



Measuring Fear of Physical Activity in Patients with Heart Failure

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Abstract

Purpose Fear of physical activity (FoPA) has been suggested as a psychological barrier to exercise-based cardiac rehabilitation and everyday physical activity (PA) in patients with heart failure (HF). We evaluated the recently developed Fear of Activity in Situations-Heart Failure (FActS-HF) questionnaire that assesses affective/cognitive fear reactions to situations of varying PA intensities.

Methods The FActS-HF was given to 132 ambulatory patients with stable HF (67 ± 12 years, 80% men). In 121 participants with valid FActS-HF data, the questionnaire's dimensionality was investigated. Psychometric properties were determined in terms of reliability and validity. We assessed convergent and discriminant correlations of FoPA with anxiety, kinesiophobia, and depression. External validation criteria encompassed clinical variables and objectively assessed accelerometer measures of everyday PA in a subsample of 61 participants.

Results The FActS-HF measures a unidimensional construct (i.e., FoPA) based on items presenting varying PA intensities (i.e., the more intense the PA, the stronger the fear response). The scale demonstrated good 2-week stability ($r_{tt} = 0.82$) and excellent internal consistency reliability ($\alpha = 0.97$). FoPA was moderately to strongly associated with anxiety and kinesiophobia, and weakly to moderately associated with state/trait depression, supporting convergent and discriminant validity, respectively. High FoPA was associated with feeling uninformed about HF, comorbidities, non participation to cardio fitness groups, and less stair climbing, as measured by accelerometry.

Conclusion The FActS-HF is a reliable and valid instrument to measure FoPA in patients with HF and provides a promising tool for further research and practice.

Keywords Heart failure · Physical activity · Kinesiophobia · Psychometrics · Accelerometry

Introduction

Recent evidence-based guidelines for the management of heart failure (HF) recommend exercise training (i.e., structured training programs) and everyday physical activities (PA), such as housework and gardening, for stable patients with heart failure [1–4]. Exercise-based rehabilitation reduces HF-related hospitalizations and increases quality of life in HF

patients with both reduced and preserved ejection fraction [5–8]. Additionally, exercise training improves exercise capacity, peak oxygen consumption, and HF symptoms in patients with impaired left ejection fraction [9, 10]. However, the beneficial effects disappear after terminating the supervised training programs because of a low adherence to home exercise [11, 12]. Non adherence to exercise regimens as well as low PA levels are related to physical symptom distress, but surprisingly not to anxiety [13, 14]. Global anxiety appears to be too unspecific to capture PA-related fear, such as worries about worsening symptoms after exercise [15, 16], which has been labeled “fear of PA” (FoPA) or “kinesiophobia” [17, 18].

The Tampa Scale for Kinesiophobia was originally developed to measure kinesiophobia in chronic pain patients and has recently been adapted for patients diagnosed with coronary heart disease (i.e., the Tampa Scale for Kinesiophobia–Swedish Version Heart (TSK)) [18, 19]. Since the TSK was derived from pain theories and has been applied to cardiac patients [19], there is no instrument assessing FoPA based

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on anxiety theory and a conceptual framework of PA in patients with HF [20]. Therefore, we developed the Fear of Activity in Situations-Heart Failure (FAcS-HF): This stimulus response inventory lists short descriptions of situations involving different domains of PA (i.e., sports, everyday life, and leisure activities) [21]. These situations vary with regard to the PA intensity levels (i.e., light, moderate, and vigorous intensity) [22]. The intensity of each PA was based on metabolic equivalent of task (MET) [23] values and validated by expert ratings. FoPA was conceptualized as a combination of a cognitive component (i.e., worry about occurring symptoms) and an affective component (i.e., sensation of autonomic arousal) [24, 25].

The purpose of this study was to evaluate the FAcS-HF in a sample of HF patients with regard to three aims. The first aim was to investigate the latent dimensionality indicated by the FAcS-HF items (i.e., FoPA based on cognitive/affective components, PA domains, and PA intensity levels) and to decide which items could be dropped to obtain a shortened version of the questionnaire. The second aim was to examine the psychometric properties of the shortened FAcS-HF in terms of reliability (internal consistency, test-retest reliability) and evidence for construct validity (convergent and discriminant validity). We expected that FoPA is related to similar constructs rather than to distinct constructs, such as anxiety and depression, respectively. The last aim was to explore associations of the FAcS-HF with validation criteria, such as the patient's self-reported engagement in sports activities. In addition, objectively assessed everyday PA in terms of activity energy expenditure (AEE), activity intensity (MET), and the frequency of engaging in PA categories (e.g., sitting, walking, and stair climbing) was used as external criteria in a subsample of participants.

