Physical Activity Patterns in Heart Transplant Women

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Maintaining regular, long-term physical activity is critical to achieve favorable effects of heart transplantation. Yet, at present, little is known about the physical activity patterns of transplant recipients, especially women. The study was conducted to (1) describe levels and types of physical activity using actigraphy and self-report, (2) determine the association between physical activity and sociodemographic variables, and (3) assess the relationship between physical activity, quality of life (QOL), and relevant health indicators (hypertension, hyperlipidemia, and obesity) among female heart transplant recipients. Twenty-seven women (average age, 57 ± 13 years, primarily Caucasian [82%], retired [89%], married [67%], average time since transplant 2.1 ± 1.3 years) from a single heart transplant facility were asked to report amount and types of physical activity and overall QOL and wear an actigraph for 1 week to measure physical activity level. Physical activity levels by actigraphy averaged 280,320 ± 52,416 counts for the week (range, 206,784–354,144); self-reported physical activity level on a 0 to 10 scale was 4.3 ± 0.37 (range, 0–7). The actigraph and self-reported measures were significantly correlated ($r = 0.661, P = .000$). It was found that women were more likely to engage in household tasks and family activities than occupational activities or sports. Significant differences in physical activity ($F = 6.319, P = .006$) were observed in participants who reported fair ($n = 13$), good ($n = 9$), and very good ($n = 5$) overall QOL. The only demographic factor associated with physical activity was age; younger women were more active than older women ($r = -0.472, P = .013$). A negative correlation was found between levels of physical activity and presence of hypertension, hyperlipidemia, and obesity. It was found that a majority of female transplant recipients remains sedentary. Given the association between physical activity and overall QOL and relevant health indicators, measures to enhance physical activity need to be developed and tested; these strategies may be beneficial in improving overall outcomes.

**KEY WORDS:** actigraphy, heart transplantation, physical activity, quality of life

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Over the last decade, exercise rehabilitation has become a widely accepted therapy for patients following heart transplantation. Favorable effects of exercise or physical activity in these patients include improvements in peak oxygen consumption, reduced blood lactate concentration, improved submaximal endurance, lessened symptoms of dyspnea and fatigue, and increased muscle strength and body mass. However, we recently reported that female recipients continue to experience increased functional limitations beyond the immediate postoperative period. Increased functional limitation may be related to pathophysiological changes associated with cardiac denervation, including chronotropic incompetence and diastolic dysfunction. It may also be related to negative emotional responses to psychological stressors after surgery. More important, functional limitations may be related to deconditioning that is associated with physical inactivity.

Regular physical activity is now widely recommended for heart transplant patients, but its role after heart transplantation has not been well defined. While all types of physical activity are often referred to as exercise, the difference between exercise and what is currently conceptualized as physical activity is not distinct. Physical activity, which includes traditional exercise done to improve physical fitness, as well as occupational, household, and leisure time activities, is defined as “any bodily movement produced by skeletal muscles that result in energy expenditure.”

Maintaining regular, long-term physical activity is critical to achieve its favorable effects; yet, at present little is known about the physical activity patterns of transplant recipients, especially women. While data exist to support that moderate levels of physical activity was associated with improved exercise capacity, the impact of physical activity on quality of life (QOL) and relevant health indicators including hypertension, hyperlipidemia, and obesity is not fully understood. Therefore, efforts to describe factors associated with physical activity are needed to improve our understanding of this phenomenon and how it affects various outcome measures in heart transplant recipients. We were particularly interested in examining the physical activity patterns of women as a result of our earlier observations indicating that they continued to suffer from functional limitations beyond the immediate posttransplant period.

The aims of the current study were to (1) describe levels and types of physical activity among female heart transplant recipients using self-report and actigraphy, (2) determine the association between physical activity and selected sociodemographic variables, and (3) assess the relationship between physical activity, QOL, and relevant health indicators that were selected for the study (hypertension, hyperlipidemia, and obesity). The overall goal of the study was to examine the prognostic value of different measures of daily activity and compare these with biobehavioral and clinical variables that may predict patient outcomes.

