Clinical Investigations

PREVENTION

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Physical Activity Behavior Two to Six Years Following Cardiac Rehabilitation: A Socioecological Analysis

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ABSTRACT

Background: Cardiac rehabilitation (CR) promotes long-term positive health behaviours, such as physical activity (PA), in patients following a cardiovascular event. We have limited knowledge of long-term PA and its correlates. Therefore, this research examined both PA behaviour and socioecological correlates among elderly graduates 2-6 years following CR.

Hypothesis: CR graduates will have a moderate PA level in the long term. Greater PA will be associated with various multilevel correlates.

Methods: This was a retrospective, cross-sectional study which quantified PA using the Physical Activity Scale for the Elderly (PASE) and collected information about socioecological correlates at the intrapersonal, interpersonal and health service levels. Both univariate and multivariate analyses assessed PA and PA correlates.

Results: The majority of the 584 participants were older (69.8 $\pm$ 9.8), male (80.3%), and well educated (75.4% $\geq$ some post-secondary). Average time since CR graduation was 41.5 $\pm$ 11.5 months. Seventy five percent of CR graduates reported current weekly PA levels that met, or exceeded, Canadian PA guidelines (>150 minutes of moderate-vigorous PA). Univariate analyses identified 13 PASE score correlates. Multivariate analyses identified age, PA enjoyment, current work status, CR staff support, location of primary residence, and perceived health as significantly associated with higher PASE scores ($p < 0.001$).

Conclusions: Three and a half years post-CR graduates had high PA levels. Greater PA was associated with several modifiable multilevel correlates at all levels of influence. Understanding correlates of long-term PA behaviour among CR graduates will help identify groups at risk for nonadherence and assist with continued program development.

Introduction

Compared to patients who only receive conventional in-hospital care, patients who complete a cardiac rehabilitation (CR) program following a cardiac event experience a significant reduction in all-cause mortality[1–3] by 20% to 25% within 3 years.[3] CR programs are traditionally short-term multifaceted interventions that include physical activity (PA) as a core element.[2,4,5] One of the overarching objectives of CR is to encourage patients to maintain PA at guideline-recommended levels after program completion. Current Canadian PA guidelines for effective health advocate at least 150 minutes of moderate–vigorous PA per week.[6] There is some evidence that states that PA behavior among CR graduates in the short term (1 year post-CR) often fails to meet the recommendations.[7,8] There is very little evidence on PA behavior over the long term (2 or more years).

Encouraging positive health behaviors among CR graduates is a complex process that involves many levels of influence. To examine these levels of influence, a comprehensive approach to health promotion must be employed, such as the socioecological model.[9] The socioecological model integrates intra- and interpersonal factors, community and organizational factors (or institutional), and public policies.[9,10] Using this model as a guide, the current research focuses on factors within 3 levels of influence: the intrapersonal level, interpersonal level, and health service level.

To our knowledge, no original research has been undertaken to examine long-term PA behavior following CR, specifically in relation to the socioecological model. Consequently, this study first evaluates the degree to which graduates of cardiac rehabilitation participate in physical activity, and then identifies the most influential correlates

The authors have no funding, financial relationships, or conflicts of interest to disclose.

Published online in Wiley Online Library (wileyonlinelibrary.com)
DOI:10.1002/clc.22084

Received: September 30, 2012
Accepted with revision: November 13, 2012

of physical activity. The time frame examined is 2 to 6 years post-CR.

Methods

Procedure and Design

Approval was obtained from the University of Toronto and the Toronto Rehabilitation Institute Research ethics boards for a retrospective cross-sectional study. The Toronto Rehabilitation Institute is a large academic CR program that offers a 12-month, comprehensive, guideline-based[2] program to cardiac patients. While enrolled in the 12-month program, patients complete supervised exercise (aerobic and resistive) sessions and are offered both health information and counseling sessions. Successful graduate status is granted to patients with ≥80% program attendance. Further details on the program have been previously published.[11]

All those enrolled in a program at the Toronto Rehabilitation Institute are asked if they are willing to be contacted for research in the future. For this research, eligible participants were English-speaking CR graduates from between 2005 and 2009. They were mailed packages including an invitation to participate, an introductory letter, a consent form, and a questionnaire. Questionnaires assessed both PA behavior and socioecological factors predicted to affect this behavior. To reduce bias, both branching questions and the "check all that apply" option were avoided.[12] In total, information was gathered for 15 candidate PA correlates at the intrapersonal level, 9 at the interpersonal level, and 4 at the health service level.

