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Original article

A prospective study examining the influence of cardiac rehabilitation on the sedentary time of highly sedentary, physically inactive patients

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ABSTRACT

Objectives: Prolonged sedentary time is recognized as a distinct health risk, and mortality risks are expected to be greatest for individuals with low exercise levels. It is unknown whether participation in exercise-based cardiac rehabilitation (CR) programs influences sedentary behaviour particularly among those patients expected to be at greatest mortality risk. This study examined the influence of CR participation on sedentary behaviour and identified the proportion and characteristics (socio-demographic and clinical) of patients who do not meet exercise recommendations and have prolonged sedentary times.
Methods: A prospective study was conducted among patients of an exercise-based CR program and assessments performed at baseline and 3 months. Physical activity and sedentary behaviour information were collected by self-report, and convergent validity was examined on an accelerometer-wearing subsample.
Results: Of 468 CR patients approached, 130 participants were recruited with an average sedentary time of 8 hours/day. Sedentary behaviour remained consistent at follow-up (relative change= −2.4%, $P = 0.07$) notwithstanding a greater proportion meeting exercise recommendations (relative change= 57.4%). 19.2% of participants were classified to have prolonged sedentary time and not meet exercise recommendations at baseline. No significant differences were found between the characteristics of high-risk individuals and lower risk subgroups. Findings were consistent among the accelerometer-derived subgroup and the overall sample despite poor to moderate convergent validity.
Conclusions: These results suggest that the exercise-focus of CR may not reduce sedentary behaviours. Future studies are needed to determine whether sedentary behaviour-specific reduction strategies are more effective than traditional exercise-based strategies and lead to meaningful improvements in clinical outcomes.

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1. Introduction

The average adult in North America spends the majority of their waking day expending little energy (≤1.5 resting metabolic equivalents) in sedentary behaviours such as sitting, lying down, watching television and using the computer [1,2]. This lifestyle trend is especially worrying as prolonged sedentary time is associated with an increased risk for cardiovascular disease and all-cause mortality [3]. Yet, increasing evidence suggests that the mortality risks associated with prolonged sedentary time can be reduced or even eliminated when individuals sufficiently meet the exercise recommendation of 150 minutes of moderate to vigorous physical activity (MVPA) a week [3,4]. Therefore, highly sedentary individuals unable to sufficiently meet exercise recommendations are likely to receive the least protective benefits from exercise, and are expected to be at greatest risk for mortality from prolonged sedentary time.

Cardiac rehabilitation (CR) programs are an integral part of the standard of care for individuals recovering from a cardiovascular event [5,6]. These exercise-based secondary prevention programs are highly effective at reducing mortality rates and improving the quality of life of patients by emphasising exercise training, patient education, psychosocial counselling, and risk factor modification [5–7]. Yet, exercise-based interventions have largely been shown to be unsuccessful in reducing sedentary behaviours [8]. Understanding the influence of CR participation on patient sedentary behaviours can inform the need for additional strategies targeted towards sedentary behaviour reduction, and potentially enhance

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the effectiveness of CR programs. Furthermore, identifying the socio-demographic and clinical characteristics of patients (age, sex, sociodemographic factors, cardiopulmonary fitness, comorbid conditions and psychosocial health) with prolonged sedentary time and not meeting exercise guidelines can facilitate sedentary behaviour reduction strategies targeted towards these individuals expected to be at highest mortality risk [9]. While Prince and others found a cross-section of individuals to be highly sedentary upon graduating from CR and associating their sedentary time with various negative cardio-metabolic markers [10], to the best of our knowledge, no study has examined the influence of CR participation on the change in sedentary behaviours of patients. Furthermore, no study has focused specifically on individuals who might be at highest sedentary behaviour-associated mortality risk. The objectives of this study were to examine the extent to which CR participation influences the sedentary behaviour of patients, and to identify the proportion and characteristics (if any) of patients with prolonged sedentary time and do not meet exercise recommendations.

2. Methods

The research ethics boards of the University Health Network and the University of Toronto approved the study protocol, and written informed consent was obtained from all participants.

