UNIVERSITY OF WISCONSIN LA CROSSE

Graduate Studies

WORKLOAD ACCOMPLISHED IN PHASE III CARDIAC REHABILITATION

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the
Degree of Master of Science in Clinical Exercise Physiology

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College of Science and Health
Clinical Exercise Physiology

May 2020

WORKLOAD ACCOMPLISHED IN PHASE III CARDIAC REHABILITATION

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We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree Master of Science, Clinical Exercise Physiology

The candidate has completed the oral defense of the thesis.

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ABSTRACT

Schultz, K.L. Workload accomplished in phase III cardiac rehabilitation MS in Clinical Exercise Physiology, May 2020, 59 pp. (C. Foster)

Cardiac rehabilitation is known for improving individual's cardiovascular health and observing other exercise related benefits. However, no studies have recorded the amount of workload accomplished in a phase III program. **PURPOSE:** To monitor and record exercise of individuals in a phase III cardiac rehabilitation program. **METHODS:** Twenty-six subjects from the La Crosse Exercise and Health Program (LEHP) participated in this study, thirteen males and thirteen females. Subjects wore an ActiGraph device on their hip for three consecutive weeks to track their steps. On the log sheet subjects recorded wearing the device and exercise session which consisted of logging minute exercised and session Rating of Perceived Exertion (sRPE). **RESULTS:** An average weekly amount of steps accomplished was 39,818.4 ± 18,612.55, 7,260.5 ± 6,169.74 steps accomplished in LEHP and 32,653.8 ± 15,363.68 steps accomplished outside of LEHP. Average weekly time exercised was 266.5 ± 170.85 min/week, with 162.4 ± 93.15 min/week accomplished in LEHP and 144.9 ± 126.83 min/week accomplished outside of LEHP. Average sRPE was 12.6 ± 3.84, with an average sRPE of 12.6 ± 1.91 in LEHP and 11.8 ± 5.76 outside LEHP. Subjects achieved an average weekly load of 3,359.8 ± 2.145.89 (AU) with a load of 2,042.5 ± 1,244.95 (AU) accomplished in LEHP and a load of 1,723.9 ± 1,526.17 (AU) was accomplished outside of LEHP. Frequency of exercise on average was 4.2 ± 1.15 days/week, with 1.8 ± 0.72 days/week in LEHP and 2.4 ± 1.51 outside LEHP. **CONCLUSION:** Amount of time exercising per week exceeded ACSM Guidelines recommended amount and a high enough workload was accomplished to see improvements in mean arterial pressure, cholesterol, body mass index and increase chance of event free survival.

ACKNOWLEDGEMENTS

I would like to extend my deepest appreciation to my thesis chairman Dr. Carl Foster for all of his help, wisdom, and guidance throughout my entire thesis process. Thank you to my thesis committee members Dr. Kim Radtke and Sue Bramwell for their guidance and commitment. Special thanks to the LEHP and its members, I quite literally could not have done this without you. I am extremely grateful for my entire cohort for the comradery, support and of course friendship that got us all through this year. To my biggest cheerleader Mathew Wendler thank you for the constant support and overwhelming belief in me and my work. Finally, I would like to thank my parents for always believing in me, encouraging me through this process and their endless amount of support. This accomplishment would not have been possible without all of you. Thank you.

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INTRODUCTION

Cardiac rehabilitation is known for improving cardiac function and decreasing the risk of future cardiovascular events (O'Connor et al., 1989; Oldridge et al., 1989; Eijsvogels, Molossi, Lee, Emery, & Thompson, 2016), delaying/reversing the progression of atherosclerotic disease (Niebauer et al, 1997; Haskell et al., 1994; Hambrecht et al., 1993), reducing the rate of reinfarction and death (Taylor et al. 2004; Lawler et al 2011, Hammill et al., 2010), and accelerating the rate of recovery of functional capacity (Foster et al., 1984, 1995). This is accomplished through monitored exercise in phase II or phase III cardiac rehabilitation programs. We know that cardiac rehabilitation, and exercise in general, decreases the risk of mortality and improves metabolic diseases (Eijsvogels et al., 2016), and that the effect is somewhat dependent on the dose of exercise accomplished in the exercise program (Ades et al, 2009; Hambrecht et al, 1993). Further, the risk of developing new cardiovascular disease has been shown to be related to the dose of exercise training (Kraus et al. 2019; Arem et al. 2009; O'Keefe et al. 2014; Tudor-Locke et al., 2004). Although there are widely accepted guidelines for exercising patients with known heart disease (ACSM Guidelines, 2018; Mezanni et al., 2012) and in view of the rich literature on monitoring exercise training in athletes (Foster et al., 2017; Borensen & Lambert, 2008), there is little evidence of how much exercise is actually accomplished by patients enrolled in rehabilitation programs. Accordingly, it would be desirable to have a practical method of quantifying the dose of exercise performed by cardiac rehabilitation patients, in a way that gets beyond the mode specificity.

One way to monitor exercise and physical activity is through step counts. ActiGraph, or other step counters, are a wrist or hip worn device that can measure steps and energy expenditure through frequency and amplitude. Kim, Barry, Kang (2015) had participants wear the ActiGraph device and a camera to measure the validity of the ActiGraph. Results showed that the ActiGraph had a 7.26% error. Rowlands et al. (2016) compared ActiGraph and GENEActive and found that ActiGraph had 80% accuracy, making it a valid device to use in a free-living environment. Tudor-Locke et al. (2004) found that individuals who took an average of 5,000 steps daily were more obese and had a higher risk of metabolic diseases, compared to individuals who took an average of 15,000 steps daily. Higher step counts were linked with weight loss and decreased risk of disease (Bassett et al., Amish Farmers). Recently, Kraus et al. (2019) found that sedentary individuals, who increased their average daily steps to 10,000 had a 46% decrease in mortality over the proceeding ten years after adjusting for daily step count and other mortality risk factors. Risk of mortality decreased by ~10% for every additional 2,000 steps per day. Recording participants' daily step count would be a simple method of estimating how much exercise is done in one session and how physical activity is completed outside of rehabilitation. To our knowledge, there are no systematic data regarding step counts routinely performed during cardiac rehabilitation programs. However, step counts alone do not account for non-weight bearing modes of activity such as cycling, Nu Step, rowing, and resistance training that are common elements of many rehabilitation programs.

