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Daily physical activity in stable heart failure patients

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Abstract

Background

Physical activity is the only non-pharmacological therapy which is proven to be effective in heart failure (HF) patients in reducing morbidity. To date, little is known about the levels of daily physical activity in HF patients and about related factors.

Objective

The objectives of this study were to (1) describe performance-based daily physical activity in HF patients; (2) compare it with physical activity guidelines; and (3) to identify related factors of daily physical activity.

Methods

Daily physical activity of 68 HF patients was measured using an accelerometer (SenseWear®) for 48 hours. Psychological characteristics (self-efficacy, motivation, and depression) were measured using questionnaires. To have an indication how to interpret daily physical activity levels of the study sample, time spent on moderate- to vigorous-intensity physical activities was compared with the 30-minute activity guideline. Steps/day was compared with the criteria for healthy adults, in the absence of HF specific criteria. Linear regression analyses were used to identify related factors of daily physical activity.

Results

Forty-four percent were active for <30 minutes/day; 56% were active for >30 minutes/day. Fifty percent took <5000 steps/day, 35% took 5000-10000 steps/day, and 15% took >10000 steps/day. Linear regression models showed that NYHA classification and self-efficacy were the most important factors explaining variance in daily physical activity.

Conclusions

The variance in daily physical activity in HF patients is considerable. Approximately half of the patients had a sedentary lifestyle. Higher NYHA classification and lower self-efficacy are associated with less daily physical activity. These findings contribute to the understanding of daily physical activity behaviour of HF patients and can help healthcare providers to promote daily physical activity in sedentary HF patients.

Keywords: heart failure, motor activity, health behaviour, self-efficacy.

Introduction

Heart failure (HF) is one of the most prevalent cardiovascular syndromes all over the world, and has a poor long term prognosis.¹ Promoting physical activity is an important treatment strategy,^{2,3} because it reduces mortality, hospitalisations, and the risk for other chronic diseases.⁴

Furthermore, physical activity decreases progression of the disease, risk of functional limitations, and loss of independence and improves quality of life.^{2,4,5}

Studies in HF patients have demonstrated that exercise is beneficial.^{2,4,5} However, not every HF patient is capable of engaging in exercise. Moreover, adherence to exercise is a problem.⁵⁻⁷ We suggest that daily physical activity can be considered as an alternative to exercise, since research suggests that daily physical activity has positive effects in HF patients as well.^{8,9} One study, for example, showed that by increasing walking duration from 10 to 60 minutes per day, HF patients can improve exercise capacity and general well being.⁸ Another study showed that reduced daily physical activity is a strong predictor of mortality.⁹ Because daily physical activity includes occupational, leisure time, household, personal care, and transportation activities,¹⁰ it may be easier to fit into daily life than exercise.

Several daily physical activity guidelines recommend HF patients to perform at least 30 minutes per day physical activities at moderate intensity on most days of the week.^{3,11-13} Although several studies have suggested that daily physical activity levels in HF patients are low,^{9,14,15} it is unclear whether these daily physical activity guidelines are followed. Most studies used only small sample sizes, self-report measurements or outcome measures that were incomparable with

physical activity recommendations.^{15, 16} The use of accelerometers, instead of questionnaires, is preferred because it can give insight into daily physical activity in a performance-based manner and can offer specific and more reliable information about the pattern, duration, and intensity of daily physical activity throughout the day and about patient adherence.¹⁷ To date, the prevalence of physical activity levels in HF patients, whether physically active or sedentary, are unknown. Patients are physically active when they perform more than 30 minutes per day physical activities at least at moderate intensity (≥ 3 METs); and patients are sedentary when they perform less than 30 minutes activities per day. Research suggests that 30 minutes per day physical activities at least at moderate intensity is equivalent to taking approximately 10,000 steps/day in healthy adults.^{18, 19} It is not evidence-based yet that this is also true for HF patients, but in absence of HF specific criteria, comparing the number of steps per day with the criteria for healthy adults as proposed by Tudor-Locke and Basset can give an indication about how to interpret the amount of steps HF patients take per day.¹⁸ Based on these criteria, less than 5000 steps/day could be considered as a 'sedentary lifestyle', from 5000 to 10000 steps/day as a 'low-somewhat physically active lifestyle', and more than 10000 steps/day as a 'physically active lifestyle'.²⁰

