Self-report Versus Measured Physical Activity Levels During Outpatient Cardiac Rehabilitation

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Self-report Versus Measured Physical Activity Levels During Outpatient Cardiac Rehabilitation

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Purpose: Many patients with coronary artery disease (CAD) do not achieve the recommended physical activity (PA) levels during and after cardiac rehabilitation (CR). The aim of this study was to analyze moderate to vigorous physical activity (MVPA) levels and the differences between perceived (self-reported) and measured (activity monitor) MVPA in CAD patients during CR. The second aim was to analyze which patient characteristics were associated with this difference.

Methods: A two-center observational-sectional study was conducted within the Department of Rehabilitation Medicine of the University Medical Center Groningen between January and April 2018. Adults with CAD, following an outpatient CR program, were included. Perceived MVPA was assessed with the Short Questionnaire to Assess Health-enhancing Physical Activity and compared with ActivPAL3 activity monitor outcomes over a period of 7 d.

Results: Fifty-one patients with CAD (age 59.4 ± 7.1 yr, eight females) were recruited. Four patients (8%) did not achieve the recommended guideline level of ≥150 min/wk of MVPA. Patients spent ≥80% of the week in sedentary activities. Patients overestimated MVPA with a median of 805 (218, 1363) min/wk ($P < .001$). The selected patient characteristics (age, body mass index, type of CAD, type of CR, social support, and self-efficacy) were not associated with this overestimation.

Conclusions: Most patients with CAD, participating in an outpatient CR program, do achieve MVPA exercise recommendations but spend simultaneously too much time in sedentary activities.

Key Words: cardiac rehabilitation • coronary artery disease • moderate to vigorous physical activity • physical activity • sedentary behavior

Coronary artery disease (CAD) is the leading cause of mortality of all chronic diseases in Europe.[1] Improvement of physical activity (PA) is one of the key strategies to decrease cardiovascular disease mortality in adults with CAD.[1,2] Performing moderate to vigorous aerobic physical activity (MVPA) for ≥30 min on ≥5 d/wk is recommended to maintain cardiorespiratory fitness and health.[3]

Cardiac rehabilitation (CR) is a commonly used strategy aimed at improving adherence to these PA levels for patients with CAD.[4,5] Despite positive physical effects of CR, many patients with CAD do not achieve the recommended levels of MVPA during and after CR.[5-7] After discharge from CR, maintaining health and recommended PA levels becomes even more difficult.[7,8]

Patients with CAD overestimate their PA levels and may have a misperception of actual achievements.[9,10] Valid measurements are necessary to evaluate MVPA levels but remain challenging in daily practice.[11] Several patient-related factors, such as self-efficacy, social support, and type of CAD, may be associated with the difference between performed and perceived MVPA levels. Previous studies showed that low self-efficacy and low social support are common barriers for daily performed PA and attendance to CR.[12,13] Low self-efficacy is also associated with increased cardiovascular risk.[14] The role of these variables on perceived MVPA remains unknown. They may be of influence on perceived MVPA levels, including the recognition of recommended intensity and duration. The primary aim of this study was to analyze MVPA levels and the differences between perceived (self-reported) and measured (activity monitor) MVPA in CAD patients during CR. The second aim was to analyze whether the factors age, body mass index (BMI), type of CAD, type of CR, social support and self-efficacy were associated with this difference.

METHODS

A two-center observational study was conducted on locations University Medical Center Groningen (UMCG), Groningen (medical center) and UMCG Beatrixoord, Haren (rehabilitation center) within the Department of Rehabilitation Medicine of the UMCG. Measurements were conducted between January 8 and April 20, 2018. All patients were screened by a cardiologist or nurse practitioner 8-10 wk after hospital discharge. During this screening, a maximum exercise test (ramp incremental, without breathing gas analysis) was performed to examine blood pressure, heart rate, and cardiorespiratory fitness during exercise.[15] If the maximum exercise test results were normal, the patient was referred for a CR intake. During the CR intake the physiotherapist examined the current daily physical functions, psychosocial situation and defined (tailored) treatment goals with the patient.[16] Based on the cardiorespiratory fitness and treatment goals, the physiotherapist decided (in agreement with the patient) which CR program would be most suitable. Patients were participating in one of the following outpatient CR programs:

CR program one. Program of 6 wk, frequency 1 session/wk (UMCG, medical center). Each session consisted of 30-min cycling on an ergometer and 45 min of general gymnastics or fitness.