The Rating of Perceived Exertion (RPE) is a method of estimating exercise intensity and has been shown to be an acceptable surrogate of other markers of exercise intensity such as %HR reserve and blood lactate accumulation either during an acute bout of exercise (Borg, 1998) or as an entire exercise session (Foster et al., 1995). RPE is easy to use and is accessible to most populations. Based on studies conducted by Foster et al. (2001), Day et al. (2004), and Herman et al. (2006), RPE has been shown to be valid in terms of evaluating entire training sessions at intensities ranging from light to moderate to vigorous, and in multiple modes of exercise Historically the session RPE (sRPE) was measured 30-minutes post exercise to get an accurate judgment on the intensity of the exercise bout (Foster et al., 1995, 2001). Subsequently, Christen, Foster, Porcari, & Mikat (2016) found that measuring sRPE at different times post exercise did not yield significant differences in sRPE, suggesting that sRPE is very temporally robust. Recent studies by Arney et al. (2019a, 2019b) have demonstrated that the two most widely used RPE scales are interchangeable, further supporting the robust nature of RPE as a surrogate of intensity. This validity and reliability of RPE makes it a great tool to use to measure exercise intensity. RPE is also inexpensive and user-friendly, which makes it ideal for cardiac rehabilitation population. Further, the ability to us sRPE to “collapse” across different modes of exercise (Foster et al., 2001) makes it attractive for the often multi-modal nature of cardiac rehabilitation programs. However, despite the generally accepted dose-response nature of responses to training in cardiac patients (Ades et al., 2009; Hambrecht et al., 1993) to our knowledge, there are no systematic data demonstrating the actual amount of training performed by cardiac patients.

When looking at exercise it can be hard to determine how much work an individual is actually doing. Training load is the amount of work done (duration x intensity) during an exercise bout. Exercise training load has an inverse relationship with mortality, meaning that the more you exercise, the less likely you are to die from cardiovascular or metabolic diseases (Kraus et al., 2019, Arem et al., 2015, Mandsager et al., 2018). Energy expenditure is correlated with weight loss, decrease in abdominal fat and reduction in waist circumference (Ades et al., 2009). These are benefits that can be observed through cardiac rehabilitation exercise. Training load can be used to track exercise and to personalize future exercise plans. This can be compared to the ACSM guidelines for 30 minutes of moderate intensity exercise, five times a week, or with 10,000 steps a day (ACSM, 2018, Kraus et al., 2019). Accordingly, the purpose of this study was to document the training load accomplished by patients with known cardiovascular disease in a community based exercise program.

METHODS

Subjects

Thirty-two participants in the phase III La Crosse Exercise and Health Program were recruited. Before testing all participants provided written informed consent. The Institutional Review Board for the Protection of Human Subjects of the University of Wisconsin-La Crosse approved the protocol. One subject was removed due to loss of the ActiGraph device. Five more subjects were removed due to either an inadequate amount of data or improper recording on the activity monitor log sheet. Thus a total of twenty-six participants were used in data evaluation.

Protocol

Participants wore the ActiGraph device for 3 weeks and tracked their daily step count. They also tracked their exercise time and sRPE during both the LEHP as well as outside activities. From this data, workload was calculated to determine the steps per day during the LEHP, during outside activities, and for the total day and week. Further, to determine training load using the sRPE method, the RPE x duration in minutes both within the LEHP and in outside activities was documented. Participants received a daily reminder to wear the device and fill out log sheet, either via text or email. Data was collected over 3 consecutive weeks, one of which contained a national holiday (Thanksgiving), during a period of the year when outside environmental temperatures were near freezing.

Analysis

Steps per day and sRPE were presented as descriptive statistics and contrasted to recommended values for steps per day (Kraus et al., 2019). Regression statistics were compared between steps per day and the sRPE. The total exercise load, computed as either the steps per week, or the sRPE computed training load per week were computed.

RESULTS

The subjects, all of whom enrolled in a community based clinical exercise program, ranged from individuals who were highly active to individuals who were not. The average amount of total steps achieved equated to approximately 40,000 steps per week (Table 1), which is below the recommended 10,000 steps a day (70,000 steps weekly). This suggests that more exercise needs to be done to see a decrease in risk of mortality (Kraus et al., 2019). The number of steps accumulated was greater on the days outside of the LEHP, probably because activity at the LEHP was very multi-modal, whereas most activity outside of the LEHP was collected by walking. Additionally, steps accumulated on the outside included steps not specifically related to exercise. On average individuals were exercising 4 days a week with the mean ± standard deviation time of 266.5 ± 170.85 minutes a week. This equates to being above the recommended amount based on the ACSM guidelines (2018). This data also showed RPE to be higher in LEHP than during outside exercise.

Table 1. Steps Achieved Per Week

	LEHP	%	Outside	%	Total
Week 1	7,354.5 ± 6,934.79	17.9%	33,845.1 ± 15,662.49	82.1%	41,199.6 ± 19,395.75
Week 2	7,482.6 ± 6,342.34	18.9%	32,307.5 ± 14,899.40	81.8%	39,502.2 ± 17,939.50
Week 3	6,944.5 ± 5,232.07	17.9%	31,808.8 ± 15,529.15	84.7%	38,753.3 ± 18,502.39
Average	7,260.5 ± 6,169.74	18.2%	32,653.8 ± 15,363.68	82.9%	39,818.4 ± 18,612.55

Values Represent (Mean ± Standard Deviation).
% Represent Percentage of Steps Relative to Total Amount.

Represented in Table 2 is the time, sRPE, and sRPE derived load and frequency accomplished in the LEHP. On average subjects spent about 162.4 ±93.15 minutes exercising a week with an RPE of about 12.6, which is just below the somewhat hard (RPE=13) verbal cue. This gives an average workload of 2,042.5 ± 1,244.95 (sRPE). Subjects also go to LEHP just under 2 times a week out of the possible 3 times a week.

Table 2. LEHP: Time, RPE, Load, and Frequency

	Time	RPE	Load	Frequency
Week 1	173.5 ± 99.38	12.1 ± 1.89	2,108.7 ± 1,230.10	1.9 ± 0.85
Week 2	157.9 ± 98.61	12.7 ± 1.96	2,035.4 ± 1,232.70	1.8 ± 0.69
Week 3	155.8 ± 81.45	12.8 ± 1.88	1,983.4 ± 1,272.05	1.7 ± 0.62
Average	162.4 ± 93.15	12.6 ± 1.91	2,042.5 ± 1,244.95	1.8 ± 0.72

Values Represent (Mean ± Standard Deviation).

Table 3 shows the time, RPE, Load (sRPE), and frequency for any exercise outside of LEHP. The average time spent exercising is 144.9 ± 126.83 minutes a week, which is slightly less than the 162.4 ± 93.15 minutes accomplished in LEHP. Average sRPE accomplished is 11.8 ± 5.76, just above the light verbal cue (RPE=11), which is also slightly lower than the sRPE in LEHP. Similarly, the average load is about 1,723.9 ± 1,526.17 which is slightly lower than the observed load in LEHP. The frequency of exercising is about 2.4 ± 1.51 times which is higher than the frequency of LEHP, indicating that participants are exercising more often, but for a shorter time and lower intensity on their own then they are in LEHP.

