as such could interfere with the findings. These conditions included breast and gynecologic cancer (Basson, Rees, Wang, Montejo, & Incrocci, 2010; Westermann, Wolford, & Krychman, 2016), prostate cancer (Wittmann et al., 2015), COPD (Vincent & Singh, 2007), and HIV infection (Toorabelly et al., 2020). An additional 29% were excluded for skilled nursing facility disposition, or a projected life expectancy of less than one year. Another 16% were excluded for stability concerns (suicide, alcohol withdrawal). The remaining 3% were excluded for other reasons, primarily for distance in mailing the surveys. Figure 3.3 details a pie chart of ineligible patients.

Figure 3. 3 - Distribution of excluded participants



Of the remaining eligible patients, 113 were approached. Of these, 14 participants were unable to be contacted during their hospital stay because they were in a procedure or were discharged before in-person contact could be made. An amendment was approved which allowed letters to be sent to patients missed during the initial contact attempt. Seven letters were sent out, with one participant returning a call to decline participation. Of the remaining 99 participants approached, 63 consented to join the study, while 36 declined. Of those declined, 27 filled out a decliner survey. The final consent/decline ratio was 63.6%. Of the 63 participants who were mailed a survey, 28 returned the first round of questionnaires, for a 44% response rate. Of these 28 participants, 21 returned the second round of questionnaires, for a response rate of 75%. The final study completion rate was 33%. Figure 3.4 details a flowsheet of all recruitment and data collection processes including attrition rates.

Figure 3. 4 - Recruitment and attrition flowchart



There were no statistically significant differences for any sociodemographic or clinical variables among those who consented vs. declined, nor between those who sent data vs. those who did not send data. However, given the small sample size, greater attention was paid to the actual tallies of each demographic group rather than the statistical significance. Patients who declined were slightly older than those consented, while patients who sent in data were slightly older than those lost to follow up. There was a slightly higher percentage of women who declined to participate in the survey (14.5% vs. 18.5%). Furthermore, among the three African Americans who were consented to the study, none returned any survey data. The data that were collected were among those who were older (70.8 years among sent data, 57.6 years among those who did not send data). Among sex, one trans female was recruited who did not return survey data. Table 3.3 displays the demographic data of the entire consented vs. declined sample, and table 3.4 compares between those who were consented and returned data with those who did not return any data. Table 3.5 compares consent, decline and data status within sex and race.

Table 3. 3 - Demographics: consented vs. declined ( $n=89$ )

	Consented ( $n=62$ )*	Declined ( $n=27$ )	p-value
Mean age (SD) in years	62.4 (13.2)	64.9 (10)	0.38
Range	29-89	48-87	
Sex, No. (%)			0.73
Male	52 (83.9)	22 (81.5)	
Female	9 (14.5)	5 (18.5)	
Trans female	1 (1.6)	0 (0)	
Race, No. (%)			0.43
White/Caucasian	58 (93.6)	24 (88.9)	
African American	3 (4.8)	3 (3.7)	
Other	1 (1.6)	2 (7.4)	

\*Ineligible participant removed from consented total

Table 3. 4 - Demographics: any data vs. no data (n=62)

Sample size, No.	Any Data (n=28)	No Data (n=34)	p-value
<b>Sociodemographic characteristics</b>			
Mean age (SD) in years	63.7 (13.4)	61.4 (13.1)	0.49
Sex, No. (%)			
Male	24 (85.7)	28 (82.4)	0.66
Female	4 (14.3)	5 (14.7)	
Trans female	0 (0)	1 (2.9)	
Race, No. (%)			
White/Caucasian	27 (96.4)	31 (91.2)	0.15
African American	0 (0)	3 (8.8)	
Other	1 (3.6)	0 (0)	
Marital status, No. (%)*			
Partnered	23 (82.1)	23 (82.1)	>0.99
Unpartnered	5 (17.9)	5 (17.9)	
<b>Clinical characteristics</b>			
MI Severity, No. (%)			
STEMI	8 (28.6)	10 (29.4)	0.29
NSTEMI	20 (71.4)	24 (70.6)	
MI Type, No. (%)			
Type 1	22 (78.6)	27 (79.4)	0.94
Type 2	6 (21.4)	6 (20.6)	
Mean troponin (SD) in ng/mL	999 (1842.3)	823.4 (1722.8)	0.72
Mean LVEF (SD) in %	49 (16.7)	47.1 (16.4)	0.68
Ineligible participant removed from consented total			

\* Partnered consisted of individuals who were married or in a relationship. Unpartnered consisted of individuals who were single, divorced, or widowed.

Table 3. 5 - Consented, declined, and data status among age, sex, race, and marital status

	# Approached	Consented/ Declined	%	# Consented	Sent Data/ No Data	%
Within age (years)		60/66 63.4/58.7			62.5/62.2 70.8/57.6	
Within sex						
Male	64	52/22	70.2	52	24/28	46.2
Female	14	9/5	64.5	9	4/5	44.4
Trans female	1	1/0	100	1	0/1	0
Within race						
White/Caucasian	82	58/24	70.7	57	27/30	47.3
African American	4	3/1	75	4	0/4	0
Other	3	1/2	33	1	1/0	100
Within marriage*		Not collected for decline	n/a			
Partnered				46	23/23	50
Unpartnered	Unknown			10	5/5	50

Ineligible participant removed from consented total

\* Partnered consisted of individuals who were married or in a relationship. Unpartnered consisted of individuals who were single, divorced, or widowed

In answering the first aim of this dissertation, the longitudinal data were analyzed. The complete results and discussion surrounding this aim are elaborated in Chapter IV: “Sexual Function and Satisfaction Post-Myocardial Infarction: An Explorative Longitudinal Study”, and will be submitted to the Archives of Sexual Behaviour. Three months after MI, most participants were sexually active. Sexual activity and sexual function scores did increase over the three months in males, but not as much in the few females who participated. Unsurprisingly, males who were sexually active had better improvements in function compared to those who were inactive. Despite these improvements, 28% of male and 66% of female participants were not sexually active three months after their MI.

For the second aim of identifying predictors, modeling was conducted with the longitudinal data. A full discussion of the results for this aim are detailed in Chapter V: “Exploratory Modeling of Predictors of Sexual Function and Satisfaction Post-Myocardial Infarction”, which will be submitted to the Canadian Journal of Cardiac Nursing. The strongest relationships between the independent and dependent variables were sexual fear, support-seeking, and problem-solving strategies with MSFI scores. There was also a strong relationship among the psychological covariates (anxiety and depression). Positive coping strategies also predicted changes in sexual function.

The third aim utilized the cross-sectional data at the first timepoint. These results and a complete discussion are described in Chapter VI: “The Relationship Between Sexual Function, Satisfaction, and Fear Post-Myocardial Infarction: A Preliminary Analysis”. This manuscript will be submitted to the Journal of Cardiovascular Nursing. Average scores on both the MSFI and FSFI were low. Strong correlations among the physical components of function were found in both sexes. However, desire and satisfaction were only weakly to moderately correlated with arousal, erection, and orgasm in male participants, while satisfaction was not correlated with any of the subscales in female participants. An expected negative correlation was found between sexual fear and the other components of function, though these correlations were weak and male participants, and strong in female participants.



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## CHAPTER IV

### **Sexual Function and Satisfaction Post-Myocardial Infarction: An Explorative Longitudinal Study**

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## **Abstract**

Myocardial infarction (MI) decreases sexual function and desire, but there are few studies that have examined changes in sexual function over a longer period. This study aimed to longitudinally describe negative and positive changes in sexual function and satisfaction over time in a sample of male and female post-MI patients. Twenty-one patients were recruited from a Midwestern hospital and mailed surveys at two weeks and three months post discharge. Sexual function was measured with the Female/Male Sexual Function Index. Important covariates collected included sexual fear (Multidimensional Sexuality Questionnaire), anxiety and depression (Patient-Reported Outcomes Measurement Information System Anxiety and Depression 4a) and use of coping strategies (Coping Strategy Indicator). Sexual function scores among males increased from 8.9 (SD 7.3) at two weeks to 14.6 (SD 8.9) at three months (18.8% improvement,  $p=0.04$ ). Males who were sexually active improved their scores by 27.3% ( $p=0.01$ ), while males who were not decreased their scores by 2.3% ( $p=0.5$ ). Scores in females increased from 13.7 (10.5) at two weeks to 16.3 (12.2) at three months (7.1% improvement,  $p=0.5$ ). Depression and anxiety scores were low and relatively stable across timepoints, though there were some slight improvements among males who were sexually active compared to those who were not. Decreased utilization of avoidance coping strategies was reported in sexually active versus inactive men. Further research is needed with larger sample sizes to understand these changes in sexual function across a longer period, and to examine any potential influence of these psychosocial predictors.

*Keywords:* Sexual function, sexual satisfaction, longitudinal, myocardial infarction

## **Background**

Myocardial infarction (MI) remains a notable acute exacerbation of chronic cardiovascular disease in the United States due to its high prevalence rates and negative effects on patient health. Approximately 470,000 men and 335,000 women were hospitalized for either a new or recurrent MI between 2005 and 2014 (Virani et al., 2020). These incidence rates have created a substantial population of 8.4 million adult survivors (Virani et al., 2020). Whether a first-time or recurrent MI, both experiences introduce new challenges for patients. The pathophysiological ramifications of MI increase activity intolerance, anxiety and depression, and probability of a repeat event (Daniel et al., 2018; Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). While mortality and readmission rates have declined due to improvements in medical management of MI, other issues remain unaddressed during the trajectory of care (Hammill, Curtis, Schulman, Whellan, & Whellan, 2010; Dunlay, Pack, Thomas, Killian, & Roger, 2014). One component that often goes unrecognized during post-MI care is diminished sexual function (Byrne, Doherty, McGee, & Murphy, 2010; Puchalski, Szymanski, Kowalik, & Filipiak, 2013). Sexual function consists of four main phases including excitement, plateau, orgasm, and resolution (Masters & Johnson, 1966). In males, these phases are traditionally presented in a successive or linear progression, while in females it is conceptualized as a more circular model, particularly among desire and arousal with other components (Basson, 2001). In addition to sexual function, sexual satisfaction pertains to an individual's appraisal of the contentedness of their sexual relationship and can include both physical and emotional satisfaction (Ashdown, Hackathorn, & Clark, 2011).

While there is some cross-sectional literature evaluating sexual health, there are very few studies that model a complete representation of sexual function and satisfaction in post-MI

patients over a longer timeframe. Previous longitudinal studies have focused primarily on sexual activity while neglecting sexual function and satisfaction (Lindau et al., 2016). Furthermore, sexual function can be influenced by several psychological factors. Fear of sexual activity, as well as anxiety and depression - commonly seen by clinicians in patients after MI - can all reduce desire for sexual activity and thus negatively influence sexual function and satisfaction (Oskay, Can, & Camci, 2015; Thombs et al., 2006; Steinke & Wright, 2006). However, previous longitudinal studies have only measured frequency of sexual problems, which leaves gaps in our understanding on how dysfunctional severity changes over time (Lindau et al., 2016). Indeed, focusing only on sexual activity without also comprehensively exploring the longitudinal changes in the functional domains produces an incomplete picture of sexual health and limits effective prescription of the support patients need to improve sexual function (sexual aids) and overall sexual confidence (counseling). Therefore, the current state of the science points to the need for more descriptive longitudinal research to understand the trends in sexual function and satisfaction over time and the factors that influence it. Development and testing of effective treatments requires a more comprehensive understanding of sexual function issues.

The purpose of this study was to examine changes in sexual function and satisfaction as well as anxiety, depression, sexual fear, and utilization of coping strategies over time in a cohort of patients post-MI. The specific aim of this study was to describe sexual function and satisfaction, sexual fear, anxiety, depression, and utilization of coping strategies in a population of adults within two weeks and at three months post-MI.

## **Methods**

The study applied a prospective longitudinal design to capture changes in sexual function and satisfaction at two timepoints; two weeks and three months after discharge from the hospital



setting. Patients were mailed questionnaires the day following discharge from the hospital. A follow up phone call was made with participants before two weeks and three months to remind them of study requirements and answer potential questions. The study received Institutional Review Board (IRB) approval before data were collected.

### **Study Population**

A total of 99 patients of 395 screened were approached during their inpatient hospitalization for an MI at one Midwestern hospital. The inclusion criteria were adult men and women admitted to the hospital with an MI who could read and write English. Diagnosis of MI was confirmed using chart review in addition to a troponin T value exceeding the 99<sup>th</sup> percentile of a normal reference population (>18 ng/mL) (Thygesen et al., 2012). The exclusion criteria included patients who had a pertinent comorbidity that would interfere with any sexual health data collected (prostate cancer, breast/gynecologic cancer, COPD, or HIV infection), patients who were medically unstable (suicide, alcohol withdrawal), or patients who had a life expectancy of less than one year. A total of 63 signed informed consent, with 21 individuals returning all survey materials (final study completion rate was 33%).

### **Measures**

The dependent variables were sexual function and satisfaction, which were operationalized using the subscales of the Female Sexual Function Index (FSFI) and the Male Sexual Function Index (MSFI). The FSFI is made up of six subscales including desire (score range 1.2-6), arousal (score range 0-6), lubrication (score range 0-6), orgasm (score range 0-6), satisfaction (score range 0-6) and pain with intercourse (score range 0.8-6), for a total score range of 2-36 (Rosen et al., 2000). The FSFI also has a designated cut-off score for sexual dysfunction, of 26.55 (Wiegel, Meston, & Rosen, 2005). The Cronbach's alphas are 0.92, 0.95,

0.96, 0.94, 0.89, and 0.94 for each subscale and 0.97 for the totals scale (Rosen et al., 2000). The MSFI was based on the wording of the FSFI and was selected to provide consistency in measurement across fields of desire (score range 1.2-6) orgasm (score range 0-6), and satisfaction (score range 0-6). The modified subscales from the FSFI were lubrication, which was replaced with erection (score range 0-6) and pain with intercourse was also removed (Kalmbach, Ciesla, Janata, & Kingsberg, 2012). The Cronbach's alphas for the MSFI subscales are 0.85, 0.82, 0.76, 0.66 and 0.82 for each subscale (Kalmbach et al., 2015). The total score range for the MSFI is 2-30. Higher scores on these measurements indicate better sexual function. Patients were not required to be sexually active to complete these surveys, but sexual activity status does influence scoring on the arousal, erection/lubrication, orgasm, and pain scores of the MSFI and FSFI.

Several key variables related to sexual function shown to be important in the literature were measured in this study. Sexual fear was measured using the sexual fear subscale of the Multidimensional Sexuality Questionnaire (MSQ). The sexual fear subscale ranges from 0-20, with higher scores indicating more sexual fear. The Cronbach's alpha of the sexual fear subscale is 0.82 (Snell, Fisher, & Walters, 1993). Anxiety and depression were measured with the Patient-Reported Outcomes Measurement Information System (PROMIS) - Anxiety and Depression Short Form 4a. Both measurements range from 0-20 with higher scores indicating worse anxiety or worse depression. The Cronbach's alpha is 0.89 for the Anxiety Short Form and 0.93 for the Depression Short Form (Kroenke, Yu, Wu, Kean, & Monahan, 2014). Lastly, utilization of coping strategies was measured with the Coping Strategy Indicator (CSI). The CSI is made up of three subscales: Seeking Support, Problem Solving, and Avoidance (Amirkhan, 1990). Each

subscale is scored from 11-33, with a higher score indicating a higher use of that coping strategy. The Cronbach's alphas for these subscales range from 0.84 to 0.93 (Amirkhan, 1990).

The demographic variables that were collected included employment status, marital status, cardiac rehabilitation status, and education status. These were collected using a demographic survey. Left ventricular ejection fraction (LVEF) percentages were collected from the medical record to assess for basic cardiac function. Whether the MI was an ST or non-ST segment elevated (STEMI/NSTEMI), and the troponin T values were also collected from the medical record to assess for MI severity.

### **Statistical Analyses**

All analysis was conducted using SAS statistical software version 9.4 (SAS Institute, Cary, NC). FSFI and MSFI scores were summarized as frequencies, means (SD), and ranges for at each timepoint. The continuous subscales of desire, arousal, lubrication/erection, orgasm, satisfaction, and pain scores on the FSFI/MSFI were compared from two weeks to three months. Univariate statistics were applied to check the normality of the data. The MSFI and FSFI scores were not normally distributed at the first timepoint, so Wilcoxon signed rank tests were used. Furthermore, some data were missing among the satisfaction subscales (four males and one female), so these and the total score changes were calculated with these participants removed. Given that these data were likely missing not at random, multiple imputation was deemed not appropriate. Subgroup analyses among males were conducted to assess for differences among those who were sexually inactive at three months compared to those who either became or were always active. A paired t-test was utilized to calculate mean changes in the covariates of depression, anxiety, use of coping strategies, and sexual fear as they fell along an approximately normal distribution. T-score transformation of the PROMIS measurements were calculated to

assess for clinical significance based on established cut points among adults (mean age 59.3 years) (Rothrock, Amtmann, & Cook, 2020). Percent changes were calculated as a change of the total possible score of a measurement or subscale rather than change over the first timepoint. A statistical significance level of 0.05 was applied.

## **Results**

The study sample ( $N=21$ ) included 17 Caucasian men, 1 Native American man, and 3 Caucasian females. The mean age of the sample was  $60.5 \pm 13.6$  years for male participants and  $70 \pm 9.9$  years for female participants. Participants were primarily married (M: 61.1%, F: 100%), college educated (M: 50%, F: 66.7%), and most of the female participants were retired (M: 33.3%, F: 66.7%). Cardiac function was below a normal LVEF in males and approached a below normal level for females (M: 48.5%, F: 57%; normal range: 55%-70%). There were no statistically significant differences among the demographic variables. Additional clinical and sociodemographic characteristics are presented in table 4.1.

Average sexual function scores among male participants were 8.9 at two weeks (SD 7.3, median 5.35, range 3.6-26.2) which increased to 14.6 (SD 8.9, median 12.45, range 3.8-30) at three months. Sexual function scores improved in 61.1% of the sample, with an overall score improvement of 18.8% ( $p=0.04$ ). While 61.1% of the sample improved, 22.2% decreased. The remaining 16.7% did not noticeably change over time. The largest percent change among the subscales were erection (27.8%,  $p=0.01$ ), and orgasm (25.9%,  $p=0.04$ ). Desire improved the least among men, at 8.9% ( $p=0.06$ ). Table 4.2 presents the total and subscale scores of the MSFI and covariates among the entire sample, and these are also visualized in figure 4.1. Individual items were also examined among the male participants to assess for clinical significance. At three months, 50% had at least moderate desire (improved from 38.9%), 38.9% had at least

moderate arousal (improved from 22%), 50% had either slight or no difficulties with erection or orgasm (improved from 16.7%), and 38.9% were at least equally satisfied and dissatisfied with their overall sex live (improved from 33.3%).

The proportion of males who were active at two weeks and three months were also calculated. Among the 13 who were sexually inactive at two weeks (72% of the total sample), 61.5% resumed sexual activity by three months ( $n=8$ ). At three months, 72.2% of the sample was sexually active. Approximately 28% were sexually active at both timepoints ( $n=5$ ), while an additional 28% of the sample were not active at either timepoint ( $n=5$ ). Male participants who were sexually active were not statistically different compared to those who were inactive in terms of age, (active: 60.2 years, inactive: 61.2 years,  $p=0.91$ ), LVEF (active: 46.3%, inactive: 54.8%,  $p=0.35$ ), or marital status ( $p=0.59$ ). Those who were sexually active had higher troponin levels, though the difference was not statistically significant (active: 1285.5 ng/mL, inactive: 471.3 ng/mL,  $p=0.91$ ). Interestingly, a statistically larger proportion of males who were sexually active were diagnosed with an ST-segment elevated MI (STEMI) ( $p=0.03$ ). Scores were mostly unchanged among sexually inactive males, with two subscales decreasing slightly (arousal and erection). Total MSFI score changes were mixed among those who were active at both timepoints; two had stable scores, while two decreased slightly, and one increased. Figure 4.5 shows individual score changes among the male participants.

Score changes on the MSFI were also examined by sexual status. Males post-MI who were sexually active at three months improved their total scores by 27.3% ( $p=0.01$ ), while those who were not sexually active decreased their total scores by 2.3% ( $p=0.5$ ). Interestingly, the largest decrease in total scores (-12.3%) was in a man who had been sexually active at both timepoints, but was not an outlier for age or any disease characteristic compared to the average

of the group. This man's largest subscale decreases were in orgasm scores (-53.3%), followed by arousal (-15%) and satisfaction (-13.3%). Conversely, all males who became sexually active at three months had higher total scores on the MSFI over time, with the largest improvement being 68%. Two subscales (desire and satisfaction) of the MSFI were not statistically increased among sexually active males. The largest changes among those who were sexually active were erection (38.8%,  $p=0.003$ ) and orgasm (35.9%,  $p=0.04$ ), followed by arousal (27.9%,  $p=0.04$ ), satisfaction (15.3%,  $p=0.18$ ) then desire (12.3%,  $p=0.06$ ). Subscale scores in male participants who were not sexually active averaged a 2% change overall. Arousal subscale scores were the same across both timepoints (1.9, possible score 0-6). Unsurprisingly, orgasm scores were 0 across both data points in those who were not sexually active. Table 4.3 shows sexual function scores by sexual status.

Score changes on the FSFI were evaluated among the female sample. All females improved their sexual function scores, though by a smaller percentage (7.1%), which was not statistically significant ( $p=0.5$ ). Two females were never sexually active from two weeks to three months while one woman was sexually active at both timepoints. The one female who was sexually active at three months improved by 11.9%, compared to a 2.2% increase among those who were not sexually active. The largest percentage increases in the FSFI subscale scores were satisfaction (16.7%), followed by desire and arousal (6.7%). Two subscales in females did not change across timepoints (lubrication and pain). Changes of female sexual function scores are presented in figure 4.3 and 4.4, while figure 4.6 shows individual scores.