Methods

Participants

Between March and October 2014, 132 patients with HF were recruited from two university hospitals, rehabilitation centers, cardiology practices, and nursing care services in Germany. Patients were eligible for the study if they were 18 years or older (and no more than 78 years in the accelerometry subsample), were able to speak German fluently, and had a diagnosis of HF stage B or C [26] with reduced or preserved ejection fraction. All underlying causes of HF were accepted, i.e., ischemic and non ischemic HF. Patients had to be stable outpatients at the time of study participation. Exclusion criteria were hospitalization during the last month, complex ventricular arrhythmias, acute myocarditis, symptomatic cardiac valve stenosis, instable angina pectoris, and orthopedic illness as well as other severe diseases (e.g., advanced stages

of cancer) interfering with PA. Approval of the Institutional Review Board of the University of Wuppertal was obtained. Each participant provided informed consent. The study has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Measures

Sociodemographic and Clinical Characteristics

A complete list of the collected sociodemographic and clinical data is provided in Table 1. The assessment of sociodemographic data included questions on age, sex, marital status, housing situation, education, and employment status. The clinical data comprised questions on NYHA classes, ejection fraction, body size and weight, rehabilitation sports (no/yes), other sports (no/yes), knowledge about HF (1 = not at all; 5 = very good), comorbidities, and implantable cardioverter defibrillator (ICD) with or without cardiac resynchronization function (no/yes).

Psychological Questionnaires

The original FAcS-HF scale provides descriptions of 24 situations counterbalanced over three PA domains, i.e., everyday life activities, sports/training, and leisure time. Occupational activity, which was included in a pilot version, was excluded for lack of specificity in the target population (i.e., many patients with HF are retired). The PAs described in the 24 items vary with regard to intensity levels (9 light-intensity items ($\text{MET} < 3$), 9 moderate-intensity items ($\text{MET} \geq 3 \leq 6$), and 6 vigorous-intensity items ($\text{MET} > 6$)) [23]. The FAcS-HF instruction asks to imagine every situation, even if it does not match individual habits or is not performed anymore. Each item is rated on two response scales to assess affective ("I feel strained") and cognitive reactions ("I am worried that uncomfortable symptoms could occur, such as breathlessness"). The response scales range from 0 (not at all) to 5 (very strong), with higher ratings indicating higher FoPA.

To assess convergent and discriminant validity of the FAcS-HF, five questionnaires were applied. Table 2 provides information about all scores, internal consistencies, and descriptive results. Two of these questionnaires were given to the entire sample:

- HF-related symptom distress caused by bodily and medical stressors was assessed with a questionnaire modified from Jalowiec et al. [27]. The scale presents 17 HF-related symptoms (e.g., dyspnea, pain, sleep disorders) and medical treatments (e.g., dependence on medical devices, pacemaker, ICD). These stressors are rated with regard to the burden caused by each stressor in the last 4 weeks.

Table 1 Sociodemographic and clinical sample characteristics of patients with stable heart failure ($N = 132$)

Characteristics	
Age (in years), mean, SD (min-max)	67.1 $\pm$ 12.1 (25–91)
Male sex, N (%)	106 (80.3)
Site of enrollment, N (%)	
Hospital	34 (25.8)
Cardiology practice	7 (5.3)
Rehabilitation center	86 (65.2)
Nursing care service	5 (3.8)
Marital status, N (%)	
Single/widowed/divorced	44 (33.3)
Married	88 (66.7)
Housing situation ($n = 131$), n (%)	
Living alone	31 (23.7)
Living with partner/others	100 (76.3)
Hospitalization in the last year ($n = 131$), n (%)	51 (38.9)
Household ($n = 130$), n (%)	
Without support	84 (64.6)
With support	46 (35.4)
Level and years of education, N (%)	
Academic degree	26 (19.7)
12/13 years	17 (12.9)
9/10 years	81 (61.3)
No graduation	8 (6.1)
Employment status ($n = 130$), n (%)	
Working full or part-time	34 (26.2)
Retired	90 (69.2)
Housewife/unemployed/certified sick	6 (4.6)
Cardiac fitness group ($n = 131$), n (%)	78 (59.5)
Other sports, N (%)	30 (22.7)
Knowledge about disease ($n = 131$), n (%)	
Very good	38 (29.0)
Good	60 (45.8)
Acceptable	30 (22.9)
Poor	3 (2.3)
Number of heart failure-related stressors, mean, SD (min-max)	13.54 $\pm$ 3.69 (2–17)
Comorbidity (multiple selection possible) ($n = 125$), n (%)	67 (53.8)
Pain (polymyalgia, rheumatism, arthritis, etc.)	40 (32.0)
Diabetes mellitus	11 (8.8)
Cancer	6 (4.8)
Chronic obstructive pulmonary disease (COPD)	3 (2.4)
Other	15 (12.0)
Implantable cardioverter defibrillator ($n = 122$), n (%)	23 (18.9)
With cardiac resynchronization function, n (%)	17 (13.9)
Body mass index ($n = 131$), mean, SD (min-max)	27.8 $\pm$ 4.6 (14.9–45.3)
Activity energy expenditure (in kcal/day) ($n = 61$), mean, SD	695.95 $\pm$ 178.10
Metabolic equivalent of task ($n = 61$), mean, SD	1.56 $\pm$ 1.31
New York Heart Association class ($n = 18$), n (%)	
II	8 (44.4)
III	9 (50.0)
IV	1 (5.6)
Ejection fraction (in %) ($n = 19$), mean, SD	39.11 $\pm$ 18.62
Activity classes (in %) ($n = 61$), mean, SD	
Lying	49.08 $\pm$ 12.84
Sitting/standing	41.26 $\pm$ 14.93
Walking	5.46 $\pm$ 2.19
Jogging	0.09 $\pm$ 0.36
Climbing stairs/walking up- and downhill	0.19 $\pm$ 0.14
Uncategorized	3.73 $\pm$ 8.75