Table 3. Outside: Time, RPE, Load, and Frequency

	Time	RPE	Load	Frequency
Week 1	146.9 ± 127.45	11.5 ± 5.69	1,700.8 ± 1,488.54	2.4 ± 1.42
Week 2	142.1 ± 111.96	12.0 ± 5.80	1,729.4 ± 1,336.79	2.3 ± 1.53
Week 3	145.7 ± 141.07	11.9 ± 5.79	1,741.6 ± 1,753.17	2.6 ± 1.58
Average	144.9 ± 126.83	11.8 ± 5.76	1,723.9 ± 1,526.17	2.4 ± 1.51

Values Represent (Mean ± Standard Deviation).

Table 4 is the combined Time, RPE, Load and Frequency from both LEHP and outside exercise. Average frequency of 4.2 ± 1.15 occasions of exercising in a week with the average time of 266.5 ± 170.85 indicates that individuals both in LEHP and outside are exceeding the recommended amount of weekly exercise (>150min/week) recommended in the ACSM guidelines. The total workload accomplished was 3,359.8 ±

2,145.89. Overall RPE averages around the 12.6 ± 3.84 which is just below the somewhat hard verbal cue (RPE=13), indicating that subjects are reaching moderate intensity level.

Table 4. Total: Time, RPE, Load, and Frequency

	Time	RPE	Load	Frequency
Week 1	286.5 ± 181.80	12.6 ± 3.79	3,617.0 ± 2,188.45	4.3 ± 1.14
Week 2	256.2 ± 163.78	12.8 ± 3.88	3,273.2 ± 2,248.05	4.2 ± 1.13
Week 3	256.7 ± 166.98	12.4 ± 3.84	3,189.2 ± 2,001.17	4.2 ± 1.18
Average	266.5 ± 170.85	12.6 ± 3.84	3,359.8 ± 2.145.89	4.2 ± 1.15

Values Represent (Mean ± Standard Deviation).

Figure 1 represents the relationship between total weekly steps and sRPE derived training load, with each week per subject being presented as a data point. The curvilinear line of best fit indicates that as step count increases there is an increase in load. This figure shows that the majority of weekly averages are in the less than 60,000 steps and less than 5,000 load. R^2 is 0.32 indicating that 32% of the variance in training load can be explained by the number of steps taken.

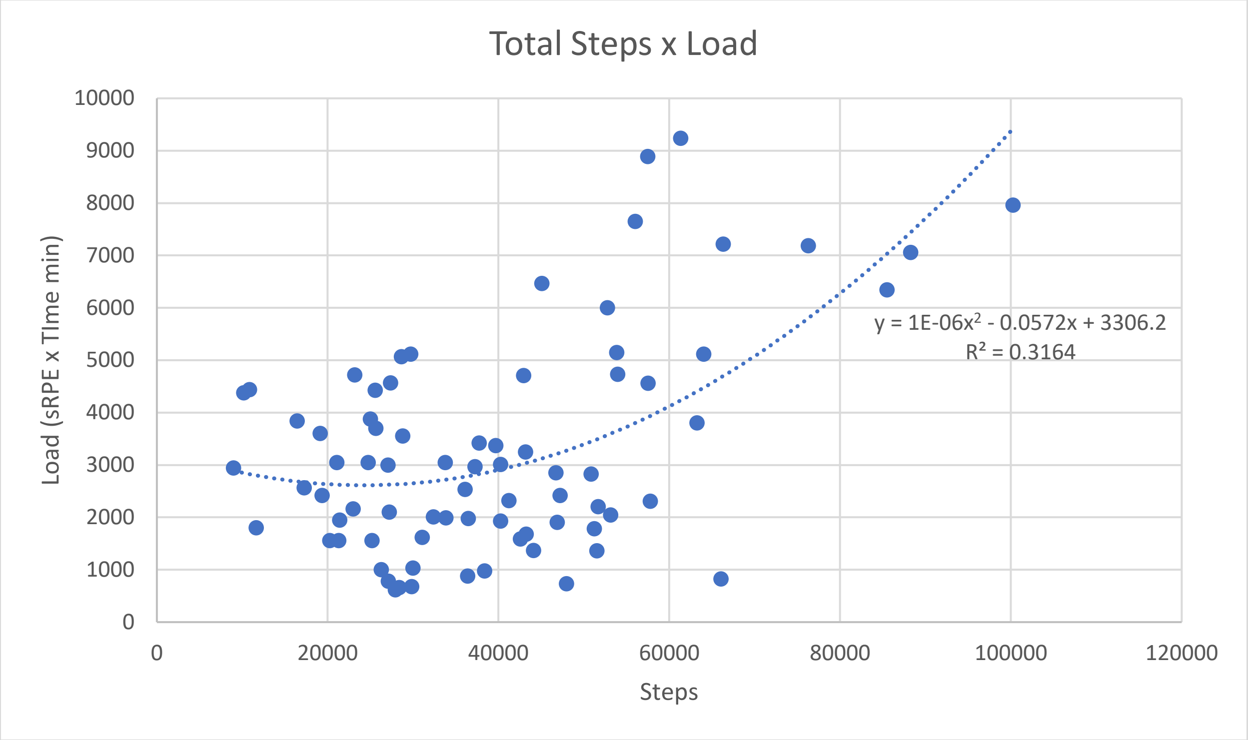

Figure 1. Comparison of total average steps and total average load ($R^2 = 0.32$).

Figure 2 represents outside LEHP weekly averages of steps and load, with each week per subject being represented as a data point. The curvilinear line of best fit indicates that as step count increases there is an increase in load. Compared to Figure 3, there is a lower workload, but a higher amount of steps accomplished. This matches up with the information in Table 3 that subjects are reaching a lower RPE and load (sRPE). The R^2 is 0.26 indicating that 26% of the variance in training load can be explained by the number of steps taken.