Measures

Dependent Variable — Physical Activity Assessment: The outcome of interest (dependent variable) was PA. To quantify PA, a self-reported questionnaire called the Physical Activity Scale for the Elderly (PASE)[13] was used because of its accepted validity,[14] reliability,[15] and suitability for CR graduates.[16] To calculate an individual's PASE score, the total time spent doing individual activities such as leisure activity, household chores, and occupational activities, is multiplied by respective item weights (available for each activity reported). The various products are then summed.[13] A higher PASE score indicates greater PA.

The PASE questionnaire was also used to compute whether or not a participants PA level met Canadian recommendations of ≥150 minutes of moderate–vigorous activity per week.[6] There are 3 PASE items that capture specific recommended activities: walking (item 2), moderate activity (item 4), and strenuous activity (item 5). Using these 3 items only, a new variable was computed as either meeting current PA guidelines or not.

Independent Variables — Socioecological Correlate Assessment: As seen in Table 1, the socioecological model describes 5 levels of influence on behavior. The current research focuses on factors within 3 levels of influence: the intrapersonal level, interpersonal level, and health service level. Based on the socioecological model[9,10] and a review of the literature,[17] there were a total of 28 potential PA correlates assessed at 3 of these levels, 15 at the intrapersonal level, 9 at the interpersonal level, and 4 at the health service level. At the intrapersonal level sociodemographic items included age, sex, and self-reported level of education. Self-reported clinical items included height and weight (to calculate body mass index), smoking status, blood pressure control, cholesterol control, medication compliance, number of comorbidities, and number of recurrent events. Clinical items extracted from patient records included peak aerobic capacity (VO_2 peak) test at the program start (initial) and end (final). Perceived health, motivation to exercise, and PA enjoyment were each scored on a 5-point Likert scale. The final item at the intrapersonal level, fear of falling, was assessed nominally as yes/no.

Table 1. Socioecological Model Levels of Influence

Level of Influence	Description
Intrapersonal	Individual characteristics that influence behavior, such as knowledge, attitudes, beliefs, and personality traits.
Interpersonal	Interpersonal processes and groups (family, friends, and peers) that provide social identity, support, and role definition.
Organizational/service	Rules, regulations, policies, and informal structures that may constrain or promote recommended behaviors.
Community	Social networks and norms, or standards, which exist as formal or informal among individuals, groups, and organizations.
Public policy	Local, state, and/or federal policies and laws that regulate or support healthy actions and practices for disease prevention, early detection, control, and management.

At the interpersonal level, self-reported items included ethnicity, household income, current marital status, current work status (as either full time or non-full time), primary residence location (as either rural or nonrural), birthplace, preferred PA location, and mode of transportation to PA. Social support was assessed using the Tangible, Informational, and Emotional Social Support Survey (TIES), which is a 16-item survey with higher scores indicative of greater social support.[18]

Finally, at the health service level, all 4 items were self-reported. Contact with health services was quantified as the number of visits within the past 6 months to either a family doctor or a cardiologist.[19] Healthcare staff support of PA was assessed nominally. The final correlate of CR staff support assessed patients' perceptions of CR staff encouragement in regard to future activity behaviors, measured as the number of health directives a patient could recall receiving.

Statistical Analysis

IBM SPSS version 19 (IBM SPSS, Armonk, NY) was used for all analyses. Descriptive statistics, including means with standard deviation or frequencies with percentages, was

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DOI:10.1002/clc.22084

Table 2. PASE Score Correlates According to the Socioecological Model.

