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Preoperative Activity Level and Outcomes in Older Adult Cardiac Surgery Patients: A Pilot Study

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ABSTRACT

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Purpose: To assess the relationship between preoperative physical activity levels and health related quality of life on intra- and post-hospital outcomes following scheduled cardiothoracic surgery in older adults.

Rationale/Background: Adults age 50 and older tend to accumulate more sedentary time and are less physically active. Sedentary behavior is linked with early morbidity and death and may predispose patients to postoperative complications. Preoperative activity levels and its relationship to surgical outcomes is an underexplored area. Insight on this topic could influence how to optimize interventions prior to surgery to improve outcomes.

Methods: Seven participants were fitted with an ActiGraph GT3X+ accelerometer to measure preoperative activity levels for 1 week and complete the RAND Short Form-36 health-related quality of life tool. This process was then supposed to be repeated during the first and last weeks of cardiac rehabilitation (rehab). This information, along with demographics, was then correlated with information pulled from the Society of Thoracic Surgeons database on post-surgical outcomes and the 6-minute walk tests (6MWT) done during rehab.

Results: The only statistically significant result was participants who experienced some type of intra-hospital complication also scored low in emotional wellbeing (r = -0.928, p = 0.003) as reflected in the quality of life score. Other findings with p values > 0.05 but < 0.1 were noted as "areas needing further exploration." Such areas for further exploration included: participants who spent more time in light physical activity reported less role limitations due to physical health (r = 0.864, p = 0.059), higher preoperative activity levels related to higher postoperative 6MWT (r = 0.830, p = 0.082), increased body mass index related to a decrease in postoperatively 6MWT (r = -0.869, p = 0.056).

Implications: Exploring the relationship between preoperative activity levels and post-surgical outcomes could provide insight optimizing interventions before surgery to improve surgical success and rehab outcomes.

Keywords: prehabilitation, cardiac surgery, older adults, activity levels, quality of life, inactivity

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Cardiovascular diseases are the number one cause of mortality worldwide (World Health Organization [WHO], 2017). The majority of cardiovascular diseases are caused by preventable conditions such as inactivity (WHO, 2017). Treating these conditions is a worldwide burden of approximately a trillion dollars annually (Bloom et al., 2011). Trust for America's Health (2008) estimates the United States could save approximately $16 billion annually if as little as 10 dollars per person per year was invested in health promotion, such as in physical activity programs. This investment could provide a potential return of more than $5 for every $1 spent on prevention (Trust for America's Health, 2008).

Older adults should avoid inactivity. It is recommended that older adults exercise at moderate intensity or greater for at least 150 minutes per week (Office of Disease Prevention and Health Promotion, 2008). Older adults with chronic conditions that may prevent this level of activity are encouraged to be as active as possible and set fitness goals in consultation with their health care provider (Office of Disease Prevention and Health Promotion, 2008). Higher levels of physical fitness are associated with decreased morbidity and mortality (Jack, West & Grocott, 2011). Conversely, sedentary lifestyles are strongly correlated with an increased risk of diabetes, cardiovascular disease, and mortality (Wilmot et al., 2012). In addition to decreasing morbidity and mortality, physical activity—even in small infrequent amounts—provides significant cardioprotective benefits to those with ischemic heart disease (Thijssen, Redington, George, Hopman, & Jones, 2017). For example, Thijssen et al. (2017) found in laboratory animal studies that acute episodes of moderate exercise lasting at least 30 minutes provides immediate cardioprotection that can last for 3-5 days and decrease the size of an infarct by 75%.

Every year, thousands of older adults undergo non-emergent surgery in the United States. Research suggests a decrease in complications following surgery if patients are physically active (Valkenet et al., 2011). Poor physical condition not only impairs a person's ability to cope physically with surgery or hospitalization (Dronkers, Chorus, Meeteren, & Hopman-Rock, 2012), but also puts a patient undergoing major surgery at higher risk for postoperative complications and an increased length of hospital stay. Cook et al. (2001) found that patients undergoing cardiac bypass surgery who have a high percentage of body fat and low activity levels are at an increased risk for at least one serious complication resulting in a longer hospital stay. Similarly, obese patients undergoing cardiac surgery are at an increased risk for development of atrial fibrillation, stroke, respiratory complications, and an increase in 30-day mortality (Phan, Khuong, Xu, Kanagaratnam, & Yan, 2016).