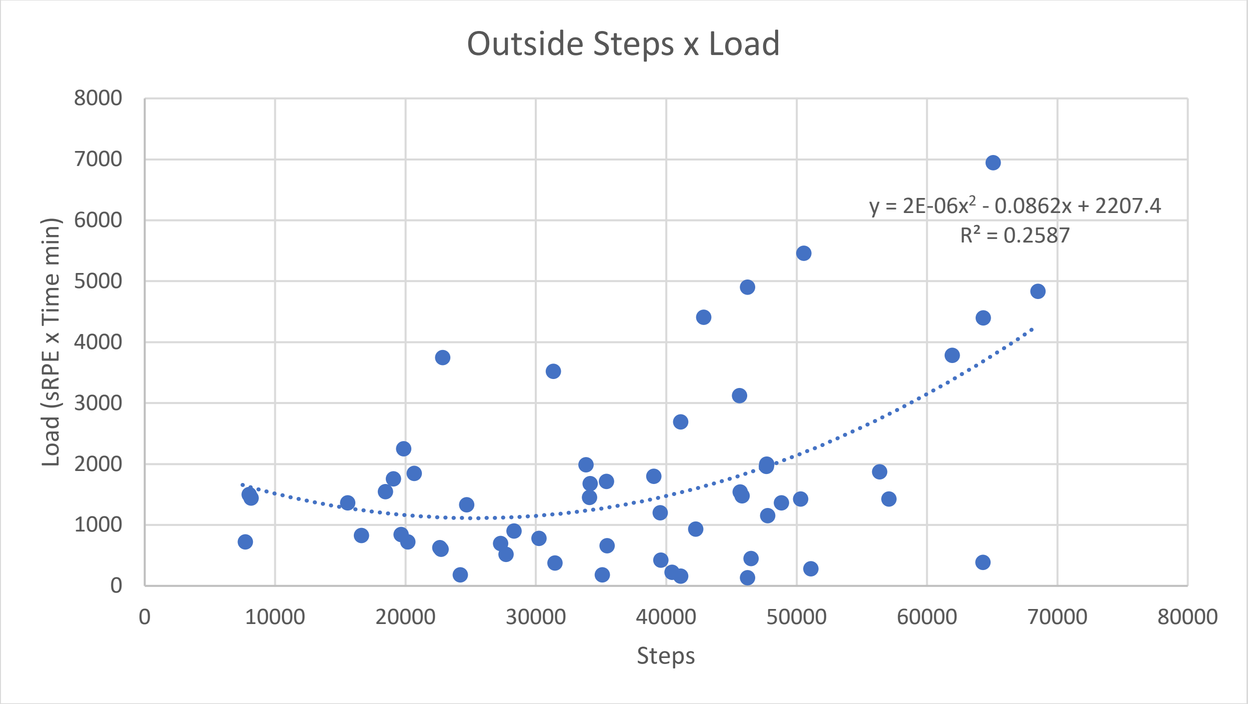

Figure 2. Comparison of average outside steps and average outside load ($R^2 = 0.26$).

Figure 3 represents LEHP weekly averages of steps and load, with each week per subject being represented as a data point. The inverse curvilinear line of best fit indicates that as step count increases there is an increase in load to a point and then a decrease in load as steps continue to increase. Compared to figure 2 there is a higher load and lower steps accomplished on average. This can be indicative of individuals exercising in modes that do not pertain to steps such as lifting weights, biking, Nu Step or rowing. The R^2 is 0.36 indicating that 36% of the variance in training load can be explained by the number of steps taken.

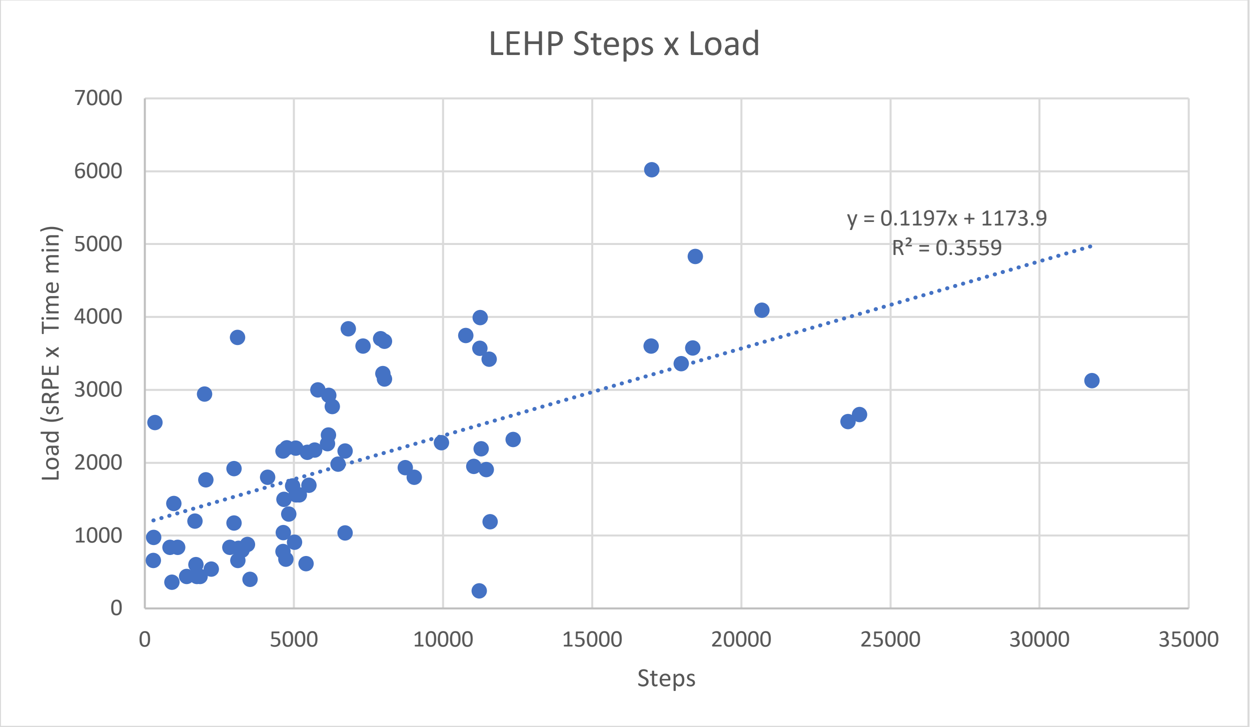

Figure 3. Comparison of average LEHP steps and average LEHP load ($R^2 = 0.36$).

DISCUSSION

The purpose of this study was to document the amount of steps and sRPE method derived training load accomplished in and outside of phase III cardiac rehabilitation. These findings suggest that the recommended amount of 10,000 steps daily is not being met, but that the suggested amount of weekly exercise (>150 min/week) is being accomplished (ACSM Guidelines, 2018). There was a curvilinear trend between steps and load accomplished (Figure 1) demonstrating that as step count increases so does training load. There are lower average steps observed in LEHP compared to outside, but overall average higher time, RPE, and load accomplished in LEHP. This indicates that these participants are working harder in the LEHP than during outside training, suggesting that individuals do more work and work harder in a community-based exercise program than they would otherwise do on their own.

Currently there are no published data in regard to daily recording in any phase of a cardiac rehabilitation program. Assuming on average the participants burn about 5.2 kcal/min (11.5 ml/kg x 90 kg=gross VO_2=1.035 liters/min, x 5=5.2 kcal/min) and the total of 266 minutes of exercise accomplished a week would equate to 1,282.2 kcal/week. Looking at only LEHP the average time accomplished was 162 minutes a week, which would equate to 842.4 kcal/week burned at program. The outside exercise time a week averaged to 144.9 ± 126.83 minutes, which would equate to 748.8kcal/week. According to Hambrecht et al. (1993) 1,400 kcal/week need to be observed in order to halt progression of coronary atherosclerosis lesions and 2,200 kcal/week needs to be observed to have regression in coronary lesions. The data shows that on average the participants are burning about 120 kcal/week less than what is needed to halt atherosclerosis.

