SOCIO-ECOLOGICAL CORRELATES OF EXERCISE AT CARDIAC REHABILITATION COMPLETION

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ABSTRACT

Objectives: To describe: (1) the amount of physical activity (PA) in cardiac rehabilitation (CR) graduates by sex, and (2) the correlates of their PA.

Design: Secondary analysis of baseline data from a randomized trial was undertaken. Graduates were recruited from 3 CR programs. Participants completed a questionnaire which assessed constructs from the Socio-ecological model (i.e., individual-level, social and physical-environmental levels). PA was measured objectively using an ActiGraph GT3X accelerometer. Multi-level modeling was performed.

Results: 255 patients consented, of which 200 (78.4%) completed the survey and provided valid accelerometer data. Participants self-reported engaging in a mean of 184.51±129.10 (standard deviation) minutes of moderate-to-vigorous-intensity PA (MVPA) per week (with men engaging in more than women, $p<.05$). Accelerometer data revealed participants engaged in 169.65±136.49 minutes of MVPA/week, with 43 (25.1%) meeting recommendations. In the mixed models, the socio-ecological correlate significantly related to greater self-reported MVPA was self-regulation ($p=.01$; 95%CI=.07-.43); the correlate of accelerometer-derived MVPA was neighborhood aesthetics ($p=.02$; 95%CI=.03-.39).

Conclusions: Approximately one-quarter of CR program completers are achieving MVPA recommendations, although two-thirds perceive they are. CR programs should exploit accelerometry, and promote self-regulation skills, namely self-monitoring, goal-setting, positive reinforcement, time management and relapse prevention. Patients should be encouraged to exercise in pleasing locations.

Keywords: Cardiovascular Disease, Physical Activity, Secondary Prevention, Socio-ecological model

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INTRODUCTION

Cardiovascular disease (CVD) is among the leading causes of mortality in North America.[1,2] Patients with CVD are at high risk of subsequent events, and thus secondary prevention is crucial. This includes smoking cessation, as well as eating a heart-healthy diet and engaging in regular physical activity.[3,4] With regard to the latter, guidelines recommend that patients accumulate at least 150 minutes of moderate- to vigorous-intensity physical activity (MVPA) per week,[3,4] preferably through exercising for 30 minutes a day on most days of the week.

Cardiac rehabilitation (CR) promotes cardiovascular health through delivery of the above prevention strategies.[5] Patients who participate in CR have a 20% lower mortality and morbidity.[6] Exercise training is a key contributor to CR-related mortality reductions.[7] In most Canadian CR programs, patients participate in 45-60 minute exercise classes twice weekly.[1] They are also prescribed independent exercise on non-CR days, such that, cumulatively, they achieve the recommended 150 minutes of MVPA each week. Promoting independent exercise during CR also serves to facilitate their engagement in, and maintenance of, their exercising lifestyle in their home or community environments post-program.

Surprisingly little has been published regarding the volume of PA achieved through CR.[8] While it may be expected that patients would meet and exceed PA targets by the end of their CR program, many programs do not assess PA outside of CR (despite recommendations by learned CR associations to do so)[5,8] such that overall volume of MVPA is unknown. In the few observational studies assessing weekly total volume of MVPA during CR in the literature, results show that not all patients meet guideline recommendations, and that they engage in significantly greater amounts of PA on CR than non-CR days.[9,10,11] To our knowledge,[8] there are only two

studies reporting total weekly volume of PA in relation to guideline recommendations at the end of CR in the literature.[12,13] First, Stevenson et al.[12] assessed MVPA in 22 patients via accelerometer, and results showed patients engaged in an average of 131 minutes/week of moderate-intensity PA at program exit and no vigorous-intensity activity. Finally, Arthur et al.[13] assessed MVPA via the self-report Godin Leisure-Time Exercise Questionnaire[14] in 157 women at the end of CR. Scores ≥24 on the Godin scale were considered to demonstrate sufficient MVPA to derive health benefit, and the mean score at CR end was 27. Therefore, there is only 1 study in the literature reporting MVPA in relation to guideline targets using objective measurement,[8,12] and hence is less biased by social desirability.

Socio-Ecological Model

Previous research has examined the determinants of PA at the end of, or after, CR,[15] but few have done so in a theoretically-informed manner. The socio-ecological model[16] is a relevant framework that can be used to understand the correlates of PA in the CR setting,[17] particularly as patients are encouraged to exercise both in and outside of CR. A socio-ecological perspective suggests that individuals vary in their behavior (i.e., PA), based on their social and physical environments. The model posits that there are individual (e.g. knowledge, attitudes, and skills), social-environmental (e.g., friends, family, and social networks) and physical-environmental (e.g. home, neighborhood and community characteristics, weather) factors that influence PA.[18,19] Through this model, modifiable aspects of a patients' environment related to greater PA at the end of CR, a crucial patient transition point to other PA settings, can be identified.

In sum, while participation in CR programs results in greater PA,[10,12] surprisingly there are few studies that consider the attainment of PA targets necessary to positively impact health outcomes in CR graduates, nor the theoretical aspects related to this PA.[8] Therefore, the purpose

of this study was to: (1) describe the amount of PA in male and female CR participants at the end of their CR program; and (2) understand the correlates of subjectively-reported and objectively-measured PA in CR graduates, in a theoretically-informed manner.

METHODS

Design and Procedure

We performed a secondary analysis of the baseline data from the randomized controlled trial entitled "ECologically OPtimizing exercise maintenance in men and women following Cardiac Rehabilitation" (ECO-PCR; clinicaltrials.gov NCT01658683). The design of this secondary analysis was cross-sectional.

Study coordinators at each site attended the second last and final CR classes to solicit patient interest. Consenting participants were provided with a self-report survey to complete, which assessed socio-demographic characteristics, PA, and elements of the socio-ecological framework.[16]

Participants were also asked to wear an ActiGraph GT3X accelerometer (ActiGraph, Pensacola, FL).[20,21] All participants were instructed to wear the monitor on their right hip using the waist belt during waking hours for nine consecutive days. A 15-second sampling epoch was used and converted into 60-second epochs (counts·min^{-1} [cpm]).

Participants and Setting

Participants were recruited from three CR programs in Ontario, Canada (one institution offered programs at two sites). These comprehensive CR programs ranged in duration from eight weeks to six months. Across all programs, participants received individualized exercise prescriptions, and participated in supervised exercise sessions two times/week. While there were

some differences in the timing and delivery format of patient education between programs, each program was based on the Canadian CR Guidelines[1] and hence consistent. Participants were provided an updated exercise prescription at program exit.

Patients were included in the study if they were currently participating in an on-site CR program of ≥ 8-weeks duration, had attended ≥ 75% of scheduled CR sessions (i.e., they would be graduating), had a documented diagnosis of coronary artery disease (CAD), were ≥18 years old, and were able to walk unaided at 2 mph. Patients who had New York Heart Association class III or IV heart failure,[22] were pregnant, lactating or planning to become pregnant during the study period, or were unable to read and understand English or French were excluded.

