# EXAMINING FACTORS ASSOCIATED WITH PHYSICAL ACTIVITY DURING CARDIAC REHABILIATION

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**Abstract**

Recurrent myocardial infarctions (MIs) account for a third of the incident rate for all MIs. Physical activity (PA) is an important health behavior to prevent a recurrent MI. Fatigue, sleepiness, anxiety, and depression are all barriers to PA. The purpose of this pilot study was to examine how fatigue tolerance, sleep, depression, and anxiety influenced PA in those attending cardiac rehabilitation (CR) after an MI or coronary artery bypass surgery.

Using a repeated measure design, we interviewed a pilot sample of 8 adults who were beginning CR. Each participant completed a demographic and health status form. A 100mm visual analog scale was used to determine fatigue tolerance. Sleep was measured using the Epworth Sleepiness Scale, the Patient Health Questionnaire-9 measured depression, and anxiety was measured using the Generalized Anxiety Disorder-7. Participants wore a Garmin activity tracker for one week and step data (PA) were calculated on full days of activity. All data were analyzed using Statistical Package for Social Sciences 25.

Most of the participants ($N$ = 8) were White (88%), women (62.5%), and had a mean age of 70.5 ($SD$ = 10.5). All had high cholesterol, 88% high blood pressure, and 38% had a history of smoking. The mean depression score was 7 ($SD$ = 4.3; range 1-15) indicating mild depression. Sleep ($M$ = 7.1; $SD$ = 6) and anxiety ($M$ = 4.88; $SD$ = 5) were in normal ranges. Average number of daily steps was 6000 ($SD$ = 2517; range = 2863-9526). The average fatigue that they could tolerate ($M$ = 59; $SD$ = 26.7) and the average fatigue that slowed them down ($M$ = 49.6; $SD$ = 24.7) were lower than their perceived normal fatigue level for people similar to them ($M$ = 70.4; $SD$ = 24). Average daily steps were negatively associated with fatigue level that slows them down ($r$ = -.78) but none of the other fatigue tolerability measures correlated with PA.

Most are not reaching the amount of PA deemed to be cardioprotective. Because most indicated lower fatigue tolerance than what they perceived as normal, further study of fatigue tolerance and PA is warranted. A larger sample size is needed to determine the relationship of fatigue tolerance, sleep, depression and anxiety on PA.

Examining Factors Associated with Physical Activity During Cardiac Rehabilitation

Coronary heart disease (CHD), one of the leading causes of death in America, affects both men and women. According to the American Heart Association (2017), heart disease accounts for 1 in 7 deaths in the United States, and the number of those living with CHD is 28.4 million. The risk for CHD increases with age, starting at age 45 for men and age 55 for women (AHA, 2014). The development of CHD begins when plaque starts to build up in the coronary arteries that supply oxygen rich blood to the heart. Over time, the plaque hardens and can cause a blockage leading to decreased blood flow to the cardiac muscle resulting in pain, angina, or a myocardial infarction (MI) (National Heart, Lung, and Blood Institute [NHLBI], 2016). Coronary artery bypass graft surgery (CABG) improves blood flow to the heart muscle by taking a healthy vein and using it to bypass or graft the blocked portion of the coronary artery (NHLBI, 2012). Unfortunately, after a cardiac event or surgery, CHD may continue. This is evidenced by the number of recurrent MIs each year accounting for over one third of the incidence rate of MIs (AHA, 2017). Halting or slowing the progressive CHD after a cardiac event, secondary prevention, is essential in affecting the lives of those who have experienced an MI or had CABG.

## Literature Review

One of the most effective ways to foster secondary prevention post MI or CABG is completing a cardiac rehabilitation (CR) program. These programs target the risk factors associated with CHD. Certain modifiable risk factors lead to CHD including high cholesterol levels, high blood pressure, smoking, diabetes, obesity, lack of physical activity, and unhealthy diet (NHLBI, 2016). Controlling modifiable risk factors can stop or reverse CHD. Because physical activity (PA) has a positive effect on other risk factors such as obesity, hypertension, and stress, it is an effective way to lower risk factors for secondary cardiac events. However, only 35% of older adults meet the Center for Disease's recommended goal (Crane, Abel, & Mccoy, 2014). Griffo et al. (2010) found that CR after revascularization results in improved outcomes, lifestyle, and medication adherence at 1 year. This study supports the importance of secondary prevention. Variables that affect adherence to PA are depression (Howarter, Bennett, Barber, Gessner, & Clark, 2014), anxiety (Ivanova, Burns, Deschênes, Knäuper, & Schmitz, 2017), and sleep (Banack et al., 2014). Therefore, the purpose of this pilot study was to examine PA, depression, anxiety, and sleep in those who attend CR post MI or CABG.