Parfitt, Evans, & Eston (2012) conducted a study on exercising for 30 minutes, three times a week (90min/week) for eight weeks at an RPE of 13 which would equal a load of 1,170 (90min/week x 13 RPE). This resulted in improvements in mean arterial pressure, total cholesterol, VO_2 and body mass index. Our subjects completed on average a workload of 2,042.5 ± 1,244.95 in LEHP and averaged a workload in total of 3,359.8 ± 2,145.89 which is well above the workload of 1,170, thus these same improvements would be expected to be observed in the participants. Hambrecht et al., (2004) conducted a randomized study that had subjects exercise 20 minutes daily, assuming they worked at a similar RPE, getting a weekly load of 1,750 ((20 min x 7 days) x 12.5 RPE). He observed a higher event free survival of 88%, versus the 70% event free survival following percutaneous angioplasty with stenting (the nominal gold standard for patients with coronary artery disease).

Some considerations of this study are that it is unknown for comparison in phase I and II cardiac rehabilitation. Conducting this study again on a larger population would provide more information about workload accomplished in rehabilitation programs. While the ActiGraph is a good device for calculating steps, there is a limitation with using multimodal equipment that may not be recognized by the device. This could be solved by computing MET x min or MET x hr from chart records, or Time x RPE from chart records in established rehabilitation programs to get a sense of the normal rate of progression of exercise load in Phase I and II rehabilitation programs. These limitations include rowing machine, stationary bike, Nu Step and lifting weights. Data collection also occurred over the thanksgiving holiday in Wisconsin. Due to the celebration of the holiday and colder weather limiting exercise, this can result in decreased exercise levels that may not have occurred otherwise. Differentiating from outside activity or LEHP activity also provided some limitations.

It would be beneficial to have this study replicated in phase I and II cardiac rehabilitation to know what workload is occurring at different phases. Most programs record minutes outside of program and monitor during rehabilitation, but it is not currently being monitored and recorded on a daily basis. This information could be used to track if rehabilitation programs are doing enough for the patients and spot areas that could be improved. Replicating this study with more thorough education on how to use RPE as well as properly fill out the log sheet would help with participant error and more accurate data.

CONCLUSION

Community based programs showed that subjects achieved about 40,000 steps a week which is less than the recommended 10,000 steps per day. Using an alternative method for calculating load by using session Rating of Perceived Exertion (sRPE) an average load of 3,359.8 ± 2,145.89 was achieved weekly. This information suggests that while 10,000 steps may not be reached, adequate exercise, via different modalities that do not include steps, is being achieved. Subjects exercised in total an averaged of 4.2 ± 1.15 times weekly with 1.8 ± 0.72 of those occurrences being at LEHP and 2.4 ± 1.51 being outside of LEHP. The total average time spent exercising was 266.5 ± 170.85 minutes per week, which is well above the recommend amount of weekly exercise according to the ACSM Guidelines (2018). Comparing this study with the works of Hambrecht et al. (1993, 2004) and Parfitt, Evans, & Eston (2012), phase III cardiac rehabilitation can improve mean arterial pressure, cholesterol, body mass index and increase chance of event free survival. Participating in a community based programs prove to be more beneficial as individuals exercise harder and longer than they otherwise would have on their own.

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APPENDIX A

INFORMED CONSENT FORM

Informed Consent

Project: Training Load of Phase II and III Cardiac Rehabilitation

Principal Investigatory:

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Faculty Advisory:

Carl Foster, Ph. D.
133 Mitchell Hall
University of Wisconsin – La Crosse
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Purpose and Procedures

- Purpose of this study is to investigate the workload based off of session RPE after exercise and daily steps taken.
- My participation will include reporting session RPE after exercise and recording daily steps from pedometer.
- I will be using a visual analog scale as instructed by the investigators to report session RPE and record on documentation.
- Total time required for this study will be around one month.

Potential Risks

- There are minimal risks in this study due to its observational nature.

Rights and Confidentiality

- My participation is voluntary and I can withdraw or refuse to answer any questions without consequence at any time.
- I can withdraw from the study at any time without reason or penalty.
- Results of this study may be shared in scientific literature or presented at professional conferences.
- All collected information will be kept confidential through the use of coding.
- By participating in the study I am constituting informed consent.

Possible Benefits

- I may gain a better understanding of session RPE and future use in exercise prescription
- I will gain knowledge on how many steps I take in day and how that relates to daily physical activity.

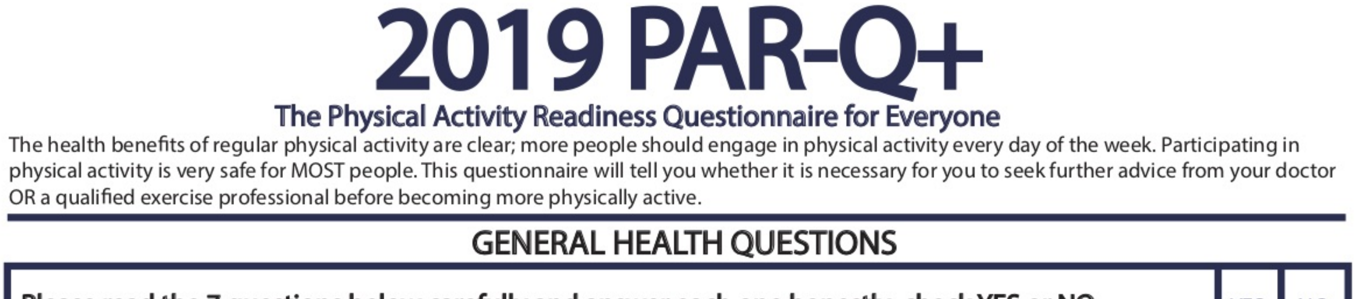
Questions regarding study procedure may be directed to Katrina Schultz (608-345-0631), the principal investigator, or the faculty advisory Carl Foster, PhD., Department of Exercise and Sport Science, UW-L (608-785-8687). Questions regarding the protection of human subjects may be addressed to the UW-La Crosse Informed Consent Institutional Review Board for the Protection of Human Subjects at irb@uwlax.edu

Participant ____ Date ____________

Researcher _______________________________________ Date ____________

APPENDIX B

PAR-Q+ FORM



2019 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO

2019 PAR-Q+

FOLLOW-UP QUESTIONS ABOUT YOUR MEDICAL CONDITION(S)

1. Do you have Arthritis, Osteoporosis, or Back Problems?

If the above condition(s) is/are present, answer questions 1a-1c — If **NO** ☐ go to question 2

1a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES ☐ NO ☐

1b. Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)? YES ☐ NO ☐

1c. Have you had steroid injections or taken steroid tablets regularly for more than 3 months? YES ☐ NO ☐

2. Do you currently have Cancer of any kind?

If the above condition(s) is/are present, answer questions 2a-2b — If **NO** ☐ go to question 3

2a. Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and/or neck? YES ☐ NO ☐

2b. Are you currently receiving cancer therapy (such as chemotheraphy or radiotherapy)? YES ☐ NO ☐