Measures

Sociodemographic characteristics were obtained through self-report questionnaires. Clinical characteristics of participants were obtained from CR records. The socio-ecological correlates of PA were assessed as outlined below, and as shown in Figure 1.

Individual Level

Correlates at the individual-level included many of the sociodemographic and clinical characteristics. Other individual-level correlates were assessed through psychometrically-validated, self-report scales. This included depressive symptoms, functional status, barrier self-efficacy, PA intention and planning, PA self-regulation, task self-efficacy, and exercise benefits and barriers. These are described in the online supplement.

Social-environmental Level

The interpersonal-level correlates assessed were living arrangements (e.g., residing with family or not, residing with someone who requires caregiving), marital status (self-reported as well), social support, subjective norm, and autonomy support. The latter are described in the online supplement.

Physical-environmental Level

The correlates at the physical-environmental level included participants' home exercise equipment availability, neighborhood environment, season and mixed-land use. The former are described in the online supplement.

The season variable was derived based on whether participants completed their survey in the months of December, January, and February (i.e., winter) in comparison to other months of the year. Lastly, mixed-land use was assessed. Participants were asked to report the type of neighborhood in which they reside as residential, mixed commercial residential or mainly commercial.

Dependent Variable

A modified and validated version[23] of the Godin Leisure-Time Exercise Questionnaire[14] was administered to ascertain the self-reported average weekly MVPA of the participants. Participants were asked, "How many days in a typical week … did you do moderate (e.g., fast walking, easy bicycling, easy swimming, dancing) PA for at least 10 minutes at a time?" and, "On the days when you did moderate PA, how many minutes on average did you spend per day doing this activity?". The same two questions assessed the frequency and duration of vigorous-intensity (e.g., running, jogging) activities. To calculate the total MVPA score, the frequency of moderate-intensity PA was multiplied with the duration of moderate-intensity PA, which resulted in the total minutes per week of moderate-intensity PA. The same equation was applied in order to calculate the total number of minutes the participants engage in vigorous-intensity PA. The total minutes of MVPA per week was then summed. Additionally, in order to determine the proportion of people meeting the recommended guidelines of 150 minutes of MVPA per week,[3,4] a dichotomous variable was computed (i.e. $< \text{or} \geq 150$ minutes).

<u>Accelerometer Data Reduction</u>

A valid day was defined as ≥10 hours of wear time, and participants were required to have a minimum of five valid days to be retained in the analyses. For participants with >7 valid days, the first day was removed (to minimize reactivity), and the subsequent seven days used for the average. Wear time was calculated by subtracting non-wear time from 24 hours. Non-wear time was defined as at least 60 minutes of consecutive zeros for counts, with an allowance of up to two minutes of counts between zero and 150.[24]

MVPA was defined using a cut-point of ≥2690 cpm for use with vector magnitude,[21,25,26] with bouts ≥10 minutes. Weekly averages were calculated by multiplying the daily average (minutes/day) by seven, for those with at least five valid days. MVPA was also analyzed as those meeting recommendations of ≥30 minutes/day on ≥5 days/week (yes/no).

Statistical Analysis

All analyses were performed using SPSS version 23.0.[27] To test for differences in the sociodemographic and clinical characteristics of the sample compared to the broader cohort, t-tests and chi-square analyses were performed.

To test the first objective, the mean Godin score and accelerometer-derived minutes of MVPA were described, overall and by sex. To assess the second objective, Pearson's correlations, Analysis of Variance or Student's t-tests were computed between MVPA/week and each of the socio-ecological correlates (including sex, as per objective one), as appropriate. The continuous variables were used to optimize variability. These analyses of association were undertaken with the self-reported MVPA (i.e., the revised Godin score) and accelerometer-derived MVPA.

Finally, variables which were significantly related to MVPA were then entered into a linear mixed-effects model, with MVPA as the dependent variable, and site as a hierarchical variable. All socio-ecological variables could not be entered as this would contravene the rule-of-

thumb of 10 cases per variable.[28] For the first model, minutes of MVPA/week on the revised Godin served as the dependent variable, and for the second model the accelerometer data were used. The latter model was adjusted for wear time. Confidence intervals were computed.

RESULTS

Respondent Characteristics

A total of 1374 patients were approached, of which 740 patients (54%) were deemed ineligible. Patients were considered ineligible for the following reasons: 297 (40.2%) patients did not have a documented CAD diagnosis, 160 (21.6%) patients had attended less than 75% of the CR classes or did not graduate from CR, 144 (19.4%) patients could not walk 2 mph to complete stress test, 26 (3.5%) patients did not read or understand English or French, 21 (2.9%) patients were planning to leave the province or region in the next 12 months, 10 (1.4%) participants were considered unable to participate in unsupervised exercise by the qualified clinical investigator, 8 (1.1%) participated in program of less than eight weeks duration, four (0.5%) patients had a New York Heart Association class III or IV,[29] and 70 (9.5%) were excluded for other reasons. Two hundred and fifty-five (40.0%) of the 634 eligible participants consented to participate. Two hundred and twenty-two (87.1%) participants completed the post-CR survey, and 200 (78.4%) participants also provided sufficient valid accelerometer data to be included and hence comprised the sample. The accelerometer assessment started an average of 10 days from CR graduation.

The sociodemographic and clinical characteristics of participants are described in Table 1. These characteristics were compared between the consenting sample and those with valid survey and accelerometer data whom comprised the sample. As shown, participants included in the sample were historically more physically active, were not currently smoking (however

caution is warranted in over-interpretation as there were so few smokers), and more often had arthritis than those not included.

Amount of MVPA

With respect to the first objective, participants self-reported engaging in a mean of 184.51±129.10 minutes of MVPA per week (median=175), with accelerometer data showing they engaged in 169.65±136.49 minutes of MVPA per week (median=143). With respect to the recommended guidelines, 134 (62.9%) participants self-reported engaging in ≥150 minutes of MVPA per week, with accelerometer data suggesting 43 (25.1%) participants engaged in ≥30 minutes of MVPA per day, ≥5 days per week.

Mean self-reported and accelerometer-derived MVPA is reported in Table 2 by socio-ecological construct. With respect to the recommended guidelines, 101 (64.6%) male participants self-reported engaging in ≥150 minutes of MVPA per week, with accelerometer data suggesting 47 (30.4%) participants engaged in ≥30 minutes of MVPA per day, five days per week. Among women, 23 (51.2%) participants self-reported engaging in ≥150 minutes of MVPA per week, with accelerometer data suggesting 8 (18.4%) female participants engaged in ≥30 minutes of MVPA per day, five days per week. Men self-reported engaging in significantly more MVPA than women ($t=2.12$, $p=0.04$); no sex difference was observed with accelerometer data.

Socio-Ecological Correlates of MVPA

The socio-ecological constructs are reported in Tables 1 and 2. Mean scores for the psychometrically-validated scales are shown in Table 2.

