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## Care of People with Heart Failure

## Seasonal variation in physical activity in patients with heart failure

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## ABSTRACT

**Background and objectives:** Physical activity is important for all heart failure (HF) patients to improve quality of life and physical function. Since adherence to physical activity is low and could differ between seasons, it is essential to explore factors related to change that may depend on seasonal changes. The purpose of this study was to describe the seasonal differences in physical activity and assess factors that influence these differences in a country with markedly different winter-to-summer weather conditions (in temperature, hours of daylight and snow fall).

**Methods:** The study had a cross-sectional survey design. Outpatients with HF completed a questionnaire on physical activity, motivation and self-efficacy to exercise and HF symptom severity in the summer and the winter in a northern hemisphere country. We used analysis of variance to evaluate seasonal differences in physical activity, motivation, self-efficacy and HF symptom severity.

**Results:** Eighty-seven patients with HF (29% women, mean age  $70 \pm 9$  years) were included and 35% performed less physical activity (METs) in the winter, compared to the summer. Increased symptom severity during the winter was associated with lower activity levels.

**Conclusion:** One-third of the patients performed less physical activity during the winter compared to the summer, and this was associated with symptom severity. Decreased physical activity was not related with motivation and self-efficacy. This study emphasises the need for personalised physical activity programmes that also assess symptom severity and change in symptom severity depending between seasons.

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## Introduction

Heart failure (HF) is a common and burdensome disease, especially among older adults and a major cause of mortality, morbidity, and poor quality of life.<sup>1</sup> The prevalence of HF is between 0.4%–2% of the general population and between 2.3–16% of people above 75 years of age.<sup>1,2</sup> A large proportion of healthcare resources are used to treat patients with HF, with the highest costs due to hospitalisation.<sup>1–3</sup> Improved self-care management, including physical activity in patients with HF could lead to reduction of hospitalisation, mortality and improved of quality of life.<sup>4</sup> Physical activity significantly improves clinically relevant outcome parameters such as exercise capacity,<sup>5,6</sup> quality of life, HF-related hospitalisation and mortality.<sup>7</sup> However, in the HF-ACTION study<sup>8</sup> (a multi-centre exercise trial, with 23,331 patients with HF) physical activity was not associated with reduction in all-cause mortality or hospitalisation was observed. The authors argued that these findings could be

explained by the low rates of adherence to the prescribed training protocol in the intervention group (60%).<sup>7</sup>

Low adherence to physical activity was also seen in other trials.<sup>8,9</sup> A majority of patients with HF (61%) report that adherence to engage in regular physical activity is more difficult than any of the other required self-care behaviours, including adherence to diet and medication, smoking cessation, or attending medical appointments.<sup>10</sup>

During physical activity, HF patients often report symptoms (e.g. shortness of breath and fatigue) that can increase feelings of fear, anxiety, and powerlessness. These feelings can decrease self-efficacy (the patients confidence in their ability) to perform physical activity and lead to a decrease in adherence.<sup>11–13</sup> Other factors that can lead to non-adherence in patients with HF are lack of motivation, lack of skills and lack of knowledge of the importance of physical activity.<sup>14–16</sup> Levels of physical activity may also vary with the seasons, and that poorer weather can be identified as a barrier for participation in physical activity, especially outdoor physical activity,<sup>14,17</sup> although seasonal variations have seldom been considered. As self-efficacy is the confidence to overcome barriers if they occur, and barriers are different between seasons, it could be that self-efficacy

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change between seasons. Weather can influence motivation, as speculated in previous studies on exercise motivation.<sup>18</sup>

Although there is a considerable heterogeneity in environmental conditions worldwide, there is little research on the influence of the environment on physical activity, and current guidelines and consensus statements are not adapted to cold and hot periods of the year or to specific climate challenges. Cardiovascular disease incidence is particularly sensitive to seasonal variation, peaking in the winter months. However, there are also summer peaks documented in CVD-related morbidity, mostly independent of the temperatures and explained by a multitude of factors, such as the susceptibility of individuals and a range of environmental factors (including ambient temperature).

<sup>19</sup>These differences may be especially pronounced in regions of the world that are subject to four distinct seasons and markedly different winter-to-summer weather conditions.<sup>19</sup> An example of a country that has four distinct seasons and different winter-to-summer conditions (in temperature, hours of daylight and snow fall) is Sweden. The climate in Sweden is relatively mild considering its northerly geographic location, due to its many lakes and the influence of the Gulf Stream. The average temperature during the summer varies between 55–63 °F/ 13–17 °C. February is usually Sweden's coldest month, with temperatures from –8 to 27 °F/ –22 to –3 °C. Snow covers the ground in southern Sweden from December to April, and in northern Sweden the first snowfall is often already in October.