3. Do you have a Heart or Cardiovascular Condition? This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm

If the above condition(s) is/are present, answer questions 3a-3d — If **NO** ☐ go to question 4

3a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES ☐ NO ☐

3b. Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction) YES ☐ NO ☐

3c. Do you have chronic heart failure? YES ☐ NO ☐

3d. Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months? YES ☐ NO ☐

4. Do you have High Blood Pressure?

If the above condition(s) is/are present, answer questions 4a-4b — If **NO** ☐ go to question 5

4a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES ☐ NO ☐

4b. Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer **YES** if you do not know your resting blood pressure) YES ☐ NO ☐

5. Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes

If the above condition(s) is/are present, answer questions 5a-5e — If **NO** ☐ go to question 6

5a. Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician-prescribed therapies? YES ☐ NO ☐

5b. Do you often suffer from signs and symptoms of low blood sugar (hypoglycemia) following exercise and/or during activities of daily living? Signs of hypoglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness. YES ☐ NO ☐

5c. Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, **OR** the sensation in your toes and feet? YES ☐ NO ☐

5d. Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)? YES ☐ NO ☐

5e. Are you planning to engage in what for you is unusually high (or vigorous) intensity exercise in the near future? YES ☐ NO ☐

6. Do you have any Mental Health Problems or Learning Difficulties? This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome

If the above condition(s) is/are present, answer questions 6a-6b — If **NO** ☐ go to question 7

6a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) — YES ☐ NO ☐

6b. Do you have Down Syndrome **AND** back problems affecting nerves or muscles? — YES ☐ NO ☐

7. Do you have a Respiratory Disease? This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure

If the above condition(s) is/are present, answer questions 7a-7d — If **NO** ☐ go to question 8

7a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) — YES ☐ NO ☐

7b. Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy? — YES ☐ NO ☐

7c. If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week? — YES ☐ NO ☐

7d. Has your doctor ever said you have high blood pressure in the blood vessels of your lungs? — YES ☐ NO ☐

8. Do you have a Spinal Cord Injury? This includes Tetraplegia and Paraplegia

If the above condition(s) is/are present, answer questions 8a-8c — If **NO** ☐ go to question 9

8a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) — YES ☐ NO ☐

8b. Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting? — YES ☐ NO ☐

8c. Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)? — YES ☐ NO ☐

9. Have you had a Stroke? This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event

If the above condition(s) is/are present, answer questions 9a-9c — If **NO** ☐ go to question 10

9a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments) — YES ☐ NO ☐

9b. Do you have any impairment in walking or mobility? — YES ☐ NO ☐

9c. Have you experienced a stroke or impairment in nerves or muscles in the past 6 months? — YES ☐ NO ☐

10. Do you have any other medical condition not listed above or do you have two or more medical conditions?

If you have other medical conditions, answer questions 10a-10c — If **NO** ☐ read the Page 4 recommendations

10a. Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months **OR** have you had a diagnosed concussion within the last 12 months? — YES ☐ NO ☐

10b. Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)? — YES ☐ NO ☐

10c. Do you currently live with two or more medical conditions? — YES ☐ NO ☐

PLEASE LIST YOUR MEDICAL CONDITION(S) AND ANY RELATED MEDICATIONS HERE: ______________________

____

GO to Page 4 for recommendations about your current medical condition(s) and sign the PARTICIPANT DECLARATION.

2019 PAR-Q+

✓ **If you answered NO to all of the FOLLOW-UP questions (pgs. 2-3) about your medical condition, you are ready to become more physically active - sign the PARTICIPANT DECLARATION below:**

- It is advised that you consult a qualified exercise professional to help you develop a safe and effective physical activity plan to meet your health needs.
- You are encouraged to start slowly and build up gradually - 20 to 60 minutes of low to moderate intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
- As you progress, you should aim to accumulate 150 minutes or more of moderate intensity physical activity per week.
- If you are over the age of 45 yr and **NOT** accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.

If you answered **YES** to **one or more of the follow-up questions** about your medical condition:

You should seek further information before becoming more physically active or engaging in a fitness appraisal. You should complete the specially designed online screening and exercise recommendations program - the **ePARmed-X+ at www.eparmedx.com** and/or visit a qualified exercise professional to work through the ePARmed-X+ and for further information.

⚠ **Delay becoming more active if:**

- ✓ You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- ✓ You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ **at www.eparmedx.com** before becoming more physically active.
- ✓ Your health changes - talk to your doctor or qualified exercise professional before continuing with any physical activity program.

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The authors, the PAR-Q+ Collaboration, partner organizations, and their agents assume no liability for persons who undertake physical activity and/or make use of the PAR-Q+ or ePARmed-X+. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.

PARTICIPANT DECLARATION

- All persons who have completed the PAR-Q+ please read and sign the declaration below.
- If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME ____ DATE ____________________________________

SIGNATURE ____ WITNESS _________________________________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ____

For more information, please contact
www.eparmedx.com
Email: eparmedx@gmail.com

Citation for PAR-Q+
Warburton DER, Jamnik VK, Bredin SSD, and Gledhill N on behalf of the PAR-Q+ Collaboration.
The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+). Health & Fitness Journal of Canada 4(2):3-23, 2011.

The PAR-Q+ was created using the evidence-based AGREE process (1) by the PAR-Q+ Collaboration chaired by Dr. Darren E. R. Warburton with Dr. Norman Gledhill, Dr. Veronica Jamnik, and Dr. Donald C. McKenzie (2). Production of this document has been made possible through financial contributions from the Public Health Agency of Canada and the BC Ministry of Health Services. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada or the BC Ministry of Health Services.

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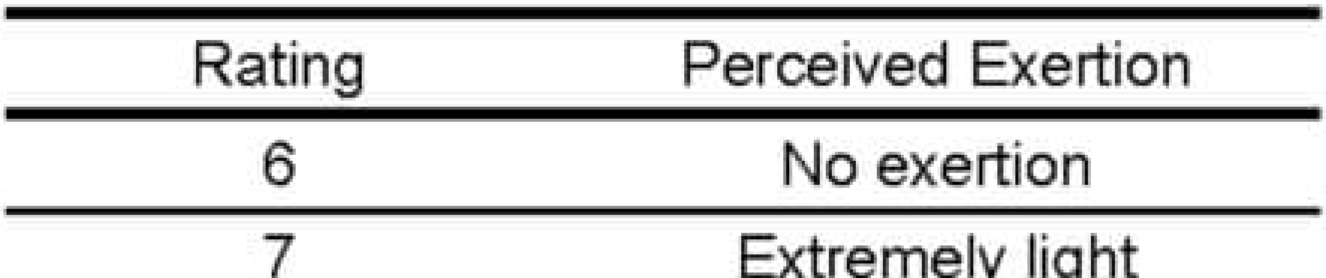
APPENDIX C