Correlate	Mean ± SD/No. (%)	Relation to PASE Score
Intrapersonal level		
Age (y)	69.8 ± 9.8	$r = -0.35$[a]
Sex, male	469 (80.3%)	$t(582) = 39.16$[a]
Highest level of education		$F(5, 566) = 0.819$
<High school	63 (11.0%)	
High school	78 (13.6%)	
Some postsecondary	112 (19.6%)	
Postsecondary	153 (26.7%)	
Graduate/professional	166 (29.1%)	
BMI (kg/m^2)	26.9 ± 5.02	$r = 0.01$
Smoking status		$F(2, 575) = 1.52$
Currently smoke	33 (5.7%)	
Quit	302 (52.4%)	
Never smoked	242 (41.9%)	
Blood pressure control		$F(2, 581) = 1.07$
Yes	544 (97.5%)	
No	11 (2.9%)	
Don't know	3 (0.5%)	
Cholesterol control		$F(2, 42.31) = 7.49$[b]
Yes	522 (89.5%)	
No	21 (3.7%)	
Don't know	40 (6.8%)	
Medication compliance, yes >80% of the time	564 (97.7%)	$r = 0.05$
Number of comorbidities	1.65 ± 1.42	$r = -0.20$[a]
Arthritis	179 (30.8%)	
Diabetes	123 (21.1%)	
Digestive	64 (11.0%)	
Respiratory	64 (11.0%)	
Other	151 (26.1%)	
Number of recurrent events	0.53 ± 0.85	$r = -0.06$
Arrhythmia	81 (13.9%)	
Angina	74 (12.7%)	
None	379 (65.1%)	
Other	48 (8.3%)	
VO_2 peak (mL/kg/min)[c]		
Intake	18.6 ± 5.1	$r = 0.23$[a]
Graduation	23.1 ± 7.7	$r = 0.27$[a]

Table 2. Continued

Correlate	Mean ± SD/No. (%)	Relation to PASE Score
Perceived health		$F(4, 570) = 9.03$[a]
Excellent	77 (13.4%)	
Very good	159 (27.7%)	
Good	233 (40.5%)	
Fair	95 (16.5%)	
Poor	11 (1.9%)	
Motivation to exercise		$F(4, 531) = 1.38$
Physician	47 (8.8%)	
Me	439 (81.2%)	
Friends	19 (3.5%)	
Other	31(5.8%)	
No choice	4 (0.7%)	
PA enjoyment		$F(5, 556) = 6.84$[a]
Very little	40 (7.1%)	
Little	38 (6.7%)	
Somewhat	169 (30.0%)	
Much	162 (28.8%)	
Very much	154 (27.4%)	
Fear of falling, yes	135 (23.6%)	$t(572) = 38.55$[a]
Interpersonal level		
Ethnicity		$F(8, 567) = 0.74$
North American	301 (52.3%)	
European	165 (28.6%)	
Other	110 (19.1%)	
Household income		$F(11, 482) = 1.55$
$0 to $39,999	129 (26.1%)	
$40,000 to $79,000	173 (35.0%)	
>$80, 000	192 (38.9%)	
Marital status		$F(3, 570) = 5.71$[a]
Married	453 (78.9%)	
Widow	46 (8.0%)	
Separated/divorced	40 (7.0%)	
Single	35 (6.1%)	
Work status		$t(186.9) = 7.46$[a]
Full time	138 (24.0%)	
Non-full time	438 (76.0%)	
Primary residence location		$t(574) = -3.0$[b]