However, there are huge differences between the southern and Northern parts. In the summer northern Sweden has continuously daylight, where the Southern of Sweden has an average of 19 h of daylight in midsummer and only about six hours in midwinter. In the winter, the sun in northern Sweden never rises above the horizon for about two months.

To our knowledge, only one study<sup>20</sup> conducted in Japan examined seasonal differences in physical activity level in patients with HF. Japan has dry and sunny winters (temperature rarely drops under 32 °F/ 0 °C) and humid and hot summers (with temperatures often over 86 °F/ 30 °C). However, there was no difference in physical activity levels that corresponded with changes in the seasons. In this study, the small difference in average ages (56–58 years old) and the short measurement period might not adequately allow for effective measurement of seasonal changes of physical activity in patients with heart failure.

The purpose of this study was to describe the seasonal differences in physical activity in patients with heart failure and assess factors that influence these differences in a country with markedly different winter-to-summer weather conditions (in temperature, hours of daylight and snow fall).

## Methods

The study is a longitudinal study with measurement points in the winter and the summer. The present study complies with the Declaration of Helsinki and was approved by the Regional Ethics Committee (Ref.: 2014/292-32).

Patients with HF were selected from the registry of a HF clinic in a county hospital in Sweden (diagnostic codes: I50.0 and I50.9). All patients diagnosed with HF (regardless of ejection fraction) and older than 18 years of age were eligible for participation. Exclusion criteria were inability to understand Swedish and/or a cognitive impairment that would make it impossible to fill in the questionnaires. All patients provided informed consent prior to taking part in the study.

We estimated the sample size using the rule of thumb of Pedhazur's and Schmelkin's rule,<sup>21</sup> that states that good power to study relationships requires 50 patients for each factor measured. In this study, the main factors were physical activity, motivation and self-efficacy, which means that 150 patients needed to be included.

The investigators mailed the invitation and the informed consent forms, questionnaires and a prepaid envelope to return the completed questionnaires. In November 2014, all patients who participated in the summer were asked to complete an identical questionnaire. To be able to recruit the 150 patients needed 300 patients between May and July 2014 were approached, as previous surveys have shown a response rate of 33–65% in HF patients in Sweden.<sup>22–24</sup>

## Variables and measures

Physical activity was measured with the Short form International Physical Activity Questionnaire (s-IPAQ). The s-IPAQ contains 7 questions for identifying the frequency and duration of light, moderate and vigorous physical activity (<600 METs/week: walking to work, from place to place, and any other recreational walking, sport, exercise, or leisure; between 600 and 3000 METs/week: carrying light loads, cycling at a regular pace, or doubles tennis; >3000 METs/week; lifting, digging, aerobics, or fast cycling respectively), as well as inactivity during the past week. The answers were converted to Metabolic Equivalent of Task (METs)/week. The MET value (light activity = 3.3, moderate activity = 4, vigorous activity = 8) was multiplied by the minutes the activity was carried out and again by the number of days the activity was undertaken). Previous research has shown that the s-IPAQ correlations with a valid and reliable accelerometer were 0.80.<sup>25,26</sup>

Exercise motivation was measured with the Exercise Motivation Index (EMI). This questionnaire includes 15 statements on physical, psychological and social motivation, followed by a five-points rating scale for each statement, ranging from 0 (not important) to 4 (extremely important). Total score of the questionnaire is the mean score of all items. The instrument is valid and reliable among patients with rheumatic conditions and healthy individuals.<sup>27</sup> The Cronbach's alpha of the EMI in this study was between 0.93.

Self-efficacy for exercise was measured with the exercise self-efficacy scale. Self-efficacy is defined as “the belief in one's capabilities to organise and execute the courses of action required to produce given attainment”.<sup>28</sup> This questionnaire assessed self-efficacy beliefs regarding six potential barriers to exercise followed with by a ten-point rating scale 1 (not confident) to 10 (very confident), with the mean score on all the items as the total score. The instrument is reliable and valid in patients with low back pain.<sup>29,30</sup> Cronbach's alpha of the Exercise Self-Efficacy Questionnaire in this study was between 0.89.