Cardiac rehabilitation (rehab) is the traditional method for helping restore function to patients who have had surgery, experienced detrimental effects from a myocardial infarction or are recovering from cardiac interventions. Patients who utilize cardiac rehab are shown to have a decrease in reinfarction and mortality (Lawler, Fillion, & Eisenberg, 2011).

Traditional postoperative cardiac rehab has been a standard for many years and is effective in helping patients after surgery. However, emerging evidence now points to beginning preoperative rehabilitation (prehab), combined with traditional postoperative cardiac rehab, to reduce intra-hospitalization and postoperative complications and overall outcomes. Prehab is a term to describe rehab activities that take place prior to surgery. Although a relatively new concept in the cardiovascular field, prehab is a practice in other types of surgeries. Evidence for using it prior to cardiovascular surgery is small but growing. For example, a study by Nery and Barbisan (2010) measured patients' leisure time activity levels prior to cardiac surgery and found

that patients who were more active during their leisure time were 78% less likely to have a major cardiac event immediately after surgery. Patients in this study also had a 33% reduction in length of hospital stay as compared to the sedentary patients. A systematic review of preoperative exercise before orthopedic, cardiovascular, and abdominal surgeries showed a significant decrease in postoperative complications and length of stay in patient populations receiving prehab (Valkenet et al., 2011). Furthermore, Herdy et al. (2008) found that physical activity both prior to, and following, surgery was shown to decrease post-surgical complications including a decreased length of stay. Even with these promising findings, the effects of preoperative physical activity and how it impacts intra- and post-hospital outcomes in older adults who have cardiac surgery is a topic that is underexplored. The purpose of this pilot study was to explore the relationship of patient activity prior to elective cardiovascular surgery, health-related quality of life (QoL), and intra- and post-hospital outcomes.

Methods

Setting

Participants were recruited from February 2015 through November 2016, during their initial visit to a cardiac office located in the mountain west. This site was selected because it had a cardiac rehab facility associated with the clinic and historically had sufficient patient volume to support the study.

Sample

The population of interest included older adults of varying socio-demographic backgrounds. Inclusion criteria for this study were males and females: 1) age 50 years or older; 2) able to freely ambulate independently (without the assistance from people or devices); and, 3) with scheduled, non-emergent cardiovascular surgery and planned cardiac rehab. Recruitment

was done as a convenience sample through screenings during the patient's initial visit to the clinic.

Procedures

Intermountain Healthcare and Brigham Young University Institutional Review Boards approved this study, and strict research ethics and protocols were adhered to throughout the course of the study. Researchers met with potential participants at the cardiac clinic to complete informed consent. Participants completed the study over the course of 2-3 months with a total of 2 visits. The first visit occurred before surgery, second visit occurred the first week of cardiac rehab (see Figure 1). During the first visit, participants completed the RAND 36-Item Short Form Health Survey (SF-36) QoL questionnaire and were fitted with the ActiGraph GT3X+ accelerometer on a waistband with the device over the right hip to wear for one week. Participants were instructed to maintain a normal activity routine, not be more or less active/sedentary than usual, and to remove the accelerometer device for bathing and any water-based activity. Postoperatively during their first week of cardiac rehabilitation participants then completed a 6 minute walk test (6MWT) to measure their capacity for physical activity. Participant burden was low since research activities occurred during normally scheduled visits. Upon completion of the study in its entirety, participants received a $50 gift card.

Instruments

ActiGraph GT3X+ Accelerometer. The ActiGraph GT3X+ device was used to objectively assess activity (ActiGraph, LLC, Pensacola, FL). Movement is captured in 3 axes and expressed in counts per minute (cpm). Data were collected at 30 Hz and then aggregated during the post-collection processing stage to 1-minute intervals. Count values obtained from the GT3X+ were categorized by intensity level by applying accelerometry cutpoints used in the

2003-2004 National Health & Nutrition Examination Survey (NHANES) data (sedentary < 100 cpm; light, 101-2019 cpm; moderate, 2020-5998 cpm; vigorous, >5999 cpm) (Troiano et al., 2008). Participant completion and usable device data exceeds 90% in studies of adults involving the GT3X+ accelerometer (Hänggi, Phillips, & Rowlands, 2013). Accelerometry precision ranges 80-98% for activity in free-living conditions (Kaminsky & Ozemek, 2012; Santos-Lozano et al., 2012). Intraclass coefficients range 0.31-0.998 and coefficients of variation (CV) range 1-22% (De Vries et al., 2006; Santos-Lozano et al., 2012). The GT3X+ accelerometer construct validity is high, typically ranging r = 0.39-0.90 (De Vries et al., 2006) or, specifically to sedentary behavior, between 80-98% agreement to direct observation (Hänggi et al., 2013).