The covariates were examined among the entire sample. PROMIS anxiety and depression scores were generally low in both sexes, indicating a lack of anxiety and depression. Depression scores in female participants changed the most, worsening by 10%. Interestingly,

overall anxiety scores in males decreased slightly (-2.2%), and overall sexual fear scores were slightly increased in females (5%), but these were not statistically significant changes. Despite the low overall scores, some interesting changes were observed among the t-score transformations. At two weeks, 57.1% of depression t-scores were within normal limits, while 33.3% were in the mild depression range, and 9.5% were in the moderate depression range. This changed to 57.1% within normal limits, 19% in the mild depression range, and 23.8% in the moderate depression range at three months. When examining anxiety t-scores, 47.6% were within normal limits, while 28.6% were in the mild anxiety range, and 23.8% were in the moderate anxiety range at two weeks. This changed to 42.9% within normal limits, 47.6% in the mild anxiety range, and 9.5% in the moderate anxiety range at three months. The percentage of participants with moderate anxiety decreased from 23.8% to 9.5%, while the percentage of participants with moderate depression increased from 9.5% to 23.8%.

Male participants had slightly improved fear scores, but still scored low at both timepoints, while fear scores among female participants only changed by 5% (M: 8.3-7.2, F: 4-5, possible score 0-20). Use of problem-solving and support-seeking coping strategies decreased among all male and female participants, though not by a statistically significant percentage. Interestingly, problem-solving and seeking support strategies decreased more among female participants than male participants (M: -0.3, -1.2%, F: -15.2, -18.2%). Use of avoidance coping strategies decreased in both samples (M: -1.3%, F: -4.3%). Table 4.2 and 4.3 contain the data for male covariate scores as an entire cohort, while table 4.4 details the changes in covariates among the females sampled. Figure 4.2 and 4.4 display bivariate associations of covariates with the MSFI or FSFI scores.

Covariates were also examined in males stratified by sexual status. Depression scores worsened slightly among all males (1.1%), while anxiety improved (-2.2%). However, among those who were sexually active, anxiety and depression scores improved slightly. As with the entire cohort, overall subgroup changes were small (within 3%). Changes in covariates were slightly more pronounced among males who were sexually inactive. While anxiety scores in sexually inactive males only worsened by 1%, depression worsened by approximately 7%, while sexual fear scores improved by 13%. The one sexually active man who decreased his total scores by 12.3% also had 20% worse anxiety scores, but only a 5% change in fear and depression scores. Those who were sexually active increased use of problem-solving and support-seeking coping strategies and reduced the amount of avoidance coping strategies. These changes in scores were small, however. The opposite effect was observed in males who were not sexually active; use of problem-solving and support-seeking coping strategies decreased, while use of avoidance coping strategies increased. Table 4.3 shows changes in covariate scores by sexual status.

## **Discussion**

This study described changes in sexual function, anxiety, depression, use of coping strategies, and sexual fear in male and female post-MI patients from two weeks to three months. Male score changes fell across a broad range, with some drastically improving over three months while others remained stable or improved only minimally. To our understanding, this is the first time that sexual function and satisfaction have been longitudinally reported over a short-term trajectory in a post-MI population. Previous longitudinal studies have found a potential protective effect of sexual activity on cardiac risk in older patients, and so it would be important to better understand how these changes in function shape over time in order to promote



enjoyable sexual activity (Liu, Waite, Shen, & Wang, 2016). One large longitudinal cohort study did examine whether patients developed functional problems one-year post-MI but only reported frequencies rather than severity, and was conducted in a sample aged 18-55 (Lindau et al., 2016). Sexual function studies in men post-MI have primarily focused on erectile quality, (Hodžić, Durek, Begić, Šabanović Bajramović, & Durak-Nalbantić 2019), and so this study also provides a unique contribution by characterizing a more comprehensive representation of sexual function.

For the most part, the males who were sexually active had higher sexual function scores over time than those who were not sexually active. In addition, physical components of function (arousal, erection, orgasm) improved more than psychosocial components (desire, satisfaction) over three months. To our understanding, no prior studies have stratified sexual function by different sexual activity statuses in post-MI males and females. The improvement in sexual activity rates from 33.3% to 72% among the male participants might explain the observed improvements in the physical components, though this could also be due to a better relationship with their partner or generally increased motivation or interest. Regardless, these changes indicate that sexual function and satisfaction can decrease or increase dramatically within a short time post-discharge, as much as 38% observed in this sample. As a result, pre-discharge interaction that provides information on managing sexual problems and returning to safe sexual activity may improve function in this population, especially within the physical components (Steinke et al., 2013). However, the overall improvement of 18.8% in the entire male sample is still relatively modest, and it is also unclear if these trends will continue to improve beyond three months.

In comparison to males post-MI, there were little to no score changes over time among the females sampled. However, scores at three months were comparable to a previously

conducted cross-sectional study of 45 women post-MI (16.3 vs. 16.41) (Oskay, Can, & Camci, 2015). Interestingly, this previous study required women to have a “normal sex life” as part of the inclusion criteria, so it is unclear whether a larger sample of active and inactive females would have changed the mean scores seen in this study. Regardless, the observed lack of changes in physical function scores in females is most likely due to 67% of the sample being sexually inactive. Furthermore, the sample was likely all postmenopausal, which may have played a role in low sexual function, though this is not always the case. The effects of menopause on sexual function should be explored in the context of other influencing biopsychosocial variables including hormonal changes, partner function, reproductive history, and medical conditions (Heidari, Ghodusi, Rezaei, Kabirian Abyaneh, Sureshjani, & Sheikhi, 2019). Despite this, sexual satisfaction scores still improved by 16.7% over time despite a lack of sexual activity. It may be that the female participants were maintaining satisfaction by applying adaptive coping strategies over time. This hypothesis is supported by a study of 460 post-MI patients which found that women typically utilized more coping strategies than men (Son, Friedman, Thomas & Son, 2016). However, as in men, it is also possible that these women did not return to sexual activity due to inadequate guidance post-discharge. As such, additional research with a larger female sample is needed to further examine these potential score changes.

Scores on anxiety and depression were relatively stable over time. It is important to consider that approximately 57% of depression and 43-48% of anxiety t-scores were within normal limits in this population at either timepoint, with very few moderate and no severe cases. However, males who were sexually active reported lower anxiety and depression scores compared to those who were not sexually active post-MI. It is also interesting that the percentage of those with moderate anxiety decreased over three months, and that the percentage of those

with moderate depression increased. Previous research has reported that depression and anxiety are often associated with decreased sexual activity. A previous cross-sectional cohort study of 493 patients found that depression significantly influenced the relationship between sexual function and quality of life (Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). In another cohort study of 64 patients, sexual satisfaction was negatively related to anxiety, and sexual satisfaction also accounted for 42% of the variance in anxiety scores (Steinke & Wright, 2006). This could either be because depression and anxiety precipitate decreased desire or interest for sexual activity, or because low sexual function are depressing and anxiety producing for men. However, the observed changes in depression and anxiety across timepoints were considerably small, and so further research is needed to undertake these potential hypotheses.

Another interesting finding revolved around the use of coping strategies, particularly among males by sexual status. A recent review found that common positive coping strategies among those with chronic conditions involved both religious coping and utilization of social support (Cheng, Inder, & Chan, 2020). In the MI literature specifically, reduced social support was associated with lower overall coping scores and decreased use of positive coping strategies, leading to a more passive overall coping style utilization (Son, Friedman, Thomas & Son, 2016). As such, it may be that males who are sexually active were able to cope better with MI compared to those who were not active. However, this relationship constitutes a preliminary finding and should be explored further given the small effect size.

Males who were sexually inactive had more sexual fear, which is expected, given that those who are not engaging might be afraid of causing additional cardiac complications. However, inactive males also decreased fear scores over time, which was unexpected, though

fears were naturally decreasing over time in both samples. Previous studies have found prevalence rates for sexual fear in post-MI samples ranging from 58.82% (Eyada & Atwa, 2007) to 88.4% (Oskay, Can, & Camci, 2015). Among those who were not sexually active, low functional scores may have been interacting with depression and anxiety. However, while these studies have identified potential associations, no study has determined whether these psychological variables directly predict changes in sexual function. In addition, the observed changes in sexual fear were not statistically significant.

The results of this study should be considered in the context of some limitations. Without pre-MI sexuality data, it is difficult to determine what kind of loss of function these participants experienced due to the MI. However, collecting pre-MI sexual function data after discharge could be subject to recall bias and may not be entirely reliable. The small sample was primarily Caucasian, well-educated, and married. Additionally, the sample included a small proportion of males to females, at 16% and 84 %. This is a considerably skewed proportion compared to recent national estimates of MI, which are approximately 60% male and 40% female (Virani et al., 2020). A possible explanation could be an observed greater interest in discussing sexual health topics by men (Lindau et al., 2007). It may also be that the sample of females were older and as such less likely to be sexually active. Regardless, the very small number of females reduces the capacity of the study to make conclusions of overall changes in female post-MI patients. Third, the study did not capture whether the included participants had any activity restrictions from their physician, which could have influenced scores. Lastly, while this study captured several covariates, the limited sample size prevented any statistical adjustment for these variables.

## **Conclusion**

Participants in this study demonstrated statistically significant improvements in total MSFI scores from two weeks to three months in males post-MI, but these changes were either minimal or absent in females. Both sexes reported sexual function scores in the dysfunctional range. Descriptive analysis between males who were sexually active compared to those who inactive helped to contextually explain positive changes over time. The results from this study suggest the need for providers to be aware of and offer guidance and information to men and women post-MI who are struggling with sexual function issues. Sexual function and interest in sex should be assessed regularly in patients with heart disease so that if an MI occurs, baseline sexual health information would already have been provided. Future longitudinal studies with larger sample sizes should be conducted to confirm whether these observed changes in sexual function can be replicated. Further research should also examine these concurrent psychosocial variables including anxiety, depression, coping strategies, or sexual fear, to better understand their association and mutual influence.

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## Tables and Figures

Table 4. 1 - Characteristics of study participants

	Male (n=18)	Female (n=3)
<b>Sociodemographic characteristics</b>		
Mean age (SD) in years	60.5 (13.6)	70 (9.9)
Race, No. (%)		
White/Caucasian	17 (94.4)	3 (100)
Other	1 (5.6)	0 (0)
Marital status, No. (%)		
Single	2 (11.1)	0 (0)
In a relationship	2 (11.1)	0 (0)
Married	11 (61.1)	3 (100)
Divorced	2 (11.1)	0 (0)
Widowed	1 (5.56)	0 (0)
Education status, No. (%)		
Some high school	2 (11.1)	0 (0)
High school degree	2 (11.1)	0 (0)
Some college	5 (27.8)	1 (33.3)
College degree	3 (16.7)	1 (33.3)
Graduate degree	6 (33.3)	1 (33.3)
Rehabilitation status, No. (%)		
Currently enrolled	3 (16.7)	0 (0)
Planning to enroll	7 (38.9)	2 (66.7)
Not enrolled	8 (44.4)	1 (33.3)
Employment status, No. (%)		
Employed	9 (50)	1 (33.3)
Unemployed	1 (5.6)	0 (0)
Retired	6 (33.3)	2 (66.7)
Medical Leave	2 (11.1)	0 (0)
<b>Clinical characteristics</b>		
MI Severity, No. (%)		
STEMI	7 (38.9)	2 (66.7)
NSTEMI	11 (61.1)	1 (33.3)
Mean troponin (SD) in ng/mL	1081.9 (2314)	1757.3 (1132.5)
Mean LVEF (SD) in %	48.5 (12.3)	57 (6.3)

(N)STEMI: ST(Non)-Elevated Myocardial Infarction; LVEF: Left Ventricular Ejection Fraction

Table 4. 2 - Mean scores and changes on sexual function, anxiety, depression, and sexual fear in male post-MI patients ( $n=18$ )

	Two Weeks Mean (SD)	Three Months Mean (SD)	% change	p-value
MSFI: Total Scores (range 2-30)*	8.9 (7.3)	14.6 (8.9)	18.8	0.03
Desire (range 1.2-6)	2.6 (1.6)	3.1 (1.3)	8.9	0.06
Arousal (range 0-6)	1.3 (1.8)	2.4 (2)	17.9	0.13
Erection (range 0-6)	1.2 (1.8)	2.8 (2.4)	27.8	0.01
Orgasm (range 0-6)	1.3 (2.2)	2.8 (2.5)	25.9	0.04
Satisfaction (range 0.8-6)*	2.2 (1.3)	2.9 (1.8)	11	0.18
PROMIS: Anxiety (range 0-20)	7.9 (3.1)	7.5 (3.1)	-2.2	0.57
PROMIS: Depression (range 0-20)	7.1 (2.6)	7.3 (3.4)	1.1	0.59
MSQ: Sexual Fear (range 0-20)	8.3 (5.9)	7.2 (5.5)	-5.3	0.4
CSI: Seeking Support (range 11-33)	20.5 (5.0)	20.4 (7.1)	-0.3	0.92
CSI: Problem Solving (range 11-33)	25.8 (4.7)	25.4 (5.8)	-1.2	0.76
CSI: Avoidance (range 11-33)	18 (3.7)	17.6 (4.6)	-1.3	0.68

MSFI: Male Sexual Function Index, MSQ: Multidimensional Sexuality Questionnaire, PROMIS: Patient-Reported Outcomes Measurement Information System.  
CSI: Coping Strategy Indicator

Higher scores on the MSFI total scores and subscales indicate higher sexual function. Higher scores on the PROMIS measurements indicate worse anxiety and depression. Higher scores on the MSQ indicate more sexual fear. Higher scores on the CSI subscales indicate greater use of coping strategies.

Paired sample t-test utilized for analysis

\* Satisfaction and total scores calculated with missing participants removed ( $n=4$ )

Table 4. 3 - Mean scores and changes on sexual function, anxiety, depression, and sexual fear in males post-MI by sexual status ( $n=18$ )

	Sexually Active ( $n=13$ )			Sexually Inactive ( $n=5$ )		
	Two Weeks Mean (SD)	Three Months Mean (SD)	% Change	Two Weeks Mean (SD)	Three Months Mean (SD)	% Change
MSFI: Total Scores (range 2-30)*	10.2 (8.2)	18.4 (7.7)	27.3 <sup>†</sup>	5.7 (1.6)	5 (1.0)	-2.3
Desire (range 1.2-6)	2.8 (1.7)	3.6 (1.1)	12.3	1.9 (1.0)	1.9 (1.0)	0
Arousal (range 0-6)	1.4 (2.0)	3.1 (2.0)	27.9 <sup>†</sup>	1.1 (1.1)	0.6 (0.8)	-8
Erection (range 0-6)	1.5 (2.0)	3.9 (2.0)	38.8 <sup>†</sup>	0.2 (0.2)	0.1 (0.2)	-1
Orgasm (range 0-6)	1.8 (2.4)	3.9 (2.0)	35.9 <sup>†</sup>	0	0	0
Satisfaction (range 0.8-6)*	2.3 (1.4)	3.4 (1.9)	15.3	2.0 (1.2)	2.0 (1.2)	0
PROMIS: Anxiety (range 0-20)	7.8 (3.1)	7.1 (2.4)	-3.5	8.4 (2.9)	8.6 (4.2)	1
PROMIS: Depression (range 0-20)	6.9 (2.3)	6.7 (2.6)	-1.2	7.6 (3)	9 (4.4)	7
MSQ: Sexual Fear (range 0-20)	6 (4.6)	5.5 (5.3)	-2.3	14.2 (4.6)	11.6 (3.3)	-13
CSI: Seeking Support (range 11-33)	20.5 (5.7)	21.4 (8)	2.6	20.4 (2.87)	17.8 (1.9)	-7.9
CSI: Problem Solving (range 11-33)	27.1 (4.1)	27.2 (5.2)	0.5	22.6 (4.6)	20.8 (4.5)	-5.5
CSI: Avoidance (range 11-33)	18.2 (3.7)	17.2 (3.8)	-3	17.6 (3.8)	18.6 (6.1)	3

Higher scores on the MSFI total scores and subscales indicate higher sexual function. Higher scores on the PROMIS measurements indicate worse anxiety and depression. Higher scores on the MSQ indicate more sexual fear. Higher scores on the CSI subscales indicate greater use of coping strategies.

Paired sample t-test utilized for analysis, <sup>†</sup> $p<0.05$

\* Satisfaction and total scores calculated with missing participants removed ( $n=3$  sexually active, 1 sexually inactive)

Table 4. 4 - Mean scores and changes on sexual function, anxiety, depression, and sexual fear in females over three months ( $n=3$ )

	Two Weeks Mean (SD)	Three Months Mean (SD)	% change	p-value
FSFI: Total Scores (range 2-36)*	13.7 (10.5)	16.3 (12.2)	7.1	0.5
Desire (range 1.2-6)	2 (1.1)	2.4 (1.7)	6.7	>0.99
Arousal (range 0-6)	1.6 (2.1)	2 (2.8)	6.7	>0.99
Lubrication (range 0-6)	2 (2.8)	2 (2.8)	0	-
Orgasm (range 0-6)	1.9 (2.6)	2 (2.8)	2.2	>0.99
Satisfaction (range 0.8-6)*	2.6 (0.6)	3.6 (0.8)	16.7	0.12
Pain (range 0-6)	0.4 (0.6)	0.4 (0.6)	0	-
PROMIS: Anxiety (range 0-20)	5.7 (2.4)	7 (2.5)	6.7	0.3
PROMIS: Depression (range 0-20)	6 (1.4)	8 (2.8)	10	0.4
MSQ: Sexual Fear (range 0-20)	4 (3.3)	5 (3.6)	5	0.42
CSI: Seeking Support (range 11-33)	20.7 (3.4)	15.7 (5.2)	-15.2	0.16
CSI: Problem Solving (range 11-33)	27.3 (4)	21.3 (7)	-18.2	0.23
CSI: Avoidance (range 11-33)	17.7 (3.7)	16.3 (1.7)	-4.3	0.66

Higher scores on the FSFI total scores and subscales indicate higher sexual function. Higher scores on the PROMIS measurements indicate worse anxiety and depression. Higher scores on the MSQ indicate more sexual fear. Higher scores on the CSI subscales indicate greater use of coping strategies.

Paired sample t-test utilized for analysis

\* Satisfaction and total scores calculated with missing participants removed ( $n=1$ )

## Figure Legend

Figure 4.1 - Baseline and follow up total and subscale MSFI scores in males post-MI ( $n=18$ )

Abbreviations: MSFI: Male Sexual Function Index

\* p-value < 0.05

\*\* p-value < 0.01

+ Satisfaction and total scores calculated with missing participants removed ( $n=4$ )

Figure 4.2 - Baseline and follow up MSQ, PROMIS, and CSI scores in males post-MI ( $n=18$ )

Abbreviations: PROMIS: Patient-Reported Outcomes Measurement Information System;  
MSQ: Multidimensional Sexuality Questionnaire; CSI: Coping Strategy Indicator

\* p-value < 0.05

\*\* p-value < 0.01

Figure 4.3 - Baseline and follow up total and subscale FSFI scores in females post-MI ( $n=3$ )

Abbreviations: FSFI: Female Sexual Function Index

\* p-value < 0.05

\*\* p-value < 0.01

+ Satisfaction and total scores calculated with missing participants removed ( $n=1$ )

Figure 4.4 - Baseline and follow up MSQ, PROMIS, and CSI scores in females post-MI ( $n=3$ )

Abbreviations: PROMIS: Patient-Reported Outcomes Measurement Information System;  
MSQ: Multidimensional Sexuality Questionnaire; CSI: Coping Strategy Indicator

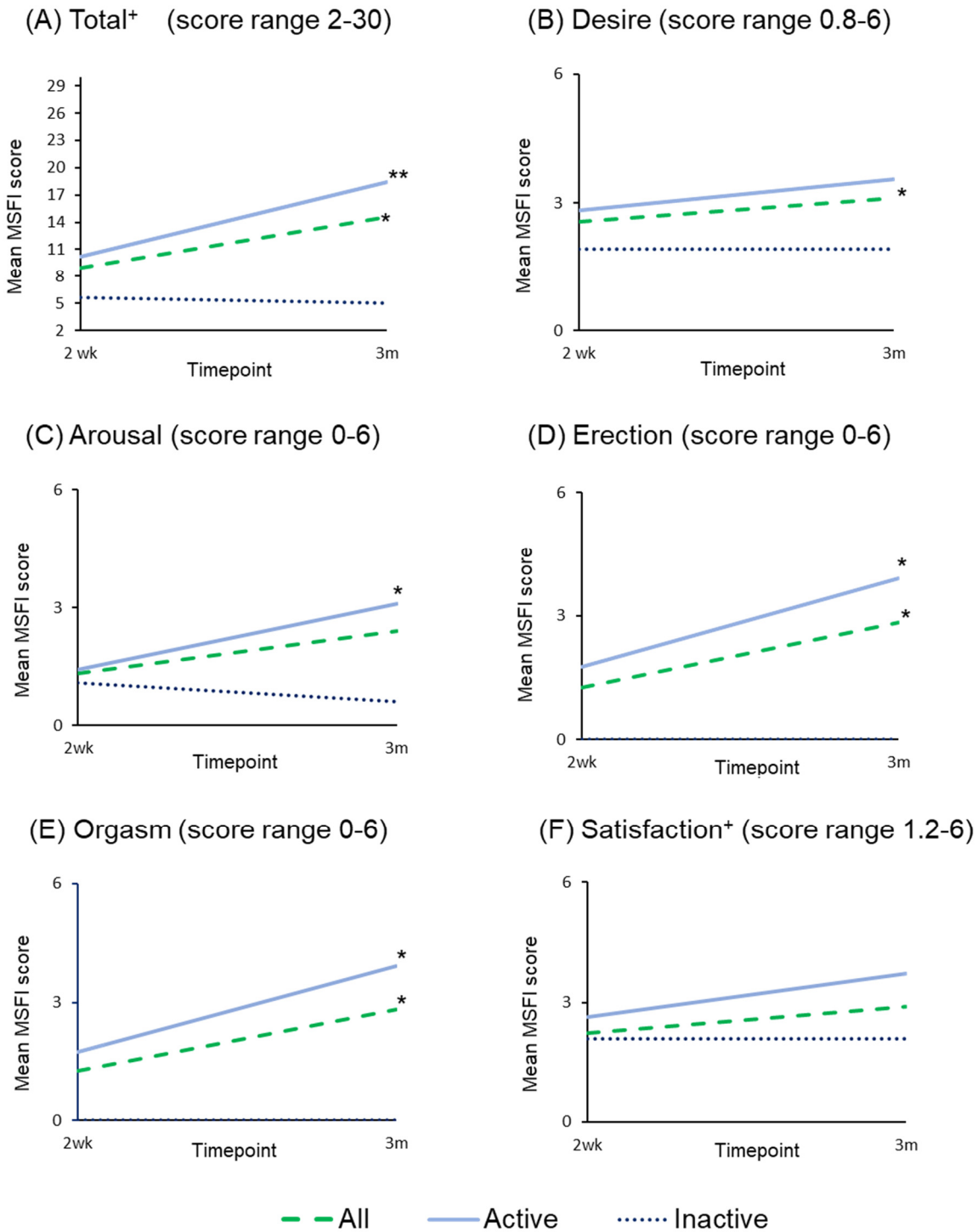
\* p-value < 0.05

\*\* p-value < 0.01

Figure 4.5 - Individual changes in MSFI scores from two weeks to three months in males post-MI ( $n=18$ )