Methods

Study Design and Subjects

A descriptive, cross-sectional design was employed. The current study was conducted as part of a larger study designed to describe the QOL and experiences of female transplant recipients. Following approval of the sub-study by the institutional review board, a convenience sample of 27 female transplant recipients (54% of original study participants) was enrolled in the study. The number was based on participants of the parent study who agreed to additional testing procedures. All participants signed a supplemental consent form prior to completion of additional procedures for this sub-study.

Procedures

To obtain general information including age, race, marital status, education, employment status, income, and cardiovascular history, we asked participants to complete the demographic and health history form. These data were verified through medical chart abstraction.

Physical activity of participants was measured using an accelerometer (Actiwatch 2, Mini Mitter Company, Bend, Ore) for one continuous week. The Actiwatch 2 is an ultracompact and lightweight activity monitor that weighs less than 17 g and is worn on the nondominant hand and programmed to quantify physical activity at 15-minute intervals during the study period. It is equipped with a very sensitive accelerometer that has the ability to record wrist movement up to 32 times a second, stores the information as activity counts, and is sensitive to movement in all directions. In previous studies, the Actiwatch has demonstrated good reliability ($r = 0.80–0.96$); while there is little published research on the validity of the Actiwatch, data have shown that motion sensors in general, highly correlated with heart rate and energy expenditure by calorimetry ($r = 0.68–0.90$), have the ability to detect different intensities of physical activity, and can distinguish activity by time of day. Participants were instructed to wear the Actiwatch 2 at all times of the day and night from the time it was placed on their wrists until the researcher removed it a week later. We used a sampling period of 7 days to minimize variability. Total activity for the participants was averaged for each day of the week as well as for the entire week. Interinstrument reliability coefficients of 2 Actiwatch...
devices worn concurrently by a 5 participants for the current study ranged from 0.87 to 0.92.

The women were also asked to rate the average amount of physical activity they engaged in during the week they wore the Actiwatch 2 using a scale of 0 to 10, with 0 reflecting the lowest and 10 the highest possible level of physical activity. They completed an activity diary to document the types and amount of physical activities that they did on a regular basis.

Participants were then asked to rate their overall health-related QOL as either “excellent,” “very good,” “good,” “fair,” or “poor.” This single-item measure of health-related QOL has been used widely in several studies to tap participants’ own ratings of their current health.\(^{10}\)

Medical data were obtained through chart abstraction by a single research assistant to measure patient health indicators, including hypertension, hyperlipidemia, and obesity. These 3 factors are relevant indicators of health in the general population and even more so among transplant recipients who are on immunosuppressive therapy.\(^5\) The research assistant abstracted data that were obtained from participants’ pretransplant and most current clinical evaluations. These data included systolic and diastolic blood pressures, cholesterol and triglycerides, and body mass index.

**Data Analysis**

Statistical analyses were carried out using SPSS for Windows (version, 10.0, SPSS, Inc, Chicago, Ill). Descriptive statistics including means, ranges, and standard deviations were used to describe the amount (based on actigraph recordings) and levels of physical activity (self-perceived level of physical activity, range, 0–10).

Physical activity diary entries were reviewed and coded to create an inclusive list of activities that were identified by participants. The list of activities was then recoded into 4 broader categories of physical activity: conditioning and sports (eg, walking, aerobics), household tasks (eg, cleaning house, gardening), occupational activities (eg, manual labor), and family activities (eg, childcare, leisure activities). Duration of time spent for each of the activities was recorded for each participant; averages for each of the 4 categories of activities were computed for the entire sample.

Differences in levels of physical activity among participants who reported excellent, very good, good, fair, or poor QOL were conducted using \(\chi^2\) statistics. Differences in pretransplant and current clinical parameters (blood pressure, cholesterol and triglycerides, body mass index) were compared using \(t\) tests. Univariate analysis (Pearson product moment or Spearman \(\rho\) correlation) was used to determine the relationships between physical activity and sociodemographic and clinical characteristics, QOL, and relevant health indicators.