## Cardiac Rehabilitation

Exercise based CR programs have shown to help prevent complications in cardiac patients. The CR programs involve exercise counseling and training, education on heart healthy living, and counseling to reduce stress (AHA, 2013). They aim to decrease cardiovascular risks, promote healthy behaviors, and increase the quality of life (Freitas et al., 2011). Not only does CR increase capacity for PA, but it has also been shown to reduce the symptoms of depression ($p = 0.001$) and anxiety ($p = 0.023$) (Rouleau, Toivonen, Aggarwal, Arena, & Campbell, 2017). Thus, patients with CHD post MI or CABG surgery should be enrolled in CR. Unfortunately, only 14% to 35% of those who survive an MI and 31% of patients after CABG surgery attend (AHA, 2013). Understanding how depression, anxiety, and sleep affect a person's PA in those who attend CR is important in developing interventions to maintain cardioprotective PA post MI and CABG.

To understand factors associated with PA in CR, a targeted review of the literature was conducted. A total of 20 research articles published from 2010 to 2017 were reviewed using a Boolean search strategy. The search terms were "depression", "sleep", "anxiety", "exercise", and "cardiac rehabilitation". Almost all reviewed articles were quantitative ($n = 19$), and all articles included different races and both men and women. Sample sizes ranged from 11 in the qualitative study, and 41 to 2168 in the quantitative studies. Only two studies did not include older adults (Lamberti et al., 2016; Kwon & Shin, 2016). Lamberti et al. (2016) focused on work related outcomes, which could be a reason why they studied a younger aged sample *(M* = 51± 8). Kwon and Shin (2016) included an average age of 54.3 ± 7.2, focused on examining how PA affected daytime sleepiness in healthy individuals, and did not examine variables related to older adults. Of the 20 studies reviewed, 12 used only questionnaires to examine PA, two used observation and questionnaires, and six studies used questionnaires and physiologic monitoring. The following details the major areas related to PA, depression, anxiety, and sleep.

**Physical Activity**

Physical activity is known to have a positive impact on those with cardiovascular disease. The vast majority of studies reviewed (*n* = 15) had objective measures of PA. A variety of questionnaires and scales were used and focused on both PA and physical function or fitness including the International Physical Activity Questionnaire (IPAQ) (Antypas & Wangberg, 2014), Compulsive Exercise Scale (CES) (Weinstein, Maayan, & Weinstein, 2015), Cardiac Exercise Self-Efficacy (ESE) instrument (Howarter et al., 2014), GOSPEL study questionnaire (Gostoli, Roncuzzi, Urbinati, Morisky, & Rafanelli, 2016), 6- minute walk test (6-MWT) (Marzolini, Danells, Oh, Jagroop, & Brooks, 2016; Zhang et al., 2014), Sit-to-Stand test (STS) (Zhang et al., 2015), stair climbing test (Zhang et al., 2014), and Borg's Rating of Perceived Exertion scale (Rouleau, Toivonen, Aggarwal, Arena, & Campbell, 2017; Rouleau et al., 2015). Almost one third of the studies (*n* = 6) reported using accelerometers for activity monitoring. Physical activity is an important measure in those enrolled in CR. The variety of measures of physical activity, function and fitness used make it difficult to compare PA across studies.

Sleep, depression, and anxiety are variables associated with PA. According to Gostoli, Roncuzzi, Urbinati, Morisky, and Rafanelli (2016), CR patients with maintained PA had improvements in sleep quality ($p$ = 0.012) measured by the Pittsburgh Sleep Quality Index. Cardiac rehabilitation patients' PA mean scores were maintained over time compared to non-CR patients. This study also measured both depression and anxiety using the DSM-IV. No associations were found with anxiety and PA. Those with higher depression scores showed a reduction in adherence to PA.