Univariate associations with self-reported and objectively-measured MVPA at CR exit are presented in Table 2. At the individual-level, there were positive, significant associations

between self-reported MVPA and being male, having fewer depressive symptoms, higher functional status, engaging in greater self-regulation, higher PA intentions, higher PA planning, higher barrier self-efficacy, as well as perceiving greater exercise benefits and fewer exercise barriers. Positive and significant associations were also found between objectively-measured MVPA and engaging in greater self-regulation, higher PA intentions, higher PA planning, higher barrier self-efficacy, as well as perceiving greater exercise benefits, and having a lower body mass index.

There were no significant social-environmental level correlates identified with respect to either self-reported or objectively-measured MVPA at CR completion. Figures 1 and 2 display the physical-environmental level constructs. In the home environment (Figure 1), willingness to use aerobic work-out videos was significantly associated with self-reported MVPA. In the neighborhood environment (Figure 2), willingness to use playing fields was significantly associated with greater self-reported MVPA; Willingness to use golf courses and swimming pools were significantly associated with objectively-measured MVPA. Lastly, neighborhood aesthetics was the only variable found to be significantly correlated, in a positive direction, to both self-reported and objectively-measured MVPA (Table 2).

Given the dependent variables were slightly positively skewed (i.e., outside of acceptable limits of ±2),[30] a log transformation was applied to each. The results of the mixed model predicting self-reported MVPA are reported in Table 3. The exercise benefits variable was excluded as it was highly correlated with exercise barriers, which could introduce multicollinearity. Greater functional status and self-regulation were significantly associated with MVPA at CR completion. The results of the mixed model predicting objectively-measured MVPA are reported in Table 4. Better neighborhood surroundings or aesthetics was significantly

associated with greater MVPA recommendation at CR completion. No other correlates were significant.

DISCUSSION

Herein the amount of MVPA at CR completion in the largest sample of graduates yet reported in the literature is characterized,[8] and this is considered by sex, using an objective measure. Approximately one-quarter were meeting the 150 minute MVPA guideline recommendation at CR completion, although two-thirds perceived they were meeting the recommendation. Clearly, all CR programs should take heed, and put greater emphasis on weekly objective monitoring of MVPA (including in the period immediately post-program), and progressing exercise prescriptions to ensure patients get to target. With regard to the socio-ecological correlates, the likelihood that patients met the PA guideline was greater in those who engaged in greater self-regulation, and lived in or were proximate to more aesthetically-pleasing neighborhoods. While the association with functional status is likely due to reverse causation and neighbourhood aesthetics may be related to socioeconomic status which is not highly modifiable in later life, self-regulation skills are highly teachable. This represents an important area of focus for CR providers.

Amount of MVPA

The discrepancy in PA by assessment method can partially be explained by several factors, but given discordance observed in other samples,[31] is likely robust. First, for self-report, how MVPA was distributed over the course of a week was not considered, but for the accelerometer it was. Second, the discrepancy is also likely related to the strengths and weaknesses inherent in each.[32] For instance, the objective measure would not capture swimming, and would not very reliably capture some other forms of PA (e.g., cycling), while the subjective measure can be biased by socially-desirable responding. Third, another consideration is that

accelerometer cut-points were based on absolute rather than relative intensity. Recent research has demonstrated great variability in activity counts/minute based on fitness level.[33] Finally, while subjective and objective measures of PA were administered at the same time, the discrepancy could be also due to the fact that the self-report scale queried PA in a "typical week". That each had different correlates deserves consideration in future research, as does the role of accelerometry in educating patients of their attainment of guideline targets and how this could inform greater attainment.

Despite clinical practice recommendations and participation in CR, the majority of patients do not meet the guideline recommendations for PA at program completion. Our findings are fairly consistent with the handful of other studies in this area.[10,11,13,34,35] When looking at accelerometer-derived MVPA specifically, the 2 other studies in the literature reported approximately 130 minutes per week,[9,12] with patients herein accruing a median of approximately 140 minutes per week. Future research is needed to investigate the initial exercise prescription of patients in relation to guideline recommendations and patient health status, how the prescriptions are increased / progressed through the program, whether exit exercise prescriptions meet guideline recommendations, and the proportion of graduates that have legitimate clinical restrictions to engaging in guideline-recommended levels of PA, to better understand this phenomenon. Considering that patients wore the accelerometer and reported their MVPA approximately 10 days post-CR, an alternative interpretation of the findings is that they met guideline recommendations at CR exit, but their PA dropped substantively the first week after program completion. Given that many patients dropout of CR and that PA decays post-CR, these results, while concerning, are also in line with the broader rates of inactivity reported in the adult population. Regardless, efforts are needed to promote guideline-recommended levels of MVPA by CR completion in all participants.

Correlates identified at the bivariate level were fairly consistent regardless of whether MVPA was assessed via self-report or accelerometer. However, it is important to note the discordance by sex. The well-established sex difference in PA, where men engage in significantly more PA than women, was observed for self-reported PA, but not where it was objectively-measured. This may suggest men's report of PA may be more highly affected by social desirability than women, or that CR education and programming can close the sex gap. Replication is warranted.

Socio-Ecological Model

Previous research has examined correlates of PA at the end or after CR[15] but few have done so in a theoretically-informed manner. This study was the first to apply the socio-ecological framework to assess the contributing factors underlying adherence to PA at the end of CR specifically. This study provides general support for the socio-ecological model as a framework in understanding the correlates of PA in a CR setting, though there was a lack of associations with factors at the social-environmental level, and few were sustained in the multivariate model.

Indeed, within the individual-level of the model, many associations observed were consistent with those reported in previous research.[36] The association identified for self-regulation is an example of this. In a study by Izawa et al.[37] it was found that the use of a self-monitoring approach (an aspect of self-regulation) during supervised CR effectively increased exercise maintenance at CR completion. Similarly, in a study by Carels et al.[38] using a self-monitoring approach increased participants' cardiorespiratory fitness, increased weekly exercise and increased kilocaloric expenditure in leisure-time PA. This is encouraging as such a strategy can be easily implemented by healthcare practitioners in the CR setting. For example, staff members could encourage participants to complete a daily exercise diary describing their

exercise type and duration, and compare this against their set goals for exercise. Patients could also use a commercially-available activity monitor, which have recently grown in accessibility and have been shown to be valid and reliable.[39,40] There are also structured internet programs with social components that are designed for eliciting social support and reinforcement, as well as promoting time management and relapse prevention, both of which have been established as effective strategies in previous research.[41] These tools can promote self-regulation and consequently enhance PA adherence among patients.

Caution is warranted when interpreting these results. An important limitation of this study is its design. In cross-sectional studies such as this, it is not possible to infer a cause-and-effect relationship between correlates and PA. However, the design is appropriate as we are interested in PA at the end of CR. Second, the objectives of this secondary study were not pre-specified in the original randomized controlled trial protocol. This can lead to under-powered tests of associations.

Other limitations relate to measurement. Third, there are likely other unmeasured factors which affect PA in this population. Fourth, the correlates were self-reported and therefore measurement error may be at play. Fifth, the accelerometer cut-points used for the exercise intensities were not based on CR samples, and therefore may have misclassified some PA. There are not validated cut-points to use in the CR population. Our previous work has shown that results do vary based on cut-points chosen.[42] Sasaki cut-points were applied herein as they are the most widely-used, and thus results can be compared to other studies. Moreover, another indicator of MVPA was used in the current study.