Severity of HF symptoms (shortness of breath and fatigue) during physical activity were measured with a numeric rating scale ranging from 0 (no shortness of breath or fatigue) to 10 (worst shortness of breath or fatigue). This scale has been validated in a previous study.<sup>31</sup>

Data were collected on New York Heart Association (NYHA) functional-class, medication, and comorbidity using the Charlson comorbidity index from medical records. We also collected information on patient age, gender, levels of education and marital status.

## Statistical analysis

Descriptive statistics were used to characterise the clinical and demographic characteristics of the sample. Means and standard deviation were calculated for continuous data, and absolute numbers and percentages were computed for nominal variables. Data were tested for normal distribution (Shapiro Wilk) and in case of non-normal distribution non-parametric statistics were used (Mann Whitney, Chi-square). The mean differences in physical activity, motivation, self-efficacy and HF symptom severity in the winter compared to the summer were analysed with ANOVA. SPSS version 23 was used to analyse the data.

A definition and cut-off for decrease in physical activity was based on clinically relevant difference in steps previously verified in

patients with COPD (600 steps a day = 35 METs, ≈250 METs a week). The clinical importance of this change is supported by a reduced risk for hospital admission in those COPD patients with a cut-off point of more than a 600 steps improvement.<sup>32</sup> There was no such cut off available for HF, but we used this definition because COPD patients report dyspnea and fatigue in relation to physical activity. A decrease of 250 METs or more was defined as a decrease in physical activity. A decrease less than 250 METs or no change was defined as the same level of physical activity. An increase in physical activity was defined as an increase more than 250 METs physical activity.

We examined the association of the change in physical activity between the seasons with demographic variables, motivation, self-efficacy and symptom severity. Associating factors were analysed with Student's t-tests or Chi-square where appropriate.

## Results

A total of 300 patients were invited, 154 patients (51%) completed the questionnaire in the summer, of these patients 87 patients (29%) completed the questionnaires in the winter and were included in the analysis. The sample included 29% women (mean age = 70 ± 9 years). There were no statistically significant differences in age (*P*-value = 0.47), gender (Person Chi-square = 0.84) or the amount of physical activity during the summer (*P*-Value = 0.47) between the patients who only completed the questionnaire once and those who completed the questionnaire during both seasons.

The median summer temperature in May was 50 °F (range = 28 to 81)/ 10 °C (range = -2 to 27) and was 57 °F (range = 43 to 8)/14 °C (range = 6 to 27) in June. The median winter temperature was 41 °F (range = 28 to 59)/5 °C (range = -2 to 15) in November and December 36 °F (range = 3 to 45)/2 °C (range = -16 to 7).

Of the 87 patients, 76% were married or cohabiting (*n* = 66), and 24% had participated in further or higher education (*n* = 21). There were 46% in NYHA-class I/II (*n* = 40) and 25% in NYHA III/IV (*n* = 22) (Table 1). Most patients had one or more comorbid conditions (mean Charlson index = 3 ± 2) with myocardial infarction (26%, *n* = 23), cancer (17%, *n* = 15) and diabetes mellitus (14%, *n* = 12) as most common conditions. In the summer months, patients reported a median of 1428 METs (Q1 297–Q3 3665) per week. Approximately, one third of the patients engaged in light physical activity (<600 METs/week), 36 (41%) engaged in moderate activity (600–3000 METs/week) and 25 (29%) engaged in vigorous physical activity (3000 METs/week). No

differences were found in the total amount of physical activity between winter and summer (Table 2).

The motivation to engage in physical activity during the summer was 2.23 (±0.91); social motivation was 1.31 (±0.85) and the psychological motivation was 2.04 (±1.02). The self-efficacy during the summer was 3.93 (±2.19). There were no differences in motivation and self-efficacy during winter compared to the summer (Table 2).

Most of the patients experienced shortness of breath (98%) or fatigue (97%) with a mean score for both symptoms a severity of 5.2 on a scale from 0–10. There were no statistically significant differences in symptom severity between the winter and summer months.

In total 35% (*n* = 30) of the patients were less active in the winter compared to the summer, a decrease of more than 250 METs/week.<sup>32</sup> Approximately two-thirds of the patients performed the same amount of exercise or were more physically active in the winter compared to the summer (*n* = 57, 66%) (Table 2). There were no differences in age, gender, marital status, NYHA-class, motivation and self-efficacy between patients whose physical activity decreased in the winter to patients whose levels stayed the same or increased (Table 2). Feeling more fatigue and experience more shortness of breath were associated with lower levels of activity in the winter compared to the summer (*P*-value fatigue = 0.02, *P*-value shortness of breath < 0.01) (Table 2).