The option “not applicable” can be chosen if the respective stressor does not apply to the patient [28]. The number of all applicable stressors (0 to 17), the HF-related distress score (mean of all applicable items), and single item scores were determined.

- The German version of the State Trait Anxiety Depression Inventory (STADI) [24] measures anxiety and depression as situational states and personality traits.

A subsample of 69 participants completed three additional questionnaires:

- The TSK [19] assesses kinesiophobia and was adapted into German.
- The Big Five personality traits were assessed with the NEO-FFI.
- The SANB-5 [29] is a short German adaption of the Fear of Negative Evaluation Scale and measures social anxiety.

All total scores and subscores were computed using the mean of item scores.

Everyday Physical Activity

Everyday PA was objectively assessed using the accelerometer Activity Sensor Move II (movisens GmbH, Karlsruhe/Germany) in a subsample of 61 patients. Patients wore the accelerometer over six consecutive days and documented wear time in an activity diary. Mean daily AEE in kilocalories, activity intensity in MET, and the relative frequencies of six activity classes (i.e., standing/sitting, lying, walking, walking uphill/stairs up, walking downhill/stairs down, and jogging) were determined. The activity classes walking uphill/stairs up and walking downhill/stairs down were merged into “stair climbing” by calculating the mean. Data were included in the analysis when the participants wore the accelerometer at least 6 h each day. The Move II is accurate in determining the energy expenditure and activity classes [30].

Statistical Analyses

Data were analyzed using SPSS Statistics 22 (IBM corporation, New York/USA), and R version 3.1.1 (GNU general public license), and DataAnalyzer 3.8.3 (movisens GmbH, Karlsruhe/Germany). The FActS-HF total score and subscores (PA domains, intensity levels, cognitive/affective component) were calculated using the arithmetic mean of the items. The distribution of the FActS-HF scores was examined using the Kolmogorov-Smirnov test and graphical representations. Missing data were tolerated up to 5% of the FActS-HF items per participant. Missing values were replaced with the participant’s rounded mean PA intensity subscore (mean

Table 2 Psychosocial sample characteristics of patients with stable heart failure

Scales and subscales	Items (rating scale ^a)	Cronbach's α	Mean $\pm$ SD
TSK total score ($n = 69$)	17 items (from 1 to 4)	0.86	2.38 $\pm$ 0.51
Danger: perceived danger for heart	4 items	0.45	2.58 $\pm$ 0.53
Fear: fear of injury	4 items	0.52	2.38 $\pm$ 0.58
Avoidance: avoidance of exercise	5 items	0.85	2.07 $\pm$ 0.74
Dysfunction: dysfunctional self	4 items	0.69	2.49 $\pm$ 0.68
NEO-FFI ($n = 69$)	60 items (from 1 to 5)		
Openness to experiences	12 items	0.69	3.15 $\pm$ 0.49
Conscientiousness	12 items	0.86	3.84 $\pm$ 0.56
Extraversion	12 items	0.74	3.26 $\pm$ 0.52
Agreeableness	12 items	0.66	3.64 $\pm$ 0.43
Neuroticism	12 items	0.79	2.57 $\pm$ 0.59
STADI ($n = 128$)	40 items (from 1 to 4)		
Anxiety trait	10 items	0.83	1.97 $\pm$ 0.65
Anxiety state	10 items	0.92	1.83 $\pm$ 0.65
Depression trait	10 items	0.90	1.94 $\pm$ 0.61
Depression state	10 items	0.87	1.94 $\pm$ 0.59
Heart failure-related distress ($N = 132$)	17 items (from 1 to 5)	0.92	2.19 $\pm$ 0.73
SANB-5-Social anxiety ($n = 67$)	5 items (from 1 to 4)	0.79	1.47 $\pm$ 0.48