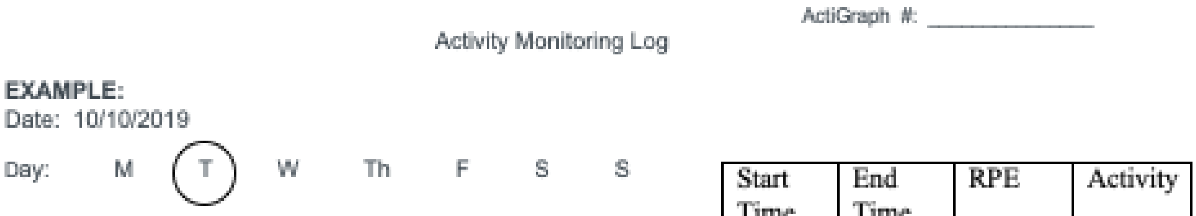
RATING OF PERCEIVED EXERTION SCALE



Rating	Perceived Exertion
6	No exertion
7	Extremely light

APPENDIX D

DAILY ACTIVITY MONITORING LOG



ActiGraph #: _______________

Activity Monitoring Log

EXAMPLE:

Date: 10/10/2019

Day: M [✓ T] W Th F S S

Start Time	End Time	RPE	Activity

Date: ________________

Day 4: M T W Th F S S

Start Time: (am / pm)
End Time: (am / pm)
Off Time: ~ (reason:
Off Time: ~ (reason:

Start Time	End Time	RPE	Activity

ActiGraph #: ______________

Activity Monitoring Log

EXAMPLE:
Date: 10/10/2019

Day: M [✓ T] W Th F S S

Start Time: **6:00** ([✓ am] / pm)

Start Time	End Time	RPE	Activity
3:30 pm	4:45 pm	14	Jogging

Date: ________________

Day 11: M T W Th F S S

Start Time: (am / pm)
End Time: (am / pm)
Off Time: ~ (reason:
Off Time: ~ (reason:
Off Time: ~ (reason:

Start Time	End Time	RPE	Activity

ActiGraph #: _______________

Activity Monitoring Log

EXAMPLE:

Date: 10/10/2019

Day: M [✓ T] W Th F S S

Start Time: **6:00** ([✓ am] / pm)

End Time: **8:00** (am / [✓ pm])

Off Time: **5:00-5:30pm** (reason: **swimming**)

Off Time: **6:00-6:15pm** (reason: **showering**)

Start Time	End Time	RPE	Activity
3:30 pm	4:45 pm	14	Jogging

Date: ________________

Day 18: M T W Th F S S

Start Time: (am / pm)
End Time: (am / pm)
Off Time: ~ (reason:
Off Time: ~ (reason:
Off Time: ~ (reason:

Start Time	End Time	RPE	Activity

RPE

Rating	Perceived Exertion
6	No exertion
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

APPENDIX E

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Introduction

Exercise and physical activity have been attributed to improving overall health and longevity across a large amount of the literature (Eijsvogels, Molossi, Lee, Emery, & Thompson, 2016). Exercise is also beneficial for rehabilitating cardiovascular health through monitored exercise. This has been shown to provide significant improvement in health and quality of life (Arem at el., 2015; Hambrecht et al., 2004) There are many ways to monitor exercise, a couple of those being step count and Rating of Perceived Exertion. Combining these two measurements can provide an understanding of workload in phase II and phase III cardiac rehabilitation programs.

Step Count

Today activity-tracking devices have become very popular to monitor exercise. The majority of these tracking activities are based on step count (i.e. pedometer). A yearlong study by Tudor-Locke et al. (2004) found a good correlation between steps taken and an active lifestyle. Individuals who took 5,000 steps daily lived a more sedentary lifestyles and were more likely to be classified as obese. Those who took an average of 10,000 steps per day achieved the recommended amount of steps (ACSM Guidelines, 2018). Individuals who took 15,000 a day were the most likely to see weight loss benefits (Bassett, Schneider, & Huntington, 2004). Individuals who took less than 5,000 steps daily were more likely to be obese with a progressively increasing level of obesity (Tudor-Locke, 2004). Kraus et al. (2019) found individuals who transitioned from a sedentary lifestyle to getting 10,000 steps a day decreased the rate of mortality by 46%. Likewise, increasing step count in 2,000 step intervals, up to 10,000, decreased cardiovascular events by 10% and decreased risk of diabetes by 5.5% per every 2,000 step interval (Kraus et al., 2019). Recording participants' daily steps, provides an opportunity to quantify and understand how much exercise participants have performed in that session, along with exercise performed outside of program times.

Rating of Perceived Exertion

The Borg Rating of Perceived Exertion (RPE) (Borg, 1998) was developed with intentions to be an easy, yet effective estimation of ones exercise intensity. The scale's purpose was to measure the level of strain or work experienced during physical activity. Today, the RPE scale is commonly used to monitor exercise intensity but can be used to quantify training. This method is widely accepted in exercise testing, training, and rehabilitation, due to its validity and ease of use (Day et al., 2004). Day et al. (2004) conducted a study to examine if the RPE scale is accurate in quantifying exercise exertion with light, moderate, and vigorous intensity. Results found, a significant difference in RPE correlation based on the level of exercise intensity, as expected. When comparing the data, no statistical difference was found between means of RPE per session, indicating that RPE is reliable tool to use with different exercise intensities (Day et al., 2004). Similar research assessed the validity of RPE over a variety of different activities. Foster et al. (1994, 2001) found that RPE is valid for quantitating exercise training over many different types of exercises, even at active exercise sessions.

Rating of Perceived Exertion can also provide information about accumulated fatigue. Fusco et al. (2019) studied swimmers who exercised at a constant duration and volume to see if RPE could measure fatigue. Through tracking the swimmers lap times with a constant external and internal intensity that remained constant, there was an observed increase in RPE. This information suggests that during constant intensity of an exercise, RPE increases and provides information about the fatigue of the individual (Fusco et al., 2019), supporting earlier work from our laboratory (Foster et al., 2001).

Historically to measure RPE, one must wait 30 minutes after exercise to get an accurate reading (Foster et al., 1995). This is done to prevent any remaining feelings of exercise to affect the individuals rating. Christen et al. (2016) questioned if RPE could be measured at different times and still be effective. Subjects, who were well trained, exercised for 30 minutes and then RPE was measured at 5, 10, 15, 20, 25, 30, and 60 minute increments and 24 hours after exercise. Results showed that although there were small differences in RPE at different times, there were no statistical difference from the standard 30-minute measurement. This indicates that there is no significant effect on rating time relative to when RPE is measured post exercise and that the standard 30 minutes might not be necessary (Christen et al., 2016).

The high validity and reliability of RPE makes it an effective tool to measure individuals exercise intensity. It is also easy to use and does not require technology, making it a user friendly option for all populations. Based on this information, RPE is a cost effective scale to use when conducting research on workload in cardiac rehabilitation.