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CR program two. Program of 6 wk, frequency 2 sessions/wk, 60 min/session (UMCG, medical center). Each session consisted of 30-min cycling on an ergometer and 30 min of general gymnastics or fitness.
CR program three. Program of 12 wk, frequency 2 sessions/wk, 135 min/session (UMCG, rehabilitation center). Each session consisted of 45-min cycling on an ergometer, 45-min fitness, and 45-min swimming or general gymnastics.

The primary goal of the cycling session was to increase the cardiorespiratory fitness.[16] The intensity level of each cycling session was gradually increased, based on the Borg scale and the estimated peak oxygen uptake (gradually increased from 50 to 80%) during the CR period.[16] General gymnastics contained multiple sports activities (ie, team sessions such as indoor football, hockey, and individual sessions such as relaxation and muscle strength training) focused on improving cardiorespiratory fitness, strength, and self-efficacy.[16]

Patients were recruited for the study at the beginning of their CR program. Inclusion criteria were ≥18 yr, diagnosed with CAD, and able to understand, speak, and read the Dutch language. Excluded were patients with valve reconstructions, congenital heart disease, (previous) heart transplantation, or chronic heart failure because these patients differ in nature and disease-related symptoms from patients with CAD.

Intensity levels of performed PA were categorized as sedentary (<1.5 metabolic equivalents [METs], light [1.5−<3 METs], and MVPA [≥3 METs]) according to current PA guidelines and including PA performed during CR sessions.[17] The Short Questionnaire to Assess Health-enhancing Physical Activity questionnaire (SQUASH) was used to assess the amount of time patients perceived to spend on domain-related activities for the last 7 d. The questionnaire covers the following domains: commuting activities, activities at work and school, household activities, and leisure-time activities. These activities are classified in light, moderate, and vigorous intensity using MET values.[17,18] The SQUASH has a reproducibility of $r = 0.58$ (Spearman's ρ) and a criterion validity of $r = 0.45$ (Spearman's ρ), using the Computer Science and Applications activity monitor as a reference.[18] The ActivPAL3 activity monitor (PAL Technologies Ltd) was used to measure MVPA. The duration, intensity levels, and postural positions of measured MVPA were obtained by accelerometer-derived data, which correlates ($r = 0.96$) with direct observation.[19] Custom-made MATLAB scripts, MATLAB R2018 (The Mathworks, Inc.) and ActivPAL-3software (version 7) were used to analyze raw accelerometer data (15-sec epoch files, Excel 2010 [IBM]). The total duration in minutes spent in MVPA and mean wear/non-wear time were calculated.

Self-efficacy and social support were measured using the Self-Management Screening (SeMaS).[20] A score of ≥4 points on the domain self-efficacy indicates that the patient has sufficient self-efficacy and internal locus of control. A score of ≥3 points on the domain social support indicates that the patient has sufficient support of peers during CR. Criterion validity of the SeMaS is considered to be moderate ($r = 0.42$) on the domain self-efficacy and strong ($r = 0.63$) on the domain of social support, validated with the Patient Activation Measure and the Short Scale of Social Support.[20] Age, sex, BMI, and type of CAD were obtained from the medical file of each participant.

This study was conducted according to the principles of the Declaration of Helsinki (October 2013). The study protocol was assessed by the Medical Ethics Committee of the UMCG (METc-2017-575) and the research does not fall under the Medical Research Involving Human Subjects Act. Patients were recruited after filling in an informed consent and were able to voluntary terminate study participation at any time.

Patients participating in outpatient CR within the Department of Rehabilitation Medicine of the UMCG were asked for study participation by their treating physiotherapist at the beginning of their CR program. All data were collected by 1 investigator, not involved in the CR program. After written informed consent, the investigator attached the activity monitor on the right thigh of the participant with Tegaderm (3M) medical adhesive dressing. The participant was informed about necessary wear, attachment, and replacement procedures according to the protocol.[19] After 7 d, the participant returned the activity monitor. The assessment of perceived MVPA (SQUASH), self-efficacy (SeMaS), and social support (SeMaS) was obtained directly thereafter in a quiet and private room. Patients completed the questionnaires in presence of the researcher. The researcher