RAND SF-36 Health-Related Quality of Life Tool. The SF-36 is one of the most widely used QoL tools (Hays & Morales, 2001). This form is a 36-item tool using yes/no or Likert-style options to assess health-related quality of life in eight domains: physical functioning, social functioning, emotional well-being, physical health problems, emotional problems, energy and fatigue, pain, and general health perception (Hays & Morales 2001). There is no global score for the SF-36 but eight individual scores based on domain questions. Each of the eight domains has several questions which are graded on a 0-100 point scale with a final score being an average of answers to questions found in each domain. Minimum clinically important differences in interpreting the SF-36 tool has been suggested to be in the 3-5 point range (Hays & Morales, 2001). Reliability of the tool (and its domains) are presented in Table 1.

Society of Thoracic Surgeons Adult Cardiac Surgery Database. The Society of Thoracic Surgeons (STS) database consists of patient specific information that is entered by hospital staff regarding surgical and intra hospital outcomes data. Health care data were abstracted retrospectively from information entered in to the STS database and downloaded to a

password-protected flash-drive. The following items were abstracted from the STS and rehab databases: age, sex, body mass index (BMI), demographics, length of stay, intensive care unit (ICU) hours, ventilator hours, hospital re-admissions, intra-hospital complications, postoperative 6-minute walk test (6MWT), and number of cardiac rehab sessions completed.

6MWT. The 6MWT is an exercise test that entails measuring the distance a participant can walk in six minutes. This measurement of distance helps demonstrate a person's capacity for cardiopulmonary exercise and response to therapeutic interventions. The 6MWT is ideally performed indoors, on a hard surface that is long and flat. Distances are marked on the floor in three meter increments with a turnaround point marked at 30 meters (American Thoracic Society, 2002). The participant is then timed while walking to the turnaround point and back as many times as possible over six minutes. At the end of six minutes, the distance walked is then calculated.

Data Analysis

Demographics were analyzed using simple descriptive statistics. Defining activity level was done using widely accepted norms using the accelerometer cut points used for the 2003-2004 NHANES data (Troiano et al., 2008). Using these cutoffs, the amount of active time was calculated using time spent in moderate-to-vigorous physical activity (MVPA). Pearson's correlations were used to compare relationships between variables.

Results

During the study period a total of seven participants met study the criteria of being age 50 or older, scheduled for non-emergent cardiovascular surgery at least five days in advance, and able to ambulate independently. In order for preoperative activity data to be sufficient for analysis and inclusion, participants needed to accumulate at least 10 hours of wear time per day,

with a 4-day minimum during the week of collection (minimum 40 total hours) and include at least one weekend day. Data from all seven participants was used in the analysis. Out of the seven participants, all completed the QoL survey though only five participants satisfactorily completing the preoperative activity level tracking to be included in the study. The five individuals who completed the activity tracking prior to surgery were the same five who enrolled in cardiac rehab. Of those enrolled in rehab, only three completed all rehab sessions (20 or more sessions). The mean age of the sample was 68 (range 57-83 years) with 71% being male. Study participants underwent one or more of the following cardiothoracic procedures: coronary artery bypass graft, aortic valve repair or replacement, mitral valve repair or replacement. See Table 2 for summary of participant demographics and outcomes. Due to the small sample size, there were two *p* value ranges that were investigated: *p* values <0.05 were considered *significant*, and $p > 0.05$ but < 0.20 were identified as potential *areas for further exploration*. Correlation results are reported based on the three areas of interest: preoperative activity level, QoL, and demographics (with some results overlapping between categories). See Table 3 for summary of significant correlations and areas for further exploration.