Tung et al. (2012) endorsed the importance of assessing and improving daily physical activity levels in HF patients.²¹ However, for a better understanding how healthcare providers can successfully improve physical activity in sedentary HF patients, more knowledge about related factors is necessary. Daily physical activity is related to a complex set of factors,²² including exercise capacity and clinical factors. We hypothesise that daily physical activity may also be associated with the physical activity advice HF patients receive from their physician.²³ In

addition, the exact contribution of demographic characteristics (e.g., age, gender, living situation, level of education); cardiac risk factors (e.g., smoking, overweight/obesity); and psychological characteristics (e.g. self-efficacy, motivation, and depression) to variance in *daily physical activity* in *HF patients* has remained elusive.

The aims of this study, therefore, were to (1) describe performance-based daily physical activity in stable outpatients with HF; (2) assess the prevalence of physical activity levels in these patients, whether physically active or sedentary; and (3) to identify related factors of daily physical activity.

Methods

Study design

For this cross-sectional study, stable outpatients with HF were recruited between February 2010 and February 2011 from HF clinics of the [REDACTED]. The study complied with the principles outlined in the Declaration of Helsinki and was approved by the Medical Ethics Committee [REDACTED]. Eligible patients were asked to participate by the researcher, during a routine visit to the HF nurse. All participants gave their written informed consent.

Study sample

The patients were screened for eligibility by a HF nurse. Inclusion criteria were (1) diagnosis of HF; (2) NYHA class I-III; (3) evidence of structural underlying heart disease; (4) stable

condition (i.e., diuretics unchanged for ≥ 4 weeks); (5) age ≥ 18 years; (6) able to walk/cycle; (7) able to understand and complete questionnaires in Dutch. Exclusion criteria were (1) life expectancy < 1 year; (2) underwent or will undergo an invasive intervention (e.g., percutaneous coronary intervention, coronary artery bypass graft, valvular replacement) in the last six months or planned within the next three months; (3) participation in another HF study; (4) has a pacemaker, implantable cardioverter-defibrillator (ICD), or cardiac resynchronisation therapy (CRT) device (non-interference with the accelerometer could not be guaranteed); (5) signs of ventricular tachycardia and atrial fibrillation during increased physical activity; (6) recent lung embolism (< 3 months prior to start of study).

Measurements

Demographic and clinical data

Demographic and clinical data were obtained from the participants' medical records and by interviewing the participants.

Daily physical activity

To measure daily physical activity, participants were instructed to wear an accelerometer SenseWear® Pro3 Armband (BodyMedia, Inc., Pittsburgh, PA) for two consecutive weekdays (48 hours). According to Rowe et al. (2007) two days of measurement are sufficient to obtain data with a reliability above $ICC=0.80$.²⁴ The SenseWear® is a 2-axis accelerometer and has to be worn on the right upper arm, over the triceps muscle. The researcher attached the device on the arm of the participant. The SenseWear® is a user-friendly device, because it is easy to

attach/detach, leads to minimal discomfort and has no interference in activity. There is no display on the device, thus the participants received no direct feedback on their physical activity. After the wearing period, the participants returned the SenseWear® to the researcher by mail. The researcher retrieved the data from the device with the corresponding software of BodyMedia. Although the SenseWear® is not specifically validated for HF patients, no extensive problems were expected. The SenseWear® has a good test-retest reliability ($r=.87-.94$),²⁵ and a high ICC (0.80) with the doubly labelled water method.²⁶ The SenseWear® has a good validity when compared with indirect calorimetry ($r=.86$; $p<0.001$)²⁷ and with the doubly labelled water method ($r=0.479$; $p<0.01$).²⁸ A few minutes per day non-wearing time is inevitable due to the non-water resistance of the SenseWear®, e.g. in case of showering. To determine the cut-off point of how much non-wearing time was allowed in order to still have a good representation of a complete day, the '70%-80%' rule was used.²⁹ Sufficient wearing time was defined as wearing the accelerometer for 80% of the "wearing day"; "wearing day" was defined as the length of time in which at least 70% of the sample was wearing the accelerometer.²⁹ Patients with insufficient wearing-time were excluded. A complete measurement of the SenseWear® had a duration of 24 hours, which is indicated by the SenseWear® as a wearing time of 100%. To standardise the values of incomplete measurements to complete 24 hours data the following formula was used: $(\text{outcome measure}/\text{percentage wearing time}) * 100$. Outcome measures of the SenseWear® are total energy expenditure (kcal); number of steps; average Metabolic Equivalent of Tasks (METs); active energy expenditure (kcal); time spent on physical activities at least at moderate intensity (≥ 3 METs); and time spent on activities at sedentary-light (up to 3 METs), moderate (3-6 METs), and vigorous (6-9 METs) intensities. Steps/day and time spent on physical activities at least at moderate intensity (≥ 3 METs) in minutes/day were the primary daily physical activity