Sixth, many potential correlates were considered and with a correspondingly high number of comparisons made, the potential for error is inflated. However, multivariate models were computed. The final limitations relate to generalizability. The consent rate was low. Moreover,

there were some differences between participants who consented to the trial and those included in this sample. In particular, participants in the study were historically physically more active than those not included. It is unknown how the sample herein compares to the sample of CR graduates more broadly. The generalizability of the findings will be limited to those who gain access to CR and complete the program, which represents only approximately 20% of cardiac outpatients.[11] Moreover, the findings may not be generalizable to other CR program models (e.g., home-based) but would be generalizable to programs of varying durations, or to jurisdictions where CR services are not reimbursed through the health care system.

In conclusion, only approximately one-quarter of CR graduates meet guideline-recommended levels of 150 minutes of MVPA per week. Clearly recommendations to assess PA in CR programs should be heeded, and programs must do more to promote guideline attainment in their patients. Attainment of PA targets was related to greater self-regulation; skills which are readily-teachable to CR participants. Working with patients to identify aesthetically-pleasing environments in their neighborhood where they could exercise should also be considered.

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REFERENCES

1. Lackland D. *Heart Disease and Stroke Statistics — 2017 Update A Report From the American Heart Association*.; 2017. doi:10.1161/CIR.0000000000000485.

2. Mozaffarian D, Benjamin EJ, Go AS, et al. *Heart Disease and Stroke Statistics-2016 Update a Report from the American Heart Association*. Vol 133.; 2016. doi:10.1161/CIR.0000000000000350.

3. Smith SC, Benjamin EJ, Bonow RO, et al. AHA / ACCF Guideline AHA / ACCF Secondary Prevention and Risk Reduction Therapy for Patients With Coronary and Other Atherosclerotic Vascular Disease : 2011 Update A Guideline From the American Heart Association and American College. *Circulation*. 2011;124(22):2458-2473. doi:10.1161/CIR.0b013e318235eb4d.

4. Tobe SW, Stone J a, Brouwers M, et al. Harmonization of guidelines for the prevention and treatment of cardiovascular disease: the C-CHANGE Initiative. *CMAJ*. 2011;183(15):E1135-50. doi:10.1503/cmaj.101508.

5. Grace SL, Turk-adawi KI, Contractor A, et al. ScienceDirect Cardiac Rehabilitation Delivery Model for Low-Resource Settings : An International Council of Cardiovascular Prevention and Rehabilitation Consensus Statement. *Prog Cardiovasc Dis*. 2016;59(3):303-322. doi:10.1016/j.pcad.2016.08.004.

6. Anderson L, Oldridge N, Thompson DR, et al. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease. *J Am Coll Cardiol*. 2016;67(1):1-12. doi:10.1016/j.jacc.2015.10.044.

7. Lavie CJ, Arena R, Swift DL, et al. Clinical Science and Cardiovascular Outcomes. 2015:207-220. doi:10.1161/CIRCRESAHA.117.305205.

8. Kaminsky LA, Brubaker PH, Guazzi M, et al. Assessing Physical Activity as a Core Component in Cardiac Rehabilitation. *J Cardiopulm Rehabil Prev*. 2016;36(4):217-229. doi:10.1097/HCR.0000000000000191.

9. Ayabe M, Brubaker PH, Dobrosielski D, et al. The physical activity patterns of cardiac rehabilitation program participants. *J Cardiopulm Rehabil*. 2004;24(2):80-86. http://www.ncbi.nlm.nih.gov/pubmed/15052109.

10. Jones NL, Schneider PL, Kaminsky L a, Riggin K, Taylor AM. An assessment of the total amount of physical activity of patients participating in a phase III cardiac rehabilitation program. *J Cardiopulm Rehabil Prev*. 2007;27(2):81-85. doi:10.1097/01.HCR.0000265034.39404.07.

11. Reid RD, Morrin LI, Pipe AL, et al. Determinants of physical activity after hospitalization for coronary artery disease: the Tracking Exercise After Cardiac Hospitalization (TEACH) Study. *Eur J Cardiovasc Prev Rehabil*. 2006;13(4):529-537. doi:10.1097/01.hjr.0000201513.13343.97.

12. Stevenson TG, Riggin K, Nagelkirk PR, Hargens T a, Strath SJ, Kaminsky L a. Physical

activity habits of cardiac patients participating in an early outpatient rehabilitation program. *J Cardiopulm Rehabil Prev*. 2009;29(5):299-303. doi:10.1097/HCR.0b013e3181b4ca61.

13. Arthur HM, Blanchard C, Gunn E, Kodis J, Walker S, Toner B. Exercise trajectories of women from entry to a 6-month cardiac rehabilitation program to one year after discharge. *Biomed Res Int*. 2013;2013:121030. doi:10.1155/2013/121030.

14. Godin G and SRJ. A simple method to assess exercise behaviour in the community. *Can J Appl Sport Sci*. 1985;10:141-146.

15. Bock BC, Albrecht a E, Traficante RM, et al. Predictors of exercise adherence following participation in a cardiac rehabilitation program. *Int J Behav Med*. 1997;4(1):60-75. doi:10.1207/s15327558ijbm0401_4.

16. Sallis JF, Bauman a, Pratt M. Environmental and policy interventions to promote physical activity. *Am J Prev Med*. 1998;15(4):379-397. http://www.ncbi.nlm.nih.gov/pubmed/9838979. Accessed November 21, 2014.

17. Dishman RK, Sallis JF, Orenstein DR. Association of Schools of Public Health The Determinants of Physical Activity and Exercise Published by : Association of Schools of Public Health content in a trusted digital archive . We use information technology and tools to increase productivity and f. *Public Health Rep*. 2014;100(2):158-171.

18. Booth ML, Owen N, Bauman A, Clavisi O, Leslie E. Social-cognitive and perceived environment influences associated with physical activity in older Australians. *Prev Med (Baltim)*. 2000;31(1):15-22. doi:10.1006/pmed.2000.0661.

19. King AC, Castro C, Wilcox S, Eyler A a., Sallis JF, Brownson RC. Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of U.S. middle-aged and older-aged women. *Heal Psychol*. 2000;19(4):354-364. doi:10.1037//0278-6133.19.4.354.

20. Lee JA, Williams SM, Brown DD, Laurson KR. Concurrent validation of the Actigraph gt3x+, Polar Active accelerometer, Omron HJ-720 and Yamax Digiwalker SW-701 pedometer step counts in lab-based and free-living settings. *J Sports Sci*. 2015;33(10):991-1000. doi:10.1080/02640414.2014.981848.

21. Sasaki JE, John D FP. Validation and comparison of ActiGraph activity monitors. *J Sci Med Sport*. 2011;14(6):411-416.

22. The Criteria Committee of the New York Heart Association. *Nomenclature and Criteria for Diagnosis of Disease of the Heart and Great Vessels*. 9th ed. Boston,Massachusetts: Little, Brown & Co.; 1994.