TSK German Adaption of the Tampa Scale of Kinesiophobia Swedish Version Heart, NEO-FFI Big Five Personality Traits Scale, STADI State Trait Anxiety Depression Inventory

^a On all scales, lower scores indicate lower levels of the particular attribute

imputation) [31], e.g., a missing moderate-intensity item was replaced with the mean moderate-intensity subscore.

Item Analysis and Dimensionality

We conducted three analyses of the 24 FActS-HF items to evaluate the item statistics and factor structure: First, corrected item-total-correlations (ITC) were calculated (ITC > 0.30 was prerequisite). Floor and ceiling effects were determined by the percentage of participants who rated the lowest (i.e., “0”) and highest (i.e., “5”) item score, respectively. Second, repeated measures ANOVAs were conducted to examine differences within Domain (everyday life, sports, leisure), Intensity (light, moderate, vigorous), and Component (affective, cognitive). Sex was included as between factor in all analyses, because sex differences in anxiety have been reported in cardiac patients [32]. Greenhouse-Geisser corrected degrees of freedom were used according to Mauchly's sphericity test, and non parametric post hoc analyses were conducted when normality could not be assumed. Third, the FActS-HF items were analyzed by exploratory factor analysis (EFA) using the principal factoring method which is free of distributional assumptions [33]. Sampling adequacy for factor analysis was determined using the Kaiser-Meyer-Olkin test (KMO), whereby a KMO-value > 0.90 indicates an adequate fit of the sampling data. To determine the number of factors, parallel analysis was applied [33].

Parallel analysis matches the EFA eigenvalues against the mean eigenvalues of randomly generated data. Factors were retained as long as the sample eigenvalues were higher than the random eigenvalues [34]. Based on all three analyses, the FActS-HF was shortened on the condition that reliability coefficients of the briefer version were comparable to the original version.

Psychometric Properties

Reliability of the FActS-HF was determined using internal consistency (Cronbach's α) and stability (test-retest reliability). To evaluate stability, a reassessment of 26 participants was conducted after 2 weeks. Regarding convergent validity, we expected moderate to high correlations of the FActS-HF total score with the kinesiophobia (TSK), HF-related distress, neuroticism (NEO-FFI), and state/trait anxiety (STADI) scores. Regarding discriminant validity, we expected low to moderate associations of FActS-HF with state/trait depression (STADI) and with social anxiety (SANB-5), i.e., the fear of negative evaluations by others.

Criterion Validity

Clinical data as well as objectively assessed PA measures served as external criteria for the validity of the FActS-HF. Bivariate correlations were calculated between the FActS-HF and the sociodemographic as well as clinical

variables. We expected that high FoPA is positively correlated with comorbidities and ICD, and negatively correlated with attendance to cardiac fitness groups and other sports. To establish criterion validity using accelerometer measures, participants with high FActS-HF scores were expected to be less physically active in everyday life than participants with low FActS-HF scores. Regression models were run to test the associations of the FActS-HF with AEE in mean kilocalories/day, intensity of PA in mean MET, and the relative frequencies of each activity class. The potential predictors gender, age, and body mass index ($BMI = kg/m^2$) were included in the regression models as well as indicators of patient's medical condition (comorbidities, number of HF symptoms and stressors, ICD).

Results

Sample Characteristics

One hundred thirty-two patients (106 males and 26 females) were enrolled in the study. The mean age was 67.1 years ($SD = \pm 12.1$ years, range from 25 to 91 years). Table 1 summarizes the sample characteristics.

Item Analysis and Dimensionality

Descriptive Characteristics of the FActS-HF

FActS-HF data was missing in 20 participants, of which ten had to be excluded from the analyses because they exceeded the 5% cutoff of missing values. One additional participant was excluded because of zero ratings on all FActS-HF items. Thus, data from 121 participants were included in the analyses. The distributions of the total score and all subscores were

positively skewed. According to the Kolmogorov-Smirnov test, the FActS-HF score and all subscores deviated significantly from normal distribution (all $ps < 0.01$). These results were confirmed by inspection of Q-Q plots and histograms. As shown in Table 3, the light-intensity subscale had the highest skew (1.49) and strongest floor effect (54%) compared to the moderate- and vigorous-intensity subscales. Therefore, the light-intensity subscale was considered for elimination. Regarding ceiling effects, the percentage of participants with maximum scores ranged from 1.7 to 19.8% (item 9: “helping a friend move to an unfurnished flat”, see appendix Table 6). The corrected ITCs of all 24 FActS-HF items ranged from 0.67 to 0.88. Even though all ITCs were acceptable, the deletion of the light-intensity items increased the lowest ITC value to 0.72.