Another study also found that depression was associated with PA. This study examined how CR influenced depression, anxiety, and sleep. They found after completion of an exercise based 12-week CR program, the participants had a significant reduction in depression and anxiety as well as improvements in insomnia symptom severity (Rouleau, Toivonen, Aggarwal, Arena, & Campbell, 2017). This study used the ISI rather than PSQI to measure sleep but had similar findings regarding improvement of sleep quality. The study also differed by measuring depression and anxiety using the HADS, not DSM-IV. Although different measures of depression, anxiety, and sleep were used, these studies demonstrated that CR positively affected these variables.

**Depression**

Depression is a common symptom experienced after MI (Howarter et al., 2014) and CABG (AHA, 2014). A majority of the studies reviewed ($n$ = 16) measured depression. Different scales and questionnaires were used to measure depression including the Beck Depression Inventory (BDI) (Hartescu et al., 2015; Kwon & Shin, 2016; Weinstein et al., 2015; Zhang et al., 2014), structured clinical interview using DSM-IV (Gostoli et al., 2016), Hospital Anxiety and Depression Scale (HADS) (Awick et al., 2017; Freitas et al., 2011; Rouleau et al., 2015; Rouleau et al., 2017; Stauber et al., 2012; Turner et al., 2010), Center for Epidemiologic Studies Depression Scale (CES-D) (Marzolini et al., 2016), Beck Depression Inventory II (BDI-II) (Banack et al., 2014; Howarter et al., 2014; Zhang et al., 2014), Kellner Symptom Questionnaires (Kachur et al., 2016), and Patient Health Questionnaire (PHQ-9) (Ivanova et al., 2017). The variety of scales used make it difficult to compare studies, but it is clear from the review that depression is an important variable to measure in those post cardiac event enrolled in CR.

Depression is shown to affect PA, and PA affects depression. In a study done by Hartescu, Morgan, and Stevinson (2015), it was found that increasing PA to the level recommended in public health guidelines had a significant effect on depression scores after 6 months. In the PA group, there was a significant improvement in BDI scores ($p < 0.001$) from baseline BDI scores. Similarly, another study showed that after completing a 12-week exercise based CR program using moderate intensity exercise twice weekly, there was a significant decrease in depression ($p = 0.001$) (Rouleau et al., 2017). Rouleau and colleagues (2017) measured depression using the HADS scale.

Depression in CR influences PA during and after CR is completed. Howarter, Bennett, Barber, Gessner, and Clark (2014) found that participants in CR with high depressive symptoms began CR with lower exercise self-efficacy levels and had significant declines in PA 6 months after CR. Also, mean depressive symptoms measured by the BDI-II were lower two years after CR than before (Howarter et al., 2014). Thus, depression is important to measure early in CR as this may influence participation in PA after CR despite depression scores decreasing. Further studies are needed to understand how depression in the early phases of CR affect adherence to PA after CR.

The importance of PA in CR patients with depression and depressive symptoms is clearly noted in the literature. Of the articles reviewed, most (*n* = 16) included depression as an objective variable. Additionally, most were consistent in demonstrating that depression has a negative effect on PA and PA has a positive effect on depression in CR patients.

**Anxiety**

Anxiety is often another symptom associated with cardiac patients. Over half of the articles (*n* = 13) included anxiety as one of the objective measures. The scales and questionnaires used to measure anxiety were Hospital Anxiety and Depression Scale (HADS) (Awick et al., 2017; Freitas et al., 2011; Rouleau et al., 2015; Rouleau et al., 2017; Stauber et al., 2012; Turner et al., 2010; Zhang et al., 2014), Beck Anxiety Inventory (BAI) (Zhang et al., 2014), Spielburger State-Trait Anxiety Inventory (STAI) (Hartescu et al., 2015; Weinstein et al., 2015), Generalized Anxiety Disorder (GAD-7) scale (Ivanova et al., 2017), Structure Clinical Interview for (DSM-IV) (Gostoli et al., 2016), and Kellner Symptom Questionnaires (Kachur et al., 2016). Of the 13 articles, the HADS scale was used most commonly (*n* = 6). Despite being a common symptom after having an MI or CABG surgery, because of the many scales and questionnaires used it is difficult to compare anxiety across studies.