Figure 4.6 - Individual changes in scores on the FSFI from two weeks to three months in females post-MI ( $n=3$ )

Figure 4. 1 - Baseline and follow up total and subscale MSFI scores in males post-MI (n=18)



Abbreviations: MSFI, Male Sexual Functioning Index

\* p-value < 0.05

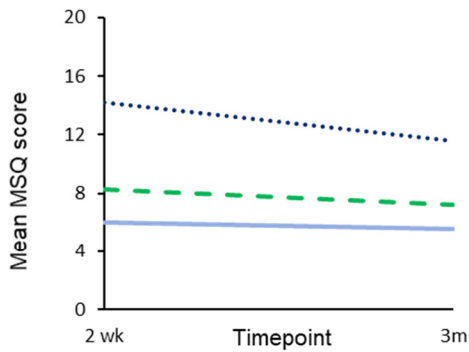
\*\* p-value < 0.01

+ Satisfaction and total scores calculated with missing data removed (4 participants)

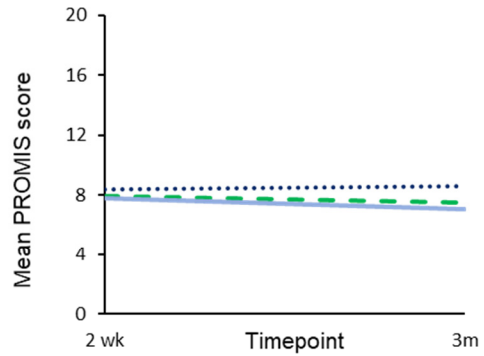


Figure 4. 2 - Baseline and follow up MSQ, PROMIS, and CSI scores in males post-MI ( $n=18$ )

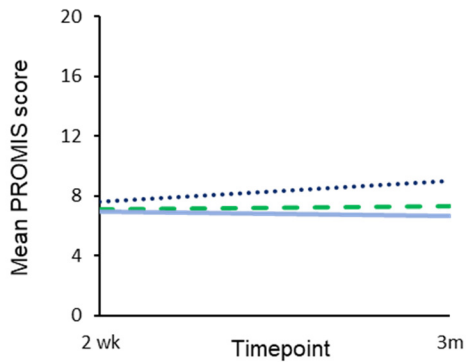
(A) Sexual Fear (score range 0-20)



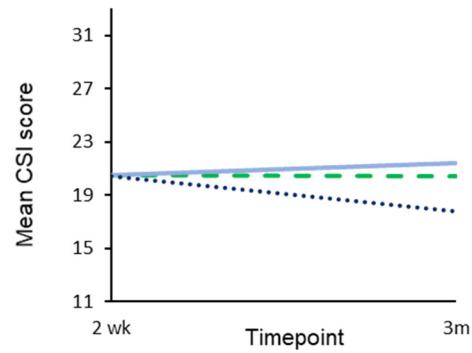
(B) Anxiety (score range 0-20)



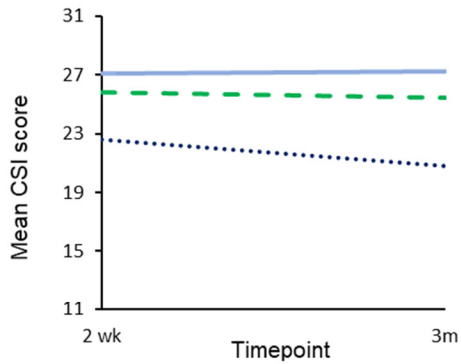
(C) Depression (score range 0-20)



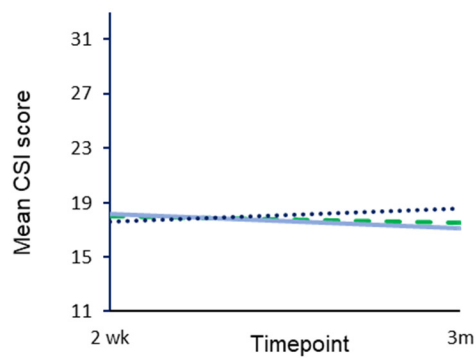
(D) Seeking Support (score range 11-33)



(E) Problem Solving (score range 11-33)



(F) Avoidance (score range 11-33)



--- All    — Active    ..... Inactive

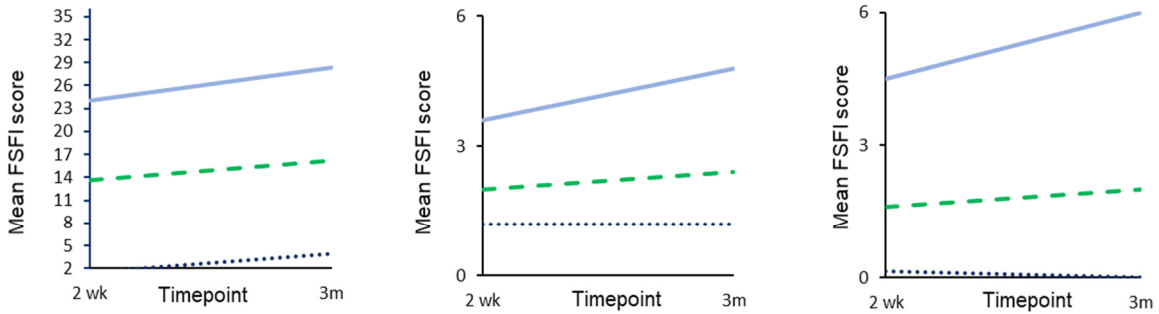
Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; MSQ, Multidimensional Sexual Questionnaire; CSI, Coping Strategy Indicator

\* p-value < 0.05

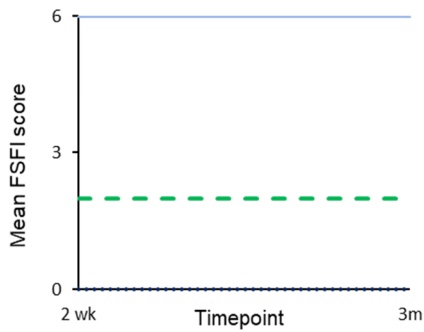
\*\* p-value < 0.01

Figure 4. 3 - Baseline and follow up total and subscale FSFI scores in females post-MI ( $n=3$ )

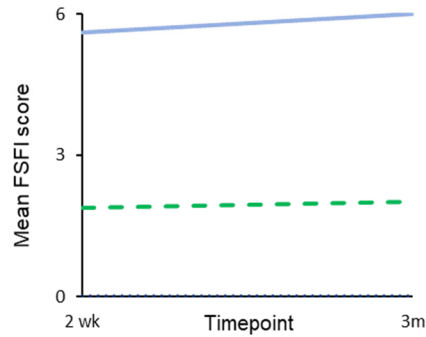
(A) Total\* (score range 2-36) (B) Desire (score range 0.8-6) (C) Arousal (score range 0-6)



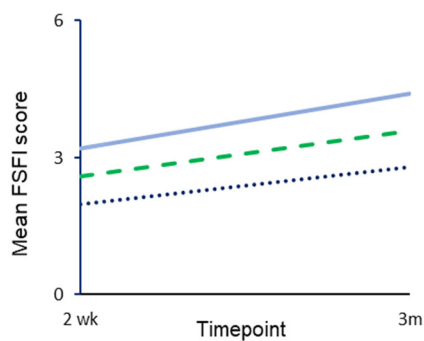
(D) Lubrication (score range 0-6)



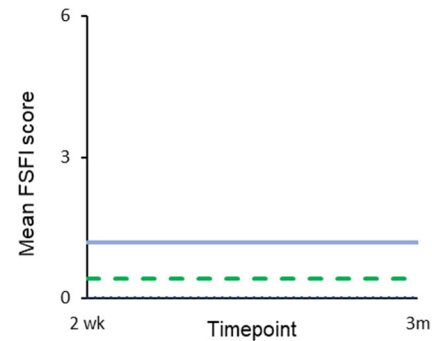
(E) Orgasm (score range 0-6)



(F) Satisfaction\* (score range 1.2-6)



(G) Pain (score range 0-6)



— All — Active ..... Inactive

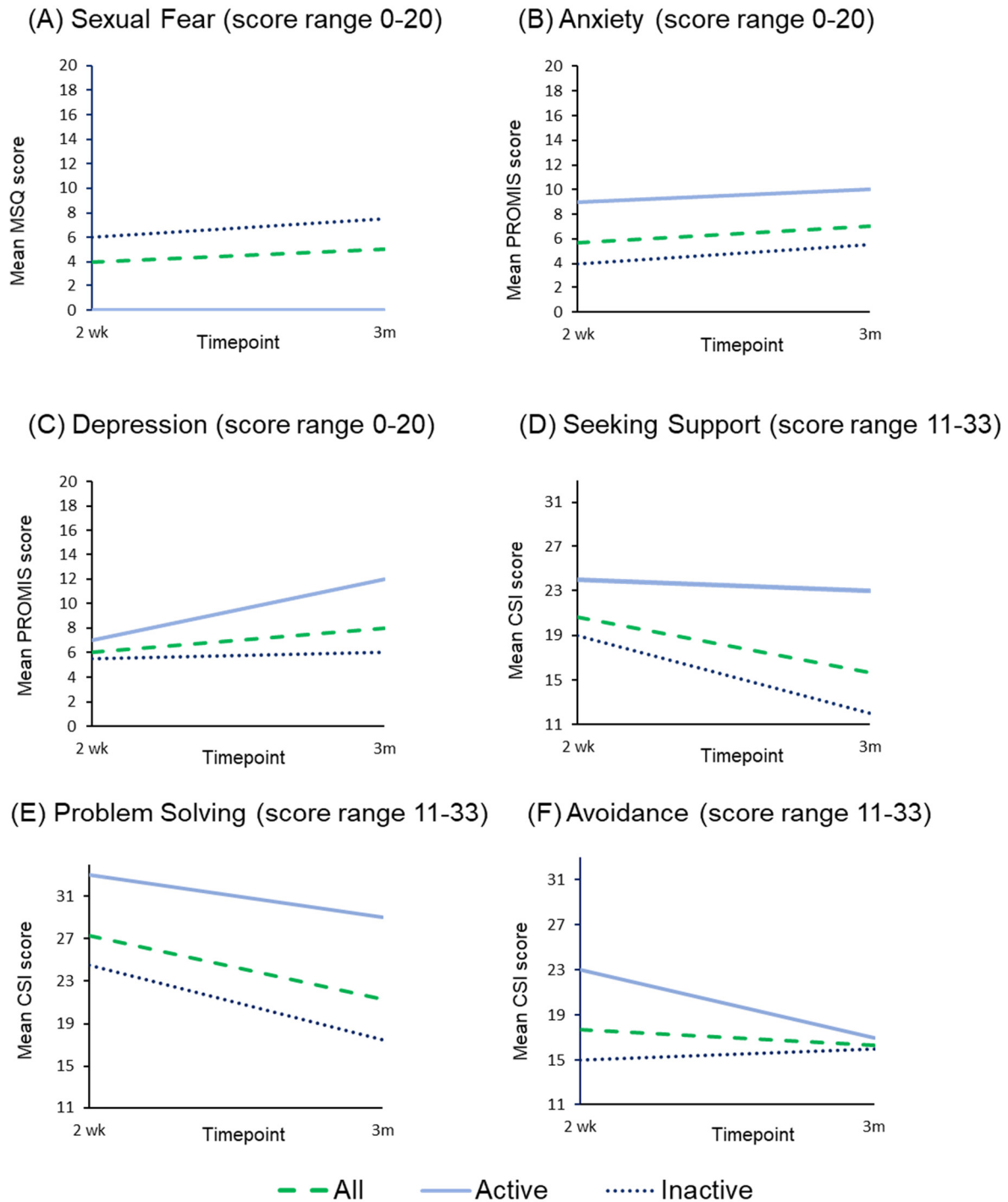
Abbreviations: FSFI: Female Sexual Functioning Index

\* p-value < 0.05

\*\* p-value < 0.01

+ Satisfaction and total scores calculated with missing data removed (1 participant)

Figure 4. 4 - Baseline and follow up MSQ, PROMIS, and CSI scores in females post-MI (n=3)



Abbreviations: PROMIS: Patient-Reported Outcomes Measurement Information System; MSQ: Multidimensional Sexual Questionnaire; CSI: Coping Strategy Indicator

\* p-value < 0.05  
 \*\* p-value < 0.01

Figure 4. 5 - Individual changes in MSFI scores from two weeks to three months in males post-MI ( $n=18$ )

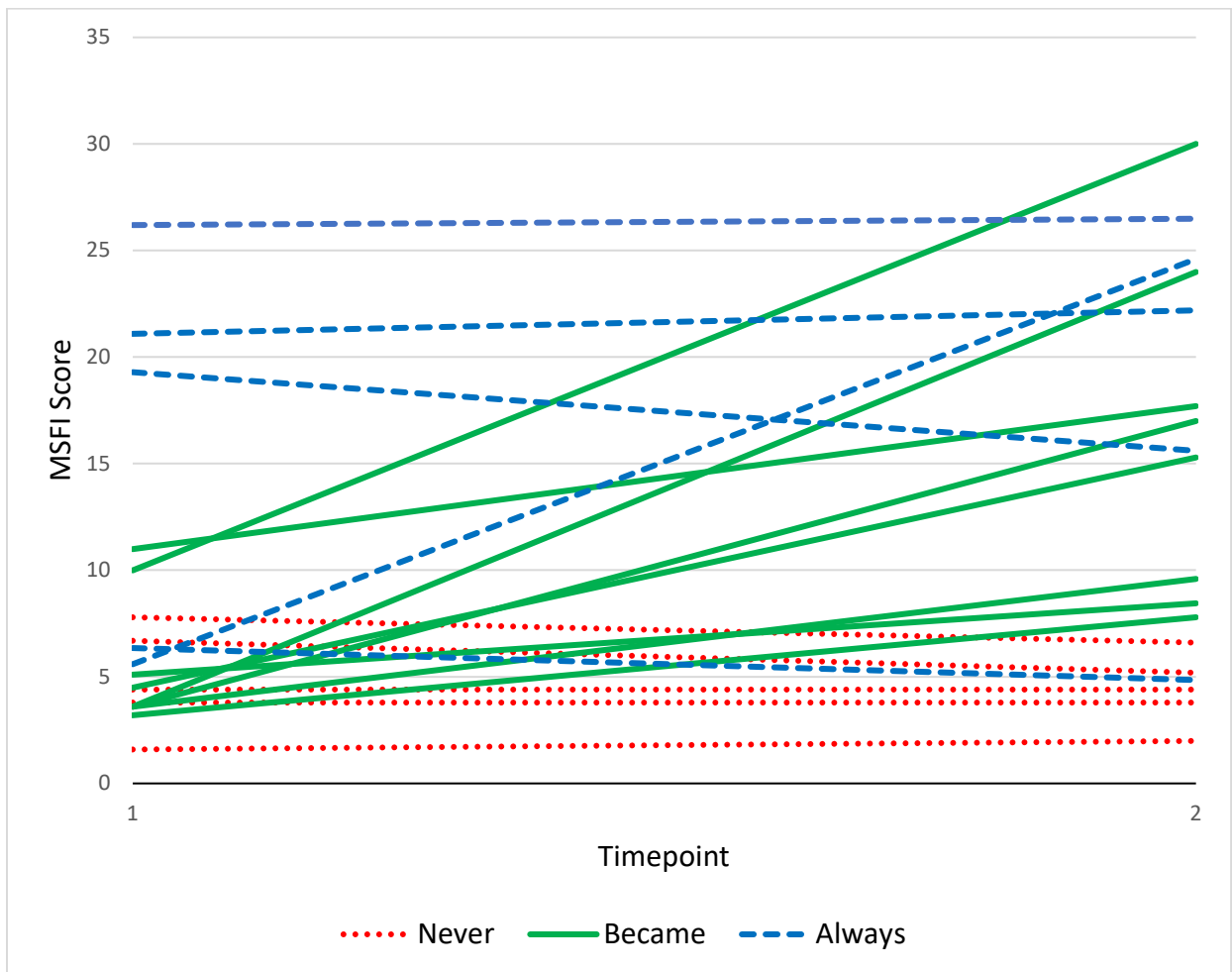
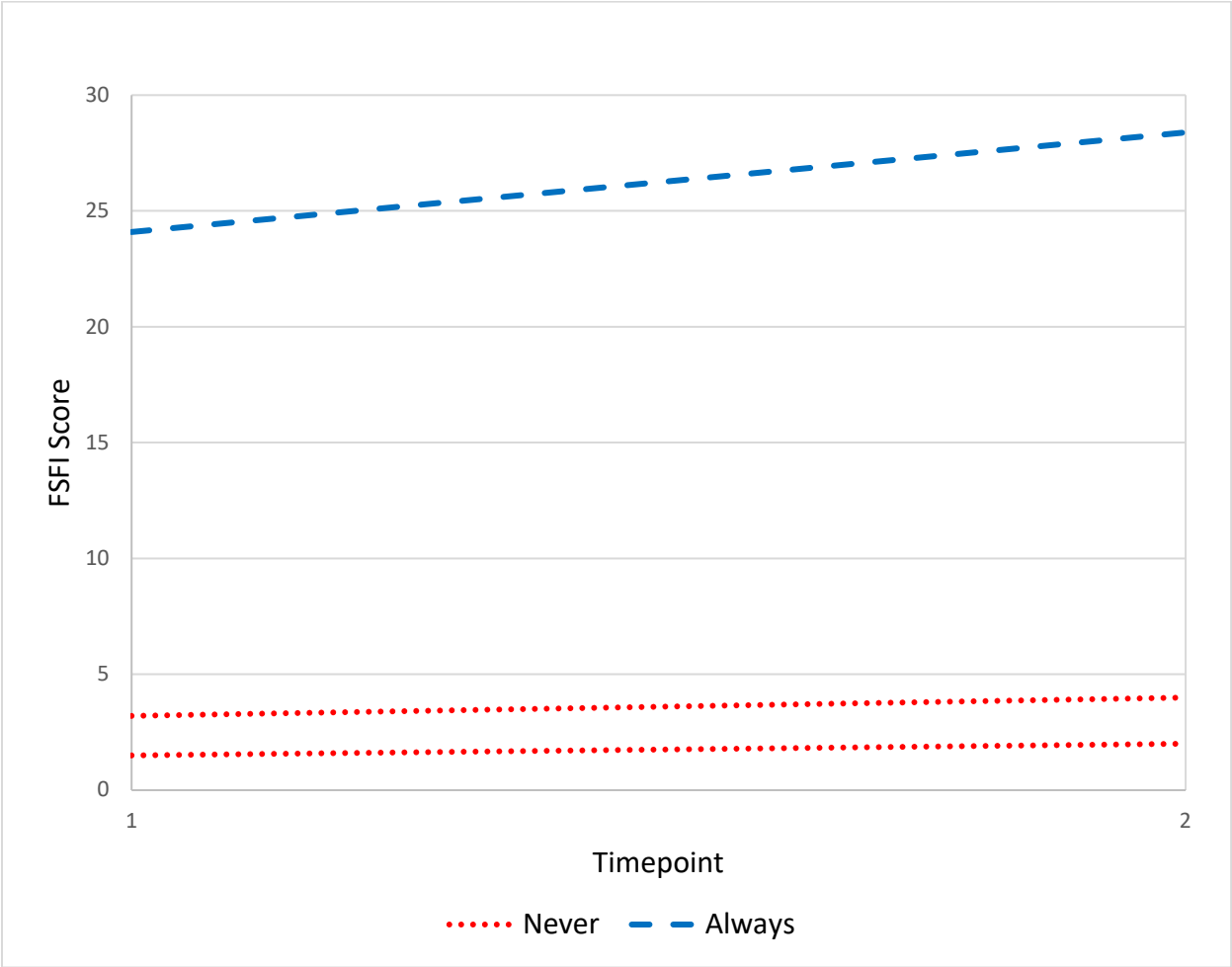


Figure 4. 6 - Individual changes in scores on the FSFI from two weeks to three months in females post-MI ( $n=3$ )



## CHAPTER V

### **Exploratory Modeling of Predictors of Sexual Function and Satisfaction Post-Myocardial Infarction**

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## **Abstract**

Sexual dysfunction often persists among males post-myocardial infarction (MI). However, there are no known modifiable targets for intervention. Identification of predictors is necessary to improve interventions for sexual dysfunction post-MI. This study aimed to explore modifiable predictive factors of higher sexual function and activity in a cohort of males post-MI. In a longitudinal study design, sexual function (MSFI), sexual fear (MSQ), anxiety and depression (PROMIS), and coping strategies (CSI) data were collected from 18 males post-MI at two weeks and three months post discharge. Linear regression and logistic regression models were conducted for sexual function and activity, respectively, while controlling for age. Sexual fear and problem-solving/seeking support coping strategies were moderately correlated with MSFI scores at three months. Problem-solving and support-seeking strategies also predicted increased function at three months (seeking support 1.47,  $p < 0.01$ ; problem-solving 0.95,  $p = 0.02$ ). However, additional studies are needed to further examine these preliminary relationships.