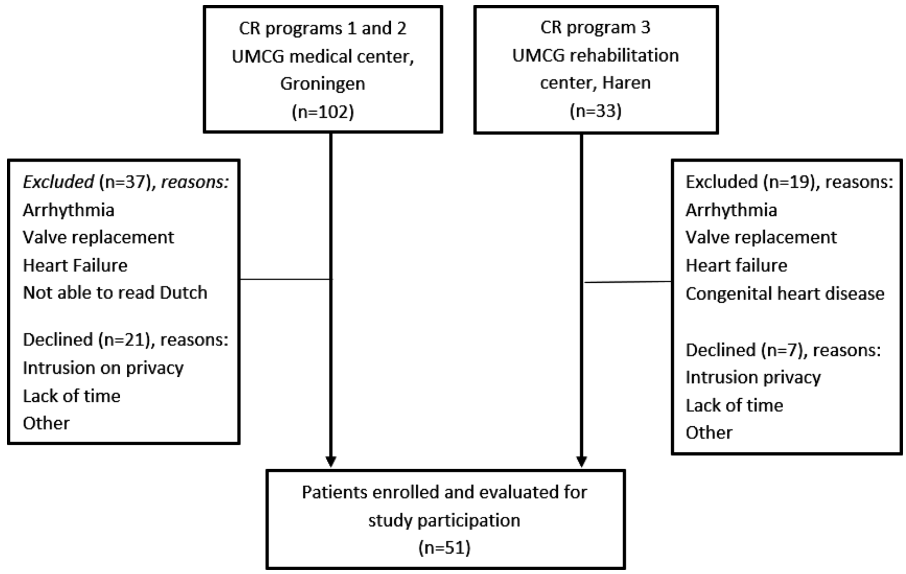

Figure 1. Flowchart of the study. Abbreviations: CR, cardiac rehabilitation; UMCG, University Medical Center Groningen.

explained questions if necessary but did not direct in reported answers.

STATISTICAL ANALYSES

Data were analyzed using IBM SPSS Statistics for Windows, Version 23.0. (IBM Corp) and custom-made MATLAB scripts, MATLAB R2018. Missing values for ActivPAL3 outcomes and self-efficacy were individually imputed by the mean sum scores on ActivPAL3 outcomes, and self-efficacy of other patients.[21] Outliers and missing data of the SQUASH outcomes were separately imputed by an SPSS syntax (2003).[22] Missing values regarding perceived MVPA were imputed by the median duration of other patients spent on similar activities. Outliers that fall ≥3 SD from the mean were corrected if possible or otherwise excluded from the dataset.

Measured MVPA (min/wk) was analyzed by a custom-made MATLAB script. Type of CAD and type of CR were transformed into dummy variables. Type of CAD was coded as follows: 1 = myocardial infarction and 0 = other (angina pectoris, atherosclerosis, or other types of CAD). Type of CR was coded as follows: 0 = UMCG, medical center, and 1 = UMCG, rehabilitation center. Univariate analysis was executed without extreme outliers, as mentioned earlier. Univariate associations between age, social support, self-efficacy, and MVPA categories were calculated using a Mann-Whitney *U* test.

MVPA-diff was calculated as the duration in minutes of perceived MVPA (SQUASH) minus the duration in minutes measured MVPA (ActivPAL3). The significance of MVPA-diff was analyzed using a Wilcoxon signed rank test. Univariate associations between age, social support, self-efficacy, and MVPA-diff were calculated using Spearman's ρ due to skewness of data. Differences between type of CAD, type of CR, and MVPA-diff were analyzed using a Mann-Whitney *U* test due to skewness of data. The level of significance was determined as $P < .05$ (two-tailed).

RESULTS

In total, 51 patients (age 59.4 ± 7.1 yr, 43 males) with CAD were enrolled (Figure 1). Myocardial infarction was the most frequent (n = 39) diagnosis. Forty-four (86%) patients were referred to CR programs one and two, located in the UMCG Medical Center, Groningen (Table 1). One patient (2%) scored low (<4 points) on self-efficacy, and all other patients scored ≥4 points. All patients experienced sufficient social support (≥3 points).

In three (6%) patients, missing values were present in the sum scores of measured MVPA, perceived MVPA, and self-efficacy. These missing values were the result of technical problems of the ActivPAL3 or incomplete questionnaires. The total percentage of missing values was 0.08% and all missing values were completely at random and equally spread. One outlier (case 31) reported 3690 min (61.5 hr/wk) of MVPA (SQUASH), ≥3 SD from the mean, and was therefore excluded for further analysis regarding to MVPA-diff. Results of factors associated with MVPA-diff including case 31 are shown in in Supplemental Digital Content (SDC) 1 (available at: http://links.lww.com/JCRP/A330).