Preoperative Activity Level Correlations

Significant results. There were no statistically significant ($p < 0.05$) results with regard to preoperative activity level.

Areas for further exploration. The following results had a $p > 0.05$ but < 0.20. Preoperative average daily MVPA had a positive relationship to the postoperative 6MWT ($r = 0.830$, $p = 0.082$). Preoperative moderate physical activity (MPA) had a positive relationship to the postoperative 6MWT ($r = 0.827$, $p = 0.084$), with similar trends regarding preoperative vigorous physical activity (VPA) ($r = 0.812$, $p = 0.095$) and preoperative MVPA ($r = 0.827$, $p =$

0.084). As preoperative light physical activity (LPA) increased, participants tended to report less role limitations due to physical health on the SF-36 (r = 0.864, p = 0.059). The opposite was true of preoperative sedentary time (r = -0.772, p = 0.126). Participants with more time spent in LPA tended to also report having more energy and less fatigue on the SF-36 (r = 0.785, p = 0.116). The opposite was true of preoperative sedentary time (r = -0.710, p = 0.179). Participants who spent more time in LPA tended to report increased social functioning on the SF-36 (r = 0.804, p = 0.101) while those who spent more time sedentary tended to report lower social functioning (r = -0.688, p = 0.199). Finally, preoperative LPA had a positive relationship to participants reporting less pain on the SF-36 (r = 0.712, p = 0.178).

Quality of Life Correlations

Significant results. Participants who experienced an intra-hospital, postoperative complication also reported lower emotional well-being on the SF-36 (r = -0.928, p = 0.003).

Areas for further exploration. The following results had a $p > 0.05$ but < 0.20. Participants who reported higher average QoL scores had a tendency to complete fewer cardiac rehab sessions (r = -0.733, p = 0.061). The number of hours a participant spent in the ICU was negatively correlated with social functioning (r = -0.570, p = 0.182), physical functioning (r = -0.560, p = 0.191), and general health on the SF-36 (r = -0.559, p = 0.192). Relationships between QoL and physical activity were reported in the previous section “Preoperative Activity Levels – Areas for further exploration.”

Patient Demographic Correlations

Significant results. There were no statistically significant (p <0.05) results with regard to patient demographics.

Areas for further exploration. The following results had a $p > 0.05$ but < 0.20. BMI had a negative relationship to the postoperative 6MWT ($r = -0.869$, $p = 0.056$). BMI also had a negative relationship to VPA ($r = -0.709$, $p = 0.180$). Age had a negative relationship to LPA ($r = -0.795$, $p = 0.108$) and a positive relationship to sedentary behavior ($r = 0.750$, $p = 0.144$).

Discussion

The aim of this pilot study was to assess how preoperative activity levels related to post-surgical outcomes in older adults who underwent cardiac surgery. Overall, there was only one statistically significant result, but many areas that should be considered for further exploration with a greater sample size.

Preoperative Activity Levels

Although there were no statistically significant findings related to activity levels in this pilot study, several areas were identified as needing further exploration and may possibly yield greater insight with a sufficient sample size. One such area was the positive relationship between MPA, VPA, and MVPA on postoperative 6MWT in cardiac rehab. These findings are consistent with studies that demonstrated the importance of being physically active prior to surgery. For example, Sawatzky et al. (2014) compared patients who participated in an exercise program for a minimum of 2 days a week for 60 minutes prior to surgery to those who were more sedentary. Their results showed an in improved 6MWT after surgery in the group who were exercising regularly. In addition to improving activity postoperatively, patients who were more physically active prior to surgery were also more likely to complete their cardiac rehab program. Of the 5 participants that completed and reported their activity levels prior to surgery, all signed up to participate in cardiac rehab. This is consistent with the findings of Arthur et al. (2000) who found that those who were active prior to surgery had a 70% enrollment in cardiac

rehab, and Sawatzky et al. (2014) showed a 100% enrollment in a cardiac rehab program among those who were more active prior to surgery. It is interesting to note that the three of the most active patients in the current study were the only ones to complete all sessions of cardiac rehab. In contrast, the two participants who never completed preoperative activity levels via accelerometry were also the only ones who did not participate in any cardiac rehab or study follow up.