Anxiety is common post cardiac symptom because of the feeling of not knowing what can happen. In the qualitative study by Simony, Pederson, Dreyer, and Birkelund (2015), 11 patients were interviewed at the end of CR. Those patients reported experiencing anxiety regarding exercise, not knowing how it would affect their hearts, and not knowing how to behave because of their diseased hearts. One person stated “You feel anxious regarding how much you might be capable of enduring. I was nervous concerning the amount of pressure to which I might expose myself” (Simony et al., 2015).  A different study using the HADS scale found anxiety decreases as age increases, and women showed considerably higher levels of anxiety than men (Turner et al., 2010). Anxiety and depression are often strongly and significantly associated ($r$ = 0.66, $p < 0.001$) (Turner et at., 2010). Anxiety is a symptom experienced by many cardiac patients because of a fear of the unknown and should be measured when examining PA post MI and CABG.

**Sleep**

Disturbed sleep patterns can cause fatigue and inability to perform and maintain PA. Of the 20 articles reviewed, only eight included sleep as a measure. The scales used to measure sleep include Pittsburgh Sleep Quality Index (PSQI) (Awick et al., 2017; Banack et al., 2014; Freitas et al., 2011; Gostoli et al., 2016; Kwon & Shin, 2014; Rouleau et al., 2015), Insomnia Severity Index (ISI) (Hartescu et al., 2015; Rouleau et al., 2015; Rouleau et al., 2017), and Epworth Sleepiness Scale (ESS) (Hartescu et al., 2015; Kwon & Shin, 2016). Disturbed sleep can affect a person's ability to perform PA. Conversely, PA has also been shown to help with quality of sleep.

Poor sleep is not only experienced as a single issue but coexists with other symptoms and diseases such as depression. Banack et al. (2014) found that depressive symptoms were the most significant cause of poor sleep, and those with depressive symptoms were six times more likely ($OR$ = 7.3; 95% CI, 4.2–12.4) to experience sleep disturbance. Sleep was measured using the PSQI and depression was measured using the BDI-II. In another study, causal relationships from depression and sleep quality were both weaker in those who regularly engaged in PA (Kwon & Shin, 2016). Kwon and Shin (2016) also measured sleep with the PSQI and depression with the BDI. Finding a directional relationship between PA and sleep quality could lead to potential treatment for those with both depressive symptoms and poor sleep quality.

Coronary heart disease affects many people and is a major cause of death in the United States. Secondary prevention behaviors started in CR is important to prevent progressive CHD in those post MI or CABG. Physical activity, a focus in CR, is a modifiable risk factor that can reduce the chances of having an MI or worsening CHD. This review found that depression, sleep, and anxiety are common after MI or CABG and affect PA. The relationship of depression, anxiety, and sleep and PA is not clear as many of the reviewed studies noted a bidirectional relationship: depression, anxiety, and sleep influenced PA, and PA influenced these symptoms. This review also supported examining these variables as they are typically coexisting in those who are post cardiac event. Although different measures of depression, anxiety, and sleep were used, this review demonstrated that CR positively affected these factors.

## Methods

The purpose of this pilot study was to examine the relationship of depression, anxiety, sleep, PA and fatigue tolerance in patients starting CR. A secondary purpose was to examine if depression, anxiety, and sleep influence physical activity. Approval for the study was obtained from the appropriate institutional review board.

This study was conducted at the Vidant Cardiovascular and Pulmonary Rehabilitation center on Stantonsburg Road in Greenville, North Carolina. Each participant was released by their physician to participate in CR. Eligibility criteria includes adults 18 and older who were post MI or CABG and ambulatory. Those who agreed to participate in the research and were eligible to do so were approached at their next visit after their initial orientation week in the CR unit. The informed consent was read to them and questions answered. Once informed consent was obtained, participants also signed HIPAA Privacy Authorization form allowing collection of variables from their medical record. Data collection sessions lasted approximately 30 minutes and were held in a private office at the CR center.

Demographic data were subsequently collected along with a health status form including height, weight, heart rate, and blood pressure. A list of current medications was also collected either from the patient or medical health record if they did not have a list of their medications with them.