*Keywords:* Prediction, sexual dysfunction, myocardial infarction

## **Introduction**

Myocardial infarction (MI) can negatively impact male sexual function and satisfaction (Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). While many patients resume sexual activity post-event, sexual function problems often persist among sexually active men (Lindau et al., 2014; Lindau et al., 2016). This is due to the impact of MI on blood flow to sex organs which impairs erectile function and orgasm (Vlachopoulos, Jackson, Stefanadis, & Montorsi, 2013). Recent estimates of sexual dysfunction in men post-MI are approximately 59.4% (Lindau et al., 2014).

While there is some literature establishing the physiologic sequelae of MI and sexual dysfunction, additional research has begun to examine contributing factors. Diagnosis and treatment of MI can subsequently increase depression, anxiety, and fear of causing a repeat event post discharge, particularly while sexually active. Cross-sectional descriptive studies have linked anxiety to decreased sexual satisfaction and general avoidance of sexual activity (Steinke et al., 2013). A recent cohort study of 99 reported anxiety rates of 37% among patients post-MI, compared to 7% in a general population (Daniel et al., 2018). Other studies have found that anxiety can persist upwards of five months into recovery post-MI (Steinke & Swan, 2004).

Like anxiety, depression has also been associated with reduced interest for sexual activity and intimacy engagement (Steinke, Mosack, Hertzog, & Wright, 2013; Steinke & Wright, 2006). Depression rates were reported as high as 35% in post-MI patients and were considerably higher than the general population (9%) (Daniel et al., 2018). Previously conducted cross-sectional studies have found that increased depression was associated with decreased sexual function and reduced health-related quality of life (Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). An additional cross-sectional study of 493 patients found that depression



was a large mediator of associations between sexual dysfunction and quality of life (Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). A systematic review and meta-analysis also found a bidirectional relationship between depression and sexual dysfunction (Atlantis & Sullivan, 2012).

In addition to depression and anxiety, some patients post-MI can experience fear of inducing a repeat event during sexual activity. Sexual fear has been associated with avoidance from sexual activity which can exacerbate depression and anxiety (Kazemi Saleh, Pishgou, Assari, & Tavallaii, 2007). Two cross-sectional studies have reported prevalence rates of sexual fear from 58.82% (Eyada & Atwa, 2007) to 88.4% (Oskay, Can, & Camci, 2015). Qualitative studies have also reported that patients expressed both sexual fear and subsequently desired recommendations regarding the proper timing for returning to sexual activity (Garcia, Denardin Budó, Schwartz, Simon, & da Silva, 2015; Søderberg, Johansen, Herning, & Berg, 2013).

The trajectory of diagnosis, treatment and discharge post-MI leaves many patients facing new challenges both with sexual health and other domains of life. As a result, both patients and partners wish to develop positive coping strategies in managing of post-infarction depression and anxiety (Nilsson, Ivarsson, Alm-Roijer, & Svedberg, 2013). There is some preliminary evidence to support the effect of coping strategies as a mediator of distress and well-being post-MI. A previous cross-sectional quantitative study of 121 male post-MI patients found a mediating effect of emotion-focused coping over time on negative emotions and general well-being (Kroemeke, 2016). Indeed, higher anxiety and depression have been linked to negative coping and thus to decreased quality of life, which may also extend to issues of sexuality (Son, Friedmann, Thomas, & Son, 2016).

While current evidence has demonstrated possible positive associations between depression, anxiety, sexual fear, and coping on sexual function, little prediction research has been conducted in this population. Overall, the existing literature remains largely descriptive, and so identifying predictors of sexual function is a necessary step towards developing interventions that can support patients' sexual recovery after MI. This gap has become evident in a recent meta-analysis which found an overall poor quality of evidence and minimal effect sizes for interventions such as sexual counseling or therapy (Byrne et al., 2016). Identifying predictors of sexual function and satisfaction will be crucial for development of an effective intervention. Therefore, the primary aim of this study was to identify modifiable predictive factors of higher sexual function among males at three months post-MI. A secondary aim was to identify the predictors of engaging in sexual activity at three months after MI.

## **Methods**

We conducted a prospective longitudinal cohort study design that measured sexual function and satisfaction at two weeks and three months post-discharge. Recruitment took place in a Midwestern teaching hospital, where patients were consented at the bedside, then mailed two packets of questionnaires to complete at two weeks and three months following their discharge. This study only analyzed the males consented due to sample size limitations (only 3 females completed all survey items). Institutional Review Board (IRB) approval was obtained before recruitment and data collection.

### **Study Population**

A total of 52 adult males who had experienced an MI and were hospitalized were consented for this study. A diagnosis of MI in the patient record combined with a troponin value exceeding the 99th percentile of a normal reference population was used to assess for patient

eligibility (>18 ng/mL) (Thygesen et al., 2012). Other inclusion criteria were the ability to read and write in English. Patients were excluded if they were medically unstable (suicide, alcohol withdrawal), had a diagnosis of COPD, HIV, or prostate cancer, or had an overall life expectancy of less than 1 year. Of the 52 males that signed informed consent, 18 individuals returned all survey materials (final study completion rate was 34.6%).

### **Measures**

The dependent variable of sexual function was measured using the Male Sexual Function Index (MSFI). The MSFI utilizes the same question structure and subscales of the Female Sexual Function Index (FSFI) (Rosen et al., 2000), which is considered the gold standard in sexual function measurement. However, the MSFI uses an erection subscale instead of lubrication and removes the pain with intercourse subscale (Kalmbach, Ciesla, Janata, & Kingsberg, 2012). The Cronbach's alphas for the MSFI total scores and subscales range from 0.66 to 0.85 with a score range of 0-30 (Kalmbach et al., 2015). A higher score indicates greater sexual function. The hypothesized predictors that were selected based on the current best empirical evidence included sexual fear, anxiety, depression, and coping strategies. Sexual fear was measured using the sexual fear subscale of the Multidimensional Sexuality Questionnaire (MSQ) (Snell, Fisher, & Walters, 1993). The MSQ has a Cronbach's alpha of 0.82 and a score range of 0-20, with higher scores indicating more sexual fear. Anxiety and depression were measured with the Patient-Reported Outcomes Measurement Information System (PROMIS) – Anxiety and Depression Short Form 4a (Cella et al., 2007). These two measurements are scored from 0-20, with a Cronbach's alpha of 0.93 for depression and 0.89 for anxiety (Kroenke, Yu, Wu, Kean, & Monahan, 2014). A higher score indicates more depression and anxiety. Lastly, use of coping strategies was measured with the Coping Strategy Indicator (CSI) (Amirkhan, 1990). The CSI

consists of three subscales: Seeking Support, Problem Solving, and Avoidance. The subscales have a Cronbach's alpha of 0.84 to 0.93, and each is scored from 11-33, with higher scores indicating greater use of coping strategies (Amirkhan, 1990).

Demographic variables that were collected included education status, employment status, marital status, and status within cardiac rehabilitation. Cardiac function was assessed with left ventricular ejection fraction (LVEF) percentages. Whether the MI was ST or non-ST segment elevated (STEMI/NSTEMI) and troponin values were used to assess for severity of the MI. Demographic variables were collected with a separate questionnaire, while LVEF, troponin and MI severity data (STEMI/NSTEMI) were collected from the medical record.

### **Statistical Analyses**

Means and standard deviations of the demographic data were calculated using descriptive statistics. The dependent variable of sexual function and satisfaction were operationalized using the MSFI and its subscales and was structured as a continuous outcome. Linear regression modelling was done to check for multicollinearity. A Shapiro-Wilk test was conducted to check for the normality of the data. Spearman rank correlation tables were created for the two timepoints of independent and predictor variables. A weak correlation coefficient was 0.1-0.39, a moderate correlation coefficient was 0.4-0.69, and a strong correlation coefficient was 0.7-0.99 (Schober, Boer, & Schwarte, 2018). T-score transformation of depression and anxiety scores was calculated to assess for clinical significance (Rothrock, Amtmann, & Cook, 2020).

Modeling for both the primary and secondary aims was conducted using SAS software version 9.4 (SAS Institute, Cary, NC). Power analysis for both aims was performed using a treatment by time approach with two groups of covariate scores (low and high) in SAS. A

hypothesized data set with means for each group of predictor scores across the two timepoints was conjectured prior to data collection (Castelloe, 2014). The results of the power analysis using this method for improved sexual function with a sample of 14 equaled 0.936.

For the primary aim of improved sexual function, linear regression was used to model three-month sexual function data. In the model, three-month function scores were the dependent variable while the predictors utilized the collapsed change scores, and age. Four participants did not provide complete answers to the MSFI satisfaction subscale and so they were excluded from this analysis. The missing questions all dealt with the presence of a partner, so they were not likely to be missing at random and so imputation was deemed not appropriate. Individual analyses were conducted with each predictor as the sample size precluded the inclusion of all effects in one model.

For the secondary aim of sexual activity, logistic regression was applied using the change scores in covariates as the independent variable while controlling for age. The entire sample of 18 was used for this analysis. A power analysis utilizing the same methods described above with a sample size of 18 equaled 0.993. Activity status at three months was coded as a binary variable (0=not active, 1=active). As in the primary aim, individual analyses were conducted with each predictor separately. A statistical significance level of 0.05 was applied for both analyses.

## **Results**

The sample consisted of 17 Caucasian men and one Native American man. The sample was aged 60.5 (SD 13.6) years with a range of 29 to 86 years. The sample of males was primarily married (61.1%), while 33.3% were either single, divorced, or widowed. Half the male participants were well educated with at least a college degree, and half were still employed. The

sample was below a normal LVEF compared to a reference population (48.5, normal 55%-70%). Three-month scores on the MSFI fell along an approximately normal distribution (Shapiro-Wilk  $p$ -value= 0.1). There was no evidence of multicollinearity between the covariates within the total sample (tolerance range 0.2-0.8; variance inflation range 1.20-4.6; eigenvalue range 0.01-4.6). Table 5.1 presents the sociodemographic and clinical characteristics of the sample.

The longitudinal results are described in a previous paper and are briefly summarized here. Approximately 28% of the sample was sexually active at two weeks which improved to 72% at three months. Sexual function scores improved in approximately 61% of the males sampled. Depression scores worsened slightly among all male participants, while anxiety improved slightly. Sexual fear scores improved slightly, while use of problem-solving and seeking support coping strategies decreased among all males but improved among those who were sexually active. None of the longitudinal changes in covariates were statistically significant.

First examined were the correlations at the two week timepoint. None of the predictor variables at two weeks showed moderate or strong correlations with total MSFI scores at the same timepoint. Moderate strength positive correlations within the two-week variables were found among fear with depression ( $r= 0.49$ ), anxiety with depression ( $r= 0.48$ ), and use of avoidance coping strategies with both anxiety ( $r= 0.57$ ) and depression ( $r= 0.64$ ). Use of problem-solving coping was positively correlated with use of social support coping at two weeks ( $r= 0.49$ ). Table 5.2 displays correlations among the total MSFI scores and covariates at two weeks and three months.

Second, correlations at the three-month timepoint were examined. Worsened sexual fear scores were associated with decreased MSFI scores ( $r= -0.67$ ). Unsurprisingly, anxiety and

depression at three months were strongly correlated ( $r= 0.88$ ). Although worse anxiety was associated with improved coping at two weeks, this did not continue at the three-month timepoint. Interestingly, use of support-seeking and problem-solving coping strategies at three months were positively correlated with MSFI scores at three months ( $r= 0.56$ ,  $r= 0.67$ ). Use of avoidance coping strategies was positively correlated with both anxiety ( $r= 0.50$ ) and depression scores ( $r= 0.58$ ) at three months. Comparable to what was observed at two weeks, use of problem-solving and seeking support coping strategies were also positively intercorrelated at three months ( $p= 0.47$ ).

Third, we examined correlations from two weeks to three months. As expected, scores on the MSFI at two weeks were positively correlated with MSFI scores at three months ( $r= 0.46$ ). However, none of the two-week covariates were significantly associated with MSFI scores, with the exception being sexual fear which presented a similar negative correlation ( $r= -0.44$ ). All the covariates at two weeks were either moderately or strongly positively correlated with their three-month counterparts (fear:  $r= 0.61$ ; anxiety:  $r= 0.54$ ; depression:  $r= 0.80$ ; seeking support:  $r= 0.77$ ; problem-solving:  $r= 0.51$ ; avoidance:  $r= 0.48$ ). A strong positive correlation was observed between depression at two weeks and anxiety at three months ( $r= 0.77$ ). Two-week fear scores were positively correlated with three-month anxiety and depression scores (anxiety:  $r= 0.48$ ; depression:  $r= 0.45$ ). Lastly, two-week depression scores and fear scores were negatively correlated with problem-solving coping strategies at three months (depression:  $r= -0.50$ ; fear:  $r= -0.56$ ). Depression scores at two weeks were also negatively correlated with avoidance coping strategies at three months ( $r= 0.59$ ). Figure 5.1 displays the full correlation matrix of the two week and three-month MSFI and covariate scores. Figure 5.2 displays bivariate plots between the predictors and 3-month MSFI scores.

The individual regression models for the primary aim of better sexual function produced negative effects for anxiety ( $\beta$  coeff.= -0.43), depression ( $\beta$  coeff.= -1.23), and fear ( $\beta$  coeff.= -0.31). For coping, a statistically significant positive effect was found for seeking support ( $\beta$  coeff.= 1.47,  $p < 0.01$ ) and problem-solving ( $\beta$  coeff.= 0.95,  $p = 0.02$ ), while a non-statistical significant negative effect was found for avoidance coping strategies ( $\beta$  coeff.= -0.55). The variance explained in the model by each predictor was low, except for support-seeking ( $R^2 = 0.64$ ) and problem-solving ( $R^2 = 0.44$ ) coping strategies. Despite these findings, the effect sizes were still relatively small, with a 1-point change in the predictors from two weeks to three months only predicting a <5% overall change in the MSFI. Regression models for the secondary aim of activity status did not produce statistically significant effects, and the overall odds ratios were small with the exception of depression and use of support-seeking coping strategies (fear odds ratio: 1.1; anxiety odds ratio: 0.91; depression odds ratio: 0.66; seeking support odds ratio: 1.5; problem-solving odds ratio: 1.09; avoidance odds ratio: 0.89). An unexpected finding was that fear predicted negative MSFI scores but an increased likelihood of returning to activity at three months. Table 5.2 displays both models of increased function and activity with a 95% confidence interval (CI) and p-values, and  $R^2$  values for the increased function models.

## **Discussion**

This study modeled several potential predictors of sexual function and activity at three months post discharge in a post-MI population utilizing multidimensional longitudinal data. Previous predictive research has utilized cross-sectional data in general cardiac patients, lumping MI with coronary/peripheral bypass, pacemaker and defibrillator implantation, heart failure, and angina (Mosack, Hill, & Steinke, 2015). This study adds to the literature by examining a different subset of psychosocial predictors and measuring a post-MI sample instead of a general



cardiac population, which to our understanding has not been studied previously. Given that longitudinal studies have reported a potential protective effect of sexual activity on cardiac risk in older patients, understanding the predictors of enjoyable sexual activity in post-MI patients are important to elucidate given their unique demarcation from other cardiac conditions (Liu, Waite, Shen, & Wang, 2016). However, previously conducted longitudinal studies of function in patients post-MI have only focused on sexual activity or percentage of sexual problems (Lindau et al., 2016; Lindau et al., 2012). These studies do not capture severity of functional problems, which are crucial for optimal assessment and intervention (Steinke et al., 2013). Furthermore, the effects of MI on sexual function in males outside of erection are understudied. The MSFI measures frequency and severity of orgasmic, erectile and arousal problems as well as satisfaction with both functional and overall emotional closeness and sex life, which provide a more robust representation of function (Kalmbach, Ciesla, Janata, & Kingsberg, 2012).

While there are no studies that model predictors of function post-MI, two studies have identified possible predictors of sexual activity in men. These included having a discussion with a physician, and having a partner (Lindau et al., 2016; Lindau et al., 2012). However, these studies did not measure anxiety, depression, fear, or use of coping strategies as potential predictors, and did not model for dysfunction. While these two previous studies modeled for activity status, this study did not find any significant effects in the activity models. Additionally, this study did not produce a significant predictive effect for anxiety or depression. This may be due to a floor effect among covariate scores in the sample. Approximately 57% of depression and 42-47% of anxiety t-scores were within normal limits, and an additional 19-33% of anxiety and depression t-scores were of mild severity. There were also relatively few moderate and no severe cases of either anxiety or depression.

Scores on the MSFI and all the covariates showed moderate correlations from two weeks to three months. Furthermore, scores on anxiety, depression and sexual fear were often intercorrelated, which is supported by previous literature detailing the high rates of depression and anxiety among post-MI populations (Daniel et al., 2018). Consistent with the correlation tables, the final models found that sexual function scores were negatively affected by increased age, anxiety, and depression, though these effect sizes were modest. Nonetheless, the negative relationships between age, anxiety and depression with sexual function seen in the models are expected findings based on the current cross-sectional literature (Daniel et al., 2018; Steinke, Mosack, Hertzog, & Wright, 2013). Altogether, the findings and models provide preliminary evidence that worsening depression and anxiety over time could decrease sexual function at three months. This constitutes a unique contribution to the current literature; while previous cross-sectional research has measured associations between sexual fear, anxiety, depression or coping strategies in tandem with sexual function, this has not been previously conducted in a longitudinal study (Steinke & Wright, 2006). However, it is important to consider the low overall effect size and  $R^2$  of anxiety and depression, which affects the clinical significance. Additionally, for every unit increase in change scores of anxiety or depression over time, function decreased by only 1.43% and 4.1% in this model.

An interesting finding is that as fear worsened, sexual function worsened both in the correlation tables and in the models, while the activity models produced an increased odds ratio. However, the observed odds ratio was relatively modest, and the confidence interval included both negative and positive values, so this relationship could be explored further with a larger sample. Additionally, this is the first study that examined the effect of coping strategies on sexual function. While previous literature has found a mediating effect of coping on several

affective outcomes (anxiety, depression), this has not been previously combined with changes to sexual function (Kroemeke, 2016). Alongside the promising relationships seen in the correlation matrix, both support-seeking and problem-solving strategies produced statistically significant predictors of increased function scores at three months. However, like with anxiety and depression, the overall net changes to function were among 3-4%. Regardless, these exploratory findings provide some interesting preliminary data that could be researched further.

While this study improves our understanding of factors that influence sexual activity and function, there are additional environmental predictors that may warrant further investigation. Examples of external predictors may include availability of sexual counseling services, the partner's sexual function and interest, and presence of dyadic support. Furthermore, while functional problems have been studied more robustly in women (Oskay, Can, & Camci, 2015), there is little research on predictors in female post-MI patients. Additional research is needed to understand how predictors of sexual function in women may compare to men.

The results of this study were affected by some limitations. One shortcoming was that the sample was predominately white, well educated, and married, which limits generalizability to other populations. However, this sample did include other marital statuses including participants who were unpartnered, which are understudied in the sexual health literature. As mentioned, the small sample size limits the ability to make clinical recommendations, and so caution should be used in implementing these results into practice. As this was largely an unadjusted analysis, future research with a larger sample could also include clinical predictors such as cardiac function, and should also control for additional covariates.

## **Implications for Practice/Research**

While the limited sample size prevents specific clinical recommendations, it has been previously documented that patients post-MI desire discussion with their providers about sexual function issues. Approximately 39.1% of sexually active males and 17.9% of sexually active females discuss sexual health with their physician post-MI (Lindau et al., 2012), and this partially stems from a lack of provider knowledge (Byrne, Doherty, McGee, & Murphy, 2010; Jaarsma et al., 2010). This study addresses a current gap in knowledge by identifying changes and factors associated with sexual function at a short term timepoint post discharge. Facilitating communication and education has improved intimacy between the individual and their partner (D'Eath, Byrne, Doherty, McGee, & Murphy, 2013). Another future direction would be to examine if utilization of coping strategies is either a mediator or moderator of function, and if coping strategies could be utilized as a modifiable target in intervention research and ultimately practice.

## **Key Highlights**

- Utilization of positive coping strategies and decreased sexual fear were associated with MSFI scores at three months.
- The study found statistically significant correlations among anxiety and depression scores with avoidance based coping strategies at three months, and relationships between sexual fear with anxiety and depression.
- Use of support-seeking and problem-solving coping strategies were identified as a significant predictor of sexual function in the final model.