outcomes. For reference purposes the primary daily physical activity outcomes were compared to the 30-minutes physical activity guideline³ and the steps criteria for healthy adults (specific HF steps criteria are lacking) as proposed by Tudor-Locke and Basset (Text box 1).¹⁸

Text box 1

Lifestyle classification when compared to:

- 30-minute activity guideline³
 - Sedentary lifestyle: <30 minutes/day physical activity (≥ 3 METs)
 - Physically active lifestyle: >30 minutes/day physical activity (≥ 3 METs)

- Steps criteria for healthy adults²⁵
 - Sedentary lifestyle: <5000 steps/day
 - Low-somewhat physically active lifestyle: 5000-10.000 steps/day
 - Physically active lifestyle: >10000 steps/day

Psychological characteristics

The Bandura's Exercise Self-Efficacy Scale (ESES) was used to assess exercise self-efficacy.^{30,31} This is a valid and reliable scale for a cardiac population.³¹ The ESES consists of 18 items on which subjects rate, on a 0-to-10 scale, how certain they are that they can perform regular physical activity across a range of circumstances. Total ESES (0-180) is the outcome measure; higher scores mean a higher level of exercise self-efficacy.

The Self-Regulation Questionnaire-Exercise (SRQ-E) was used to assess intrinsic motivation.^{32,}³³ The SRQ-E is a reliable instrument and has a good construct validity.³³ Patients rate, on a 7-point scale, to what degree 16 different reasons explain why they exercise regularly. The Relative Autonomy Index (RAI) was calculated from the scores. Higher scores mean a more autonomous regulatory style.

The depression subscale of the Hospital Anxiety and Depression Scale (HADS) was used to assess depression.^{34, 35} This scale is a reliable and valid screening tool for depression in cardiac patients.^{34, 35} The depression subscale consists of seven items, rated on a 4-point Likert scale. Higher scores indicate more depressive symptoms. A score of 8 points or higher is a consensus cut-off score for indication of a psychiatric condition.

Physical activity advice

Participants were asked by questionnaire whether they received any physical activity advice from their cardiologist and, if any, what comprised that advice.

Data analysis

Descriptive statistics were used to characterise the participants and their daily physical activity outcomes. Spearman ranks correlation coefficients of daily physical activity outcomes were calculated. The scores on the primary daily physical activity outcomes were compared with the 30 minutes guideline³ and the steps criteria¹⁸. To identify determinants of daily physical activity, we used multiple linear regression analyses for the total group. Variables which showed significant differences in daily physical activity between categories (dichotomous/ordinal variables) and variables that were significantly correlated to daily physical activity (continuous variables) were entered into the analyses as independent variables. In secondary analyses, linear regression analyses were also performed separately for patients with NYHA I-II and NYHA III. All analyses were performed in the statistical programming language and environment R and SPSS (17.0); p-values of <0.05 were considered significant.