Health-Related Quality of Life

The relationship between activity level and quality of life was another area of interest for this study. This pilot research identified several findings that, while not statistically significant, warrant further exploration in a larger study. In general, higher activity levels showed a positive correlation with several QoL domains while sedentary behavior had negative correlations. This was true, to varying degrees, of role limitations from physical health, energy, fatigue, social functioning, and pain domains on the SF-36. For example, participants who spent more preoperative time in sedentary behavior were more likely to report an increase in role limitations and fatigue with a decrease in social functioning. It is possible that the participant's disease process was creating the sedentary behavior and thus adversely affecting the participant's QoL. However, QoL scores from those who were more physically active prior to surgery were more likely to report less role limitations due to illness and had less fatigue. These more active participants also reported increased social functioning and less postoperative pain as compared to their less active counterparts. This result is consistent with a study by Acree et al., (2006), which found that older adults who were physical active at a moderate intensity for one hour a week, reported higher quality of life both physically and mentally.

Again, these findings were not statistically significant but provide an insight into what future studies should explore.

Reported QoL and post-surgical outcomes appear to be related. The only statistically significant result from the pilot study was in this area. Patients who experienced some type of intra-hospital complication also reported lower emotional well-being. However it is important to note that 1 in 20 variables have a chance to show randomly statistical significance so it is important to utilize caution when considering this result. Although this pilot study focused on how physical aspects (such as activity level) related to surgical outcomes, this finding indicates other areas, like emotional wellness, may play a role in surgical outcomes. There were also non-statistically significant findings in this area that should be explored further. Participants who had a longer ICU stay tended to have reported lower social functioning, physical functioning, and general health on their preoperative SF-36.

Demographical Relationships

Age and BMI were two demographical variables that were expected to be related to one or more areas of the study. Unfortunately, the pilot study was unable to find statistically significant correlations with these variables and measures of activity, QoL, and surgical outcomes. BMI did have a near-significant negative correlation to postoperative 6MWT (p = 0.056). Other BMI areas for further exploration include its negative relationship to VPA. Furthermore, age tended to have an inverse relationship to LPA and positive correlation with sedentary behavior. These findings, though not statistically significant, make common sense considering the limitations that an elevated BMI or advanced age can impose on an individual's ability to be active. This result is similar to findings published by Tucker et al. (2013) who found that obesity in middle aged women puts them at risk for decline in physical activity as compared

to their non-obese counterparts. Additionally Milanović et al. (2013) found that from ages 60-69 there is a decline in activity levels which are attributed to decreases in endurance, flexibility and agility. As anecdotal evidence of this in this pilot study, the 2 oldest participants did not report activity levels preoperatively and were also the only ones who did not participate in cardiac rehab.

Conclusion

In conclusion, this pilot study, while only able to find one statistically significant correlation, had numerous areas for further exploration that may yield additional insights into how preoperative activity levels, QoL, demographics, and outcomes are correlated in older adults undergoing cardiac surgery. As emphasized earlier, 1 in 20 variables will be statistically significant by chance. It is for this reason that we urge caution when interpreting this statistically significant result. The biggest limitation of this pilot study was the small sample size, and an increase in sample size would not necessarily resulted in additional significant results. However, based on findings in similar studies it is reasonable to consider our areas for further exploration could yield significance with a larger sample. Reasons for the small sample size were directly related to a decrease in the number of qualified participants at the study site over the study period and unanticipated and significant difficulties in recruitment of qualified participants. In a future study it will be important for us to increase the power of the study by increasing the sample size. Additionally future studies should include a preoperative intervention and 6MWT to compare with postoperative findings. Discovering connections between activity levels, improved health-related QoL, and post-surgical outcomes is an important area of future research that could lead to new preoperative interventions, such as a prehab program.