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## Tables and Figures

Table 5. 1 - Characteristics of study participants

	Male ( <i>n</i> =18)
Sociodemographic characteristics	60.5 (13.6)
Mean age (SD) in years	
Race, No. (%)	
White/Caucasian	17 (94.4)
Other	1 (5.6)
Marital status, No. (%)	
Single	2 (11.1)
In a relationship	2 (11.1)
Married	11 (61.1)
Divorced	2 (11.1)
Widowed	1 (5.6)
Education status, No. (%)	
Some high school	2 (11.1)
High school degree	2 (11.1)
Some college	5 (27.8)
College degree	3 (16.7)
Graduate degree	6 (33.3)
Rehabilitation status, No. (%)	
Currently enrolled	3 (16.7)
Planning to enroll	7 (38.9)
Not enrolled	8 (44.4)
Employment status, No. (%)	
Employed	9 (50)
Unemployed	1 (5.6)
Retired	6 (33.3)
Medical leave	2 (11.1)
Clinical characteristics	
MI Severity, No. (%)	
STEMI	7 (38.9)
NSTEMI	11 (61.1)
Mean troponin (SD) in ng/mL	1081.9 (2314)
Mean LVEF (SD) in %	48.5 (12.3)

LVEF: Left Ventricular Ejection Fraction; (N)STEMI: (Non)ST-Segment elevated Myocardial Infarction

## Figure Legend

Figure 5.1 - Bivariate plots of association between predictors and sexual function scores at long-term (three months) follow-up

Abbreviations: MSFI: Male Sexual Function Index; PROMIS: Patient-Reported Outcomes Measurement Information System; MSQ: Multidimensional Sexuality Questionnaire; CSI: Coping Strategy Indicator

Lines represents least-squares regression and dashed line represents LoWeSS (locally weighted scatterplot smoothing) moving average fitted curve

Figure 5.2 - Unadjusted associations between predictors and sexual function scores at short-term (two weeks) and long-term (three months) follow-up

Abbreviations: MSFI: Male Sexual Function Index

rs: Spearman correlation coefficient

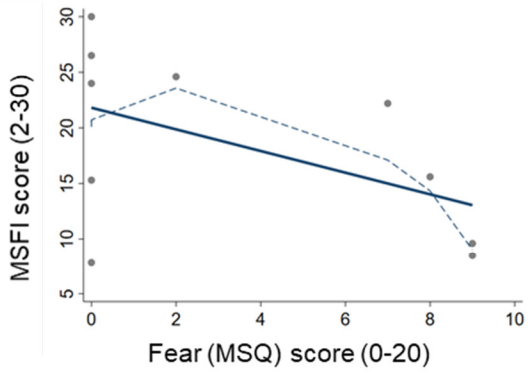
\* p-value < 0.05

\*\* p-value < 0.01

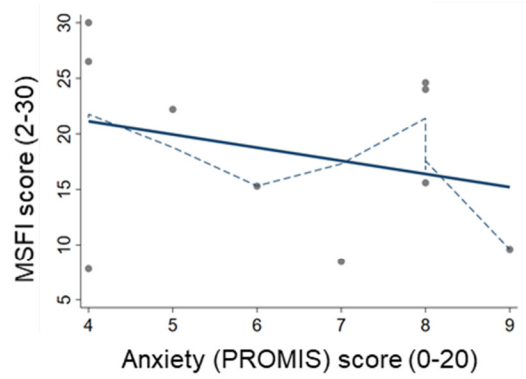
+ Total scores calculated with missing participants removed ( $n=4$ )

Figure 5. 1 - Bivariate plots of association between predictors and sexual function scores at long-term (three months) follow-up

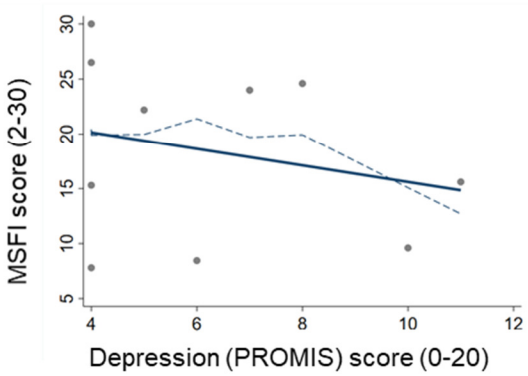
(A) Fear



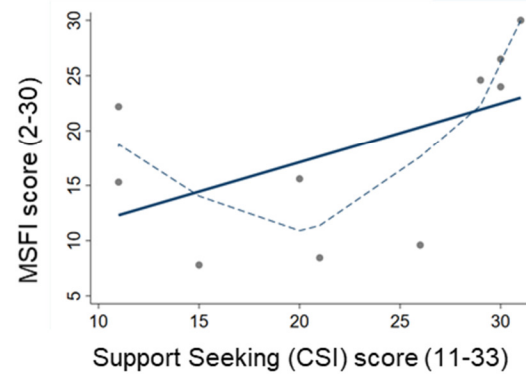
(B) Anxiety



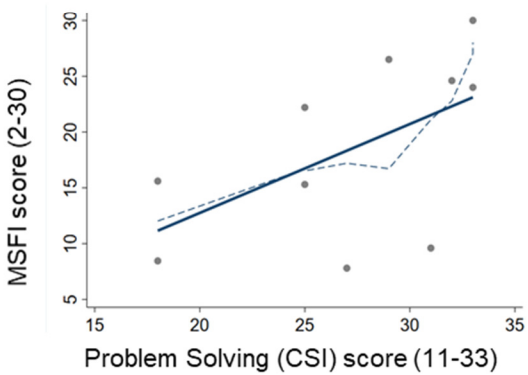
(C) Depression



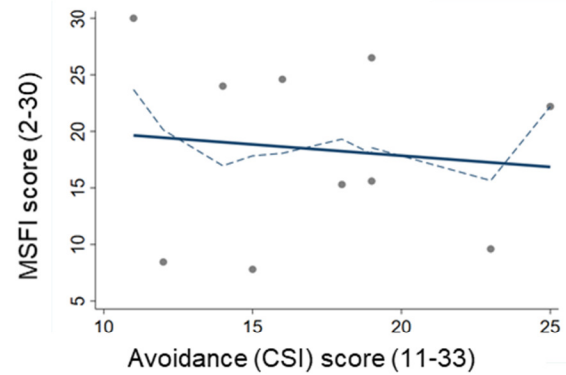
(D) Support Seeking



(E) Problem solving



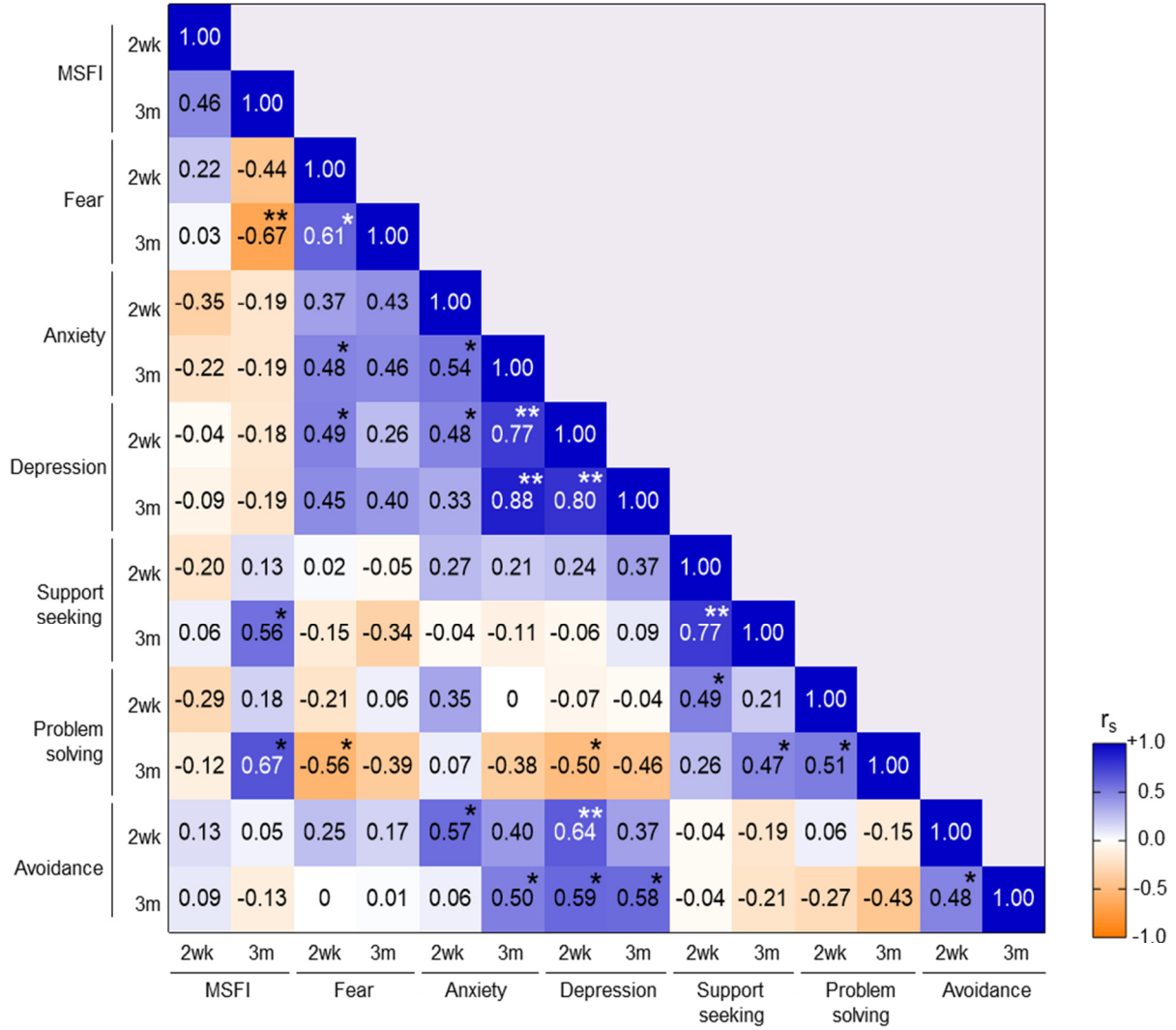
(F) Avoidance



Abbreviations: MSFI: Male Sexual Function Index; PROMIS: Patient-Reported Outcomes Measurement Information System; MSQ: Multidimensional Sexual Questionnaire; CSI: Coping Strategy Indicator

Lines represents least-squares regression and dashed line represents LoWeSS (locally weighted scatterplot smoothing) moving average fitted curve

Figure 5. 2 - Unadjusted associations between predictors and sexual function scores at short-term (two weeks) and long-term (three months) follow-up



Abbreviations: MSFI: Male Sexual Function Index

$r_s$ : Spearman correlation coefficient

\* p-value < 0.05

\*\* p-value < 0.01

Table 5. 2 - Association between predictors and 3-month sexual function scores and sexual activity status while controlling for age

	Function ( <i>n</i> =14)					Activity ( <i>n</i> =18)	
	Intercept	$\beta$ (95% CI)*	% of MSFI	p-value	R <sup>2</sup>	Odds (95% CI)	p-value
Increasing sexual fear (MSQ)	24.4	-0.31 (-1.47, 0.83)	-1.03%	0.55	0.09	1.1 (0.87, 1.37)	0.73
Increasing anxiety (PROMIS)	24.3	-0.43 (-2.31, 1.4)	-1.43%	0.62	0.08	0.91 (0.65, 1.26)	0.84
Increasing depression (PROMIS)	25.8	-1.23 (-4.4, 1.9)	-4.1%	0.41	0.11	0.66 (0.38, 1.16)	0.35
Increasing seeking support (CSI)	19	1.47 (0.71, 2.23)	4.9%	<0.01	0.64	1.5 (0.9, 1.8)	0.39
Increasing problem solving (CSI)	27.5	0.95 (0.19, 1.72)	3.16%	0.02	0.44	1.09 (0.87, 1.4)	0.75
Increasing avoidance (CSI)	25.4	-0.55 (-1.89, 0.8)	-1.83%	0.39	0.12	0.89 (0.69, 1.15)	0.66

MSFI: Male Sexual Function Index, MSQ: Multidimensional Sexuality Questionnaire, PROMIS: Patient-Reported Outcomes Measurement Information System, CSI: Coping Strategy Indicator.

Higher scores on the MSFI total scores and subscales indicate higher sexual function. Higher scores on the PROMIS measurements indicate worse anxiety and depression. Higher scores on the MSQ indicate more sexual fear. Higher scores on the CSI indicate a larger use of the associated coping strategy.

\* Unstandardized  $\beta$  coefficients

## CHAPTER VI

### **The Relationship Between Sexual Function, Satisfaction, and Post-Myocardial Infarction: A Preliminary Analysis**

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## **Abstract**

Myocardial infarction (MI) negatively influences many physical aspects of patient's sexual function. However, there is limited literature that examines sexual function beyond the most basic physical components, such as erectile function. Exploring sexual function with a broader psychosocial perspective is paramount to advance the science in this area. This study aimed to describe the relationships between the physical, psychological, and social domains of sexual function in male and female post-MI patients. Adults post-MI were mailed self-report surveys at two weeks post discharge. Physical domains of sexual function were measured with the arousal, orgasm, erection, lubrication, and pain subscales of the Female/Male Sexual Function Index, (FSFI/MSFI). The social domain utilized the sexual satisfaction subscale of the FSFI/MSFI. The psychological domain was represented by desire (subscale of FSFI/MSFI) and sexual fear (Multidimensional Sexuality Questionnaire (MSQ)). Spearman correlations were constructed to examine associations among the different measurement subscales. Twenty-four males and four females post-MI were analyzed. Average scores on the FSFI were  $10.8 \pm 11.5$ , and on the MSFI were  $9.2 \pm 7.7$ . Correlations among the physical components of function were strong to moderate in both sexes. Desire and satisfaction were only weakly to moderately correlated with arousal, erection, and orgasm in male participants, while satisfaction was not correlated with any of the subscales in female participants. There was minimal support for sexual fear's relationship with function in both sexes. However, there is preliminary support for other dimensions of sexual functioning. More research is also needed with larger samples.

*Keywords:* Myocardial infarction, sexual health, sexual dysfunction

## **Background**

More than 8.4 million individuals are living post myocardial infarction (MI) in the United States (Virani et al., 2020). Current prevalence predictions suggest that 40.5% of the United States population will have had an MI in 2030 (Heidenreich et al., 2011). The impact of MI presentation and subsequent treatment produces new challenges to patients' lives, one of which is sexual health (Kazukauskas & Lam, 2010; Clayton, Harsh, & Clayton, 2016). Sexual health is a vital facet of health-related quality of life as an integration of emotional, social, and somatic dimensions, and a crucial component of this is sexual function. Sexual function is defined as "sexual activity with transition through the phases from arousal to relaxation with no problems, and with a feeling of pleasure, fulfilment and satisfaction" (Corona, Jannini, & Maggi, 2006). As such, embedded within sexual function are physical, psychological, and social domains (Tierney, 2008).

The physical domain of sexual function consists of four main phases including excitement, plateau, orgasm, and resolution (Masters & Johnson, 1966). These phases are conceptualized in a linear fashion among men, but revisions have modeled function in females as a more circular representation (Basson, 2001). This domain has received the most study given the frequent co-occurrence of erectile dysfunction with chronic cardiovascular disease and MI (Goldstein, Chambers, Tang, Stecher, & Hassan, 2018). Sexual dysfunction in patients post-MI is thought to be caused by an impairment of blood flow to sex organs. Symptoms of sexual dysfunction in males include erectile dysfunction, orgasmic dysfunction, and decreased sexual desire (Puchalski, Szymanski, Kowalik, & Filipiak, 2013). Sexual dysfunction in females post-MI is characterized by decreased vaginal lubrication, decreased libido, and orgasmic problems (Søderberg, Johansen, Herning, & Berg, 2013; Zeydi, Sharafkhani, Armat, Gould, Soleimani, &

Hosseini, 2016). These changes in function can also decrease frequency of sexual activity. Among previously sexually active patients, the average percentage that had resumed activity at one-month post-MI had decreased to 54% for women and 63-64% for men (Lindau et al., 2014; Lindau et al., 2016).

The above-mentioned physiologic changes can subsequently influence the psychological domain of sexual function, such as sexual desire. In post-MI patients, fear of inducing a repeat event often plays into hesitancy for many activities, including sexual intercourse (Oskay, Can, & Camci, 2015). In addition, several studies have identified sexual fear as a common complication of MI development which has been documented in as high as 88% of women and in 58% of their husbands (Oskay, Can, & Camci, 2015). In one cross-sectional study of 35 women post-MI, fear of resuming sexual activity was expressed by 51% of patients and 44% of partners, and these rates of sexual fear were also found to negatively impact sexual activity rates (Eyada & Atwa, 2007).

The physical and psychological components also tie into a broader relationship-centered domain of sexual function, of which one component is sexual satisfaction. Sexual satisfaction is defined as an individual's physical and emotional appraisal of the contentedness of their sexual relationship (Ashdown, Hackathorn, & Clark, 2011). In general cardiovascular populations, sexual satisfaction remains high even in the context of diminished physical function (Ghanbari Afra, Taghadosi, & Gilasi, 2015; Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007). A previous cross-sectional study of 45 women post-MI found relatively high sexual satisfaction scores comparable to a general population (Oskay, Can, & Camci, 2015). Furthermore, sexual satisfaction has been linked to changes in other non-sexual psychosocial outcomes including anxiety. A cohort study of 64 men and women found that sexual satisfaction was inversely

related to significantly higher anxiety in both sexes with an odds ratio of -2, and that sexual satisfaction also accounted for 42% of the variance in anxiety scores (Steinke & Wright, 2006).

### **Objective**

Given that sexual function is a multi-faceted construct, a comprehensive approach is necessary to promote positive sexual function in patients post-MI. However, there is a lack of a complete multi-dimensional representation of sexual function in the MI literature, partially due to the challenges in measuring sexuality empirically. Although sexual function is conceptualized as an intersection of biopsychosocial components in other chronic conditions, such as cancer (Tierney, 2008; Walker, Wassersug, & Robinson, 2015), the physical domain is given the most attention in the MI literature. Ultimately, understanding the relationships between each domain of sexual function is paramount to building effective interventions. Therefore, the purpose of this study was to describe the relationships between the physical, psychologic, and relationship domains of sexual function in male and female post-MI patients.

### **Methods**

The study was a longitudinal design, evaluating dimensions of sexual function at two weeks and three months post-MI. The data for this paper represents the first timepoint only given the lack of early data on sexual function post discharge for MI in the currently available literature. Within seven days post discharge, a baseline survey was sent to 63 consented participant's homes for completion. A phone call was made to follow up after the initial point of contact to remind patients of study requirements and answer potential questions that may have developed. This study received approval from the local Institutional Review Board (IRB).

## **Study Population**

A total of 99 patients in a Midwestern hospital were approached of 395 screened, and 63 signed informed consent (consent/decline rate 63.6%). To be eligible, patients had to have a diagnosis of an MI in the past seven days within their medical record combined with a troponin value greater than the 99th percentile of a normal reference population (>18 ng/mL) (Thygesen et al., 2012). Patients also had to be able to read and write in English. Exclusion criteria included those who were medically unstable (suicide, alcohol withdrawal), presented with medical conditions that would interfere with the sexual function data collected (prostate cancer, breast/gynecologic cancer, COPD, or HIV infection) or had a life expectancy of less than one year. A total of 63 signed informed consent, with 28 individuals returning the first round of surveys (response rate 44%).

## **Measures**

The physical domain of sexual function was operationalized using the arousal, lubrication, orgasm, and pain subscales of the Female Sexual Function Index (FSFI) (Rosen et al., 2000), and the arousal, erection, and orgasm subscales of the Male Sexual Function Index (MSFI) (Kalmbach, Ciesla, Janata, & Kingsberg, 2012). Both the MSFI and FSFI contain the same wording and question structure, though the subscales are adjusted to contain relevant aspects of sexual function for both sexes (erection vs. lubrication). The Cronbach's alphas for the FSFI are 0.95 for arousal, 0.96 for lubrication, 0.94 for orgasm, and 0.94 for pain with intercourse (Rosen et al., 2000). The Cronbach's alphas for the MSFI are 0.82 for arousal, 0.76 for erection, and 0.66 for orgasm (Kalmbach et al., 2015). The score ranges for the subscales are from 0-6, except for pain with intercourse (0.8-6) (Rosen et al., 2000). Higher scores on the total score and subscales of the MSFI and FSFI indicate better sexual function. The FSFI has a

designated cut-off score for sexual dysfunction, which is 26.55 (Wiegel, Meston, & Rosen, 2005).

The psychological domain utilized the desire subscale of the MSFI and FSFI. The Chronbach's alpha for the desire subscale is 0.92 in the FSFI and 0.85 in the MSFI (Rosen et al., 2000; Kalmbach et al., 2015). The score range is 1.2-6 in both measurements (Rosen et al., 2000; Kalmbach, Ciesla, Janata, & Kingsberg, 2012). The psychological domain of sexual function also included sexual fear, which was measured using the sexual fear subscale of the Multidimensional Sexuality Questionnaire (MSQ). The MSQ sexual fear subscale has a Cronbach's alpha of 0.82 (Snell, Fisher, & Walters, 1993). Higher scores on the MSQ indicate more sexual fear.

The social domain of sexual function was operationalized with the sexual satisfaction subscale of the FSFI and MSFI. This subscale asks participants to rate their level of satisfaction with their partner and in their sex life overall. The Cronbach's alpha for this subscale is 0.89 within the FSFI, and 0.82 within the MSFI (Rosen et al., 2000; Kalmbach et al., 2015). The possible score range is 0.8-6 in both measurements (Rosen et al., 2000; Kalmbach, Ciesla, Janata, & Kingsberg, 2012).

Other covariates that were collected included left ventricular ejection fraction (LVEF) to assess for cardiac function. Type and severity of the MI were assessed with troponin T and whether the MI was ST or non-ST segment elevated (STEMI/NSTEMI). These were collected from the medical record. Other demographic variables that were collected included marital status, education status, employment status, and cardiac rehabilitation status, which were collected with a separately mailed demographic survey.

## **Statistical Analyses**

All analysis was conducted using SAS software version 9.4 (SAS Institute, Cary, NC). Descriptive statistics were calculated for demographic data including means, ranges, and standard deviations. Independent samples t-tests and chi-square tests were performed to check for any statistically significant differences in the sociodemographic characteristics among males and females. Normality of the MSFI and MSQ was checked using Shapiro-Wilk. Because the MSFI and FSFI scores did not meet assumptions of normality, nonparametric Spearman rank correlations were used. Five participants did not answer all questions on the satisfaction subscale of the MSFI/FSFI (four males, one female). The missing questions in this subscale dealt with activity between a partner, so they were not likely to be missing at random and so multiple imputation was deemed not appropriate. To address this, total scores and satisfaction subscale scores are analyzed with those participants removed. Correlation coefficients were calculated between the subscales of the FSFI/MSFI with the sexual fear subscale of the MSQ. A coefficient of 0.1-0.39 was considered weak correlation, a coefficient of 0.4-0.69 was considered moderate correlation, and a coefficient of 0.7-0.99 was considered strong correlation (Schober, Boer, & Schwarte, 2018). A statistical significance level of 0.05 was applied.

## **Results**

The study sample consisted of 23 Caucasian males and 1 Native American male with a mean age of  $62.5 \pm 13.8$  years, and 4 Caucasian females with a mean age of  $70.8 \pm 8.2$  years. The sample was primarily married (M: 70.8%, F: 100%) and with at minimum some college education (M: 79.2%, F: 75%). Approximately 53% of males and 75% of females had either enrolled in a cardiac rehabilitation program or were planning to enroll at the time of the survey. Participants were considered below normal heart health based on LVEF scores (M: 48.7%, F:

50.9%, normal range: 55%-70%). One-third of males and half of females in the sample were diagnosed with an ST-segment elevated MI (STEMI). There were no statistically significant differences among the males and females surveyed. Additional clinical and sociodemographic characteristics are presented in Table 6.2.