Analysis of Variance

The ANOVA revealed a main effect of Intensity, $F(1.54, 177.99) = 201.12$, $p < 0.01$, $\eta_p^2 = 0.63$. A follow-up analysis using pairwise Friedman tests confirmed that FoPA significantly differed between the PA intensity levels (vigorous > moderate > light; all $p < 0.01$; Table 3). Furthermore, there was a significant interaction of intensity $\times$ gender, $F(1.54, 177.99) = 6.09$, $p < 0.01$, $\eta_p^2 = 0.05$. However, a follow-up analysis using the Kruskal-Wallis test showed no significant group differences between women and men on all three intensity subscales (all $ps > 0.05$). The ANOVA revealed no main effects of Domain and Component. The affective and cognitive component were highly intercorrelated ($r = 0.87$). Since factor intercorrelations above 0.80 or 0.85 imply poor discriminant validity, two distinct components could not be assumed [33]. Therefore, the affective and cognitive rating scales were collapsed into one scale by calculating

Table 3 Descriptive statistics and reliability coefficients of the original and shortened FActS-HF scales in the sample of patients with stable heart failure ($n = 121$)

Scale	<i>M Mean</i>	<i>SD</i>	<i>Median</i>	<i>Skew</i>	<i>Kurtosis</i>	<i>Floor</i>	α	<i>Retest</i>
FActS-HF 24	1.51	1.22	1.02	0.89	-0.12	0 (39.9)	0.98	0.82
Light intensity	0.98	1.06	0.39	1.49	1.57	0 (53.6)	0.94	0.76
Moderate intensity	1.65	1.32	1.11	0.78	-0.39	0 (35.4)	0.95	0.82
Vigorous intensity	2.10	1.44	1.83	0.40	-0.94	0 (26.0)	0.94	0.81
Affective component	1.52	1.16	1.08	0.89	-0.09	0 (36.8)	0.97	0.78
Cognitive component	1.50	1.33	0.96	0.82	-0.26	0 (43.0)	0.98	0.85
FActS-HF 15	1.83	1.35	1.40	0.62	-0.65	0 (31.6)	0.97	0.82
Moderate intensity	1.65	1.32	1.11	0.78	-0.39	0 (35.4)	0.95	0.82
Vigorous intensity	2.10	1.44	1.83	0.40	-0.94	0 (26.0)	0.94	0.81
Affective component	1.83	1.31	1.40	0.67	-0.63	0 (29.0)	0.96	0.78
Cognitive component	1.83	1.47	1.40	0.50	-0.84	0 (34.2)	0.97	0.86

FActS-HF Fear of Activity in Situations–Heart Failure (number of items), *Floor* (min, %) percentage of zero ratings in the sample, *Retest* test-retest reliability after 2 weeks ($n = 26$)

the mean affective and cognitive rating on each item (i.e., item parceling) for further analyses.

Exploratory Factor Analysis

The FActS-HF items demonstrated an acceptable sampling adequacy for factor analysis ($KMO = 0.92$). To determine the number of factors, a parallel analysis was run using 24-item parcels combining the affective and cognitive rating scales. A second parallel analysis was conducted using 15-item parcels after eliminating 9 light-intensity items. Both parallel analyses of 24 items (first two eigenvalues, 16.04 and 0.95) and 15 items (first two eigenvalues, 10.55 and 0.35) indicated a one-factor solution. In addition, the one-factor solution was consistently supported by other statistical criteria, such as the Kaiser-Guttman rule (i.e., eigenvalues > 1.0) and the scree-test (i.e., inspection of a scree-plot of the eigenvalues). The first factor explained 72% of the total variance among the 15 items.

Psychometric Properties

Reliability

We decided to shorten the original FActS-HF with 24 items (i.e., FActS-HF 24) to 15 items (i.e., FActS-HF 15) by eliminating the 9 light-intensity items. As shown in Table 3, internal consistencies of both the FActS-HF 24 ($\alpha = 0.98$) and the FActS-HF 15 ($\alpha = 0.97$) were excellent. Cronbach's α of the FActS-HF intensity subscales ranged from 0.94 to 0.95. The test-retest analysis demonstrated a good reliability for both the FActS-HF 24 and the FActS-HF 15 (both $r = 0.82$). Since there were no striking differences in the psychometric properties of both FActS-HF versions, the following statistical results will solely be reported for the FActS-HF 15 (see appendix Table 6 for the FActS-HF 15 items).