Results

Study sample characteristics

In total 89 (82%) of the approached 109 stable outpatients with HF (all Caucasians) agreed to participate in the study. Twenty patients (60% men, 40% women) refused to participate for a variety of reasons (e.g. no time, not interested, too much of a burden). Twenty-one patients (44% men, mean age 59 ± 13 years, 94% NYHA I-II) had to be excluded, because they had insufficient SenseWear® data. The excluded patients differed significantly only in NYHA classification from the patients who had sufficient SenseWear® data ($\text{Chi}^2=6.6$; $p<0.05$). In total, data from 68 HF patients (71% men, mean age 62 ± 14 years, 60% NYHA I-II , LVEF $35\pm 15\%$) could be analysed. The majority (61%) of those 68 participants reported receiving physical activity advice from their cardiologist, but most of the advice were limited to the remark that physical activity is good or desirable (89%). Four patients (11%) reported that they received advice that included a recommendation about type, duration, intensity or frequency of physical activity. Other patient characteristics are presented in Table 1.

Insert table 1

Performance-based description of daily physical activity

SenseWear® wearing time ranged from 39 to 48 hours (mean 47 ± 2 hours). The median number of steps was 4950 (IQR 2961-7934) and the median time spent on activities at least at moderate intensity was 43 minutes/day (IQR 13-70) (Table 2). The intraclass correlation coefficient (ICC) between the measurements of steps/day was 0.728 and between the measurements of time spent on activities at least at moderate intensity the ICC was 0.705. The association between “steps/day” and “time spent on physical activities at least at moderate intensity in minutes/day” is illustrated in Figure 1 (Spearman's $\rho=.77$; $p<0.01$). Figure 1 shows the wide range in steps/day (464-15300) and in time spent on physical activities at least at moderate intensity in minutes/day (0-255). In addition, there was also a wide range of daily physical activity across the different NYHA classes. A more detailed description of daily physical activity is presented in Table 2 for the total group, and for patients with NYHA I-II and NYHA III separately. All daily physical activity outcomes were significantly correlated to each other (Spearman's $\rho=.28 - .99$). Patients with NYHA III took significantly fewer steps/day than patients with NYHA I-II ($U=267.0$; $p<0.001$) and spent significantly less time on physical activities at least at moderate intensity than patients with NYHA I-II ($U=276.5$; $p<0.01$).

Insert Figure 1

Insert Table 2

Daily physical activity compared to guidelines

Table 2 shows also the primary daily physical activity outcomes in relation to the steps criteria¹⁸ and the 30 minutes guideline,³ for the total group and for patients with NYHA I-II and NYHA III separately (Table 2). Fifty percent of all participants took less than 5000 steps/day and 44% was less than 30 minutes/day physically active at least at moderate intensity. Fifteen percent of all participants took more than 10000 steps/day and 56% was more than 30 minutes/day physically active at least at moderate intensity.

Related factors of daily physical activity (steps/day)

Steps/day differed significantly between patients with NYHA I-II (median=6113) and patients with NYHA III (median= 3150) ($U=267.0$; $p<0.001$). There was also a significant difference in steps/day between patients with $EF \leq 40$ (median= 5854) and patients with $EF >40$ (median=3246) ($U=328.0$; $p<0.05$). There was no significant difference in steps/day between men and women ($U= 416.0$; $p=0.389$). Steps/day was only significantly correlated to age (Spearman's $\rho=-.43$) and self-efficacy (Spearman's $\rho=.40$), but not to other characteristics. A linear regression model using NYHA classification, EF, age, and self-efficacy explained 42% of the variance in steps/day ($F=8.69$; $p<0.001$). NYHA classification and self-efficacy contributed significantly to the model (Table 3).

Stratification by NYHA classification showed that, in patients with NYHA I-II, self-efficacy remains the most important factor in explaining variance in steps/day. In patients with NYHA

III, the most important factors were self-efficacy and physical activity advice patients received from their cardiologist (data not shown).