In this sample, 58.3% of males and 25% of females were sexually active two weeks post discharge. Mean total scores on the MSFI and FSFI were 9.2 for males out of a possible 30, and 10.8 for females out of a possible 36 (M range: 2-26.2, F range: 3.2-24.1). All four female participants scored in the dysfunction range for the total score and all subscales of the FSFI. Mean scores of the MSQ were 7.5 in males and 6.3 in females out of a possible 20 (M range: 0-17, F range: 0-13). Table 6.3 provides the full means, standard deviations, and ranges of the total scores and subscale scores for the MSFI and FSFI along with the MSQ scores.

In men, total scores on the MSFI were all either highly or moderately correlated with the individual subscales, which ranged from 0.63 to 0.88. Among the physical subscales (arousal, erection, and orgasm) the strongest correlations were between erection and arousal ( $r= 0.73$ ). The remaining physical components were moderately correlated (see table 6.4). When examining the psychologic variables, desire was moderately correlated with orgasm ( $r= 0.45$ ) and weakly correlated with arousal and erection. Fear was weakly correlated with all the subscales and the total scores of the MSFI but did show the highest correlations with orgasm. The social domain of sexual satisfaction was moderately correlated with orgasm ( $r= 0.50$ ). All the correlations of the MSQ with the other subscales of the MSFI were negative, meaning that as function scores improved, fear decreased.

In females, the total scores of the FSFI were all highly correlated ( $r= 0.87$ ) except for the satisfaction subscale, which was moderately correlated ( $r= 0.50$ ). Strong positive correlations



were found between desire, lubrication, and orgasm with other subscales. However, the social domain (satisfaction) had no correlation with any FSFI subscale. As in the men, all interactions between the MSQ and the FSFI subscales were expectedly negative, with the exception being fear with satisfaction ( $r= 0.50$ ). Table 6.5 provides a complete summary of the correlations among the FSFI total score with its subscales and the MSQ.

## **Discussion**

The results of this study helped to illuminate the relationships between the domains of sexual function with sexual satisfaction and sexual fear within two weeks of discharge for MI, which to our understanding has not been studied previously. While these results are modest, the clinical relevancy uncovers important short-term relationships between function and satisfaction in males and females. Currently available rigorous studies of post-MI sexual function and satisfaction in both sexes have focused on one month (Lindau et al., 2016), three months (Oskay, Can, & Camci, 2015) and one year post-event (Lindau et al., 2012; Lindau et al., 2014). This study also adds to the current literature by measuring sexual function and satisfaction scores in males using a multidimensional instrument with a comparable structure to the FSFI. This is an important contribution, as sexual activity in terms of intercourse is given far more focus in the current MI literature, and non-physical components of sexual function overall are less understood, particularly in men.

An explanation for the observed low function scores might be the relatively low levels of sexual activity among the females (25%) and males (58.3%) surveyed. Another explanation could be the age of the sample, and possibly the menopausal status among the female participants. However, the effects of menopause and sexual function should be considered within the context of other influencing biopsychosocial variables, and may not be an indicator of

dysfunction necessarily (Heidari, Ghodusi, Rezaei, Kabirian Abyaneh, Sureshjani & Sheikhi, 2019). In a previously conducted multi-site study of over 2,800 patients post-MI, 73% of females and 85% of males were sexually active (Lindau et al., 2016). This disparity could be due to the older age in this sample compared to this previous study (62.5 years vs. 49 years). Physical function scores also appeared to be related to sexual activity status, but a weaker relationship was observed between sexual activity status and other components of function (desire, sexual fear, and satisfaction). The short time post-discharge to survey completion may also explain the low overall sexual function scores observed in this sample. This is consistent with a previous cross-sectional study of 45 females at three months post-MI using the FSFI, which reported a total score of approximately 16.4, compared to 9.2 observed in this study (Oskay, Can, & Camci, 2015). Importantly, American Heart Association (AHA) guidelines have indicated that sexual activity is reasonable within 1-2 weeks post discharge, given an uncomplicated MI with no adverse cardiac symptoms during physical activity (Levine et al., 2012; ACC/AHA, 2004). However, the question remains whether patients are counseled about sexual issues. There is some literature that has reported that women are generally counseled less often than men, which is an important consideration given that activity often decreases at one year post event without counseling (Lindau et al., 2016). As such, these results may indicate that patients' sexual function and satisfaction require attention even in the first weeks following discharge. Patients post-MI frequently disclose issues with diminished sexual function prior to discharge, and so education and counseling on both short- and long-term expectations for sexual health changes is crucial regardless of sexual activity status (Steinke et al., 2013).

As would be expected, this cross-sectional study found strong correlations among five subscales of the MSFI and FSFI, providing evidence for validation of this instrument in the post-

MI population. However, the correlation between sexual desire with the other subscales of the MSFI was weak to moderate. There were also a mix of moderate and weak correlations between satisfaction and the other subscales of the MSFI. This could suggest the absence of a relationship among satisfaction with erection, orgasm, or arousal in male post-MI patients. However, it is important to consider the role that the partner's interest and sexual function could play in sexual function neither of which are captured on the FSFI or MSFI.

In this small sample of females post-MI, sexual satisfaction was not correlated with the other subscales of the FSFI. While these relationships have not been examined previously, this disconnect is consistent with a study of 45 post-MI women which found high satisfaction scores on the FSFI, compared to diminished scores on the other subscales (Oskay, Can, & Camci, 2015). This previously conducted study also found no statistically significant differences in sexual satisfaction among women post-MI in comparison with healthy participants. Overall, there is very little literature that captures these relationships between the different components of function and satisfaction in females post-MI. However, this study was only able to measure a small sample of female participants, so it is difficult to make any concrete hypotheses or conclusions. The small sample size also increases the likelihood of producing extreme positive and negative correlations (0.99 and 0), which would likely stabilize with a larger sample. These limitations implicate further research with a larger female sample to clarify these potential relationships.

An expected finding was the negative correlations seen in both males and female participants among fear with the other subscales. It is conceivable that someone might either develop fear as they engage more in activity, but this relationship should be studied further. In addition, while scores on the MSQ landed a cross a broad range, only 16% of male and 25% of

female participants had scores  $\geq 10$  out of 20, indicating relatively low sexual fear levels in this sample. These low scores might explain why sexual fear was only weakly correlated with sexual function and satisfaction in men. While the correlations between fear with the FSFI subscales were higher in female compared to male participants, it is unclear whether these correlations would change with a larger sample size. The low levels of fear seen in this sample contrasted with the growing body of literature surrounding sexual fear in patients post-MI. Several quantitative studies have produced a range of prevalence rates for sexual fear as high as 88.4% (Oskay, Can, & Camci, 2015). However, measurements of sexual fear in these studies were investigator-developed and so their validity and reliability remain largely unknown. In the qualitative literature, a study of 19 post-MI participants found themes of sexual fear in the interviews alongside a desire for recommendations of how and when to engage in sexual activity without increasing risk for a repeat MI (López-Medina, Gil-García, Sánchez-Criado, & Pancorbo-Hidalgo, 2016). Another qualitative study of 130 women after a first-time MI found that 51% expressed fear of resuming sexual activity (Søderberg, Johansen, Herning, & Berg, 2013). These qualitative studies found that patients post-MI are often afraid of a repeat MI or death during intercourse, which is exacerbated by a hesitancy among both patients and clinicians to discuss sexual health topics (Zeydi, Sharafkhani, Armat, Gould, Soleimani, & Hosseini, 2016). However, patients still desire some form of sexual activity or intimate relationships, which may explain the lack of correlation among the physical and psychosocial domains of sexual function (López-Medina, Gil-García, Sánchez-Criado, & Pancorbo-Hidalgo, 2016).

There were some limitations of this study. Firstly, the small sample size limits much of the ability to control for covariates and make concrete conclusions regarding the findings. In particular, the small sample of female participants produced a relatively unstable correlation

matrix that would require a much larger sample to fully investigate. Furthermore, the homogenous sample in terms of education, race, and marital status limits external generalizability to other populations. Secondly, this sample included a very small number of female compared to male participants. Recent estimates of MI prevalence are approximately 60% male and 40% female compared to 86% and 14% in this sample (Benjamin et al., 2019). This may be related to a greater interest in discussion of sexual health topics from males (Lindau et al., 2007). Age might have also influenced activity rates and as a result inclination to join the study. Lastly, some aspects of the psychosocial domain were not measured, such as self-image, general intimacy, role engagement, and emotional closeness (Mosack & Steinke, 2009).

## **Conclusion**

In this limited preliminary study, the relationships among the physical components of function were strongly to moderately correlated in both sexes. However, relationships between the physical and psychosocial components of function were only moderately to weakly correlated in men. Low desire was strongly correlated with low physical function in females, but they reported a reasonable level of satisfaction, indicating that the relationship component may play a significant role in female sexuality in older age and possibly after an MI. There was minimal support for a relationship between sexual fear and the other components of sexual function in both males and females. However, the next step is to conduct further research with a larger sample to further solidify the hypothesized relationships observed in this study. A larger sample size of females is especially needed. In addition, qualitative research may be especially enlightening to provide a more detailed and nuanced representation of sexual desire and sexual satisfaction with overall relationship satisfaction beyond the capacity of the MSFI/FSFI.

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## What's New?

- Physical components of sexual function (erection, lubrication, orgasm) were moderately to strongly correlated in both sexes.
- While physical components were moderately intercorrelated, physical and psychological (desire, satisfaction), were weakly to moderately correlated among males and strongly to weakly correlated among females.
- Fear of sexual activity did not appear to significantly influence sexual function or satisfaction scores, though there was an expected negative relationship.

## Tables and Figures

Table 6. 1 - Domains and operationalization of sexual function

Domain	Operationalization	Questions
Physical	Arousal, orgasm	MSFI: Q3-13
	Erection (male)	FSFI: Q3-13, Q17-19
	Lubrication (female), pain (female)	
Psychological	Desire, sexual fear	MSFI: Q1-2
		FSFI: Q1-2
		MSQ: Q1-5
Social	Satisfaction	MSFI: Q14-16
		FSFI: Q14-16

MSFI: Male Sexual Function Index; FSFI: Female Sexual Function Index; MSQ: Multidimensional Sexuality Questionnaire

Table 6. 2 - Characteristics of study participants

	Male (n=24)	Female (n=4)
<b>Sociodemographic characteristics</b>		
Mean age (SD) in years	62.5 (13.8)	70.8 (8.2)
Race, No. (%)		
White/Caucasian	23 (95.8)	4 (100)
Other	1 (4.2)	0 (0)
Marital status, No. (%)		
Single	2 (8.3)	0 (0)
In a relationship	2 (8.3)	0 (0)
Married	17 (70.8)	4 (100)
Divorced	2 (8.3)	0 (0)
Widowed	1 (4.2)	0 (0)
Education status, No. (%)		
Some high school	2 (8.3)	0 (0)
High school degree	3 (12.5)	1 (25)
Some college	7 (29.2)	1 (25)
College degree	5 (20.8)	1 (25)
Graduate degree	7 (29.2)	1 (25)
Rehabilitation status, No. (%)		
Currently enrolled	5 (20.8)	0 (0)
Planning to enroll	8 (33.3)	3 (75)
Not enrolled	11 (45.8)	1 (25)
Employment status, No. (%)		
Employed	11 (45.8)	1 (25)
Unemployed	1 (4.2)	0 (0)
Retired	10 (41.7)	3 (75)
Medical leave	2 (8.3)	0 (0)
MI Severity, No. (%)		
STEMI	8 (33.3)	2 (50)
NSTEMI	16 (66.7)	2 (50)
<b>Clinical characteristics</b>		
Mean troponin (SD) in ng/mL	907.6 (1990.7)	1502.3 (1132.5)
Mean LVEF, No. (%)	48.7 (18.0)	50.9 (13.3)

MI: Myocardial infarction; STEMI: ST-segment elevated myocardial infarction; LVEF: Left ventricular ejection fraction

Table 6. 3 - Means (standard deviation) of FSFI, MSFI and MSQ scores at two weeks ( $n=28$ )

Male ( $n=24$ )	Mean (SD)	Possible Scores	Female ( $n=4$ )	Mean (SD)	Possible Scores
MSFI: Total*	9.2 (7.7)	2-30	FSFI: Total*	10.8 (11.5)	2-36
Desire	2.5 (1.5)	1.2-6	Desire	1.8 (1.2)	1.2-6
Arousal	1.5 (1.9)	0-6	Arousal	1.2 (2.2)	0-6
Erection	1.2 (1.9)	0-6	Lubrication	1.5 (3.0)	0-6
Orgasm	1.4 (2.3)	0-6	Orgasm	1.4 (2.8)	0-6
Satisfaction*	2.36 (1.6)	0.8-6	Satisfaction*	3.1 (1)	0.8-6
			Pain	0.3 (0.6)	0-6
MSQ: Sexual Fear	7.5 (5.6)	0-20	MSQ: Sexual Fear	6.3 (5.6)	0-20

SD: Standard deviation; MSFI: Male Sexual Function Index; FSFI: Female Sexual Function Index; MSQ: Multidimensional Sexuality Questionnaire

\* Satisfaction and total scores calculated with missing participants removed (male=4, female=1)

## Figure Legend

Figure 6.1 - Association between sexual function (MSFI) and sexual fear (MSQ) in males post myocardial infarction ( $n=24$ )

Abbreviations: MSFI: Male Sexual Function Index; MSQ: Multidimensional Sexuality Questionnaire

$r_s$ : Spearman correlation coefficient

\* p-value < 0.05

\*\* p-value < 0.01

+ Satisfaction and total scores calculated with missing participants removed ( $n=4$ )

Figure 6.2 - Association between sexual function (FSFI) and sexual fear (MSQ) in females post myocardial infarction ( $n=4$ )

Abbreviations: FSFI: Female Sexual Function Index; MSQ: Multidimensional Sexuality Questionnaire

$r_s$ : Spearman correlation coefficient

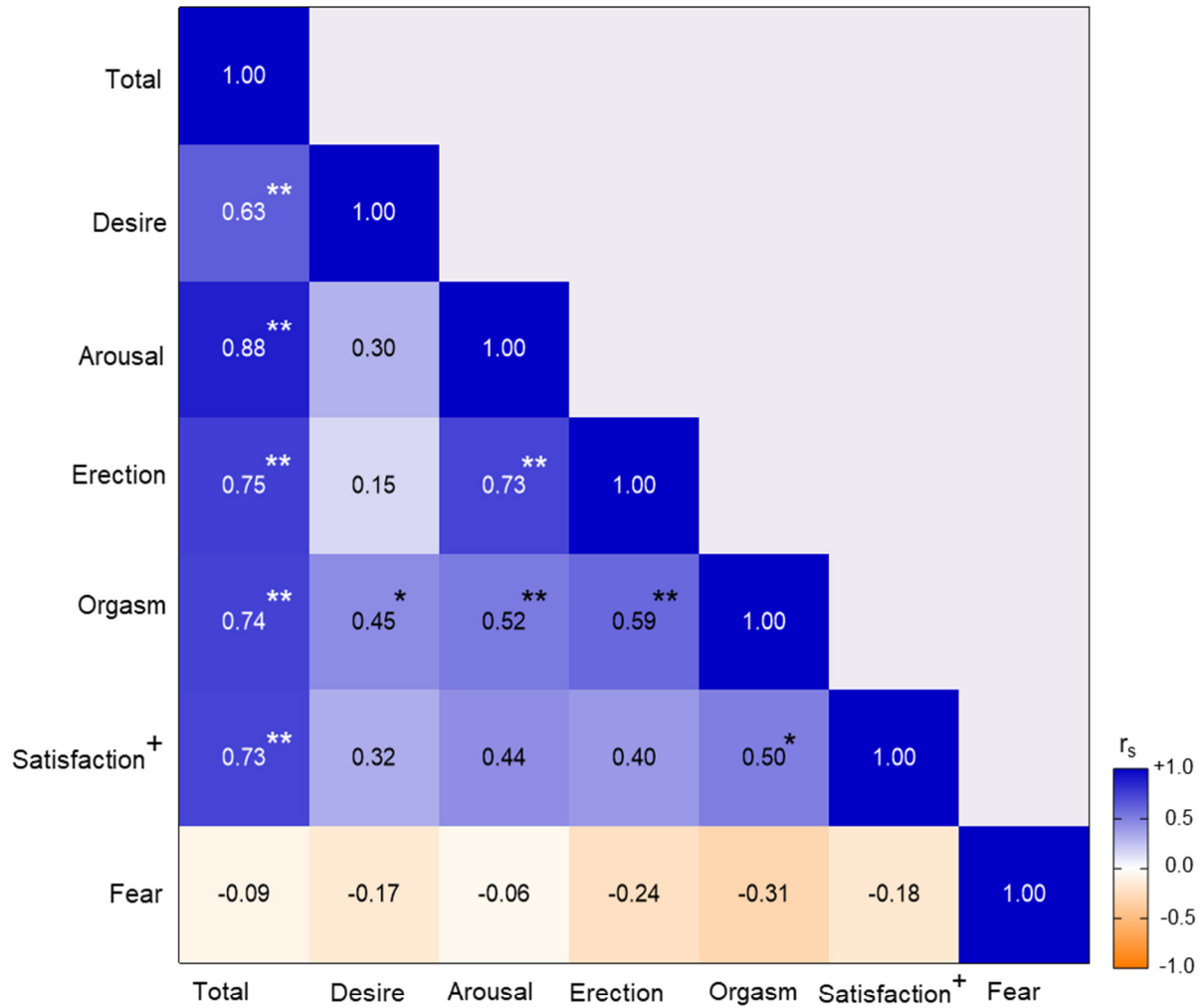
\* p-value < 0.05

\*\* p-value < 0.01

+ Satisfaction and total scores calculated with missing participants removed ( $n=1$ )



Figure 6. 1 - Association between sexual function (MSFI) and sexual fear (MSQ) in males post myocardial infarction (n=24)



Abbreviations: MSFI, Male Sexual Function Index; MSQ, Multidimensional Sexual Questionnaire

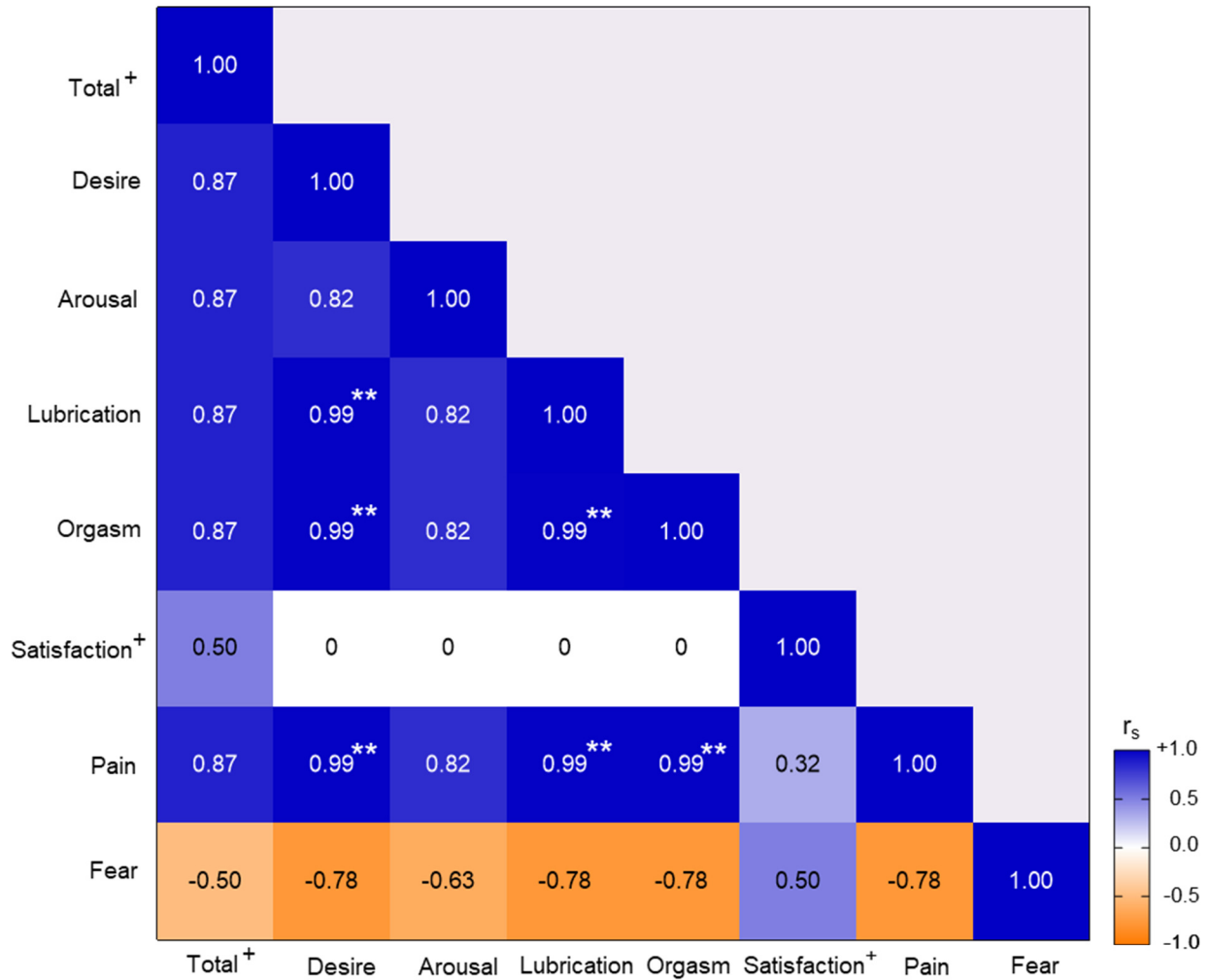
$r_s$ : Spearman correlation coefficient

\* p-value < 0.05

\*\* p-value < 0.01

+ Satisfaction and total scores calculated with missing data removed (4 participants)

Figure 6. 2 - Association between sexual function (FSFI) and sexual fear (MSQ) in females post myocardial infarction (n=4)



Abbreviations: FSFI, Female Sexual Function Index; MSQ, Multidimensional Sexual Questionnaire

$r_s$ : Spearman correlation coefficient

\* p-value < 0.05

\*\* p-value < 0.01

+ Satisfaction calculated with missing data removed (1 participant)

## **CHAPTER VII**

### **Conclusion**

This dissertation aimed to understand how sexual function and satisfaction change over time post-MI using several quantitative methods. A multidimensional measurement of sexual function and satisfaction was collected from patients along with several covariates including fear, anxiety, depression, and utilization of coping strategies. These surveys were used to examine longitudinal changes in sexual function over a three-month time period. Linear and logistic regression were then applied to explore possible predictors of sexual function and satisfaction. Lastly, a cross-sectional examination of the interconnected domains of sexual function, satisfaction, and sexual fear was conducted at two weeks.