Convergent and Discriminant Validity

Bivariate Spearman correlations of the FActS-HF 15 total score and the test battery scores are shown in Table 4. In terms of convergent validity, the FActS-HF 15 was highly correlated with the TSK total score. The highest correlation was found for the TSK subscale “fear of injury” and the lowest, but still significant correlation for “perceived danger for heart problem.” Among the NEO-FFI personality traits, FoPA was positively correlated with neuroticism. There was a positive association between FoPA and HF-related distress. The FActS-HF 15 demonstrated moderate to strong positive associations with state and trait anxiety, respectively (Table 4). In terms of discriminant validity, the FActS-HF 15 showed small to moderate positive correlations with state and trait depression, respectively. Furthermore, there was a moderate positive

Table 4 Bivariate correlations of the FActS-HF 15 with psychosocial and clinical data in the sample of patients with stable heart failure

Variables	FActS-HF 15
TSK–total score ($n = 60$)	0.70**
Perceived danger for heart problem	0.36**
Fear of injury	0.63**
Avoidance of exercise	0.57**
Dysfunctional self	0.55**
STADI ($n = 115$)	
State anxiety	0.43**
Trait anxiety	0.50**
State depression	0.29**
Trait depression	0.47**
NEO-FFI ($n = 60$)	
Neuroticism	0.46**
Extraversion	−0.33**
Social anxiety score ($n = 58$)	0.46**
Heart failure-related distress score ($n = 121$)	0.47**
Weakness ($n = 116$)	0.54**
Dyspnea ($n = 101$)	0.51**
Tachycardia ($n = 103$)	0.45**
Dependence on medical devices ($n = 72$)	0.43**
Fluid restriction ($n = 83$)	0.40**
Edema ($n = 94$)	0.38**
Fatigue ($n = 119$)	0.37**
Concentration and memory disturbances ($n = 112$)	0.36**
Numbness in hands/feet ($n = 105$)	0.32**
Sexual problems ($n = 87$)	0.31**
Sleep disorders ($n = 101$)	0.31**
Medical examinations ($n = 105$)	0.29**
Pain ($n = 100$)	0.28**
Side effects of medication ($n = 104$)	0.27**
Level of education ^a ($n = 121$)	−0.21*
Cardio fitness group participation ^b ($n = 121$)	−0.29**
Other sports ^b ($n = 121$)	−0.30**
Less informed about heart failure ($n = 120$)	0.21**
Comorbidities ^b ($n = 115$)	0.33**
Implantable cardioverter defibrillator ^b ($n = 111$)	0.39**
with cardiac resynchronization function ^b ($n = 17$)	0.50**

All coefficients are Spearman correlations if not indicated otherwise

FActS-HF Fear of Activity in Situations–Heart Failure, TSK German Adaption of the Tampa Scale of Kinesiophobia Swedish Version Heart, STADI State Trait Anxiety Depression Inventory, NEO-FFI Big Five Personality Traits Scale

** $p < 0.01$ (two-tailed); * $p < 0.05$ (two-tailed); (only significant results are listed; the authors provide a full list of correlation coefficients on request)

^a Coding: 0 = no education; 5 = highest education); ^b Pearson correlation between dichotomous (coding: 1 = yes, 0 = no) and metric variables;

association of the FActS-HF 15 with social anxiety and a negative correlation with extraversion.

Criterion Validity

Clinical Data

Table 4 summarizes significant correlates of the FActS-HF 15 total score with external criteria. Patients with higher FoPA had a lower level of education and felt less informed about their disease. FoPA was also positively correlated with reported comorbidities, ICD (especially with cardiac resynchronization function), and HF-related distress caused by single symptoms or treatment aspects, especially weakness, dyspnea, tachycardia, and dependence on medical devices. Patients with higher FoPA were less likely to participate in cardio fitness groups or other sports than patients with lower FoPA (Table 4).

Accelerometer Data

Table 5 provides regression models with predictors of accelerometer outcome measures. Regarding the PA classes, FoPA was negatively associated with stair climbing, even after controlling for age and BMI. Furthermore, higher FoPA predicted lower AEE in kilocalories ($\beta = -0.30$, $p < 0.05$), but this association was reduced after controlling for age and gender ($\beta = -0.18$, $p = 0.18$). However, higher FActS-HF moderate-intensity subscores tended to predict lower AEE and MET values adjusted for age/gender and age/BMI, respectively. These findings were independent of clinical indicators of disease severity, which were unrelated to accelerometer outcome measures (all p values > 0.59).