Training Load

There are many benefits that come from exercise, but at what volume and intensity should one be exercising to receive those benefits? Exercise has an inverse relationship with long-term mortality; meaning the more you exercise the lower the mortality rate. Cardiovascular fitness has been shown to decrease mortality regardless of sex, race/ethnicity, or comorbidities (Myers et al., 2002; Mandsager et al., 2018).

Increasing cardiovascular fitness has also shown to decrease the risk of coronary artery disease, hypertension, diabetes, stroke, and cancer.

Mandsager et al. (2018) assessed cardiorespiratory fitness as it relates to long-term mortality. They found a dose response relationship with reduction in mortality in relation to increasing cardiorespiratory fitness. Another interesting finding was that they found no upper limit on the benefits of increasing aerobic fitness (Mandsager et al., 2018). They concluded that increasing cardiorespiratory fitness reduced long-term mortality rates. Similar findings were reported by Arem at al., (2015). Cardiac rehabilitation has been shown to reduce cardiac mortality (Ades et al., 2009). Historically the incidence rates of obesity have increased, creating a need for prevention. Weight loss observed in a cardiac rehabilitation setting has been shown to decrease cardiovascular events over a six-year time frame. Ades et al., (2009) evaluated how a standard cardiac rehabilitation protocol compared to a high caloric expenditure exercise program. Results showed that high caloric energy expenditure doubled the weight loss, abdominal fat loss, and reduction in waist circumference compared to standard cardiac rehabilitation (Ades et al., 2009). In order to attain the higher caloric expenditure, individuals need to be able to exercise five to six times a week, which may not be achievable by all populations. Overall exercise and weight loss show positive effects on decreasing long-term coronary events.

Exercise training can have an impact on fitness and exercise outcomes. Training in different ways can have outcomes that benefit other areas of exercise. Foster et al. (1995) evaluated improvement on how one mode of exercise training was affected by different exercise modes (e.g. cross training). This study found runners who also included swimming as a form of cross training significantly improved running performance, but not to the same degree as specific training load (Foster et al., 1994). This can be used to help increase specific training loads when an optimal level has been reached. While most cardiac rehabilitation patients are not reaching optimal levels, using a variety of exercises could be beneficial to achieve specific personal goals, but benefit them on other areas as well. Another way to look at training is to look at how our ancestors exercised. O'Keefe et al. (2011) researched how daily energy was used via physical activity of hunter-gatherers and from this made exercise recommendations. Looking at exercise mode, duration, intensity, and frequency O'Keefe (2011) devised a fitness regimen, including how our bodies are designed for large amounts of walking or carrying. They estimated that hunter-gatherers walked 3 to 10 miles daily. From this, recommendations to participate in large amounts of daily physical activity in the light to moderate intensity range were suggested. It was also noted that strenuous days were typically followed by rest days, with daily expenditures counts that were five times greater than sedentary adults (O'Keefe et al., 2011). The author recommended interval training once or twice a week, including bursts of moderate to high levels of intensity followed by rest (O'Keefe et al., 2011). This was found to improve fitness but can also be time-effective to meet hectic daily schedules. Variety in exercise is important to include in training as our ancestors, strength training, aerobic training, and flexibility were a part of hunter-gatherer's daily life. Cross training as stated above by Foster et al. (1995), helped improve resilience, decreased overuse injuries, and increased adherence to an exercise program. Social settings, such as cardiac rehabilitation programs, have been shown to increase exercise adherence, as well as improve mental and psychological health. Our ancestors did most activities in groups and as observed today, being around others while performing the same activity can encourage individuals to continue. Incorporating these factors into training programs can help improve fitness and workload.

Monitoring training load comes with the intent to improve exercise capacity. Historically, training load was discovered by using the fartlek method and later interval training was developed from that. It was first systematically organized by Banister et al., (1991) using the training impulse (TRIMP) method. Interval training helped discover current pace and goal pace and how that could be accomplished (Foster, Rodriguez-Marroyo, & Koning, 2017). Improvement markers helped to discover and track the physiological responses that occur during training, and from that, training load was discovered. Exercise prescription including frequency, intensity, time, and training load become part of a personalized exercise plan. By monitoring external training load and internal training load, we can figure out how to improve overall fitness levels (Foster, Rodriguez-Marroyo, & Koning, 2017). From these concepts, training zones have evolved (Mezzani et al., 2012; Seilen 2010)

Exercise Risks

Arem et al. (2015) looked at the relationship between leisure physical activity and its relationship to mortality. Most literature concludes that exercise is good for individual's health and will decrease mortality, but there is some literature that suggests that too much activity can lead to a higher risk of cardiac issues. Based on findings from Arem et al. (2015), individuals who exercised less than the recommended, amount compared to those who do not exercise at all, had a 20% lower risk of mortality, and an inverse relationship was found with individuals who performed 1-2 times or 2-3 times the recommended amount. Individuals who performed 3-10 times the recommended amount of exercise had a 39% lower mortality risk. This study showed no upper limit or risk of exercising 10+ times the recommended amount. Similar findings were found in Eijsvogels et al. (2016) research. The typical cardiac rehabilitation protocol consists of exercising three times a week at 60%-85% of maximal values. Increased exercise intensity has been linked to adverse cardiac outcomes in some athletes. Exercise can also cause artery calcification, cardiac dysfunction, and arrhythmias (Eijsvogels et al., 2016). In comparison, exercise can also reduce cardiovascular disease and mortality. The benefits outweigh the risk when in comparison and cardiac rehabilitation should continue to focus on exercise training.

Conflicting scientific findings indicate that high intensity training may not be ideal. O’Keefe et al. (2014) theorized that there are no cardiovascular benefits once 10 metabolic equivalents or higher is met, suggesting that it may trigger myocardial dysfunction. Walking and running can have equal benefits if the same amount of calories were burned during training. When looking at previous studies O’Keefe et al. (2014) found that performing strenuous exercise most days of the week doubles the chance of fatal myocardial infarction or stroke. Exercising more than five hours a week after age 30 can increase the chance of developing atrial fibrillation later in life. Other health concerns can come from high intensity exercise such as orthopedic overuse. This can appear as plantar fasciitis, Achilles tendonitis, shin splints, and tennis elbow (O’Keefe et al., 2014). The goal of exercise is to improve one’s health and decrease the risk of cardiovascular disease. While high volume and high intensity can increase the risk for adverse outcomes, it is still recommended to exercise at a light to moderate intensity for recommended amounts (O’Keefe et al., 2014). With the findings from O’Keefe et al. (2014), Mandsager et al. (2018) has noted that adverse cardiovascular findings in high intensity exercise could result from benign cardiovascular features that occur due to high activity levels.

Conclusion

While there is a risk to exercise, most literature agrees that exercise at appropriate amounts is beneficial to one’s health and longevity. Knowing the risks and benefits, this can be applied to work load to ensure that individuals are exercising at an appropriate level that will promote beneficial outcomes. Using rating of perceived exertion and step count can give information on workload in phase II and III cardiac rehabilitation. Further research needs to be conducted to see the relationship between these two programs.

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