### **Major Research Findings**

The first aim was to longitudinally describe sexual function and satisfaction from two weeks to three months post-MI. Rather than an isolated point in time, this study uncovered several interesting overall changes in sexual function which have not been previously captured in this patient population. Indeed, this study illuminated the degree to which sexual function and satisfaction could improve - or not improve - over three months, with erection and orgasm scores improving by almost 30% while desire and satisfaction only improved by approximately 10%. Furthermore, the percent of male participants who were sexually active improved from 33.3% to

72%. However, perhaps the most interesting sexual health variable studied in this dissertation was sexual satisfaction. While satisfaction scores improved overall, more than half of males and one third of females remained either dissatisfied with the amount of emotional closeness with their partner or were dissatisfied with their sexual relationship or overall sex life. Despite this, satisfaction appeared to change regardless of changes in function or activity status. Sexual satisfaction is often left unaddressed in the MI literature as dysfunction and activity are given more focus. Altogether, these results broadened our understanding of the full breadth of issues patients face post-MI and reinforced the importance of assessing for both sexual dysfunction and dissatisfaction prior to discharge. These results also generated some interesting hypotheses that the overall relationship between satisfaction and function is complex and nuanced and should be studied in further detail.

The second aim was to determine the impact of depression, fear, anxiety, and use of coping strategies on predicting sexual function and satisfaction at three months post-MI. Previous cross-sectional literature has found multiple associations between these covariates and sexual health, and this research aimed to explore their capacity for predicting changes in sexual function. There was an expected negative association among anxiety, depression, and fear with function. Positive coping strategies were associated with increased function and likelihood of being active at three months, while avoidance strategies achieved the opposite effect, which were also expected findings. While this research was limited in its ability to conclusively determine a predictive effect, the results provide some hypotheses for future research with a larger sample, particularly with examining the effects of coping strategies.

The third aim was to describe the relationships between the domains of sexual function, satisfaction, and sexual fear at two weeks post-MI. This analysis explored relationships between

the physical and psychosocial components of function among males and females. This study provided an important contribution, being the first to profile sexual function, satisfaction, and fear within the earliest weeks suitable for sexual activity post-discharge. An interesting finding was the lack of a strong relationship between desire and satisfaction with overall function compared to arousal, erection, and orgasm. These findings in combination with the longitudinal findings in this dissertation and previously conducted 1-year outcome studies furthers our understanding of sexual function over time (Lindau et al., 2012; Lindau et al., 2014). While previous studies have provided the percentage of those with sexual problems at 1 year, this study provides some detail into functional severity before that one-year timepoint (Lindau et al., 2014). This was also the first study to empirically study sexual fear using a validated measurement in a post-MI population, as previous research has only used investigator developed instruments with unspecified development or validation beforehand (Oskay, Can, & Camci, 2015).

The results of all three aims largely supported one another with one major inconsistency. First, the disconnect between satisfaction and function was observed both in the cross-sectional and longitudinal findings. Sexual satisfaction did not appear to correlate with function in the cross-sectional analysis, and satisfaction increased among females in the longitudinal analysis, despite lower function scores. Taken together, these results could indicate that the relationship between satisfaction and function may be more complex than previously studied, especially considering that sexual satisfaction has remained high despite diminished function in both CAD and MI populations, and was comparable to health controls (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007; Oskay, Can, & Camci, 2015). Second, while net changes on the covariates were minimal, the negative correlations observed between fear and function, and the positive correlations seen between support-seeking and problem-solving coping strategies with function

were consistently reflected in the models. The largely inconsistent findings were among the sexual fear data. Sexual fear was negatively associated with function in the models, which was expected. However, increasing fear over time was also associated with an increased likelihood of becoming sexually active. Furthermore, in the cross-sectional findings, sexual fear was positively correlated at two weeks and negatively correlated at three months (the expected correlation would be positive). As mentioned previously, it is temporally unclear whether someone might either develop fear as they engage more in activity, or if their fear precludes them from engaging in the first place.

Patients post-MI can have more depression and anxiety than a general population, and these affective conditions can reduce sexual health in addition to overall quality of life (Daniel et al., 2018; Steinke et al., 2013; Kriston, Gunzler, Agyemang, Bengel, Berner, & SPARK Study Group, 2010). Depression and anxiety often present together, which would explain the relationships seen among the correlation tables, and makes sense clinically, given the evidence regarding their relationship with sexual function. Interestingly, sexual satisfaction has remained high in previous literature among patients with both MI and CAD, despite lower function scores (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007; Oskay, Can, & Camci, 2015). This was in contrast to the comparable satisfaction scores with other components of function seen in this study, and so the contrast between these results with previous literature indicates that these relationships are complex and need additional research. Theoretically, the conceptual definition of satisfaction used in this dissertation is simply “the desire for one’s sexual needs to be met”, which may or may not include intercourse (Ashdown, Hackathorn, & Clark, 2011). As such, it may be that satisfaction is independent of function and can be high or low regardless of physical function scores.

## **Reflection**

Upon reflection, several changes were considered should this study be repeated with the same aims. One possible change might be the adjustment of the measurements. One of the advantages of the FSFI and MSFI is its remarkably detailed measurement of multiple components of function and satisfaction. However, such granularity might have increased discomfort among participants, so a broader survey might have improved overall response rates, but with the tradeoff of a less detailed dataset. Another survey that might have been changed was the CSI. Rather than measuring the number of coping strategies one uses, it may have been more informative to assess whether someone was employing more positive or negative coping, general coping styles, or directly measure whether one was coping effectively with their illness. Many conceptualizations and measurements of coping have been created over the past decades, such as the Coping Self-Efficacy Scale (CSES) (Chesney, Neilands, Chambers, Taylor, & Folkman, 2006), which measures confidence in application of coping strategies, and the Brief Resilient Coping Scale (BRCS) (Sinclair & Wallston, 2004), which measures highly adaptive coping. These measurements may have been more clinically useful to capture.

The eligibility criteria were also reconsidered. In a perfect recruitment scenario, the patients approached would only have an MI and no other comorbidities. Unfortunately, a balance had to be struck between controlling for some chronic conditions while also maintaining the feasibility of the study. As such, the criteria were structured to exclude for the conditions that had the strongest representation in the literature. However, because of this, there may have been some unidentified chronic conditions that were influencing patient's sexual health that were not accounted for. The idea of requiring patients to be sexually active was also considered as part of the eligibility criteria. This has been part of the inclusion criteria for multiple studies conducted

in this population (Oskay, Can, & Camci, 2015; Ghanbari Afra, Taghadosi, & Gilasi, 2015; Kazemi Saleh, Pishgou, Farrohki, Assari, Fotros, & Naseri, 2008). However, the intention of this dissertation was to measure sexual function in a general population of patients post-MI, regardless of sexual status. Given that the MSFI/FSFI do not exclude patients who were not active, the measurement could still be completed by both subgroups, though activity status does substantially impact the scoring.

One of the largest weaknesses of this dissertation was that 56% did not provide data after consent, and only 33% of participants completed all the surveys. Several modifications were considered to reduce attrition should this study be repeated in the future. Response rates might have improved if the participant filled out the questionnaire at the bedside immediately upon consent rather than waiting until after discharge. This could have improved response rates at the first timepoint, where attrition was the highest. However, surveying patients who were still in the hospital might not be appropriate, as they are likely not ready to start considering sexual health issues. Thus, while response rates might improve, any data collected would likely not be useful clinically. Additionally, this method may not reduce attrition at the second timepoint. Increasing the number of follow up contact points may also have improved the response rates over time, but it may not have been ethical to continuously contact the participant and could be perceived as manipulative.

Another possible change involves the consent process. All consent procedures were conducted by the primary investigator alone. As such, there may have been some hesitancy to share sexual health information given the age and gender of the primary investigator. While consent rates were reasonable (63%), the inclusion of a nurse or physician involved in the patient's care may have increased response rates. A disadvantage to this method is that it would



have likely produced a substantial burden on nurses' and physicians' already demanding and busy schedules. As an alternative, letters with a signature from the lead cardiac physician may have been a suitable workaround. However, some patients who deferred contact in the hospital were mailed letters in this dissertation, but response rates were very low (14%), and no additional patients were recruited using this method. It is therefore unlikely that response rates would have improved using mailed letters, especially given the sensitive subject matter of the study combined with the lack of any face-to-face interaction with the primary investigator.

Another shortcoming was the overall small sample size and low numbers of female participants. If a more comprehensive screening tool such as DataDirect had been employed at the outset of the dissertation, a wider pool of patients post-MI could have been identified. DataDirect is a self-service analytic platform that provides up-to-date admission data on the entire inpatient census at the University of Michigan Health System. Supplemental screening through DataDirect was implemented into the study IRB, but was approved with only one month of recruitment remaining. Given more time and the additional bandwidth provided by DataDirect, purposive sampling could have been employed to recruit more females and minorities to the study.

A final change that could be implemented is collecting pre-MI sexual health data to provide an even better understanding of the effects of MI longitudinally. The weakness of collecting such data retrospectively is that asking patients about pre-MI sexual function introduces a high risk of recall bias and may not be reliable or accurate information. There is also the increased burden of requiring patients to fill out another set of questionnaires, which would have likely exacerbated the already high attrition rates.

The conceptual model was also revisited. It is unclear whether education or employment status would truly influence sexual function, so these variables might be dropped from a revision to the model. Partner status could be expanded into capturing partner sexual function to better capture those effects. Rehabilitation status could be replaced as an environmental factor with education/resources provided to encompass the quality of education (or lack thereof) regarding management of sexual function issues. While the selected predictors largely matched with the conceptual framework, coping strategies may still require additional investigation. Coping was conceptualized as a mediator in the original model, but a mediation analysis was not conducted in this dissertation. A full mediation analysis utilizing a Baron and Kenny approach might be an informative follow-up study (Baron & Kenny, 1986).

### **Implications for Further Research**

Taken together, the results of this dissertation contribute to our understanding of sexual function and satisfaction post-MI by both describing and modeling changes over time. Through this study, the groundwork has been created for four main avenues of future research. The first are additional studies examining sexual function and satisfaction changes in women. While some cross-sectional work in women with the FSFI has been conducted, longitudinal and predictive research is still needed, as this dissertation was unfortunately unable to recruit enough females for a suitable analysis. A follow up longitudinal study with an adequate sample of females post-MI could provide an informative companion to this work. Outside of the increasing the number of female participants, a larger study over a longer period of time in general is also indicated.

The second relates to our lack of knowledge surrounding outcomes further than one year. Long term sexuality research has been previously conducted with registries such as the National Social Life, Health, and Aging Project (NSHAP), which is entering its fourth renewal after a

decade of data collection. While promising, this initiative collected self-report data on MI status with no methods of determining the length of time post-event (Laumann & Waite, 2008).

Furthermore, the NSHAP sexuality data primarily revolves around physical and emotional satisfaction, and amount of activity, and does not assess quality of physical function. Regardless, measuring the same outcomes in this dissertation at one year and beyond, while challenging to implement, could identify the long-term trajectory of functional changes, and determine if scores eventually plateau or decrease. However, the overall length of such a study and the number of data collection points needed would require careful consideration to avoid the risk of attrition bias. A recent systematic review and meta-analysis reported that the most effective attrition reduction strategies include barrier reduction (a shorter questionnaire, less intrusive sexual health questions), and improving community and follow up strategies (incentives for every stage of data collection, more follow up contact points) (Teague et al., 2018). Ultimately, it is important to consider the advantages and disadvantages with regards to quality vs. quantity of the any resultant data when implementing these changes.

The third is for research that incorporates a more robust representation of sexual health overall, which would provide additional clarity and could supplement the findings observed in the cross-sectional research conducted in this dissertation. Topics in sexual health that were not assessed in this dissertation included self-image, general intimacy, and stratification among penetrative and non-penetrative forms of intercourse. In particular, the conceptualization of intimacy in this work could be more comprehensive, which is one limitation of the measurements utilized. Qualitative research may be especially helpful in this regard to capture a more personal open-ended discussion on the many nuances and intricacies of sexuality.

Fourth, additional research is needed of post-MI patients who are unpartnered. Patients who do not have a partner are still sexual beings, but they are often neglected in sexual health research. While this study did collect data from unpartnered individuals, the sample size limited any subgroup analysis. The MSFI/FSFI also require some element of partnered sexual activity to complete some of the survey items, which limits its applicability to all post-MI patients and led to some missing data. As such, a larger sample is needed in future studies to elucidate if there are any possible differences between partnered and unpartnered patients.

Future intervention research might also be informed by the findings from this dissertation, particularly with regards to satisfaction. For example, despite the low rates of sexual activity, satisfaction improved by 16.7% among all females. There was frequent disconnect between satisfaction and function in both the cross-sectional and descriptive findings. Sexual health literature post-MI is often focused solely on activity, but even patients who are sexually active may be dissatisfied with their sex lives. As mentioned, previous literature has demonstrated that satisfaction remains high in comparison to function in both general populations of CAD and MI patients (Kaya, Yilmaz, Nurkalem, Ilktac, & Karaman, 2007; Oskay, Can, & Camci, 2015). Given this evidence, satisfaction and function may constitute separate targets for intervention. It may be that participants are not prioritizing function and activity, and as such interventions that stem from any future descriptive work may be best suited in addressing sexual dissatisfaction. Regardless of if, or how often, an individual engages in activity, all have the potential to create a healthy view of themselves as a sexual being and enjoy a satisfactory intimate relationship with their partner, if applicable. However, this hypothesis will need additional descriptive research to fully evaluate.

## **Implications for Practice and Policy**

The results of this study can be used to inform providers about the potential short-term changes to sexual function and its trajectory over the first three months post-discharge. The limited scope of these data hinder recommendations for high-level policy. However, previous studies have found that only 39.1% of sexually active men and 17.9% of sexually active women discuss sexual health with their physician (Lindau et al., 2012), which provide an important commentary on how little providers are presenting sexual health education to patients at discharge. A portion of this disparity stems from a lack of provider knowledge (Byrne, Doherty, McGee, & Murphy, 2010), which means patients are typically not given the proper tools to address sexual issues (Brännström, Kristofferzon, Ivarsson, Nilsson, Svedberg & Thylén, 2014; Nilsson, Svedberg, Fridlund, Alm-Roijer, & Thylén, 2012). This research could help inform providers more comprehensively, although further sexual health training in general is needed to assuage the discomfort that many providers feel with regards to sexual education (Byrne, Doherty, McGee, & Murphy, 2010). Ultimately, the objective is promoting standard assessment of functional issues in all post-MI patients prior to discharge, and these results, along with additional descriptive research, can help providers with determining whether a patient post-MI needs additional assistance beyond standard education.

Nurses play an important role in the management of sexual dysfunction. Sexual dysfunction is classified as a human response to disease processes, and therefore is within nursing's scope of practice for intervention (Ackley & Ladwig, 2014). Indeed, assessing sexual health has been defined as a component of holistic nursing practice by the American Nurses' Association (ANA) since 1974 (Dattilo & Brewer, 2005). Given the extraordinary trust that patients have put in nurses throughout the past two decades, nurses are uniquely positioned to

discuss sexual health issues with patients (Reinhart, 2020). As mentioned, however, nurses often lack the knowledge, confidence, and practice to discuss sexual health, and this research can provide nurses with additional information to assess sexual function problems in a nonjudgmental and respectful manner (Jaarsma et al., 2010). Continuing education for nurses may include workshops or role-playing to build nurse's knowledge and confidence with discussing sexual health issues (Gazestani, Shahrabaki, Rabori, & Forouzi, 2019). This could involve active reflection of a nurse's potential barriers to discussing sexual concerns, which may include discomfort, lack of knowledge, or embarrassment (Steinke, Mosack, Barnason, & Wright, 2011). The findings from this research solidified previous evidence that patients who are single or older are still sexually active, which are important to remain cognizant of to reduce bias. The changes that sexual function can undergo in a short period of time also behooves nurses to assess sexual function early and comprehensively. Lastly, sexual satisfaction is crucial to assess, given the lack of connection with function, and placement within a holistic representation of sexual health.

Approximately half of patients who are post-MI are admitted to cardiac rehabilitation following discharge (Fang, Ayala, Luncheon, Ritchey, & Loustalot, 2017). However, while core components of cardiac rehabilitation include management of psychosocial factors as a preventative measure to reduce the probability of a repeat event, sexual fears and anxieties are often not included (Sandesara et al., 2015). Furthermore, a review of exercise-based cardiac rehabilitation protocols did not identify guidelines or educational standards for sexual health (Price, Gordon, Bird, & Benson, 2016). Unfortunately, sexual health education remains an understudied component of standard rehabilitation care for patients post-MI. There is an urgent need for more consideration and study of sexual counseling within rehabilitation services

(Araújo, Stein, & Sardinha, 2018). This is because sexual activity post-MI requires a tailored set of recommendations depending on the patient's physical capabilities. These include encouraging intercourse positions with less energy expenditure, avoidance of anal sex, and identification and report of warning signs associated with sexual activity (i.e., chest pain, shortness of breath) (Steinke et al., 2013).

### **Strengths and Limitations**

Sexual health remains understudied in many chronic illness populations, of one cardiac illness is included (Basson, Rees, Wang, Montejo, & Incrocci, 2010). This research aimed to address several key gaps in the current literature: the lack of short-term sexual function data, the paucity of research on longitudinal changes in function, and the absence of robust predictive research. The strengths of this dissertation work include the application of a well validated multidimensional instrument of sexual function and satisfaction (FSFI and MSFI). This study was also designed using well developed sampling, recruitment, consent, and follow up techniques. Furthermore, the study used comprehensive screening and diagnostic methods for identification of patients post-MI, utilizing a combination of diagnostic reports and clinical biomarkers. The application of a comprehensive exclusion criteria also helped to alleviate some issues of confounding factors, which are important given the rates of comorbidities generally seen in U.S. adult and geriatric populations. The study collected data from patients who were unpartnered, who are critically understudied. Lastly, <2% of data were missing from the surveys that were collected, which aided the statistical analysis.

The results of this dissertation work should be considered within the context of some limitations. One shortfall was the disproportionate percentage of females to males recruited (17% to 83%). Several factors may explain this disparity. First, MI tends to affect more males than

females, with national rates at approximately 60% to 40% respectively (Virani et al., 2020). In addition, rates of females with MI were in fact lower at the recruitment site than the national average based on admission data tabulated from DataDirect. A cohort of all patients admitted with an MI diagnosis during the recruitment period of the study (September 2018 to November 2019) were gathered. This analysis produced an admission diagnosis breakdown of 67% male and 33% female ( $n=1337$ ). Second, the exclusion criteria might have disproportionately excluded females, particularly in terms of cancer diagnoses. This is because breast, uterine, and ovarian cancer account for a larger percentage of cancer diagnoses over prostate cancer (59.2% vs. 44.8%) (American Cancer Society, 2019). A final possibility might be a greater willingness among men to share information on sexual health compared to women (Lindau et al., 2012). However, there were only minimal differences in consent and decline rates among males and females to the study (70.2% male vs. 64.3% female), and for response rates (46.2% male vs. 44.4% female, first timepoint).

The small sample size produced unique limitations. These analyses were unable to be adjusted for covariates other than age due to the sample size. In addition to low numbers of females, the sample was predominately white, married, and well educated, which limits the dissertation's external validity. Attrition rates were high from consent to three months (66.7%), which raises questions about the internal validity of the study findings (i.e. the people who completed all the data were different than those who dropped out.) That said, there were no identifiable differences among those who consented vs. declined nor those who turned in data vs. those who did not. However, it is impossible to know the sexual function scores of those who declined to participate or submit data. The MSFI/FSFI ask two questions in the satisfaction subscale that pertain to partnered sexual activity, which produced some missing responses



among the unpartnered individuals. Finally, familial support was collected in this dissertation but was dropped from analysis to give priority to the predictors with a more robust representation in the literature. However, this could still be explored with a larger sample size in future research.

### **Next Steps**

The first immediate step of this work will be to disseminate the findings. The results of this dissertation will be implemented into three academic manuscripts. The process of recruitment, consent, and data collection will be integrated into an additional methods paper. By doing this, the intention is to include assessment of sexual health as a standard of post-MI care by bringing patient's voices and needs to the decision-making table when future interventions are being created. Furthermore, this dissertation experience will be utilized as the foundation for training on development and implementation of dyadic-focused interventions for management of chronic illness in a future postdoctoral fellowship.

### **Conclusion**

In summary, this dissertation work provided some important preliminary data into changes of function and satisfaction over time and their possible predictive factors for patients post-MI. While the results from this dissertation were modest, and the applicability to female participants was unfortunately minimal, the results still provide important information that helps build towards a more complete understanding of sexual function and satisfaction in the post-MI population.

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## **APPENDICES**

## Appendix A

### Female Sexual Function Index (FSFI)

(Rosen et al., 2000)

INSTRUCTIONS: The following questions evaluate your sexual interest or functioning. Remember that all responses to these questions will be kept confidential. Please circle the number next to the answer to each question.

1. Over the past week, how **often** did you feel sexual desire or interest?

5	4	3	2	1
Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

2. Over the past week, how would you rate your **level** (degree) of sexual desire or interest?

5	4	3	2	1
Very high	High	Moderate	Low	Very low or none at all

3. Over the past week, how often did you feel sexually aroused (“turned on”) during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never



4. Over the past week, how would you rate your **level** of sexual arousal (“turn on”) during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Very high	High	Moderate	Low	Very low or none at all

5. Over the past week, how **confident** were you about becoming sexually aroused during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Very high confidence	High confidence	Moderate confidence	Low confidence	Very low or no confidence

6. Over the past week, how **often** have you been satisfied with your arousal (excitement) during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

7. Over the past week, how **often** did you become lubricated (“wet”) during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

8. Over the past week, how **difficult** was it to become lubricated (“wet”) during sexual activity or intercourse?

0	1	2	3	4	5
No sexual activity	Extremely difficult or impossible	Very difficult	Difficult	Slightly difficult	Not difficult

9. Over the past week, how **often** did you maintain your lubrication (“wetness”) until completion of sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

10. Over the past week, how **difficult** was it to maintain your lubrication (“wetness”) until completion of sexual activity or intercourse?

