Physical Activity Monitoring in Patients with Intermittent Claudication

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WHAT THIS PAPER ADDS

This study used the newest generation of accelerometers to objectively assess the free-living daily physical activity level (PA, in metabolic equivalents) of patients with intermittent claudication (IC). Results demonstrate that less than half of these patients meet the current minimal PA recommendations. The quantified daily level of PA in IC is significantly lower than in healthy adults. Because a low PA level in IC is considered a strong predictor of mortality and functional decline, this paper emphasises the need for more awareness to improve physical exercise in patients with IC.

Objectives: Reduced physical activity (PA) is associated with a higher mortality rate and more rapid functional decline in patients with intermittent claudication (IC). The newest generation of accelerometers can assess both direction and intensity of activities three-dimensionally and may also adequately calculate energy expenditure in daily life. The aim of this study was to quantify daily PA level and energy expenditure of newly diagnosed patients with IC and healthy controls. PA outcomes are compared with contemporary public health physical activity guidelines.

Methods: Before initiating treatment, 94 patients with newly diagnosed IC and 36 healthy controls were instructed to wear a tri-axial seismic accelerometer for 1 week. Daily PA levels (in metabolic equivalents, METs) were compared with the ACSM/AHA public health PA minimum recommendations ($\geq$64 METs·min·day, in bouts of $\geq$10 minutes). A subgroup analysis assessed the effect of functional impairment on daily PA levels.

Results: Data from 56 IC patients and 27 healthy controls were available for analysis. Patients with IC demonstrated significantly lower mean daily PA levels ($\pm$SD) than controls (387 $\pm$ 198 METs·min vs. 500 $\pm$ 156 METs·min, $p = .02$). This difference was solely attributable to a subgroup of IC patients with the largest functional impairment (WIQ-score < 0.4). Only 45% of IC patients met the public health physical activity guidelines compared with 74% of the healthy controls ($p = .01$).

Conclusions: More than half of patients with IC do not meet recommended standards of PA. Considering the serious health risks associated with low PA levels, these findings underscore the need for more awareness to improve physical exercise in patients with IC.

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INTRODUCTION

Intermittent claudication (IC) is closely associated with cardiovascular and cerebrovascular disease.[1–3] Compared with healthy adults, IC patients are burdened with a low health-related quality of life and functional impairment during daily activities.[4,5] A reduced exercise capacity and lower daily free-living physical activity (PA) level are both strong predictors of long-term mortality. In contrast, higher PA levels are associated with less functional decline.[6–9]

The ACSM/AHA have issued recommendations on types and amounts of PA needed for (older) adults to improve and maintain health.[10] Specific recommendations are provided that apply to adults >65 years of age or to adults aged 50–64 years with chronic conditions or physical functional limitations.[11] All adults are advised to engage in moderate-intensity aerobic exercise for a minimum of 30 minutes on 5 days a week, or vigorous-intensity aerobic PA for a minimum of 20 minutes on 3 days a week. Activities should be performed in bouts of at least 10 minutes. Combinations of moderate- and vigorous-intensity aerobic PA can also be performed to meet these recommendations.

Metabolic equivalents (METs) are used by the ACSM/AHA as a means to express the energy expenditure or energy costs of physical activities. The total amount of PA is a function of its intensity, duration, and frequency.

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Accordingly, vigorous intensity activities (>6.0 METs) performed for a particular duration and frequency generate greater energy expenditure than moderate-intensity activities (3.0–6.0 METs) of the same duration and frequency. When combining the recommendations on moderate- and vigorous-intensity physical activity, the daily minimum goal of PA should be in the range of 64–107 METs·min.[10,11]

In the literature, PA is defined and determined in different ways. Frequently used definitions of PA are "time spent in different activities (sedentary/ambulatory), number of steps, duration of walking events or the score on a specific exercise test or questionnaire".[8,12–15] PA objectively measured by energy expenditure is seldom performed in patients with IC.[15–17] Regularly described methods for PA measurement are PA questionnaires, pedometers, or activity monitors. However, only the last method is found capable of adequately assessing energy expenditure.[18,19]

The newest generation of activity monitors is based on tri-axial accelerometer techniques measuring accelerations in three dimensions that can be converted to intensities and METs. In contrast to unilateral accelerometers (or vertical accelerometers), tri-axial accelerometers also measure activities that do not include vertical movement. As such, PA is determined more precisely as demonstrated with high correlations between indirect calorimetry and generated MET output at different walking speeds.[18,20,21] To our knowledge, no studies are available on the use of a tri-axial accelerometer in patients with IC compared with healthy adults.