Discussion

The findings of the present study show that the FActS-HF is a valid and reliable instrument to assess FoPA in

patients with symptomatic, stable HF. We provide preliminary evidence that the FActS-HF measures a unidimensional construct (i.e., FoPA) based on items presenting varying PA intensity levels (i.e., the more intensive the PA, the stronger the affective/cognitive fear response). The association between affective and cognitive components of fear, found in the present study, was so strong that distinct dimensions could not be assumed. This is in line with reports of strong positive associations between both components in other domains of anxiety research [24]. Moreover, the stimulus-response design of the FActS-HF avoids reverse scoring of items. The latter can affect dimensionality by resulting in a method factor, as shown for the multidimensional TSK [19]. It is noteworthy that the TSK was derived from the pain theory, defining kinesiophobia as fear of specific movements that are avoided by pain patients [35]. FoPA as measured by the FActS-HF is derived from the anxiety theory taking into account both worries about symptoms and tense feelings with regard to PA. Thereby, it is compatible with a broad definition of kinesiophobia as fear of physiological symptoms, i.e., fear of physical or mental discomfort [36].

As expected, increasing intensity of PA depicted in the items was associated with stronger fear responses. However, item analysis revealed strong floor effects for the items describing situations with light PA intensity. These situations might be perceived too comfortable to elicit stress responses in patients with HF. In addition to this statistical consideration, clinical research has shown that only moderate to vigorous physical activation (3 to 7 MET) is predictive of a reduction of cardiovascular mortality and HF hospitalization [37]. Thus, the diagnostics of FoPA in terms of moderate to vigorous PA seems to have the most clinical relevance for HF treatment and rehabilitation. Consequently, the FActS-HF light-intensity subscale was dropped to minimize floor effects. The result is a briefer version of the FActS-HF that comprises 15

Table 5 Multivariate regression analysis of fear of physical activity and demographic factors associated with everyday physical activity (accelerometer outcome measures) in the subsample of patients with stable heart failure ($n = 61$)

	Criterion					
	Activity energy expenditure (kcal/d)		Activity intensity (MET)		Activity class (stair climbing in %)	
	β	p	β	p	β	p
Female sex	-0.34	< 0.01	–		–	
Age	-0.49	< 0.01	-0.39	< 0.01	-0.33	< 0.05
BMI	–		-0.55	< 0.01	-0.33	< 0.05
FActS-HF 15 total score	–		–		-0.35	< 0.01
FActS-HF moderate intensity	-0.20	0.06	-0.20	0.08	*	
Adjusted R^2 in %	39		31		26	

FActS-HF Fear of Activity in Situations–Heart Failure, BMI body mass index, MET metabolic equivalent of task, – nonsignificant predictor excluded from the model, * significant predictor excluded

items describing situations with moderate and vigorous PA intensities (i.e., the FActS-HF 15).

The FActS-HF 15 demonstrated excellent internal consistency and good stability (after 2 weeks). In terms of convergent validity, FoPA and kinesiophobia assessed with the FActS-HF 15 and the TSK, respectively, were highly associated. Convergent validity was also supported by the association of FoPA with neuroticism and HF-related symptom distress. Patients who reported to be burdened by HF symptoms, especially weakness, tachycardia, and dyspnea, showed higher FoPA. The experience of aversive bodily symptoms during PA might lead to classical fear conditioning and, consequently, avoidance of PA in patients with HF. FoPA was moderately to strongly associated with anxiety, and weakly to moderately correlated with depression, supporting convergent and discriminant validity, respectively. Moreover, FoPA was negatively correlated with extraversion. High extraversion might be a protective factor against FoPA [38]. Contrary to our expectation, FoPA was rather moderately than slightly associated with social evaluation anxiety. It is conceivable that relatives or partners might express worries about the patient's health status, thereby contributing to the patient's FoPA.

In patients with HF, higher FoPA was associated with the report of comorbidities, ICD, and feeling uninformed about HF. Interestingly, FoPA was positively associated with reported burden by HF symptoms and comorbidities, but unrelated to the reported number of HF symptoms and type of comorbidity. The latter finding is in line with reports that kinesiophobia is unrelated or weakly linked to cardiac patients' underlying conditions, such as angina pectoris, hypertension, myocardial infarction, diabetes, coronary syndrome, or HF [18, 39]. Furthermore, in patients with chronic fatigue syndrome, kinesiophobia assessed with the TSK was independent of peakVO₂ [40]. Thus, FoPA appears to be influenced by the patient's perception of accompanying complaints rather than by the actual medical condition itself. Importantly, patients with higher FoPA were less likely to participate in cardio fitness groups or other sports. These findings underline the significance of FoPA with regard to PA outcome variables, especially since global anxiety is not predictive of those variables in patients with HF [13, 14]. Furthermore, our results are in line with a recent report that kinesiophobia mediates the influence of both anxiety and HF diagnosis on participation in exercise-based rehabilitation [41].