23. Riley DL, Mark AE, Kristjansson E, Sawada MC, Reid RD. Neighbourhood walkability and physical activity among family members of people with heart disease who participated in a randomized controlled trial of a behavioural risk reduction intervention. *Health Place*. 2013;21:148-155. doi:10.1016/j.healthplace.2013.01.010.

24. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity

in the United States measured by accelerometer. *Med Sci Sports Exerc*. 2008;40(1):181-188. doi:10.1249/mss.0b013e31815a51b3.

25. Nichols JF, Morgan CG, Chabot LE, Sallis JF, Calfas KJ. Assessment of physical activity with the Computer Science and Applications Inc accelerometer: laboratory versus field evaluation. *Res Q Exerc Sport*. 2000;71:36-43. doi:10.1080/02701367.2000.10608878.

26. Freedson PS, Melanson E SJ. Caliberation of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sport Exerc*. 1998;30(50):777-781.

27. IBM. SPSS for Windows. 2012. http://www-01.ibm.com/software/analytics/spss/.

28. Vanvoorhis CRW, Morgan BL. Understanding Power and Rules of Thumb for Determining Sample Sizes. *Tutorials Quant Methods*. 2007;3(2):43-50.

29. Dolgin M, The Criteria Committee of the New York Heart Association. *Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Great Vessels*. 9th ed. Boston, Massachusetts, Massachusetts: Little, Brown & Co.; 1994.

30. Edition E. SPSS for Windows Step by Step Simple Eleventh Edition.

31. Dyrstad SM, Hansen BH, Holme IM AS. Comparison of self-reported versus accelerometer-measured physical activity. *Med Sci Sport Exerc*. 2014;46(1):99-106.

32. Strath SJ, Kaminsky LA, Ainsworth BE, et al. Clinical and Research Applications. 2013:1-22. doi:10.1161/01.cir.0000435708.67487.da.

33. Ozemek C, Cochran HL, Strath SJ, Byun W, Kaminsky LA. Estimating relative intensity using individualized accelerometer cutpoints : the importance of fitness level. *BMC Med Res Methodol*. 2013;13(53):1-7.

34. Blanchard CM, Giacomantonio N, Lyons R, et al. Examining the Steps-Per-Day Trajectories of Cardiac Rehabilitation Patients: A LATENT CLASS GROWTH ANALYSIS PERSPECTIVE. *J Cardiopulm Rehabil Prev*. December 2013:2-5. doi:10.1097/HCR.0000000000000031.

35. Savage PD, Brochu M, Scott P, Ades P a. Low caloric expenditure in cardiac rehabilitation. *Am Heart J*. 2000;140(3):527-533. doi:10.1067/mhj.2000.109219.

36. Petter M, Blanchard C, Kemp KAR, Mazoff AS, Ferrier SN. Correlates of exercise among coronary heart disease patients: review, implications and future directions. *Eur J Cardiovasc Prev Rehabil*. 2009;16(5):515-526. doi:10.1097/HJR.0b013e3283299585.

37. Izawa KP, Watanabe S, Omiya K, et al. Effect of the Self-Monitoring Approach on Exercise Maintenance During Cardiac Rehabilitation. *Am J Phys Med Rehabil*. 2005;84(5):313-321. doi:10.1097/01.PHM.0000156901.95289.09.

38. Carels R a, Darby L a, Rydin S, Douglass OM, Cacciapaglia HM, O'Brien WH. The relationship between self-monitoring, outcome expectancies, difficulties with eating and exercise, and physical activity and weight loss treatment outcomes. *Ann Behav Med*. 2005;30(3):182-190. doi:10.1207/s15324796abm3003_2.

39. Lee JM, Kim Y, Welk GJ. Validity of consumer-based physical activity monitors. *Med Sci Sports Exerc*. 2014;46(9):1840-1848. doi:10.1249/MSS.0000000000000287.

40. Ferguson T, Rowlands A V, Olds T, Maher C. The validity of consumer-level, activity monitors in healthy adults worn in free-living conditions: a cross-sectional study. *Int J Behav Nutr Phys Act*. 2015;12:42. doi:10.1186/s12966-015-0201-9.

41. Burke LE, Wang J SM. NIH Public Access. *J Amercian Diet Assoc*. 2012;111(1):92-102. doi:10.1016/j.jada.2010.10.008.Self-Monitoring.

42. Prince SA, Reed JL, Mark AE, Blanchard CM, Grace SL RR. A Comparison of Accelerometer Cut-Points among Individuals with Coronary Artery Disease. *PLoS One*. 2015;10(9):e0137759.

FIGURE CAPTIONS

Figure 1: Socio-Ecological Correlates of Physical Activity at the Physical-environmental Level: Home Environment

This figure displays the mean percentage of participants reporting they have access to specific pieces of exercise equipment, and whether they use it, as per a modified version of Sallis' Perceived Environment Related to Physical Activity Scale. The association of this access and use to exercise is also demarcated where significant.

Figure 2: Socio-Ecological Correlates of Physical Activity at the Physical-environmental Level: Neighbourhood Environment

This figure displays the mean percentage of participants reporting they have access to specific facilities where they can engage in physical activity, and whether they use them, as per a modified version of the Physical Activity Neighborhood Environment Scale (PANES). The association of this access and use to exercise is also demarcated where significant.

Online Supplement

Individual-Level, Psychometrically-Validated Measures

First, the Patient Health Questionnaire-2 (PHQ-2)[1] was administered to assess depressive symptoms over the previous two weeks. For each item the response option ranged from 0 "not at all" to 3 "nearly every day". PHQ-2 total scores ranged from zero to six, with higher scores indicating greater depressive symptoms.

Functional status was assessed using the Duke Activity Status Index (DASI),[2] which is a self-administered questionnaire that correlates highly with patients' peak oxygen uptake. There were 12 items, with a yes/no response option for each. These items related to personal care, ambulation, sexual function and recreational activities. Higher scores on this scale denoted greater functional capacity.

The barrier self-efficacy construct was measured using a modified version of the 13-item scale developed by Plotnikoff et al.[3] This scale evaluated one's confidence to engage in 30 or more minutes of moderate to vigorous physical activity (MVPA)/day on at least five days a week against 14 potential hindrances. Each item was scored between 0% "not at all confident" and 100% "extremely confident", in 10% increments. There was also a response option of 'not applicable' for each barrier. The mean of the items was calculated to provide a total score.

Blanchard's two-item PA intention scale[4] was administered. Each item was scored from one to five on a scale from "strongly disagree" to "strongly agree". The mean of the items was calculated, with higher scores denoting greater intentions. PA planning was measured using a four-item action planning scale also developed by. Each item was again scored from one to five on a scale from "strongly disagree to strongly agree". The mean of the items was computed, with higher scores denoting greater PA intentions and planning.