The mean wear time of the ActivPAL3 was 167 ± 0.1 hr (~7 d). A distribution of performed PA sedentary time, light PA, and MVPA is presented in Figure 2 and SDC 2 (available at: http://links.lww.com/JCRP/A331). At least 80% of the week was spent in sedentary activities, which is above the threshold of 7.5 sedentary hr/d (<1.5 METs), associated with increased all-cause mortality[23] (Figure 2).

Table 1

Characteristics of the Study Population (N = 51)[a]

Characteristics	
Age, yr	59.4 ± 7.1
BMI, kg/m^2	28.0 ± 4.4
Measured MVPA	326 (222, 492)[b]
Perceived MVPA	1230 (585, 1842)[b]
Social support	5.0 (4.0, 7.0)[b]
Self-efficacy	6.0 (4.0, 6.0)[b]
Sex, female	8 (16)
Comorbidities	21 (41)
Currently employed	19 (37)
Partnered	45 (88)
Type of CAD	
Atherosclerosis	4 (8)
Myocardial infarction	39 (77)
Stable angina pectoris	5 (10)
Unstable angina pectoris	2 (4)
Other	1 (2)
Type of medical intervention	
Medication only	2 (4)
PCI	36 (71)
CABG	8 (16)
PCI + CABG	5 (10)
Type of CR	
CR program 1	12 (24)
CR program 2	32 (63)
CR program 3	7 (14)
Location of CR	
Medical center (Groningen)	44 (86)
Rehabilitation center (Haren)	7 (14)

Abbreviations: BMI, body mass index; CABG, coronary artery bypass grafting; CAD, coronary artery disease; CR, cardiac rehabilitation; MVPA, moderate to vigorous physical activity; PCI, percutaneous coronary intervention.

[a]Data are presented as mean ± SD or median (IQR) or n (%).

[b]Not normally distributed: expressed in median and interquartile range.

Forty-seven (92%) patients achieved the recommended level of ≥150 min/wk MVPA. Four patients (8%) did not achieve this level.[3] Weekly performed PA patterns, measured by the activity monitor, of a sedentary, moderate active and an active patient are presented in SDC 3 (available at: http://links.lww.com/JCRP/A332).

No significant differences were found in age, BMI, social support, and self-efficacy between achievers and non-achievers (see SDC 4, available at: http://links.lww.com/JCRP/A333). The activity monitor measured a median 326.0 (222.0, 492.3) min/wk MVPA and patients reported a median 1230.0 (585.0, 1842.5) min/wk MVPA using the SQUASH (see SDC 5, available at: http://links.lww.com/JCRP/A334). Patients significantly overestimated MVPA with a median 805 (218, 1363) min/wk ($P < .001$), corresponding to a median overestimation of almost 2 hr/d of