2.1. Program setting

Participants were enrolled in the University Health Network-Toronto Rehabilitation Institute's Cardiac Prevention and Rehabilitation program. The publicly-funded, outpatient CR program is among the largest in North America, accommodating as many as 1800 patients per year [11]. Patients are referred to the program by a physician or after discharge from a hospital if they had a recent cardiovascular hospitalization or were assessed to be at risk for cardiovascular disease. The service delivery model follows established clinical guidelines for traditional outpatient programs [12], and the core components include patient assessments, risk stratification, health behaviour interventions, risk factor modification, psychosocial counselling, exercise training, and patient education. At program intake, patients undergo a medical assessment and graded exercise stress testing to determine their suitability for exercise training, and to facilitate the development of an individualized exercise prescription. Once approved for exercise training, patients participate in supervised, group-based exercise classes, typically held once or twice per week over a 6-month period with the expectation that patients will continue to exercise unsupervised. Exercise training consists of MVPA with the goal of reaching at least 60% of their peak aerobic exercise testing threshold, and strength (resistance) training. While moderate physical exertion in leisure time activities is routinely promoted, information and recommendations specifically for reducing sedentary behaviour are not part of program guidelines. Patients repeat medical assessments and graded exercise stress testing after 3 months (midpoint) and at the conclusion of the program to examine their cardiovascular health status and renew their exercise prescription.

2.2. Sampling

This prospective study was conducted among patients of an exercise-based, 6-month outpatient CR program in Toronto, Canada. Assessments were conducted at baseline and after 3 months (program midpoint). This follow-up period is considered a critical period in which to examine the adherence to exercise recommendations and the uptake of healthy lifestyles [13]. Furthermore, considering the high nonattendance and dropout rates of CR programs [14], this time period was expected to be more inclusive of patients prematurely dropping out from CR. Participants were selected by non-random, convenience sampling of consecutive CR intake classes during August 2015 to January 2016. Patients were included in the study if they were newly enrolled in the CR program, had completed a medical assessment at intake, and did not begin on-site exercise training. No further selection criteria were applied. Patients were approached with information about the study and invited to consent if they had completed their initial medical assessment and had not begun supervised exercise training. A sample size analysis for cross-sectional surveys using the z-test indicated that at least 130 patients would need to be sampled. This was based on an expected population proportion of highly sedentary patients with similar age-sex characteristics ($P = 0.3$) [15], 80% power, a marginal error of $d = 1/4p$, and a two-tailed alpha of 0.05.

2.3. Data collection

Participants were asked to self-report the time they typically spend in sedentary behaviours and MVPA. Self-reported questionnaires were used to minimize participant burden [16]. Participants provided their baseline assessment at study enrolment, and were followed-up within two weeks after their second medical assessment (approximately 3 months from their baseline assessment). Clinical characteristics were extracted from medical assessment data and patient records including anthropometry (height, weight, waist and hip circumference), medical history (referral indication, existing and prior disease history and risk factors), depressive symptoms using the Centre for Epidemiological Studies–Depression Scale [17], and indicators of cardio-metabolic health from graded exercise stress testing.

Self-reported sedentary behaviour information was collected using the Sedentary Behaviour Questionnaire (SBQ) [18]. The SBQ has been validated as an approximate measure of overall and domain-specific sedentary time among adults [18], has a low participant burden, can be implemented on a large scale, and provides context on the nature of activities undertaken [19,20]. Time spent in each activity was converted into hours (e.g. a response of 15 minutes recorded as .25 hours). For total scores, hours per day for each activity were summed separately for weekday and weekend days. Weekday hours were multiplied by 5 and weekend hours multiplied by 2 and summed for an estimate of total hours/week. MVPA information such as the typical MVPA activities undertaken, duration and frequency was available from the self-reported exercise component of the in-program medical health assessment questionnaires. While the validity of this MVPA measure is unknown, it is readily available from the program and was chosen to lower the overall assessment burden for participants.

2.4. Assessment of validity

A convenience-sampled subgroup of participants wore an ActiGraph GT3X+ inclinometer-enabled, triaxial accelerometer device on their hip (attached by an elastic belt) (ActiGraph, Pensacola, FL, USA) to assess convergent validity with the self-reported measures of physical activity and sedentary behaviour. Half of all participants were targeted to wear the accelerometer devices to ensure that a minimum of 20 to 30 participants required for accelerometer validity studies were included [21,22]. Participants selected to wear an accelerometer wore the device upon

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