PA self-regulation was measured using the 12-item PA Self-Regulation scale (PASR-12).[5] The items assessed self-monitoring, goal setting, eliciting social support (e.g., "I asked someone for PA advice or a demonstration"), reinforcement (e.g., "I reminded myself of PA health benefits"), time management (e.g., "I re-arranged my schedule to ensure I had time for PA"), and relapse prevention (e.g., "I purposely planned ways to do PA when on trips away from home), with two questions pertaining to each. Each item was scored on a five-point Likert scale with response options ranging from "never" to "very often". The PA self-regulation score was calculated by computing the mean of all item responses.

Task self-efficacy was measured using Blanchard's seven-item scale.[4] This scale assessed one's confidence to continue to participate in at least 30 minutes of regular MVPA for an increasing number of days of the week (i.e., 1-7). Each item was scored from 10-100% corresponding to the range from "not at all confident" to "completely confident". The mean of all items was computed to provide a total score, with higher scores denoting greater self-efficacy.

Beliefs about the benefits and barriers to exercise were measured using the 43-item Exercise Benefits/Barriers scale (EBBS).[6] Participants were asked to rate the degree to which they agree with each of the items by choosing one of four response options ranging between "strongly agree" to "strongly disagree". The mean of the 14 barrier sub-scale items was calculated, with higher scores indicative of more barriers. The mean of the 29 benefit sub-scale items was calculated, with higher scores indicative of more benefits.

Social-Environmental Level, Psychometrically-Validated Measures

Social support from family, friends and other CAD patients or peers was measured using Sallis *et al.*'s[7] 13-item scale. Ten of the items in the scale related to encouragement, two of the items related to rewards while one item related to punishment. Each item was scored from one to

five, ranging from “none” to “very often”. A score of eight corresponded to the option of “does not apply,” and was considered missing. The sum of scores was calculated separately for encouragement, rewards and punishment by family, friends and others with higher scores denoting greater social support.

The subjective norm construct was assessed by Blanchard’s three-item scale.[8] This scale reflected one’s beliefs about the perception of family and friends regarding the importance of regular PA. Each item was scored from one to five, ranging from “strongly disagree” to “strongly agree”. The mean of all three items was computed, with higher scores indicating the respondent perceives PA as more normative.

Lastly, autonomy support from healthcare providers was measured using the six-item Health Care Climate Questionnaire.[9] Each item was scored from one to seven ranging from “not at all true” to “very true”. Higher mean scores represented a higher level of autonomy support.

Physical-Environmental Level, Psychometrically-Validated Measures

Perceived home environment was measured using a modified version of Sallis et al.’s[10] Perceived Environment Related to Physical Activity scale. This survey assessed the types of PA equipment participants owned, and whether they would use them during the next week, with a yes/no response option.

Places to engage in PA was measured using a modified version of the Physical Activity Neighborhood Environment Scale[11] and the Perceived Environment Related to Physical Activity.[10] This scale evaluated the availability and use of facilities. Each item was assessed with a “Yes” or “No” response. A descriptive frequency analysis was conducted to calculate the availability and use of each place to do PA.

Perceptions of neighborhood characteristics were measured using a subscale of the Neighborhood Environment Walkability Scale developed by Saelens et al.[12] There were nine items on this scale, with subscales for neighborhood aesthetics, perceived neighborhood crime rate, and street connectivity. Each item was scored from one to four, ranging from "strongly disagree" to "strongly agree". Applicable responses were averaged to ascertain subscale scores, with higher scores denoting more PA-friendly characteristics.

References

1. Kroenke, K, Spitzer, R, Williams J, Kroenke K, Spitzer RL, et al. The Patient Health Questionnaire-2: validity of a two-item depression screener. *Med Care*. 2003;41(11):1284-1292.
2. Hlatky MA, Boineau RE, Higginbotham MB, et al. A brief self-administered questionnaire to determine functional capacity (the Duke Activity Status Index). *Am J Cardiol*. 1989;64(10):651-654.
3. Plotnikoff RC, Lippke S, Trinh L, Courneya KS, Birkett N, Sigal RJ. Protection motivation theory and the prediction of physical activity among adults with type 1 or type 2 diabetes in a large population sample. *Br. J. Health Psychol*. 2010;15(Pt 3):643-61.
4. Blanchard CM, Reid RD, Morrin LI, et al. Understanding physical activity during home-based cardiac rehabilitation from multiple theoretical perspectives. *J. Cardiopulm. Rehabil. Prev.* 2011;31(3):173-80.
5. Umstattd MR, Motl R, Wilcox S, Saunders R, Watford M. Measuring physical activity self-regulation strategies in older adults. *J. Phys. Act. Health* 2009;6 Suppl 1(Suppl 1):S105-12.
6. Sechrist KR, Walker SN, Pender NJ. Development and psychometric evaluation of the exercise benefits/barriers scale. *Res Nurs Health*. 1987;10(6):357-365.
7. Sallis JF, Grossman RM, Pinski RB, Patterson TL, Nader PR. The development of scales to measure social support for diet and exercise behaviors. *Prev Med (Baltim)*. 1987;16(6):825-836.
8. Blanchard CM, Courneya KS, Rodgers WM, et al. Is the theory of planned behavior a useful framework for understanding exercise adherence during phase II cardiac rehabilitation? *J Cardiopulm Rehabil*. 2003;23(1):29-39.

9. http://selfdeterminationtheory.org/pas-health-care-climate/

10. Sallis JF, Johnson MF, Calfas KJ, Caparosa S, Nichols JF. Assessing perceived physical environmental variables that may influence physical activity. *Res Q Exerc Sport*. 1997;68(4):345-351.

11. Sallis JF, Kerr J, Carlson JA, et al. Evaluating a brief self-report measure of neighborhood environments for physical activity research and surveillance: Physical Activity Neighborhood Environment Scale (PANES). *J Phys Act Health*. 2010;7(4):533-540.

12. Saelens BE, Sallis JF, Black JB, Chen D. Neighborhood-based differences in physical activity: an environment scale evaluation. *Am J Public Health*. 2003;93(9):1552-1558.

Table 1: **Socio-demographic and Clinical Characteristics of Participants at CR Exit.**