Insert Table 3

Related factors of daily physical activity (time spent on physical activities at least at moderate intensity/day)

Also time spent on physical activities at least at moderate intensity (min/day) differed significantly between patients with NYHA I-II (median= 54 min/day) and patients with NYHA III (median= 15 min/day) ($U=276.5$; $p<0.01$). There was also a difference between patients with $EF \leq 40$ (median= 257 min/day) and patients with $EF >40$ (median= 78 min/day) ($U=331.5$; $p<0.05$), but not between men and women ($U=458.0$; $p=0.767$). Time spent on physical activities at least at moderate intensity was only significantly correlated to age (Spearman's $\rho=-.28$), BMI (Spearman's $\rho=-.25$), and self-efficacy (Spearman's $\rho=.28$), but not to other characteristics. A linear regression model using NYHA classification, EF, age, BMI, and self-efficacy explained 19% of the variance in time spent on physical activities at least at moderate intensity (min/day), but was not significant ($F=2.26$; $p=.064$). NYHA classification contributed significantly to the model, but the other variables were not significant (Table 4).

Stratification by NYHA classification showed that self-efficacy was also the most important variable in explaining the variance in time spent on physical activities at least at moderate intensity (min/day) in patients with NYHA III (data not shown).

Insert Table 4

Discussion

From the performance-based description of daily physical activity in stable outpatients with HF it can be concluded that approximately half of the patients have a sedentary lifestyle. Our results indicate that NYHA classification and self-efficacy are the most important factors related to daily physical activity in HF patients; higher NYHA classification and lower self-efficacy are associated with less daily physical activity.

Physical activity guidelines are necessary for interpreting daily physical activity behaviour. Based on the 30-minute activity guideline,^{3, 11-13} 44% of the HF patients in our study can be considered as having a sedentary lifestyle, because they performed less than 30 minutes of moderate- to vigorous intensity physical activities per day. The number of steps/day can give an indication about patients' lifestyle as well. Fifty percent took less than 5000 steps/day. Compared to criteria for healthy adults, these patients could therefore, be considered as sedentary. However, we have to keep in mind that these steps criteria are based on normative data in healthy adults and might not be suitable for all HF patients.^{19, 20} Although for some HF patients it might be

impossible to achieve >10.000 steps/day (which is recommended for a healthy lifestyle for healthy adults), we showed that this is not necessarily impossible for all HF patients; 15% took >10.000 steps/day. However, specific step-criteria for HF patients are lacking because normative data of HF patients is limited and the levels of physical activity varies considerably between patients.¹⁹ Further research is necessary to adjust the originally steps criteria for HF patients.

In general, patients with a chronic disease are less physically active compared to healthy adults.¹⁹ Normative data for healthy adults range from 2000-9000 steps/day and for special populations from 1200 to 8800 steps/day.¹⁹ The mean number of steps/day in the stable outpatients with HF in the present study was 5619 (\pm 3384) and ranges from 464-15300. The average time spent on moderate-intensity physical activities was comparable with healthy (older) adults. Hamer et al. (2012) showed that 54.4% of healthy adults with a mean age of 66 (\pm 6) years was at least 30 minutes/day physically active at moderate intensity,³⁶ compared to 56% of the HF patients in the present study. The time that stable outpatients with HF spent on activities at moderate intensity is also comparable with patients with congenital heart disease (54 \pm SD 55 versus 59 \pm SD 40 min/day respectively).³⁷ However, a smaller proportion of HF patients met the recommended level of physical activity (56%) than patients with congenital heart disease (76%).³⁷ Only a few other studies reported employing more objective daily physical activity measures in HF patients.^{9, 14, 15} Those studies reported a low level of daily physical activity as well, with a mean number of steps/day comparable to our findings: approximately 3000-5000.^{9, 15} One study reported a higher level of daily physical activity (7257 \pm 3226 steps/day).¹⁴ However, they found that the participants felt encouraged to perform more physical activity when they wore an accelerometer, which implies that the actual daily physical activity level was lower. The issue of encouragement

is less relevant in our study, since the accelerometer did not provide any direct feedback to the participants.