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DOI:10.1002/clc.22084

Table 2. Continued

Correlate	Mean ± SD/No. (%)	Relation to PASE Score
Urban	469 (81.4%)	
Nonurban	107 (18.6%)	
Birthplace		$t(576) = 38.81$
Canada	328 (56.8%)	
Other	249 (43.2%)	
Preferred PA location		$F(8, 501) = 1.45$
Community locations	273 (53.6%)	
Private locations	237 (46.4%)	
Mode of transportation to PA		$F(7, 539) = 3.18$[b]
Personal modes	389 (71.1%)	
Public modes	44 (8.0%)	
None	114 (20.9%)	
Social support (TIES)	20.95 ± 9.43	$r = 0.10$[d]
Health service level		
Number of visits to a family doctor	2.73 ± 2.61	$r = -0.06$
Number of visits to a cardiologist	0.78 ± 0.71	$r = -0.07$
Healthcare staff support		$t(676) = 42.14$
Yes, PA suggestion(s) made	99 (17.4%)	
No, PA suggestion not made	469 (82.6%)	
CR staff support (% yes)	355 (61%)	$r = 0.15$[d]
Was asked how	391 (69.6%)	$t(560) = 2.99$[b]
Was asked where	215 (38.4%)	$t(558) = 2.36$[d]
Was provided information	138 (23.5%)	$t(559) = 2.74$)[d]
None	126 (22.4%)	$t(560) = -2.47$[d]

Abbreviations: BMI, body mass index; CR, cardiac rehabilitation; PA, physical activity; PASE, Physical Activity Scale for the Elderly; SD, standard deviation; TIES, Tangible, Informational, and Emotional Social Support Survey; VO_2 peak, peak aerobic capacity. [a] $P < 0.001$. [b] $P < 0.005$. [c] Denotes information collected from patient chart. [d] $P < 0.01$.

performed on the PASE with each correlate. Outputs can be found in Table 2.

Univariate analyses were used to investigate the initial association between each correlate and total PASE score (the dependent variable) using either Pearson correlation, one way analysis of variance, or Student t test as appropriate. The significance level was set at $P < 0.05$. Afterward, a stepwise multivariate linear regression analysis was computed to ascertain a correlate model of total PASE score. Only those variables related to PASE in the univariate analyses were entered into the model. Regression diagnostics were performed, and the presence of multicollinearity was assessed using eigenvalues and condition indices.

Results

Based on research inclusion criteria, between 2005 and 2009 there were 1642 CR graduates who consented to be contacted for research, and they were all mailed study materials. Of these, 1058 either declined or were nonresponsive, and 584 consented to participate (36% response rate, Figure 1).

Descriptive characteristics of participants can be found in Table 2. The average time since CR graduation was 41.5 ± 11.5 months, with no significant association between the number of months since CR graduation and PASE scores ($r = 0.02$, $P = 0.66$).

Dependent Variable — Physical Activity Assessment

PASE scores ranged from 0 to 432.1 (122.9 ± 74.6). PASE scores were normally distributed with acceptable measures of skewness (0.92 ± 0.10) and kurtosis (0.74 ± 0.20). Two cases were identified as potential outliers; however, further exploration determined their respective values to be indicative of overall activity. Four hundred thirty-seven (75%) participants were meeting the Canadian PA guidelines for older adults[6] at the time of questionnaire distribution.

Independent Variables — Socioecological Correlate Assessment

Of the 15 correlates assessed at the intrapersonal level, those that had a statistically significant association with greater PASE scores (Table 2) were younger age, male sex, cholesterol control, fewer comorbidities, higher VO_2 peak at both measurement points, higher perceived health, greater PA enjoyment, and no fear of falling. Of the 9 correlates assessed at the interpersonal level, those who had a statistically significant association with greater PASE scores (Table 2) were higher household income, being married, full-time work status, living outside the city, having a personal form of transportation, and higher social support (TIES). Of the 4 correlates assessed at the health service level (Table 2), the only item that had a statistically significant association with greater PASE scores (Table 2) was higher level of perceived support from CR staff.

Multivariate Correlate Model

After confirming normality, linearity, and homoscedasticity of residuals (plots omitted), a stepwise linear regression was performed which included correlates that were significant at the univariate level. All tolerance values within the final model were above 0.74, and all variance inflation factors (VIFs) were below 1.3, indicating the absence of multicollinearity.[20] The final regression model accounts for 23.9% of the variance in total PASE scores and includes at least 1 correlate from each of the socioecological levels assessed: PASE score = 226.75 + (−1.60·Age) + (13.90·PAenjoyment) + (−31.24·WorkStatus) + (7.93·CRstaffSupport) + (19.46·PrimaryResidenceLocation) + (7.93·PerceivedHealth). Full analysis can be seen in Table 3.