Fatigue tolerance was measured by a 3-item fatigue tolerance 100mm visual analog scale (VAS) placed horizontally and anchored by 0 (not at all) and 100 (worst fatigue). Participants were asked to place a line perpendicular to the VAS line at the point that represents their answer. The 3-item fatigue tolerability VAS included: a) the highest level of fatigue you can tolerate while continuing to do the things you need/want to do, b) the level of fatigue that you think slows you down, and c) the level of fatigue you think is normal for people like you (or similar to you). Each of the fatigue tolerability items were analyzed separately.

Sleep was measured using the Epworth Sleepiness Scale (ESS). This scale consists of eight situations that can be measure from 0 (would never dose) to 3 (high chance of dosing) measuring daytime sleepiness. Scores range from 0 to 24 with a higher score indicating poorer sleep. The ESS has a high reliability ($r$ = 0.82) and high level of internal consistency with a Cronbach’s alpha (0.88) (Johns, 1992).

Depression was measured using the Patient Health Questionnaire-9 (PHQ-9). It asks nine questions that relate to depression over the last two weeks, with each scored from 0 (not at all) to 3 (nearly every day). At the end of the questionnaire, there is a question for the participants to indicate how difficult any of the problems checked make it to do work, take care of things at home, and get along with other people. This question is rated from not difficult at all to extremely difficult. The PHQ-9 has strong reliability (*r* = 0.79) and validity (sensitivity of 0.89 and specificity of 0.97) (Zhang et al., 2013).

Anxiety was measured using the Generalized Anxiety Disorder-7 (GAD-7) scale that questions how often you have been bothered over the last two weeks, given 7 situations. Each question was scaled 0 (no at all sure) to 3 (nearly every day). Scores can range from 0 to 21 with higher scores indicating higher levels of anxiety. The internal consistency of the GAD-7 was excellent (Cronbach α = .92) and test retest reliability was acceptable (*r* = 0.83) (Spitzer, Kroenke, Williams, & Lowe, 2006).

Pain was measured using the PROMIS Pain Interface Short Form 8a. If the participant answered “yes” to having pain in the last seven days, they were asked to complete the PROMIS Pain Interface Short Form 8a by responding to the 8 situations given. The range was from 1 (not at all) to 5 (very much) and each person’s pain was measure with a score from 8 to 40. Those answering no pain in the past week received a score of 0.

Physical activity was measured in different ways. Physical function was measured by hand grip strength using a Dynamometer. Each participant completed the grip test three times and the average result was recorded. Exercise capacity was measured by a 6-minute walk test. This is a common test where patients determine their own speed and distance. Each participant was given a Garmin step monitor during the first visit to wear on their ankle for approximately one week until their fourth visit to CR to measure the number of steps per day and percent of active time. An active hour was defined as an hour where more than 10 steps were taken. On the second data collection time, the participants returned the step monitors and were again asked to complete the VAS tolerance to fatigue questions. Participants received a $25 gift card to Walmart upon completion of the first visit as well as the final visit for a total of $50 as a thank you for participating in the study. All data were analyzed using the Statistical Package for Social Sciences (SPSS) 25.

All data were secured on a password protected computer with appropriate firewalls. Data were collected in a private area using assigned identification (ID) numbers. The list of names and ID numbers were kept in separate computer encrypted files and will be destroyed when data analyses are complete.

## Results

The pilot study included 8 participants in CR who answered questionnaires and wore the Garmin activity tracker for a week. Most of the participants were White (88%) and female (62.5%) with an average age of 70.5 (*SD* = 10.5). Cardiovascular risk factors examination noted that all had high cholesterol, 88% had high blood pressure, 38% had a history of smoking, and 62% had diabetes or took medications to control blood sugar.

Depression was measured using the PHQ-9, and of the participants (N = 8), the mean score was 7 (*SD* = 4.3; range 1-15) indicating mild depression. The ESS measured a mean sleep score of 7.1 (*SD* = 6), in a normal range. Participants completed the GAD-7 to measure anxiety and had an average of 5.6 (*SD* = 6), also indicating a normal range.

Physical activity was measured using the Garmin activity step tracker. Each participant wore the tracker for a week to measure steps taken on full days. We found that the average steps taken was 6001 (*SD* = 2517; range = 2863-9526). Average daily steps were negatively associated with fatigue level that slows them down ($r$ = - 0.78). No other fatigue tolerability measures correlated with PA.