Characteristics	**All consenting participants N=255**	**Consenting Participants who completed survey & accelerometer n=200 (78.4%)**	**Consenting Participants who did not complete survey & accelerometer n=55 (21.6%)**
Socio-demographic	**n (%)** / mean ± SD		
Age, years	63.40 ± 9.37	63.67 ± 9.25	62.44 ± 8.31
Sex (% Male)	205 (80.4%)	156 (70.0%)	49 (89.1%)
Racial/Ethnic Background (% White/Caucasian)	194 (87.0%)	171 (86.4%)	23 (92.0%)
Living Arrangements (% with Family)	171 (76.3%)	152 (76.4%)	19 (76.0%)
Living with Someone Who Requires Caregiving	17 (7.6%)	16 (8.1%)	1 (4.0%)
Employment Status (% Retired)	107 (47.8%)	97 (48.7%)	10 (40.0%)
Marital Status (% Married/Equivalent)	166 (74.8%)	147 (74.2%)	19 (79.2%)
Highest Education (% University)	115 (51.6%)	103 (52.0%)	12 (48.0%)
Income Level (≥ $50,000 CAD/year)	119 (56.9%)	104 (56.2%)	15 (62.5%)
Clinical			
Referral Indication (% PCI)	161 (63.1%)	127 (63.5%)	34 (61.8%)
Duke Activity Status Index score	47.37 ± 11.48	47.17 ± 11.60	49.02 ± 10.52
Risk Factors (% yes)			
History of Physical Inactivity	82 (36.9%)**	66 (33.5%)	16 (64.0%)
Smoking History	119 (60.7%)	107 (61.5%)	12 (54.5%)
Current Smoking	3 (1.3%)*	2 (1.0%)	1 (4.0%)
Body Mass Index, kg/m^2	28.16 ± 4.83	28.16 ± 4.68	28.15 ± 5.39
Hypertension	114 (45.1%)	93 (46.7%)	21 (38.9%)
Dyslipidemia	126 (49.8%)	100 (50.5%)	26 (47.3%)
Comorbidities (% yes)			
Musculoskeletal or joint issues	17 (7.6%)	15 (7.6%)	2 (8.0%)
Arthritis	53 (23.8%)*	52 (26.3%)	1 (4.0%)
Diabetes	43 (19.4%)	39 (19.8%)	4 (16.0%)
Asthma	21 (9.5%)	20 (10.1%)	1 (4.2%)

Cancer	16 (7.2%)	13 (6.6%)	3 (12.0%)
Osteoporosis	10 (4.5%)	9 (4.5%)	1 (4.0%)
Chronic Obstructive Pulmonary Disease	8 (3.6%)	6 (3.0%)	2 (8.0%)

CR=Cardiac Rehabilitation; PCI=Percutaneous Coronary Intervention; SD=Standard Deviation.

*p<.05, **p<.01, ***p<.001 comparing retained and non-retained samples.

Table 2: **Socio-ecological Constructs, by Level, and Association with Moderate and Vigorous-Intensity Physical Activity at Cardiac Rehabilitation Exit, N=200**

Socio-ecological Constructs	**Minutes MVPA / Week Mean ± SD†**	
	Self-Report	**Accelerometer**
Individual Level		
Sex		
Male	196.35 ± 140.41*	180.81 ± 141.52
Female	147.33 ± 94.89	159.39 ± 134.57
Racial/Ethnic Background		
White/Caucasian	178.45 ± 133.37	171.38 ± 144.44
Other	222.05 ± 126.31	206.21 ± 105.56
Work Status		
Retired	186.56 ± 134.01	169.92 ± 145.47
Other	181.32 ± 131.72	184.27 ± 134.12
Education Attainment		
University	198.10 ± 136.34	180.14 ± 141.73
Other	169.62 ± 127.84	174.75 ± 138.61
Annual Income		
$0-15,999 CAD	176.29 ± 154.40	198.01 ± 127.90
$16,000-49,999 CAD	165.05 ± 119.27	163.76 ± 156.44
≥ $50,000 CAD	197.56 ± 133.34	181.61 ± 132.85
Depressive Symptoms†	0.58 ± 1.14**	-
Functional Status†	47.17 ± 11.60**	-
Comorbidities		
Yes	184.41 ± 137.63	171.02 ± 143.76
No	185.46 ± 123.68	184.75 ± 133.78
Smoking Status		
Never	172.34 ± 122.09	173.99 ± 148.64
Former	187.62 ± 140.90	178.68 ± 135.07
PA Self-Regulation†	3.50 ± 0.73***	*
PA Intention†	4.76 ± 0.44**	**
PA Planning†	4.49 ± 0.69*	**
Task Self-Efficacy†	8.49 ± 11.47	-
Barrier Self-Efficacy†	7.20 ± 2.34*	*
Exercise Benefits†	95.70 ± 11.83***	*
Exercise Barriers†	24.24 ± 5.63**	
Body Mass Index	-	*
Social-Environmental Level		
Living Status		
With Family	194.15 ± 130.04	181.93 ± 144.32
Alone	151.93 ± 137.19	160.08 ± 124.97

Number of People in the Household†	2.21 ± 1.09	-
Living with Someone Who Requires Caregiving		
Yes	111.15 ± 89.73	98.28 ± 96.08
No	190.53 ± 134.10	183.38 ± 141.67
Marital Status		
Married/Equivalent	194.44 ± 127.56	182.24 ± 146.36
Other	155.36 ± 144.97	164.07 ± 119.70
Subjective Norm†	4.35 ± 0.65	-
Social Support†		
Family Participation	23.30 ± 11.13	-
Friend Participation	15.63 ± 9.08	-
Other Participation	13.19 ± 16.06	-
Family Rewards	1.51 ± 1.18	-
Friend Rewards	1.13 ± 0.69	-
Other Rewards	1.10 ± 0.76	-
Family Punishment	2.25 ± 1.35	-
Friend Punishment	2.16 ± 1.33	-
Other Punishment	2.19 ± 1.50	-
Autonomy Support†		
Health Care Climate	5.36 ± 1.54	-
Physical-environmental Level		
Neighborhood Characteristics†		
Aesthetics	3.47 ± 0.60*	*
Crime Rate	1.20 ± 0.39	-
Street Connectivity	3.06 ± 0.77	-
Mixed Land-Use		
Residential	180.61 ± 125.36	167.17 ± 134.64
Mixed Commercial and Residential	194.77 ± 153.52	207.80 ± 153.52
Season		
Winter	160.31 ± 140.24	153.28 ± 137.87
All Other Seasons	188.73 ± 121.57	185.67 ± 142.09

CAD Canadian dollars; MVPA=moderate to vigorous-intensity physical activity; PA=physical activity

*p<.05, assessing association between amount of MVPA and correlate.

†for continuous variables which are not described in Table 1, the mean scores and standard deviations are reported.

**p<.01, ***p<.001 assessing association between amount of MVPA and correlate.

Table 3: **Mixed Model of the Socio-ecological Correlates of Self-Reported Physical Activity (log-transformed)**