0	1	2	3	4	5
No sexual activity	Extremely difficult or impossible	Very difficult	Difficult	Slightly difficult	Not difficult

11. Over the past week, when you had sexual stimulation or intercourse, how **often** did you reach orgasm (climax)?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

12. Over the past week, when you had sexual stimulation or intercourse, how **difficult** was it for you to reach orgasm (climax)?

0	1	2	3	4	5
No sexual activity	Extremely difficult or impossible	Very difficult	Difficult	Slightly difficult	Not difficult

13. Over the past week, how **satisfied** were you with your ability to reach orgasm (climax) during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Very satisfied	Moderately satisfied	About equally satisfied and dissatisfied	Moderately dissatisfied	Very dissatisfied

14. Over the past week, how **satisfied** have you been with the amount of emotional closeness during sexual activity between you and your partner?

0	5	4	3	2	1
No sexual activity	Very satisfied	Moderately satisfied	About equally satisfied and dissatisfied	Moderately dissatisfied	Very dissatisfied

15. Over the past week, how **satisfied** have you been with your sexual relationship with your partner?

5	4	3	2	1
Very satisfied	Moderately satisfied	About equally satisfied and dissatisfied	Moderately dissatisfied	Very dissatisfied

16. Over the past week, how **satisfied** have you been with your overall sex life?

5	4	3	2	1
Very satisfied	Moderately satisfied	About equally satisfied and dissatisfied	Moderately dissatisfied	Very dissatisfied

17. Over the past week, how **often** did you experience discomfort or pain during vaginal penetration?

0	5	4	3	2	1
Did not attempt intercourse	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

18. Over the past week, how **often** did you experience discomfort or pain following vaginal penetration?

0	5	4	3	2	1
Did not attempt intercourse	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

19. Over the past week, how would you rate your level (degree) of discomfort or pain during or following vaginal penetration?

0	5	4	3	2	1
Did not attempt intercourse	Very high	High	Moderate	Low	Very low or none at all

**FSFI Domain and Full-Scale Scores and Factors**

Domain	Question #s	Score Range	Factor	Minimum Score	Maximum Score
Desire	1, 2	1 - 5	0.6	1.2	6
Arousal	3, 4, 5, 6	0 - 5	0.3	0	6
Lubrication	7, 8, 9, 10	0 - 5	0.3	0	6
Orgasm	11, 12, 13	0 - 5	0.4	0	6
Satisfaction	14, 15, 16	0 (or 1) - 5	0.4	0.8	6
Pain	17, 18, 19	0-5	0.4	0	6
Total Score				2	36

## Appendix B

### Male Sexual Function Index (MSFI)

(Kalmbach, Ciesla, Janata, & Kingsberg, 2012)

INSTRUCTIONS: The following questions evaluate your sexual interest or functioning. Remember that all responses to these questions will be kept confidential. Please circle the number next to the answer to each question.

1. Over the past week, how **often** did you feel sexual desire or interest?

5	4	3	2	1
Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

2. Over the past week, how would you rate your **level** (degree) of sexual desire or interest?

5	4	3	2	1
Very high	High	Moderate	Low	Very low or none at all

3. Over the past week, how **often** did you feel sexually aroused (“turned on”) during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

4. Over the past week, how would you rate your **level** of sexual arousal (“turn on”) during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Very high	High	Moderate	Low	Very low or none at all

5. Over the past week, how **confident** were you about becoming sexually aroused during sexual activity or intercourse?

0	5	4	3	2	1
No sexual Activity	Very high confidence	High confidence	Moderate confidence	Low confidence	Very low or no confidence

6. Over the past week, how **often** have you been satisfied with your arousal (excitement) during sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

7. Over the past week, how **often** did your penis become erect when trying to engage in sexual activity or intercourse?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

8. Over the past week, how **difficult** was it to produce an erection during sexual activity or intercourse?

0	1	2	3	4	5
No sexual activity	Extremely difficult or impossible	Very difficult	Difficult	Slightly difficult	Not difficult

9. Over the past week, how **often** did you maintain your erection for the desired length of time?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

10. Over the past week, how **difficult** was it to maintain your erection for the desired length of time?

0	1	2	3	4	5
No sexual activity	Extremely difficult or impossible	Very difficult	Difficult	Slightly difficult	Not difficult

11. Over the past week, when you had sexual stimulation or intercourse, how **often** did you reach orgasm (climax)?

0	5	4	3	2	1
No sexual activity	Almost always or always	Most times (more than half the time)	Sometimes (about half the time)	A few times (less than half the time)	Almost never or never

12. Over the past week, when you had sexual stimulation or intercourse, how **difficult** was it for you to reach orgasm (climax)?

0	1	2	3	4	5
No sexual activity	Extremely difficult or impossible	Very difficult	Difficult	Slightly difficult	Not difficult



13. Over the past week, how **satisfied** were you with your ability to reach orgasm (climax) during sexual activity or intercourse?

0	1	2	3	4	5
No sexual activity	Very satisfied	Moderately satisfied	About equally satisfied and dissatisfied	Moderately dissatisfied	Very dissatisfied

14. Over the past week, how **satisfied** have you been with the amount of emotional closeness during sexual activity between you and your partner?

0	1	2	3	4	5
No sexual activity	Very satisfied	Moderately satisfied	About equally satisfied and dissatisfied	Moderately dissatisfied	Very dissatisfied

15. Over the past week, how **satisfied** have you been with your sexual relationship with your partner?

5	4	3	2	1
Very satisfied	Moderately satisfied	About equally satisfied and dissatisfied	Moderately dissatisfied	Very dissatisfied

16. Over the past week, how **satisfied** have you been with your overall sex life?

5	4	3	2	1
Very satisfied	Moderately satisfied	About equally satisfied and dissatisfied	Moderately dissatisfied	Very dissatisfied

**MSFI Domain and Full-Scale Scores and Factors**

Domain	Question #s	Score Range	Factor	Minimum Score	Maximum Score
Desire	1, 2	1 - 5	0.6	1.2	6
Arousal	3, 4, 5, 6	0 - 5	0.3	0	6
Erection	7, 8, 9, 10	0 - 5	0.3	0	6
Orgasm	11, 12, 13	0 - 5	0.4	0	6
Satisfaction	14, 15, 16	0 (or 1) - 5	0.4	0.8	6
Total Score				2	30

**Appendix C**  
**Sexual Fear Subscale of the Multidimensional Sexuality Questionnaire (MSQ)**  
**(Snell, Fisher, & Walters, 1993)**

INSTRUCTIONS: Please read each item, and then indicate how distressing each difficulty has been for you with respect to your MI. How much have you been distressed or bothered by these activities?

1. I am somewhat afraid of becoming sexually involved with another person

4	3	2	1	0
Very characteristic of me	Moderately characteristic of me	Somewhat characteristic of me	Slightly characteristic of me	Not at all characteristic of me

2. I sometimes have a fear of sexual relationships

4	3	2	1	0
Very characteristic of me	Moderately characteristic of me	Somewhat characteristic of me	Slightly characteristic of me	Not at all characteristic of me

3. I sometimes am fearful of sexual activity

4	3	2	1	0
Very characteristic of me	Moderately characteristic of me	Somewhat characteristic of me	Slightly characteristic of me	Not at all characteristic of me

4. I don't have very much fear about engaging in sex

0	1	2	3	4
Very characteristic of me	Moderately characteristic of me	Somewhat characteristic of me	Slightly characteristic of me	Not at all characteristic of me

5. I'm not very afraid of becoming sexually active

0	1	2	3	4
Very	Moderately	Somewhat	Slightly	Not at all
characteristic	characteristic of	characteristic of	characteristic of	characteristic of
of me	me	me	me	me

## Appendix D

### Patient-Reported Outcomes Measurement Information System (PROMIS) Anxiety 4a (Cella et al., 2007)

INSTRUCTIONS: Please read each item, and then indicate your response by circling one option below.

1. In the past 7 days, I felt fearful

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never

2. In the past 7 days, I found it hard to focus on anything other than my anxiety

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never

3. In the past 7 days, my worries overwhelmed me

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never

4. In the past 7 days, I felt uneasy

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never

## Appendix E

### Patient-Reported Outcomes Measurement Information System (PROMIS) Depression 4a (Cella et al., 2007)

INSTRUCTIONS: Please read each item, and then indicate your response by circling one option below.

1. In the past 7 days, I felt worthless

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never

2. In the past 7 days, I felt helpless

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never

3. In the past 7 days, I felt depressed

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never

4. In the past 7 days, I felt hopeless

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never

**Appendix F**  
**Coping Strategy Indicator (CSI)**  
**(Amirkhan, 1990)**

INSTRUCTIONS: Keeping the heart attack in mind, indicate the extent to which you:

1. Let your feelings out to a friend?

3	2	1
A lot	A little	Not at all

2. Rearranged things around you so that your problem had the best chance of being resolved?

3	2	1
A lot	A little	Not at all

3. Brainstormed all possible solutions before deciding what to do?

3	2	1
A lot	A little	Not at all

4. Tried to distract yourself from the problem?

3	2	1
A lot	A little	Not at all

5. Accepted sympathy and understanding from someone?

3	2	1
A lot	A little	Not at all

6. Did all you could to keep others from seeing how bad things really were?

3	2	1
A lot	A little	Not at all

7. Talked to people about the situation because talking about it helped you to feel better?

3	2	1
A lot	A little	Not at all

8. Set some goals for yourself to deal with the situation?

3	2	1
A lot	A little	Not at all

9. Weighed your options very carefully?

3	2	1
A lot	A little	Not at all

10. Daydreamed about better times?

3	2	1
A lot	A little	Not at all

11. Tried different ways to solve the problem until you found one that worked?

3	2	1
A lot	A little	Not at all

12. Confided your fears and worries to a friend or relative?

3	2	1
A lot	A little	Not at all



13. Spent more time than usual alone?

3	2	1
A lot	A little	Not at all

14. Told people about the situation because just talking about it helped you to come up with solutions?

3	2	1
A lot	A little	Not at all

15. Thought about what needed to be done to straighten things out?

3	2	1
A lot	A little	Not at all

16. Turned your full attention to solving the problem?

3	2	1
A lot	A little	Not at all

17. Formed a plan of action in your mind?

3	2	1
A lot	A little	Not at all

18. Watched more television than usual?

3	2	1
A lot	A little	Not at all

19. Went to someone (friend or professional) in order to help you feel better?

3	2	1
A lot	A little	Not at all

20. Stood firm and fought for what you wanted in the situation?

3	2	1
A lot	A little	Not at all

21. Avoided being with people in general?

3	2	1
A lot	A little	Not at all

22. Buried yourself in a hobby or sports activity to avoid the problem?

3	2	1
A lot	A little	Not at all

23. Went to a friend to help you feel better about the problem?

3	2	1
A lot	A little	Not at all

24. Went to a friend for advice on how to change the situation?

3	2	1
A lot	A little	Not at all

25. Accepted sympathy and understanding from friends who had the same problem?

3	2	1
A lot	A little	Not at all

26. Slept more than usual?

3	2	1
A lot	A little	Not at all

27. Fantasized about how things could have been different?

3	2	1
A lot	A little	Not at all

28. [Redacted]

3	2	1
A lot	A little	Not at all

29. [Redacted]

3	2	1
A lot	A little	Not at all

30. [Redacted]

3	2	1
A lot	A little	Not at all

31. [Redacted]

3	2	1
A lot	A little	Not at all

32. [Redacted]

3	2	1
A lot	A little	Not at all

33. [Redacted]

3	2	1
A lot	A little	Not at all

NOTE: Selected questions within each subscale of this survey were withheld at the request of the instrument developer.

### CSI Subscale Distribution

Question Item	Subscale
<p>2. Rearranged things around you so that your problem had the best chance of being resolved?</p> <p>3. Brainstormed all possible solutions before deciding what to do?</p> <p>8. Set some goals for yourself to deal with the situation?</p> <p>9. Weighed your options very carefully?</p> <p>11. Tried different ways to solve the problem until you found one that worked?</p> <p>15. Thought about what needed to be done to straighten things out?</p> <p>16. Turned your full attention to solving the problem?</p> <p>17. Formed a plan of action in your mind?</p> <p>20. Stood firm and fought for what you wanted in the situation?</p> <p>29. [Redacted]</p> <p>33. [Redacted]</p>	<p><b>Problem Solving</b></p>
<p>1. Let your feelings out to a friend?</p> <p>5. Accepted sympathy and understanding from someone?</p> <p>7. Talked to people about the situation because talking about it helped you to feel better?</p> <p>12. Confided your fears and worries to a friend or relative?</p> <p>14. Told people about the situation because just talking about it helped you to come up with solutions?</p> <p>19. Went to someone (friend or professional) in order to help you feel better?</p> <p>23. Went to a friend to help you feel better about the problem?</p> <p>24. Went to a friend for advice on how to change the situation?</p> <p>25. Accepted sympathy and understanding from friends who had the same problem?</p> <p>31. [Redacted]</p> <p>32. [Redacted]</p>	<p><b>Seeking Support</b></p>

<p>4. Tried to distract yourself from the problem?</p> <p>6. Did all you could to keep others from seeing how bad things really were?</p> <p>10. Daydreamed about better times?</p> <p>13. Spent more time than usual alone?</p> <p>18. Watched more television than usual?</p> <p>21. Avoided being with people in general?</p> <p>22. Buried yourself in a hobby or sports activity to avoid the problem?</p> <p>26. Slept more than usual?</p> <p>27. Fantasized about how things could have been different?</p> <p>28. [Redacted]</p> <p>30. [Redacted]</p>	<p>Avoidance</p>
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NOTE: Selected questions within each subscale of this survey were withheld at the request of the instrument developer

## Appendix G

### Family Support Subscale of the Multidimensional Scale of Perceived Social Support (MSPSS)

(Zimet, Dahlem, Zimet, & Farley, 1998)

INSTRUCTIONS: We are interested in how you feel about the following statements. Read each statement carefully. Indicate how you feel about each statement.

1. My family really tries to help me

1	2	3	4	5	6	7
Very strongly disagree	Strongly disagree	Mildly disagree	Neutral	Mildly agree	Strongly agree	Very strongly agree

2. I get the emotional help and support I need from my family

1	2	3	4	5	6	7
Very strongly disagree	Strongly disagree	Mildly disagree	Neutral	Mildly agree	Strongly agree	Very strongly Agree

3. I can talk about my problems with my family

1	2	3	4	5	6	7
Very strongly disagree	Strongly disagree	Mildly disagree	Neutral	Mildly agree	Strongly agree	Very strongly agree

4. My family is willing to help me make decisions

1	2	3	4	5	6	7
Very strongly disagree	Strongly disagree	Mildly disagree	Neutral	Mildly agree	Strongly agree	Very strongly agree

## Appendix H

### Nursing Research and Translation Committee Approval Form

Nursing at Michigan



University of Michigan  
Health System

Leah L. Shever, PhD, RN  
Director of Nursing Research,  
Quality, and Innovation  
University of Michigan Health System  
300 North Ingalls, Room NI 5A07  
Ann Arbor, MI 48109-5446  
Phone: 734-647-7373  
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[sheverl@med.umich.edu](mailto:sheverl@med.umich.edu)  
[www.med.umich.edu/nursing](http://www.med.umich.edu/nursing)

March 22, 2019

RE: Predictors of sexual health in patient's post-myocardial infarction: A longitudinal study  
PI: Asa Smith

Dear Asa,

Thank you for soliciting the participation of the University of Michigan University Hospital, in your proposed study, *Predictors of sexual health in patient's post-myocardial infarction: A longitudinal study*.

The Nursing Research and Translation Committee reviewed your proposed study. We are pleased to inform you that the Committee approved the nursing participation in your study as outlined in the Research Synopsis and Application form that you submitted, which includes:

- Communicating to the staff nurses on 7B, 7C, 7D and CVC5 through nursing unit leadership (Clinical Nursing Director or Clinical Nursing Specialist) about the study for staff nurses' awareness.
- Communicating with the study investigator about patients that may meet eligibility criteria.

Our participation is with the understanding that you will obtain and retain IRB approval for this study and that your faculty supervisor (Debra Barton) will be overseeing your work. We understand that the principal investigator (PI) will serve as primary contact for this study if any questions arise.

If you have questions or we can provide you with additional information, please do not hesitate to call. We look forward to working with you on this important initiative.

Sincerely,

Leah Shever, PhD, RN; Corinne Lee, DNP, RN  
Co-Chairs, Nursing Research and Translation Committee

cc: Rob Burke; Regi Freeman, Robin Lund; Cathy Kendrick; Diane Lopez; Scherolyn Leggett; Annette Walblay; Devin Carr; Debra Barton

**Appendix I**  
**Follow Up Letters**

Follow Up Letter 1 - Two weeks

[DATE]

Dear **[participant name]**,

Thank you again for choosing to participate in this study. This envelope includes two different questionnaires as well as a copy of the consent form for you to keep for your records. I have highlighted my contact information on the consent form should you wish to contact me for any reason.

I'd like for you to fill out these questionnaires at any time between the **[7-14 days post discharge date]**. If you could fill out both enclosed surveys, place them in the included pre-stamped envelope, and mail them back to Ann Arbor, that would be greatly appreciated. The return envelope purposely has no return address to ensure your confidentiality.

If you have any questions or concerns, you may either call at 810-772-8296, or email at [smiasa@umich.edu](mailto:smiasa@umich.edu).

Sincerely,

Asa Smith, BSN, RN  
PhD Candidate, Hillman Scholar  
School of Nursing  
University of Michigan, Ann Arbor, MI



Follow Up Letter 2 - Three months

[DATE]

Dear [**participant name**],

Thank you again for choosing to participate in this study. This envelope includes the final packet of surveys. **If you haven't had a chance to send your first packet, please do so at your earliest convenience.** Following completion of this packet you will receive a gift card issued through the University of Michigan.

I'd like for you to fill out these questionnaires at any time after [**three months post discharge date**], which would be approximately three months after your discharge from the hospital. If you could fill out the enclosed survey, place it in the included pre-stamped envelope, and mail it back to Ann Arbor, that would be greatly appreciated. The return envelope purposely has no return address to ensure your confidentiality.

If you have any questions or concerns, you may either call at 810-772-8296, or email at [smiasa@umich.edu](mailto:smiasa@umich.edu).

Sincerely,

Asa Smith, BSN, RN  
PhD Candidate, Hillman Scholar  
School of Nursing  
University of Michigan, Ann Arbor, MI

**Appendix J**  
**Invitation Letter**

[DATE]

**[participant name],**

You are receiving this letter because you have recently been diagnosed with a heart attack. Sometimes the experience of having a heart attack can impact sexual function. The purpose of this letter is to let you know about a study that is being done at the University of Michigan to better understand changes in sexual function over time in people who have had a recent heart attack. Researchers will use this information to develop ways to help people improve sexual function after a heart attack.

If you participate, you will be asked to complete a set of questionnaires about sexual function, satisfaction, coping, anxiety and depression at 3 weeks and three months after you left the hospital related to your heart attack. The questionnaires can be filled out at home and sent back in a stamped, self-addressed envelope. Neither your name nor any identifying information will be on the questionnaire themselves. You will receive a gift card of \$30 for completing both sets of questionnaires at 3 weeks and three months.

Taking part in this study is completely voluntary. You do not have to participate if you do not want to. The care you receive at Michigan Medicine will not change whether you join the study or not.

If you are interested in hearing more about the study, one of our study team members would be happy to call you to explain the study in more detail. Hearing more about the study does not require you to participate. If you would like us to contact you, please complete the information below and send it back to us in the self-addressed, stamped envelope included with this letter. If you would rather contact us, you can reach the research investigator, Asa Smith, by calling 810-772-8296 or by emailing [smiasa@umich.edu](mailto:smiasa@umich.edu)

Thank you for your time in considering this request,

Asa Smith, BSN, RN  
Suite 3236, 400 North Ingalls Building  
Ann Arbor, MI 48109-5482

Debra Barton PhD, RN, FAAN  
400 North Ingalls Building  
Ann Arbor, MI 48109-5482

Name: \_\_\_\_\_

Phone number: \_\_\_\_\_

Best days/times to call: \_\_\_\_\_

\_\_\_\_ I am interested in hearing more about the study, please call me.

\_\_\_\_ It is okay to leave a brief message at this number.

**Appendix K  
Demographic Survey**

1. Age \_\_\_\_\_

2. Gender

Male                      Female

3. Race

Caucasian/White      Black/African Descent      Asian                      Other \_\_\_\_\_

4. Please indicate your educational status

Some high school      High school degree      Some college      College Degree      Graduate degree

5. Please indicate your relationship status

Single      In a relationship (living together)      In a relationship (not living together)      Married      Divorced      Widowed

6. Please indicate your employment status

Employed (full time)      Employed (part time)      Unemployed      Retired      Medical leave

7. Are you or were you currently enrolled in cardiac rehabilitation (CR) services after you had your heart attack? (this current heart attack only)

Currently enrolled in CR      Previously enrolled in CR      Planning to enroll in CR      Not enrolled in CR

## Supplemental Biomarkers Form

1. Type of MI

Type 1      Type 2      Unknown

2. STEMI vs. NSTEMI

STEMI      NSTEMI      Unknown

3. Troponin levels

Troponin T \_\_\_\_\_ Troponin I \_\_\_\_\_

4. Left Ventricular Ejection Fraction (LVEF) \_\_\_\_\_

**Appendix L**  
**Decliner Survey**

- 1) Age \_\_\_\_\_
- 2) Gender
  - a. Male
  - b. Female
  - c. Other
- 3) Race
  - a. Caucasian
  - b. African American
  - c. Native American
  - d. Asian
  - e. Pacific Islander
  - f. Multiracial
  - g. Other
- 4) Ethnicity
  - a. Hispanic
  - b. Non-Hispanic