## Discussion

To our knowledge, this is the first study that examined symptom severity, motivation and self-efficacy as factors that might affect seasonal change in physical activity in patients with HF. Over a third of the patients (35%) with HF decreased their physical activity in the winter compared to the summer, but surprisingly 65% increased levels or stayed the same. An explanation for these results could be that the median differences in temperature between winter and summer were not as clear as we expected, and this might maybe have been part of the explanation of the lack of change in physical activity between the seasons. However, at the same time, it should be noted that it is not only the aspect of temperature that can cause difference in physical activity between seasons but additional factors such as early darkness, cold winds and rain. Another explanation that we did not find differences in physical activity could be the sample size. Although we succeeded to include the targeted 150 patients in the summer, of these patients 58% responded in the winter period.

**Table 1**  
Demographic variables of 87 patients with heart failure

	Total N = 87
Age (Years)	70 (±9)
Female gender	25 (29%)
Education	
Primary school	39 (45%)
Secondary school	26 (30%)
Higher than secondary school	21 (24%)
Marital status	
Married/in a relationship	66 (76%)
NYHA functional class	
NYHA I-II	40 (46%)
NYHA III-IV	22 (25%)
Smoking	3 (3%)
Alcohol consumption	
One glass or less a week	37 (54%)
2–7 glasses a week	34 (40%)
More than 7 glasses a week	5 (6%)
Charlson Comorbidity Index	3 (±2)
Overweight/Obesity (BMI > 25) <sup>a</sup>	46 (53%)

<sup>a</sup> BMI, Body Mass Index.

**Table 2**  
Differences in patients who decrease in physical activity and patients who stayed the same or increased in their physical activity in the winter compared to the summer

	Decrease in physical activity <sup>a</sup> N = 37	Increased or stayed the same in physical activity N = 50	<i>P</i> -Value
Age	70 ± 9	71 ± 10	0.62
Female gender	10 (27%)	15 (30%)	0.51
Marital status			
Married/in a relationship	27 (73%)	39 (78%)	0.86
NYHA <sup>b</sup> functional class I/II	15 (41%)	25 (50%)	0.54
Difference in motivation	-0.14 ± 0.48	-0.06 ± 0.47	0.50
Physical	-0.08 (±0.56)	-0.13 (±0.57)	0.68
Social	-0.10 (±0.65)	-0.14 (±0.58)	0.98
Psychological	-0.06 (±0.60)	-0.18 (±0.64)	0.41
Change in self-efficacy	-0.08 ± 1.36	-0.05 ± 1.70	0.94
Change SOB <sup>c</sup>	0.90 ± 1.95	-0.51 ± 2.16	<0.01
Change in fatigue	0.73 ± 1.96	-0.42 ± 2.21	0.02

<sup>a</sup> Based on clinical significant relevant in steps previously verified in patients with COPD (600 steps a day = 35 METs, ≈250 METs a week).<sup>32</sup>

<sup>b</sup> NYHA, New York Heart Association Class.

<sup>c</sup> SOB, Shortness of Breath.

Increased symptom severity was associated with a decrease in physical activity in the winter. We did not find a large difference in symptom severity between winter and summer, however, an increase in symptom severity was related to decreased physical activity in the winter. If physical activity causes shortness of breath, patients often reduce their physical activity or are advised to reduce physical activity to a comfortable level for daily life activities. We should however provide advice and motivate patients to be regular physical active, even if shortness of breath occurs, because of the favourable changes in myocardial function, HF symptoms, functional capacity, and increased hospitalization free life span and probably survival.<sup>7</sup> Techniques that could increase motivation are prompt goal setting, specify goals in relation to contextualized action, self-monitoring of behaviour, feedback on performance and review on previously-set goals.<sup>33</sup>

Although the study shows that 35% of patients with HF were less active in the winter compared to the summer months, it is possible that an increase of symptom severity in certain patients is due to the worsening of HF during winter time. Symptom-monitoring behaviours are performed infrequently by HF patients.<sup>34</sup> Helping patients to recognise and improve their symptom severity in time might help them to keep up with their physical activity.