**Results**

Women in our sample had a mean age of 57.2 ± 12.9 years. They had their heart transplant surgery a mean of 5.2 ± 4.4 years prior to study enrollment. Most (82%) were Caucasian and 80% were unemployed or retired. Approximately half of the sample were married, had a high school education or less, and an annual income below $15,000. Eight (30%) were former smokers, 1 smoked currently (4%), and 10 (37%) reported regular exposure to second-hand smoke.

![Mean 280,320 ± 52,416 counts for the week (range, 206,784–354,144)](image)

Figure 1 represents the average physical activity counts of participants for every day of the week. The physical activity count generally was higher at the beginning of the week and lower during the weekends. The mean physical activity for the week was 280,320 ± 52,416 counts (range, 206,784–354,144). The average self-reported physical activity level on a 0 to 10 scale was 4.3 ± 0.37 (range, 0–7). More than half of the women in our sample (55%) reported engaging in minimal levels of physical activity (score 0–2); one third of the patients (29%) reported low levels of physical activity (score 3–4); and only 15% reported moderate and high levels of physical activity (score 5–7 and 8–10, respectively).

Based on 1 week of detailed physical activity records, 2 frequent moderate-intensity activities were identified: household tasks and family activities. Between 90% and 95% reported doing these activities for most days for a median duration of 20 to 40 minutes per day. Fewer than 15% reported occupational and sports activities and, among women who did do these activities, the median duration was less than 10 minutes per day.

The women reported fair (48.2%), good (33.3%), or very good (18%) health status. None of the women reported excellent or poor health.

When we measured blood pressure, total cholesterol, and triglycerides of women at the time of study enrollment, we found that there was a significant increase in
population perform regular, sustained physical activity. Evidently, our data contradict previous reports that physical activity postransplant is roughly the same as that expended throughout adulthood. Reports from Myers and colleagues also suggest that while exercise capacity following heart transplantation is only partially restored to normal, the surgery itself does not overtly limit activity levels per se. This information led us to explore other potential explanations for our findings.

Data from our previous observations suggest that physical inactivity following heart transplantation could be attributed to several factors. These factors include doubt about the expected benefits and efficacy of the behavior; real or perceived barriers including side effects of immunosuppressive therapy; unique demands of the behavior itself; fear that physical activity might precipitate an acute rejection; a sense of negative well-being; and lack of help and support from family and peers. In a similar sample of cardiac patients, data show that symptom distress, negative affect, and poor self-efficacy were inversely related to physical activity. The very low physical activity levels we observed could also be attributed to the fact that our study included only women. Studies have shown that women tend to report less regular activity than men, with lower levels associated with increasing age and in ethnic minorities. Of note are the findings of Franklin and colleagues, who reported that an important predictor of poor adherence to exercise in cardiac patients is continued cigarette smoking. Up to 26% of heart transplant recipients have been reported to smoke. In our sample, there was 1 current smoker, 8 former smokers, and more than one third were exposed to second-hand smoke. Further study is needed to determine if the factors that affect physical activity after a cardiac event are also influential in transplant recipients.

Nevertheless, efforts to address the issues that affect the biobehavioral factors associated with physical inactivity may be key to reducing the barriers that hinder increased levels of physical activity in this population. Of utmost importance are strategies that promote a supportive environment for female transplant recipients and provide them with the education and counseling they need to willingly engage in

| Table 1: Relevant Health Indicators That Were Selected for the Study at the Time of Surgery and Study Participation (N = 27) |

| Indicator                | Surgery (Mean ± SD) | Current (Mean ± SD) | P   |
|--------------------------|---------------------|---------------------|-----|
| Hypertension             |                     |                     |     |
| Systolic blood pressure  | 132.0 ± 11.5        | 146.0 ± 16.2        | <.001|
| Diastolic blood pressure | 78.0 ± 12.3         | 92.0 ± 15.6         | <.001|
| Hyperlipidemia           |                     |                     |     |
| Total cholesterol        | 174.0 ± 51.6        | 195.0 ± 47.5        | <.001|
| Triglycerides            | 120.0 ± 57.6        | 167.0 ± 81.7        | <.001|
| Body Mass Index*         | 24.6 ± 4.3          | 26.5 ± 5.2          | <.001|

*Body mass index is calculated as weight [kg] divided by height [m²].