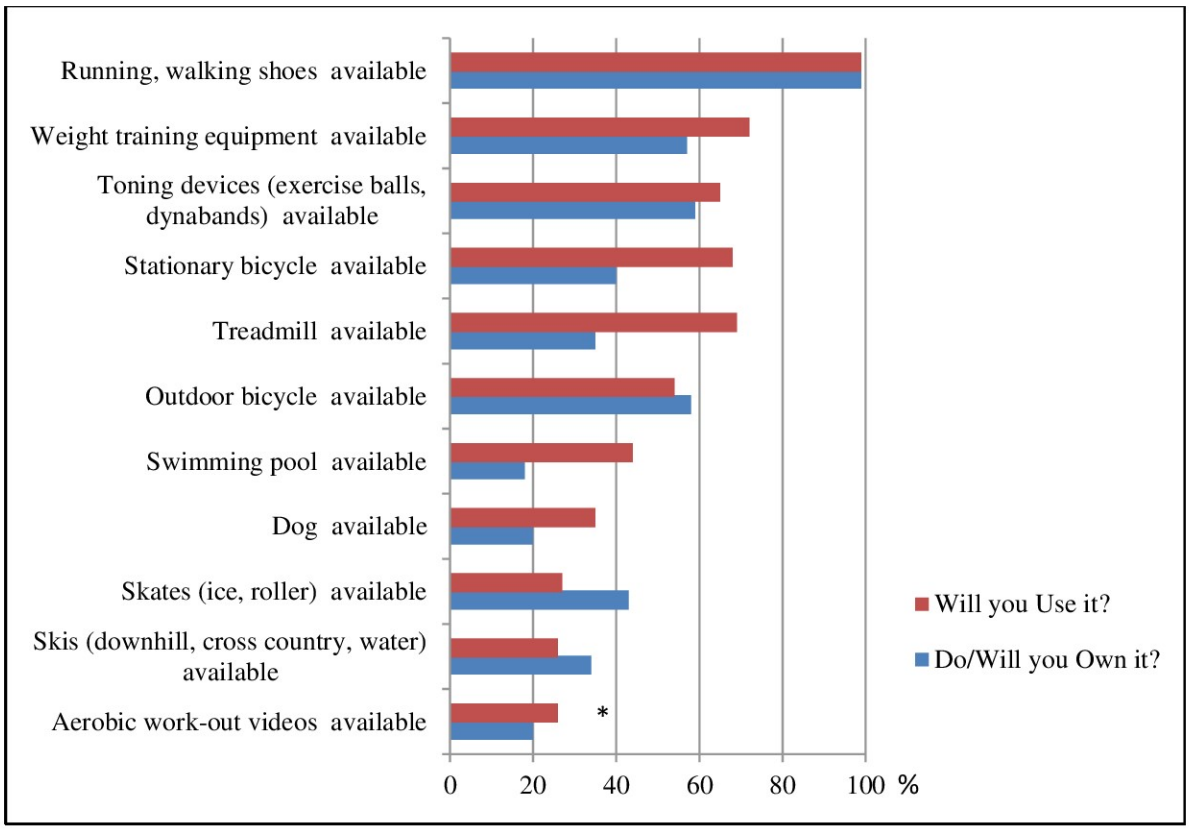
Socio-Ecological Level Independent Variables	**t**	**p**	**95% CI**	
Individual				
Sex	0.77	0.45	-0.19	0.43
Depressive Symptoms	-0.55	0.59	-0.15	0.84
Functional Status	2.36	0.02	<0.01	0.02
Barrier Self-Efficacy	0.65	0.52	-0.03	0.07
PA Intention	1.19	0.24	-0.11	0.44
PA Planning	-1.14	0.26	-0.32	0.09
Self-Regulation	2.79	0.01	0.07	0.43
Exercise Barriers	0.03	0.98	-0.02	0.03
Physical-Environmental				
Aerobic Workout Videos Available	1.31	0.19	-0.10	0.49
Playing Fields Available	0.04	0.97	-0.35	0.37
Neighborhood Aesthetics	0.43	0.67	-0.17	0.27

CI=Confidence Interval; PA=Physical Activity

Table 4: **Mixed Model of the Socio-ecological Correlates of Accelerometer-Assessed Physical Activity (log-transformed)**

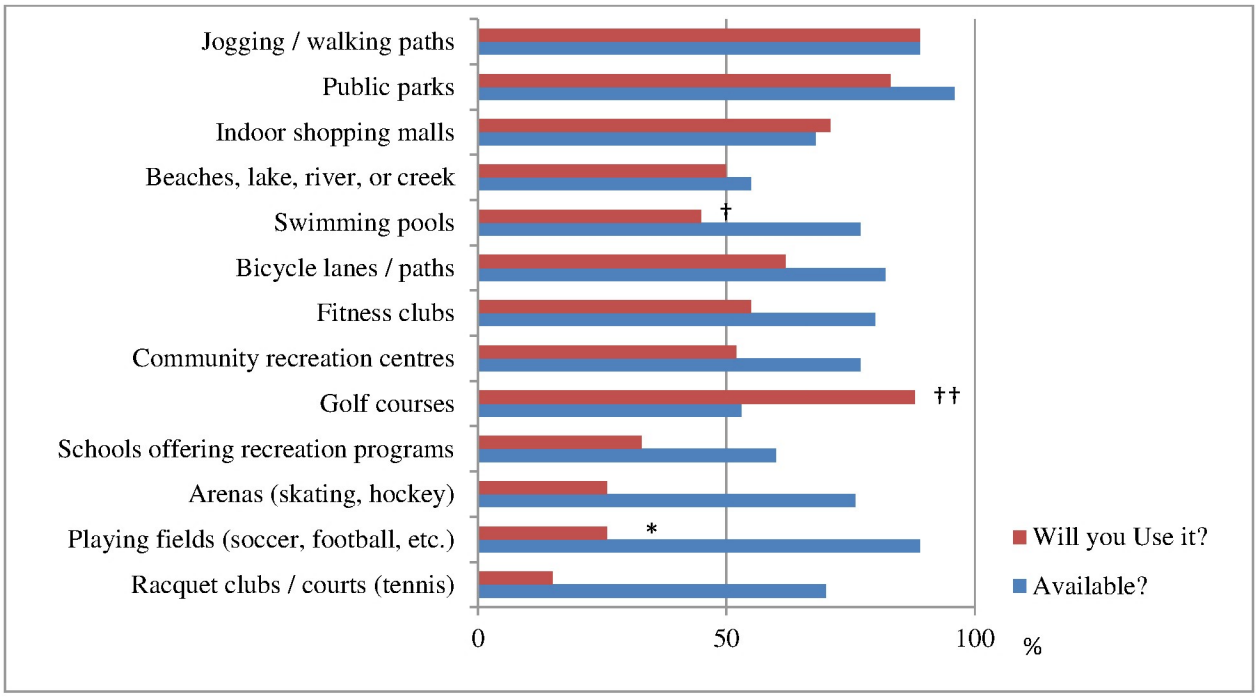
Independent Variables	**t**	**p**	**95% C.I.**	
Average Wear Time	1.70	0.09	-0.00	0.00
Self-Regulation	0.55	0.57	-0.12	0.21
PA Intention	0.08	0.94	-0.25	0.28
PA Planning	0.84	0.40	-0.10	0.25
Barrier Self-Efficacy	0.68	0.50	-0.03	0.06
Exercise Benefits	0.97	0.33	-0.01	0.02
Body Mass Index	-1.03	0.30	-0.03	0.01
Neighborhood Aesthetics	2.30	0.02	0.03	0.39
Swimming Pool Available	-0.22	0.83	-0.28	0.23
Golf Course Available	-0.21	0.84	-0.22	0.18

CI=Confidence Interval; PA=physical activity.



*p<0.05 for self-reported MVPA
Note: all p>.05 for objectively reported MVPA

Figure 2: **Socio-Ecological Correlates of Physical Activity at the Physical-environmental Level: Neighbourhood Environment**



*p<0.05 for self-reported MVPA.
††p<.01; †p<0.05 for objectively-measured MVPA