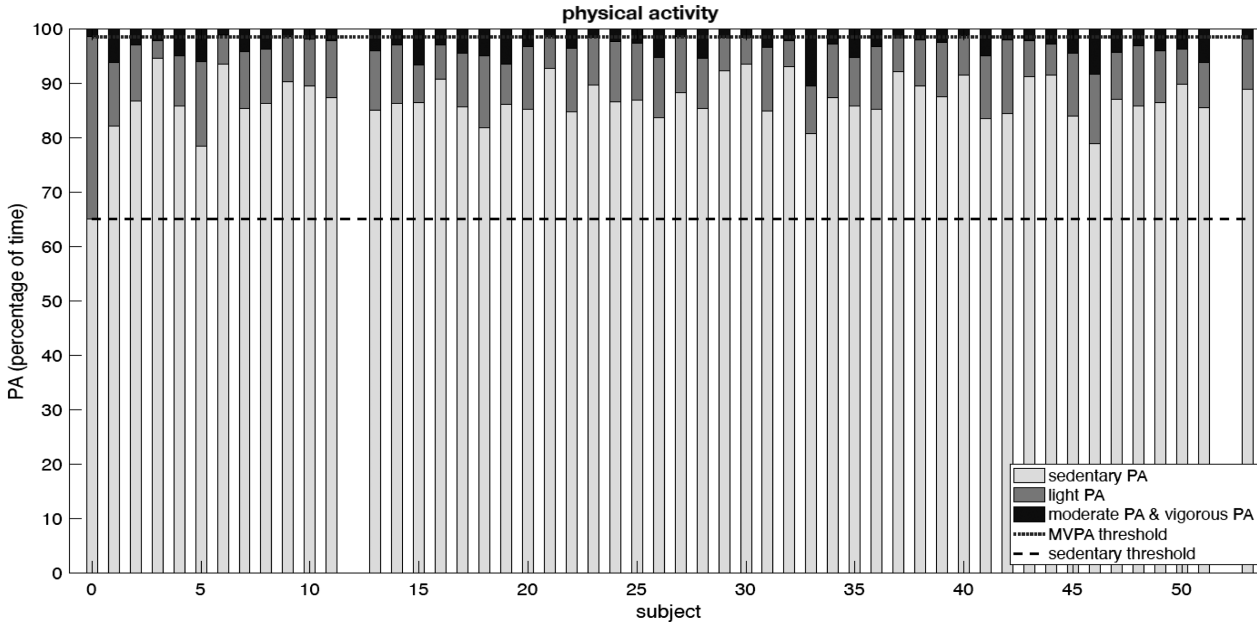

Figure 2. Distribution of time spend in sedentary, physical activity (PA), light PA, or moderate to vigorous physical activity (MVPA)/subject (N = 51). Note. Data of participants 12 and 52 are missing. Presented PA is measured by the ActivPAL3 over a period of 7 d. Sedentary PA is defined as <1.5 metabolic equivalents (METs), light PA as 1.5−<3 METs, and MVPA as ≥3 METs. Percentage is calculated as minutes spent to one of the categories divided by the total minutes of recorded PA. The sedentary threshold is defined on 65% sedentary time/wk (7.5 hr/d). Sedentary time above this threshold is associated with increased mortality (Ekelund et al[23]). MVPA threshold is based on the WHO guideline for adults (18-64 yr), recommending ≥150 min/wk of MVPA (World Health Organization[3]). Subject 0 (left side) is a theoretical reference subject presenting both thresholds.

MVPA. No associations were found between MVPA-diff and age, BMI, type of CAD, type of CR, social support, and self-efficacy (Tables 2 and 3).

DISCUSSION

Most patients with CAD, participating in an outpatient CR program, do achieve MVPA exercise recommendations but spend simultaneously too much time in sedentary activities (<1.5 METs). None of the selected variables were associated with MVPA-diff.

The SQUASH overestimated moderate PA by >1 hr and vigorous PA by almost 1 hr/wk compared with the ActivPAL3. The SQUASH underestimates sedentary time by 20 min/wk in comparison with the ActivPAL3. Other studies have also shown a similar overestimation of self-reported MVPA compared with activity monitoring.[24,25]

Patients diagnosed with myocardial infarction tend to report lower PA by the SQUASH in comparison with other types of CAD; however, this difference was not significant (Table 3). Other studies found that MVPA difference could also be influenced by other environmental or personal factors, such as educational level, BMI, and body self-image.[10,26] However, we did not find an association between BMI and MVPA difference in our study population.

Regarding the measured MVPA, no significant differences were found between included variables. There was a noticeable trend for an inverse association between age and MVPA difference; however, this trend was not significant (Table 2). Previous studies indicated that perceived disease severity, including the awareness of symptoms, was related to physical and mental functioning in patients with CAD.[27] Based on those findings, it may be reasonable to assume that type and severity of CAD are of influence on performed MVPA levels. Within the CAD subcategories no differences were found in performed MVPA levels in our study population.

Finally, no significant associations were found between self-efficacy, social support, and MVPA-diff or perceived MVPA. In comparison with previous studies, the SeMaS measured another construct regarding self-efficacy and social support, which could partly explain a difference in outcomes.[13,28,29] The relatively small sample size and the use of other inclusion criteria in comparison with other studies could explain this difference with results of previous studies. Excluding missing values did not result in other outcomes than mean imputation.