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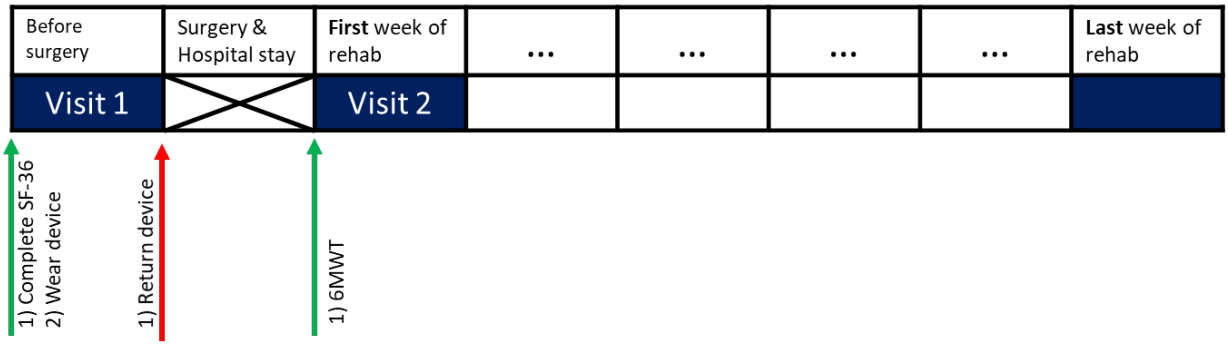

Figure 1. Summary of timeline

Table 1
Reliability, Central Tendency, And Variability Of Scales For The RAND 36-Item Short Form Health Survey (SF-36)

Domain	Items	Alpha	Mean	SD
Physical functioning	10	0.93	70.61	27.42
Social functioning	2	0.85	78.77	25.43
Emotional well-being	5	0.90	70.38	21.97
Physical health problems	4	0.84	52.97	40.78
Emotional health problems	3	0.83	65.78	40.71
Energy and fatigue	4	0.86	52.15	22.39
Pain	2	0.78	70.77	25.46
General health perception	1	Not measured	59.14	23.12

Note: As summarized from: http://www.rand.org/health/surveys_tools/mos/mos_core_36item_scoring.html

Table 2
Summary Of Participant Demographics And Outcomes

Demographics			Preoperative Activity	Intra-Hospital Outcomes					Post-Hospital Outcomes	
Age	Sex	BMI	Average MVPA per day (minutes)	Length of stay (days)	ICU Hours	Ventilator Hours	Re-Admitted to Hospital	Intra-Hospital complications	6-Minute Walk Test (feet)	Cardiac rehab sessions completed
57	F	47.5	2.15	6	23	4	No	No	460	12
60	F	32.4	1.7	4	24.5	1	No	No	860	23
65	M	27.1	4.6	7	95.2	1	No	No	1300	20
67	F	41.5	0.88	8	48.4	4	No	Yes	200	1
68	F	37.1	1	8	48.4	20	Yes	Yes	650	20
77	F	27.6	DNC	8	44.7	7	No	No	DNC	DNC
83	M	26.0	DNC	7	27.9	8	Yes	No	DNC	DNC

Note: DNC = Did not complete

Table 3
Summary Of Significant Correlations And Areas For Further Exploration

	Statistically Significant	Further Exploration Needed
Preoperative Activity Level	None	a. Increased preoperative MVPA related to an increased postoperative 6MWT b. Increased preoperative MPA or VPA related to improved postoperative 6MWT c. Increased LPA related to a decrease in limitations due to physical health. d. Increased time spent sedentary related to increased limitations due to physical health. e. Increased time in LPA related to increased energy and less fatigue. f. Increased sedentary time related to decreased energy and increased fatigue. g. Increased time in LPA related to increased social functioning. h. Increased sedentary time related to decreased social functioning i. Increased time in LPA related to decreased reported pain.
QoL	a.Postoperative complications related to decreased QoL	a. Higher reported QoL scores related to fewer rehab sessions. b. Increased LPA related to decrease in limitations due to physical health. c. Increased time spent in ICU related to decreased social functioning, physical functioning, and general health. d. Increased time in LPA related to increased energy and less fatigue e. Increased sedentary time related to decreased energy and increased fatigue. f. Increased time in LPA related to increased social functioning. g. Increased sedentary time related to decreased social functioning h. Increased time in LPA related to decreased reported pain.
Patient Demographics	None	a. Increased BMI related to decreased 6MWT postoperatively b. Increased BMI related to decreased time spent in VPA c. Increased age related to decreased time spent in LPA and increased sedentary behavior.

Note: MVPA= Moderate to Vigorous Physical Activity, LPA= Light Physical Activity, MPA= Moderate Physical Activity, VPA= Vigorous Physical Activity, 6MWT= Six Minute Walk Test, BMI= Body Mass index, QoL= Quality of Life