TABLE 2: Correlational Matrix for the Key Variables (N = 27)

| Variable               | 1    | 2    | 3    | 4    | 5    | 6    | 7    |
|------------------------|------|------|------|------|------|------|------|
| Physical activity      | 1.00 |      |      |      |      |      |      |
| Age                    | -0.472* | 1.00 |      |      |      |      |      |
| Quality of life        | 0.566* | -0.351* | 1.00 |      |      |      |      |
| Systolic blood pressure| -0.595* | 0.179 | -0.141 | 1.00 |      |      |      |
| Diastolic blood pressure| -0.612* | 0.286 | -0.166 | 0.835* | 1.00 |      |      |
| Hyperlipidemia         | -0.392* | -0.115 | -0.436* | 0.267 | 0.339* | 1.00 |      |
| Body mass index        | -0.413* | 0.256 | -0.142 | 0.399* | -0.299 | -0.004 | 1.00 |

*P < .05.
†P < .001.

Discussion

In the current study, we sought to describe the physical activity levels and patterns in women following heart transplant surgery. Our actigraph data showed that women demonstrated extremely low levels of physical activity in the posttransplant period. This was confirmed and supported by self-report data from the participants. We found that more than half (55%) of the participants were inactive and that a strikingly low level of physical activity is even more remarkable given the careful efforts of transplant centers to include written guidelines for specific conditioning exercises and incremental walking recommendations (ie, 30–40 minutes per day) in standardized postoperative care following heart transplant surgery.

National statistics show that 30% of the US population is entirely inactive and only 25% of the US population perform regular, sustained physical activity. Evidently, our data contradict previous reports that physical activity postransplant is roughly the same as that expended throughout adulthood. Reports from Myers and colleagues also suggest that while exercise capacity following heart transplantation is only partially restored to normal, the surgery itself does not overtly limit activity levels per se. This information led us to explore other potential explanations for our findings.
increased levels of physical activity. In patients recovering from cardiac events, investigators have found evidence that social support in the form of positive health provider-patient interactions positively influences patients’ perceptions of benefit from health-promoting behaviors, such as increased physical activity.16

Habitual physical activity is an important determinant of exercise among healthy individuals.17 However, prior to our study, little was known about the habitual activities of female transplant recipients. Our data revealed that women were more likely to engage in household tasks and family activities than occupational activities or sports. Our findings concur with earlier reports that women were less likely then men to participate in organized sports outside the home or to engage in “heavy” labor at work and more likely to devote large proportions of their time to household activities.18 The drop in physical activity levels we observed during the weekends is most likely a reflection of women routinely taking time off from their usual activities during the week to rest and relax. Our findings imply that for women to meet the recommendations of 30 or more minutes of moderate to vigorous physical activity on most days of the week,19 they should be given the choice of their own combination of moderate-intensity leisure time and household physical activity that will provide them with the conditioning they would obtain from organized sports outside the home. Consequently, scales developed for women must account for these variations.20

Our findings also show that older women were more sedentary than younger women. This observation is consistent with previous research. For example, in a study of 633 healthy women, the percentage meeting the definition of regular physical activity in the study sample was significantly different by age group; 59% in the youngest age category (<30 years) engaged in regular physical activity as compared with only 33% of those 60 years and older.21 Researchers have also reported that older age and female gender were associated with lower exercise capacity following heart transplant surgery.22 Reports indicate that these associations may be secondary to decreased skeletal muscle mass in older persons or perhaps related to irreversible skeletal muscle changes as a result of a lengthy disease process before the procedure.23 The question of whether older women in general are less able to tolerate the physiologic stress of physical activity may be an explanation for the observations we made in our sample.