Regarding accelerometer measures, higher fear in situations of moderate intensity was slightly associated with less daily AEE and also with lower intensities of PA (in MET). Furthermore, higher FoPA predicted less stair climbing. However, there were no associations of FoPA with walking and sedentary behavior (e.g., lying down, sitting/standing). It

is conceivable that FoPA only triggers avoidance of moderate to vigorous PAs, such as stair climbing. More studies are needed to further elucidate the relationship of FoPA with different activity classes with varying intensities.

Our study has several limitations. First, the factorial structure obtained with the EFA is preliminary and will be cross-validated using confirmatory factor analysis in a subsequent study of a larger sample size. Second, the sample was self-selected and the findings might be biased towards patients with higher motivation to be physically active. However, FoPA scores and accelerometer outcome variables varied considerably, indicating that the FActS-HF vigorous and moderate intensity items addressed fit and frail patients, respectively. Third, in this pilot study, it was not feasible to extract indicators of disease severity from medical records. Only a few participants provided self-reported NYHA classes and ejection fraction. Apparently, the majority of patients with HF lack profound knowledge about their medical condition. This highlights the importance of adequate patient and caregiver education with regard to PA [14], which is also recommended in recent HF guidelines [2]. Further study is deserved to elucidate the relation between FoPA, objectively assessed data on patients' medical condition, and patients' perception of his or her condition.

In summary, the present study provides first evidence that the FActS-HF 15 is a reliable and valid instrument to measure FoPA as a psychological barrier to being engaged in PA in patients with HF. Higher FoPA might be linked to lower everyday PA, particularly with regard to moderate to vigorous activities such as stair climbing/walking uphill and downhill. It is desirable that cardiac rehabilitation considers FoPA in health education and psychological interventions to foster adherence to exercise regimen. The FActS-HF 15 provides a promising tool for further research and practice.

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Compliance with Ethical Standards Approval of the Institutional Review Board of the University of Wuppertal was obtained.

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Appendix

Table 6 English translation of the items and item statistics of the FActS-HF 15 ($n = 121$)

No.	Content of the items	MET	Mean (SD)	Median	ITC
(1)	You have been purchasing food in a supermarket ten minutes away from home. Now you have to carry two heavy shopping bags.	mod.	1.79 (1.49)	1.5	0.84
(2)	To stay fit, you go running once a week. You just start your running session.	vig.	1.81 (1.74)	1	0.82
(3)	You are going to do a half-day biking trip. Your route involves some light hill climbing.	vig.	2.18 (1.70)	2	0.81
(4)	As part of a cure you have to take a swimming class. The instructor wants you to swim laps for 10 minutes.	mod.	1.90 (1.68)	1.5	0.77
(5)	Your connecting train leaves in 5 minutes. You have to take the stairs to get to the other track.	vig.	2.23 (1.65)	2	0.86
(6)	You are on vacation. Your partner convinced you to go hiking. You hike for an hour and then turn back.	mod.	1.93 (1.68)	1.5	0.85
(7)	You wash all the curtains in your house and then hang them back up.	mod.	1.66 (1.59)	1	0.84
(8)	Today you have to do endurance exercises with your cardiac fitness group.	vig.	1.57 (1.56)	1	0.86
(9)	You spend the entire afternoon helping a friend move to an unfurnished two room flat.	vig.	2.75 (1.55)	3	0.83
(10)	You participate at a cardio fitness group and are instructed to warm up.	mod.	1.59 (1.55)	1	0.86
(11)	You have to get the laundry hamper to the roof top to hang up the laundry.	vig.	1.97 (1.68)	2	0.88
(12)	Every year you are excited to pluck the cherries off the cherry tree in your garden. Now it is that time again and it will take some time to get all the cherries.	mod.	1.36 (1.54)	1	0.81
(13)	You hear the garbage service at the end of your street. You need to get two full bags from the second floor down to the street.	mod.	1.73 (1.55)	1	0.87
(14)	You got to know your partner at a badminton club. For today's anniversary you want to play badminton with her/him and you just entered the gymnasium.	mod.	1.82 (1.69)	1.5	0.72
(15)	You are playing with your dog in the park. He has a lot of energy, so you throw his ball a few times as far as you can.	mod.	0.97 (1.34)	0	0.75

MET metabolic equivalent of task (moderate, vigorous), *ITC* corrected item total correlation

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