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DOI:10.1002/clc.22084

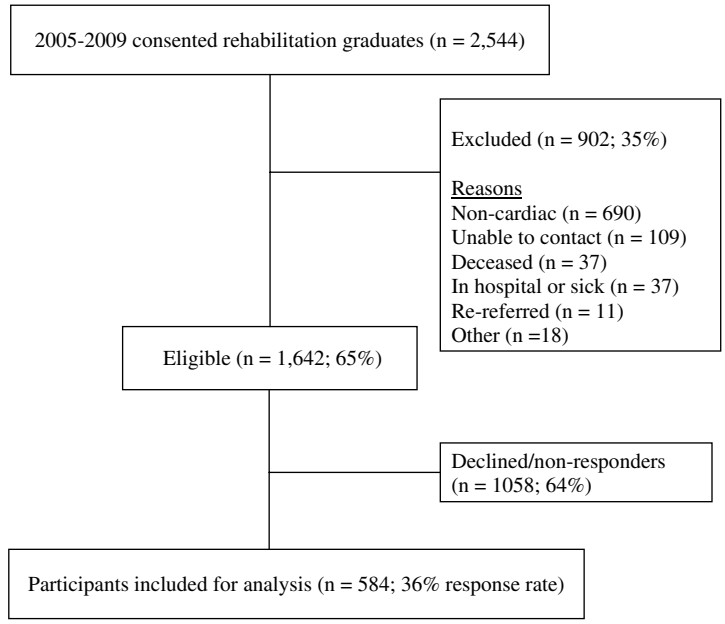

Figure 1. Recruitment flow diagram.

Table 3. Stepwise Linear Regression Output

	Unstandarized β	SE Unstandardized β	Standarized β	Significance (*P*)
Step 1				
Constant	302.99	21.69		
Age	−2.58	0.31	−0.34	<0.001
Step 6				
Constant	226.75	26.84		
Age	−1.60	0.33	−0.21	<0.001
PA enjoyment	13.90	2.53	0.22	<0.001
Work status	−31.24	7.48	−0.18	<0.001
CR staff support	7.93	2.82	0.11	0.005
Primary residence location	19.46	7.15	0 .10	<0.01
Perceived health	7.93	3.06	−0.10	<0.05

Abbreviations: CR, cardiac rehabilitation; PA, physical activity; SE, standard error. $R^2 = 0.24$ for step 6 ($P < 0.001$).

Discussion

Physical Activity Level

An average of 3.5 years after CR completion, three quarters of study participants reported PA participation at a level that meets the current Canadian PA guidelines of ≥150 minutes of moderate–vigorous intensity activity per week.[6] To our knowledge, few studies have reported such high percentages of PA post-CR, although considerable variation between studies is evident. Both Zullo et al[21] and Moore et al[22] reported low activity adherence of 41% and 48%, respectively, whereas Bock et al[8] reported high activity adherence of 84%. Results from the present study fall within these ranges but support higher PA adherence. More importantly, the current results dispute skeptics who perceive PA is not maintained post-CR.

The wide range of reported PA adherence values may be related to PA measurement techniques. Several methods are available including accelerometers, heart rate monitors, direct calorimetry, indirect activity logs, and self-reported questionnaires.[16] For large cross-sectional studies, self-reported questionnaires are the method of choice despite the potential for social desirability bias to cause an exaggeration of PA levels when compared to more objective measures.[23,24] Using objective measures in large cross-sectional studies of CR graduates is rare, with only 2 groups utilizing heart rate wristwatch monitors[22] and pedometers.[25] Additionally, discrepancies in reported PA participation may

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DOI:10.1002/clc.22084

be related to the amount of time since CR graduation, which ranges across studies from 1 month to a few years. However, there was no significant relationship between PA levels and time since graduation in the current study.