Both instruments in this study have their limitations, leading to a disagreement in measured and self-reported MVPA. Self-reported overestimation of PA may not only be the result of misperception but could also be the result of the construct of the SQUASH and/or social desirability.[30,31] By filling in higher amounts of performed PA levels, patients may consciously or unconsciously intend to please the researcher or physical therapist during assessment.[32] In addition, overestimation of MVPA could also be the result of

Table 2

Associations, Spearman's ρ, Between MVPA-Diff and Age, BMI, Social Support, and self-Efficacy (N = 51)

	Age	BMI	Social Support[a]	Self-efficacy[a]
MVPA-diff	−0.27 (0.06)	0.02 (0.89)	−0.10 (0.48)	−0.12 (0.41)

Abbreviations: BMI, body mass index; MVPA-diff, difference between perceived and measured moderate to vigorous physical activity (total min/wk).
[a]Social support and self-efficacy expressed as sum scores of the Self-Management Screening.

Table 3

Differences Between MVPA-Diff, Type of CAD and Type of CR (N = 51)[a]

MVPA-Diff			Mann-Whitney *U*	*P* Value (Two-Tailed)[b]
	MI (n = 39)	No MI (n = 12)		
Type of CAD	638 (203, 1332)	1492 (334, 1934)	138.00	.09
	Medical center (n = 44)	Rehabilitation center (n = 7)		
Type of CR	804 (248, 1364)	494.75 (85, 1437)	157.00	.41

Abbreviations: CAD, coronary artery disease; CR, cardiac rehabilitation; MI, myocardial infarction; MVPA-diff, difference between perceived and measured moderate to vigorous physical activity (total min/wk).

[a]Data presented as median (IQR).

[b]Differences between both groups were assessed by Mann-Whitney *U* tests with two-tailed *P* values ($P < .05$).

misinterpretation of the duration of exercise. If the patient includes activities such as getting dressed, warming up, or cooling down, this amount of time will be reported as MVPA.

Second, the SQUASH calculates MVPA by using noncorrected MET values of standard compendia.[18] Metabolic energy expenditure is influenced by age, sex, body weight, and physical fitness, and MET values should be corrected for these variables.[33] By using noncorrected MET values, MVPA could have partly been overestimated.[33] In addition, the determined MET values of the SQUASH were high compared with ActivPAL3 outcomes. For example, the given MET value for indoor bicycling (ergometer) by the SQUASH is seven.[18] According to the ActivPAL3 outcomes, none of the patients reached this MET value while all CR sessions contained an indoor cycling session on an ergometer. Also, activities on work reported with a moderate intensity level were classified as ≥3 METs and not detected on the ActivPAL3.[18] This overall misclassification of the SQUASH has contributed to an overestimation in perceived MVPA.

The ActivPAL3 also has measurement limitations and seems to be more suitable in detecting changes in body positions (lying, sitting, standing, and walking) than in detecting exercise intensity.[34] It is known that the ActivPAL3 slightly underestimates actual MVPA levels.[19,35] Over a period of 90 min of performed MVPA, the ActivPAL3 underestimates the actual level of MVPA by 4.3 min, leading to a reduction of 39 min on the median overestimation (min/wk) in our study population.[34] Accelerometry combined with heart rate monitoring could be more appropriate for determining intensity levels, such as MVPA.[35] Accelerometers are more expensive to purchase compared with self-report; however, they also derive more detailed and valid information about PA intensity and duration.[11,36,37] A strength of this study was that all patients succeeded to wear the ActivPAL3 continuously (24 hr) for 7 d, which has been advised as a minimum to assess a valid estimate of weekly performed MVPA.[19]

Current findings in exercise adherence emphasize the need for further evaluation of weekly MVPA. The assessment of weekly PA performed is currently not part of standard measurement procedures in CR, which makes it more difficult for physiotherapists to evaluate and improve PA levels in patients with CAD.[16] Accelerometry is more valid to assess PA intensity and therefore more appropriate than the commonly-used self-reported questionnaires.[38] In addition, investigators should consider which measurement tool is the most suitable for the aimed PA dimension or domain they would like to investigate.[11,39]

Future research should focus on the development of valid instruments for determining MVPA levels and further investigate which factors influence overestimation of perceived MVPA.[30-32] A better evaluation of PA could increase the awareness for achieving exercise recommendations during CR, leading to better health outcomes.[39]

CONCLUSION

Most patients with CAD, participating in an outpatient CR program, do achieve MVPA exercise recommendations but spend simultaneously too much time in sedentary activities. A better evaluation of PA and combining self-reported questionnaires with activity monitoring could increase the awareness for achieving exercise recommendations during CR. Increased awareness of performed PA could lead to better health outcomes.

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