Fatigue tolerance was measured using 3 VAS scales and found that the average highest tolerable fatigue was 59 (*SD* = 26.7), the average fatigue that slows them down was 49.6 (*SD* = 24.7), and average normal fatigue level for those similar to them was 70.4 (*SD* = 24).

**Discussion**

In this pilot study, cardiovascular risk factors were examined and several differences were found compared to the general population. High cholesterol, high blood pressure, and smoking are key risk factors for heart disease. According to the CDC (2017), 47% of Americans have at least one of these three risk factors, and about 33% of American adults have high cholesterol, 32% have high blood pressure, 15.5% smoke and 12.2 % of have diabetes. Our sample had higher levels of each of these risk factors. These higher proportions may be related to the higher risk as all participants had experienced a recent MI or CABG. The level of diabetes for our sample (62%) is most likely higher than other parts of the U.S. because of the diet and lifestyle habits of people in the region. Further studies with larger sample sizes are needed to understand cardiovascular risk in Eastern North Carolina.

The average depression score of this pilot study, using the PHQ-9, indicated mild depression. In another study examining factors in CR patients also stated that 47% of the participants reported experiencing at least mild depression symptoms (Banack et al., 2014). The highest score in PHQ-9 is 27, so this person that scored 15 fell into the moderate depression range. Because of the prevalence of depression after MI or CABG, it is important that patients be screened when attending CR post cardiac event. Further, interventions targeting depression post MI and CABG are needed to facilitate increased physical activity.

Mean sleep and anxiety scores were both found to be in normal ranges for our sample. In another study, 52% of patients in the study reported poor sleep quality using the Pittsburg Sleep

Quality Index (Banack et al., 2014). The difference could be because of sample size, or use of a different tool to measure sleep quality. Our results are similar to a study by Antypas and Wangberg (2014) examining patients in CR. They noted participants had a median anxiety score of 4.5 according to the Hospital Anxiety and Depression Scale, also falling within the normal range. Sleep and anxiety levels may be normal in our sample because of self-selection bias. Those who chose to participate may have done so because they are not suffering from sleep and anxiety problems. Further study of sleep and anxiety is warranted in adults post MI or CABG to determine if these influence fatigue tolerance and participation in PA.

We found that participants are not reaching the amount of PA deemed to be cardioprotective. The average steps participants should be taking per day is 10,000 (Tudor-Locke et al., 2011), but the highest number was only 9526, falling short of that goal. This is a problem because getting the recommended amount of PA is important in lowering the risk of having another cardiac event. Tucker, Welk, and Beyler (2011) studied American adult's PA levels using an accelerometer for seven days, and found that only 9.6% of those individuals were meeting recommended amounts of PA. The findings in that study are similar to ours because it seems that most of the general population does not meet the recommended amounts of PA as the CR patients in our pilot study.

In this small pilot study, the average daily steps were negatively associated with fatigue levels that slows them down. A study completed by Crane, McCoy, and Abel (2014) demonstrated that higher levels of fatigue coincided with lower PA, similar to our findings of a negative correlation. There are no other tools used to measure fatigue tolerability in this population. Perception of self-efficacy may relate to fatigue tolerance as perceived tolerance is related to the belief that a person can do something. Future studies should add a measure of self-efficacy in addition to fatigue tolerance to understand how perceptions of fatigue influence PA.

### Limitations

A limitation of this study was using a repeated measure pilot study with a small sample size. Only one repeated measure may not capture the changes in behavior over time. Additionally, only measuring the variables in the first weeks of CR may not reflect relationships over time or if PA was sustained over time in CR. No significant relationships were identified, therefore more participants are needed to determine the relationships of fatigue tolerance, sleep, depression, and anxiety on PA. Finally, this study lacks generalizability to the target population.

## Conclusion

In this study, we examined the relationship between anxiety, sleep, depression, and fatigue tolerability on PA in those attending cardiac rehabilitation post MI and CABG. We found that participants did not meet the recommended number of steps per day to be cardio protective and most indicated lower fatigue tolerance than what they perceived as normal. These findings indicate the need to conduct further studies to determine relationships of fatigue tolerance, sleep, depression, and anxiety on PA post MI or CABG.

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