Socioecological Correlates of Physical Activity

In this study, a comprehensive list of evidence-based correlates potentially related to PA among CR graduates at the intrapersonal, interpersonal, and health service levels was investigated. Many of the findings were consistent with the literature; greater PA was significantly associated with male sex, younger age, better perceived health status, higher VO_2 peak, better cholesterol control, greater social support, higher income, location, being married, and full-time work status.[21,25] To our knowledge, we were first to identify among this population a significant relationship between PA and the correlates of PA enjoyment, number of comorbidities, fear of falling, mode of transportation to PA, and CR staff support. The PA enjoyment variable is particularly interesting.

Current literature describes PA enjoyment as an impactful correlate of PA among adolescents.[26,27] Our results indicate that this relationship may be extended to also include an older population of CR graduates. It has been shown that within CR PA enjoyment may be mediated by immediate program benefits such as weight loss.[28] However, in the current study CR and its immediate benefits occurred many years ago suggesting a deeper, habitual, intrinsic source of PA enjoyment. It is important that future studies continue to explore this correlate because a lack of PA enjoyment may lead to withdrawal from CR programs and inactivity.[29]

A stepwise linear regression identified the strongest model able to predict PA behavior among CR graduates. This model included established items (age and work status) and new items (PA enjoyment, CR staff support, and home location). Additionally, the model may identify potential groups who are vulnerable to PA dropout including those who were female, unmarried, of older age, with a lower fitness capacity, a higher number of comorbidities, and a fear of falling.

Historically, women have been dramatically underrepresented in CR programs[30,31] despite documented benefits.[2,3] The present participant pool was only 19.1% female. This low percentage is to be expected when considering the high CR dropout rates reported in women.[32] Creating environments focused on women and heart health is especially important because women reported lower PASE scores (103.8 ± 69.8) when compared to men (125.7 ± 74.6) ($t582 = 2.86$, $P < 0.005$). In-depth PASE analysis revealed that women were more likely to participate in light housework and the caring of others. Other activities, such as gardening, lawn work, and light to moderate exercise/sport, are PA opportunities available to women with the potential for further development. By incorporating other vulnerable traits, such as fear of falling, CR programs may continue to develop attractiveness to at-risk groups.

Limitations

This study and its conclusion about PA must be read within its limitations. There is potential self-selection and social desirability bias that may have been present in this pool of CR graduates who were eager to volunteer for research. Our response rate was 36%. Those who responded were likely more motivated and health conscious than nonresponders[33]; however, emerging evidence suggests that nonresponse bias may not be a large threat to the generalizability of findings.[34] In comparison to a previous sample of 5922 CR patients at the same center, there were no differences in smoking status, marital status, or the sex ratio of our respondents. However, the current sample was less obese, had greater intake VO_2peak, and had a higher proportion of diabetes.[11] Nevertheless, a repeat mailing should have been instituted to increase the response rate. The overall generalizability of the results are limited in that this study was undertaken at a single CR center with a program that is both long in duration and financially covered under the provincial government. Finally, the cross-sectional study design, although common in CR research, meant that we could not come to causal conclusions about the PA correlates and PA.

Conclusion

Three quarters of CR graduates were achieving at least the minimum level of PA associated with health benefits 2 to 6 years post-CR. This PA maintenance may contribute to the mortality and morbidity benefits reported in meta-analyses on CR outcomes.[30] As a final regression model, younger age, PA enjoyment, working status, CR staff support, home location, and high perceived health were significantly related to greater PA. The importance of both post-CR PA enjoyment and encouragement from CR staff should not be underestimated within the CR environment.

Acknowledgments

The authors thank all participants who volunteered their time to complete the questionnaire. In addition, the authors thank Jack Goodman, Amy Hwang, and Peter Polyzotis for their help in this research project.

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Published online in Wiley Online Library (wileyonlinelibrary.com)
DOI:10.1002/clc.22084