Change in motivation and self-efficacy did not influence the physical activity between seasons. Although change in self-efficacy did not influence the physical activity change in the winter compared to the summer, it should be emphasised that self-efficacy was rather low during both seasons and therefore this variable did not influence the amount of physical activity in both seasons. Self-efficacy plays a major role in adherence to regular exercise recommendations for cardiac patients and has demonstrated to have influential short-term effects on adherence to exercise. Self-efficacy has been considered as a predictor for cardiac recovery management, social, mental and physical functioning. Nevertheless, research is limited in patients with HF and interventions to specifically target self-efficacy in physical activity.<sup>35,36</sup> Therefore, it is highly important to develop effective interventions for patients with HF to increase their self-efficacy. Potential intervention techniques to increase self-efficacy in future research include action planning (planning of when, where and how the physical activity will be performed), and providing instructions and reinforcing effort towards physical activity.<sup>35,37</sup>

In the general population, we see how people are more active during the summer which can be related to the weather.<sup>38</sup> Levels of physical activity in winter may be lower than those in summer, because winter activities may be less convenient and accessible (physically and financially).<sup>38</sup> In patients with HF however, as we found in our study, the decrease in winter activity is also related to symptom severity. Environmental variables, specifically weather, should be considered when developing physical activity interventions for patients with HF. In regions where sustained periods of poor weather and long seasons persist, or where there is a low amount of hours of daylight during the winter, it is important to offer indoor activities, such as dancing,<sup>39</sup> yoga<sup>40</sup> and exergaming.<sup>41</sup> For potential outdoor activities that are better suited to good weather or days with a lot of daylight, it can help to ensure good anti-slip surfaces to pavements or adequate lighting in certain areas. An increase to individual competence for maintaining activity level on days with poor weather could be an alternative approach. Suitable clothing and equipment for wet weather could be one way to address concerns in patients with HF, and consequently increase motivation for physical activity. Motivational sources that could be used in future interventions are successful performance, vicarious experience, and verbal encouragement, physiologic and affective state.<sup>42</sup>

We know that there are no “one size fits all” physical activity programmes for patients with HF and for this reason, tailored physical activity interventions are preferable. This tailoring should take

weather conditions into account, as well as any possible concerns and barriers, such as severity of symptoms.

Patient preference of physical activity could differ between seasons, which could impact the uptake and adherence to physical activity and their motivation and self-efficacy. This is difficult to test in traditional randomised controlled trials. However a cohort study, which incorporated an element of preference, showed that the group of cardiac patients who chose a program that suited their lifestyle and preferences had a higher rate of adherence and improved outcomes.<sup>43</sup> Knowledge about the effect of preference-based treatment on physical activity in RCTs in cardiovascular nursing research is limited and therefore future research is needed that conducts preference-based RCT studies on clinical outcomes.

Since we included patients from a HF clinic registry, this is data from a ‘real world’ heart failure population, in other words patients probably did not only have HF but could also have problems that were a result of co-morbidities that could prevent them to engage in PA, such as arthritis, cachexia, history of stroke etc. This makes our results applicable to the wider group of HF patients.

Future research should be conducted on larger samples, that include more data on physical activity of patients with HF during the winter period. Furthermore, future research could include more environmental characteristics, such as the amount of snow during the winter period, or humidity in the air during the seasons, and include information whether patients with HF had activity limitations, such as arthritis or confinement to wheelchair that may also influence the results.

A limitation in this study was the physical activity assessment. Although this assessment is used to measure physical activity in the elderly, it was developed for persons between the 18–69. Furthermore, this assessment measures physical activity subjectively and future research should consider using validated activity monitors to assess objectively physical activity in this population.

## Conclusion

This is the first study to examine symptom severity, motivation and self-efficacy as factors in seasonal differences in physical activity in patients with HF. One-third of patients decreased in their physical activity in the winter compared to the summer. This decrease in physical activity level was mainly due to an increase in symptom severity in the winter. Furthermore, it should be noted that although change in self-efficacy did not influence the changes to physical activity in the winter compared to the summer, overall self-efficacy was low during both seasons. This emphasises the need for more personalised physical activity training programmes that also assess symptom severity change between seasons.

## CRedit authorship contribution statement

**Leonie Klompstra:** Methodology, Data curation, Formal analysis, Writing - original draft, Validation. **Tiny Jaarsma:** Methodology, Writing - original draft, Validation. **Anna Strömberg:** Methodology, Writing - original draft, Validation. **Martje H.L.van:** der Wal, Formal analysis, Writing - original draft, Validation.

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## Disclosure

The author reports no conflicts of interest in this work.

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