While several epidemiological and observational studies have been published demonstrating a strong inverse association between level of activity or physical fitness and mortality,24 the relationship between level of physical activity and perceived QOL is less well understood. Our findings indicate that physical activity may have particularly powerful effects on QOL. As might be expected, low levels of physical activity were associated with lower levels of perceived health. In addition, the symptoms of physical disabilities associated with chronic disease are frequently reported as major barriers to physical activity, especially among the elderly.25 These findings are consistent with research showing a positive effect of adherence with exercise and treatment outcomes.26 Such research suggests that physical activity may improve QOL through positive expectations and perceived control over one’s treatment regimens and lifestyle behaviors.

Finally, our observations support the relationship between levels of physical activity and severity of relevant health indicators that were selected for the study (hypertension, hyperlipidemia, and obesity). The mechanisms that support these findings are not as evident and well defined. Clearly, physiologic characteristics unique to heart transplant patients, such as immunosuppressive therapy, play a more important role in clinical outcomes like hypertension, hyperlipidemia, and obesity. The relationship between physical activity patterns and relevant health indicators, as well as factors which influence them, require further explication in future studies.

Several important limitations must be considered when interpreting the results from our study. First, as expected with descriptive, correlational studies, causation cannot be inferred. We cannot say that low levels of physical activity will result in poorer QOL or worse health outcomes. Our findings merely support the association between low physical activity, QOL, and the relevant health indicators that were selected for the study. As previously mentioned, future research is needed to better explicate these relationships.

The small sample size also limits generalization to all female heart transplant recipients. It should also be noted that data from the study were gathered in a primarily Caucasian sample, therefore our findings may not generalize to other ethnic groups. Nevertheless, we do make several observations in our study that advance this field of inquiry. Our findings show that physical activity levels as measured by activity monitors are dramatically decreased in women following heart transplant surgery. We cannot underestimate the pivotal role of interventions aimed at encouraging adherence with physical activity recommendations in this patient population. Likewise, while considerable progress has been made to measure activity patterns of women, the challenge herein remains to develop surveys that are meaningful to women, culturally relevant, short in length, and easily understood by respondents in various settings.18

Finally, data related to donor variables and presence or absence of acute rejection during the posttransplant period were not examined in this study. While one study showed that donor variables did not contribute significantly to posttransplant peak oxygen consumption,22 another study revealed that exercise...
capacity declined among those in whom coronary artery disease developed during follow-up. Nevertheless, additional studies that examine donor variables and presence or absence of acute rejection at any time during the posttransplant period may further improve our understanding related to physical activity patterns and long-term outcomes among female heart transplant recipients.

**Summary**

This study supports the prognostic value of measuring physical activity and relating it with QOL and other health indicators previously shown to be related to outcome. We found that a majority of women remain sedentary, that younger women were more active than older women, that women with higher levels of physical activity perceived improved QOL, and that higher level of physical activity was associated with better health outcomes.

Given the limitations of the current study, we recommend that additional longitudinal studies that describe physical activity in a more diverse population including men and ethnic minorities undergoing heart transplant are needed to explicate the role of physical activity on QOL and outcomes. Likewise, although a great deal of progress has been made with objective monitoring of physical activity using devices such as vertical accelerometers, the need for reliable and valid physical activity questionnaires is not diminished. Measures of activity specific to women need to be included in these instruments. More importantly, since data support the benefits of a regular physical activity program on increasing functional capacity, efforts to identify potential reasons for limited physical activity need to be included in the plan of care of heart transplant recipients during the recovery period. Interventions that address these specific barriers may be key to improving functional outcomes and QOL and should be considered standard postoperative care for female heart transplant recipients.

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