The purpose of this prospective observational study was to objectively determine the PA using a tri-axial accelerometer in patients with IC and healthy adults. Furthermore, the number and percentage of participants meeting the lower limit of the ACSM/AHA recommendations for PA and public health are determined. It was hypothesised that healthy adults had a higher PA level and complied more frequently with these minimum recommendations than IC patients.

MATERIALS AND METHODS

Participant selection

Patients with clinical manifestations of IC were recruited at the vascular surgery outpatient clinic at the Catharina Hospital, Eindhoven, and Maxima Medical Center, Veldhoven/Eindhoven, The Netherlands. Healthy individuals recruited from family or friends of health-care workers served as controls. All subjects gave written informed consent and all procedures described in this study were approved by the Medical Ethical Committee, Catharina Hospital, Eindhoven.

Eligibility assessment

IC group. Patients without any previous history of peripheral arterial occlusive disease (PAOD) presenting with new-onset clinical manifestations of IC underwent an ankle–brachial index (ABI) measurement using standard equipment. Patients with values below 0.90 at rest or a drop in value of more than 0.15 after a standard treadmill test were considered eligible. Exclusion criteria included serious cardiopulmonary limitations (NYHA class 3–4), critical limb ischaemia or previous lower-limb amputation, use of walking aids, psychiatric instability, or other serious comorbidity which might possibly limit the patient's walking ability.

Control group. Healthy volunteers aged >45 years without a history of PAOD, or cardiac or pulmonary disease were included if they were able to walk without any limitations or walking aids. Participants were excluded if an ABI measurement was below 0.90 at rest or decreased more than 0.15 after a standard treadmill test.

Functional impairment and health-related quality of life scores

After consenting to the study specifics, a Dutch validated version of the Walking Impairment Questionnaire (WIQ), the 12-item Short Form Physical Functioning Summary (SF-12 PCS), and the 12-item Short Form Mental Functioning Summary (SF-12 MCS) were assessed prior to treatment in the IC patients and in controls.[22,23]

Evidence-based conservative treatment was subsequently started in the IC group. Each patient received cardiovascular risk management including antiplatelet therapy and a statin.

Physical activity monitoring

Dynaport tri-axial seismic accelerometer. Both groups of study participants were asked to wear a tri-axial seismic accelerometer (Dynaport MoveMonitor, McRoberts B.V., The Hague, The Netherlands) during a 1-week time period. The Dynaport MoveMonitor (size 84 mm × 50 m × 8 mm; weight 55 g) contains three orthogonal piezo-capacitive acceleration sensors, each measuring at a sample rate of 100 Hz. The accelerometer has a direct current response to the Earth's gravitational field, and uses a seismic or a proof mass suspended by a spring structure in a case. The case has a micro USB connection and a rechargeable battery and stores the raw data on a Micro-SD card. The Dynaport MoveMonitor is placed in a belt that is strapped around the waist. It is positioned at the base of the lumbar column just cranial to the buttocks. The Dynaport technology is validated for counting steps, detecting time spent in different activities, activity-related energy expenditure, and assessment of reproducibility.[18,21,26–30]

Monitoring protocol. All participants were instructed to correctly wear the Dynaport MoveMonitor for 7 consecutive days. As the device is not waterproof, participants were asked to take off the device when taking a shower or a bath. Furthermore, to achieve better compliance, participants were instructed not to wear the device during sleeping.

They were instructed to perform their regular daily activities during this week. Supervised exercise therapy (SET)