The complexity of daily physical activity is also illustrated by the great variance in daily physical activity between our patients, even within NYHA classes.²² NYHA classification was one of the most important determinants in explaining the variance in daily physical activity. HF patients with a higher NYHA classification were significantly less physically active than those with a lower NYHA classification, which is consistent with the literature.¹⁴ More strikingly is that self-efficacy, defined as belief in one's own competences, is also related to performance-based daily physical activity in HF patients. Patients with a higher self-efficacy were more physically active in daily life than patients with a lower self-efficacy. Regardless of NYHA classification, self-efficacy seemed to be the most important variable in explaining the variance in daily physical activity. This is consistent with the findings of Tierney et al. (2011), who concluded that self-efficacy is one of the factors which influences physical activity in HF patients.³⁸ Other research has shown that self-efficacy is a strong predictor of adherence of HF patients to physical activity recommendations.³⁹

In our study, 61% reported that they received physical activity advice from their cardiologist. However, the advice did not affect a patient's daily physical activity. It is likely that the cardiologists did not give the specific daily physical activity advice which is needed for behavioural change, which reinforces the findings of another study.¹⁶ Most advices were limited to remarks like "Physical activity is good" or "Just do it!", but to have an effect, advice should be

structured, specific, and concrete.²³ Maybe other healthcare providers in the HF team (e.g. advanced practice nurses/heart failure nurses) are more suitable to deliver such advice.⁴⁰

Besides the small sample size and the cross-sectional study design, some additional characteristics of this study should be noted when interpreting the results. Compared to self-report measurements of daily physical activity, progress has been made by measuring daily physical activity on a performance-based way with accelerometry. However, we measured only two weekdays. Several studies recommend to measure daily physical activity for 3-7 days to obtain an accurate view of actual daily physical activity.^{e.g. 41} However, none of those studies included HF patients. We measured two weekdays, because research suggests that fewer days of data are sufficient in measuring daily physical activity in older adults, due to less variability between the days,^{24, 42} which is probably also true for our study population. We showed indeed, in the present study, that the reliability between the two measured days was high, with ICC's of 0.728 and 0.705 for steps/day and time spent on moderate-intensity physical activities respectively. However, there is no consensus yet on the number of measurement days needed to accurately measure actual daily physical activity behaviour, especially in patient populations.⁴³ Furthermore, the SenseWear® Pro 3 armband was not validated specifically for HF patients. More research is necessary to confirm our assumption that the validity and reliability estimates of the SenseWear® Pro 3 armband in healthy (older) adults are not very different in HF patients. Another characteristic what should be taken into account is that 21 patients (of 89) had to be excluded due to insufficient accelerometer data. The majority of those excluded patients (94%) were classified as NYHA I-II, possibly introducing bias. Failure to obtain sufficient accelerometer data can be due to several (known and unknown) reasons, e.g. mechanical flaws,

or early removal of the accelerometer due to (skin) irritations. For future research, we recommend to assess adherence to wearing instructions and reasons for lack of adherence.

Conclusions

The variance in daily physical activity in stable outpatients with HF is considerable.

Approximately half of the patients have a sedentary lifestyle. Higher NYHA classification and lower self-efficacy are associated with less daily physical activity. We suggest that advanced practice nurses/heart failure nurses can play an important role in promoting daily physical activity in 'sedentary' HF patients by delivering structured, concrete and specific advice, thereby taking into account the role of self-efficacy. More research is needed to optimise daily physical activity guidelines and steps criteria for HF patients and to further explore associated variables, preferably with a larger sample size and a longitudinal study design. Finally, these findings contribute to the understanding of daily physical activity behaviour of HF patients and can help healthcare providers to promote daily physical activity in sedentary HF patients.

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What's new?

- This study confirms the suggestion of low levels of daily physical activity in HF patients by means of performance-based measurements of daily physical activity. Performance-based measurements, in contrast to questionnaires, give a detailed insight into daily physical activity in real-time. It offers specific information about the diversity, duration, and intensity of daily physical activity throughout the day. The measurements showed approximately half of the participating HF patients can be classified as 'sedentary'.
- NYHA classification and self-efficacy are the most important factors related to daily physical activity in HF patients; higher NYHA classification and lower self-efficacy are associated with less daily physical activity.
- The findings of the present study contribute to the understanding of daily physical activity behaviour of HF patients and can help healthcare providers to promote daily physical activity in sedentary HF patients.

Tables

Table 1. Characteristics of participants (N=68)

Table 2. Description of daily physical activity

Table 3. Coefficients of overall regression model; dependent variable steps/day

Table 4. Coefficients overall regression model; dependent variable time spent on physical activities at \geq moderate intensity