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ORIGINAL ARTICLE

Depression mediates physical activity readiness and physical activity in patients with heart failure

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Abstract

Aims Although physical activity (PA) and exercise are essential for patients with heart failure (HF), adherence to the recommended guidelines is low. Not much is known about the mediating effect of HF patients' mental state with their readiness for PA and reported activity levels. The purpose of this study is to investigate the mediatory effect of depression on PA readiness (physical limitation and psychological readiness) and self-reported PA in patients with HF.

Methods and results In this cross-sectional study, 163 New York Heart Association Class I and II HF patients, during their clinic visit, reported on their physical limitation (PAR-Q) and psychological readiness [self-efficacy (ESES) and motivation (RM 4-FM)] for PA, depression (HADS-D), and PA (s-IPAQ). Mediation analysis was performed to test the mediating effect of depression on PA readiness (physical limitation and psychological readiness) and self-reported PA following the steps described by Baron and Kenny (1986). Hierarchical regression models were tested for their effects. The Self-Efficacy Theory and Self-Determination theory provided the theoretical platform for the study. Depression completely mediated the effect of physical limitation (β_{dep} = 268.57; $P < 0.0001$) and partially mediated the effect of self-efficacy on PA (β_{dep} = 344.16; $P < 0.0001$). Both intrinsic ($P < .0001$) and extrinsic motivation ($P < .0001$) for PA had an independent and significant effect on PA, not mediated by depression.

Conclusions Patients with HF should be screened for depression throughout the trajectory of the disease as it can impact their physical and psychological readiness to perform PA.

Keywords Heart failure; Depression; Physical activity; Readiness; Motivation; Self-efficacy

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Introduction

With more than 26 million people diagnosed with heart failure (HF) worldwide, the prevalence of HF is a global healthcare concern.[1] HF patients, irrespective of the diagnosis of reduced or preserved ejection fraction (i.e. HF with reduced ejection fraction vs. HF with preserved ejection fraction), experience symptoms of dyspnoea, fatigue, exercise intolerance, and decline in physical functioning. The increase in the incidence of HF is directly related to the aging population as the majority of patients diagnosed with HF are older adults.[2–4] HF has the highest rehospitalization rate among all chronic diseases[5] and about 25–30% of HF patients die within a year of their first hospitalization.[6,7] Regular physical activity (PA) and exercise are important lifestyle modifications for HF patients as they help to improve HF symptoms and also reduce hospitalizations.[8]

Even though the known benefits of exercise have been established in this population, engagement in regular PA and exercise remains low. Even large intervention trials, such as HF-ACTION and HEART-Camp, have not been able to achieve the desired exercise adherence outcomes with only ~35% of participants achieving full adherence.[8,9] Exercise and PA participation requires readiness, both physical and

psychological, on the part of the individual. Physical limitation especially with mobility, poor health, and fear of adverse event negatively impacts PA in older adults.[10] As such, it is likely that HF patients may not evaluate themselves to be ready to engage in PA and exercise. Self-efficacy as described by Bandura's Self-Efficacy Theory[11,12] and motivation as postulated by the Self-Determination Theory (SDT)[13] are important psychological determinants that influence engagement in PA. Self-efficacy, often situation-specific, is the confidence to perform a specific activity based on an acquired skillset[11] while motivation explains the driving force behind the performance of an activity.[13] As suggested by the SDT, competence is an essential attribute of motivation to perform a task.[13] Higher levels of self-efficacy can motivate individuals to improve competence which in turn influences the performance of the task and persistence with it even when encountering difficulties.[14,15] Competence, developed through performance of the task such as PA, can directly and positively influence both self-efficacy and motivation for PA.[16] This observation is also true for engagement and adherence to PA in patients with HF.[17–19] Although the mediating effect of self-efficacy on motivation and PA has been demonstrated in this population,[20] we find a lack of investigation of the readiness for PA among patients with HF. In this study, we investigate the effect of physical limitation and psychological readiness (self-efficacy and motivation) on self-reported PA behaviour.

It can be argued that comorbidities can impact a person's readiness for PA and engagement in PA. Depression negatively impacts PA levels for most individuals.[21] A meta-analysis reported 21.5% of HF patients to exhibit clinically significant depression.[22] Other studies report depression to be more prevalent among patients with HF with nearly 50% of HF patients in the outpatient setting experiencing depression.[23,24] A study published in 2018 on patients with coronary artery disease found depressive symptoms to mediate the effect of exercise self-efficacy on PA.[25] While assessment of HF patients' readiness for behavioural changes has been investigated,[26] the mediating effect of depression on PA readiness and PA among patients with HF is not known. To achieve desired health outcomes in patients with HF, the influence of both the physical and mental health on PA needs to be evaluated.

Thus, the purpose of this study is to investigate the mediatory effect of depression on PA readiness (both physical limitation and psychological readiness) and self-reported PA in patients with HF. In this study, we investigate the following mediation model (*Figure 1*).

Method

Design and setting

In this cross-sectional study, participants completed surveys during their visit at the outpatient cardiology clinic at the Hospital Universitari i Politècnic La Fe in Spain between January and July 2018. Participants provided oral and written informed consent prior to filling out the questionnaires. Participants were provided help with interpretation of questions in the questionnaire and filling them out. The study complied with the Declaration of Helsinki and was approved by the Regional Ethics Committee (H1510342565432).

Sample

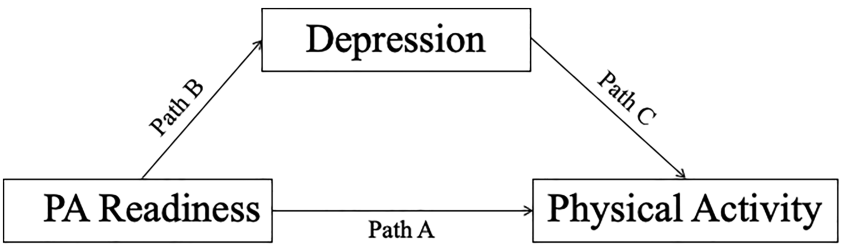
Participants were above 18 years of age, had a clinical diagnosis of HF (including HF with preserved and reduced ejection fraction), and able to speak Spanish. Participants with cognitive and neuropsychiatric disorders were excluded from the study as their response on the questionnaires would not be accurate and reliable.

Outcome and measures

1 PA readiness

a Physical limitation: The Physical Activity Readiness Questionnaire (PAR-Q) questionnaire with seven questions was used to assess physical limitation. The PAR-Q is used

Figure 1 Mediation model; Path A is the direct effect of the independent variable on the dependent variable; Path B is the effect of the independent variable on mediator variable; and Path C is the effect of the mediator and independent variable on the dependent variable. PA, physical activity.



to determine any physical limitation and the need for medical evaluation prior to starting PA and exercise.[27] Because all HF patients are on standard cardiac medications, q6 was marked as a 'Yes' for all participants. From responses on the questionnaire, participants were categorized as ready (score = 0) and not ready (score > 0). A score of 0 indicates no physical limitation for PA and exercise.

2 Psychological readiness

a Self-efficacy: The Exercise Self-Efficacy Scale was used to assess self-efficacy for exercise. The questionnaire contains nine questions and assessed participants' confidence to exercise under different conditions or constraints. Participants responded on a 4-point scale, ranging from 1 (*very sure*) to 4 (*not at all sure*). A score of 15 and higher indicates adequate self-efficacy for exercise. The scale has been tested for its validity and reliability.[28]

b Motivation: Motivation was measured using the 16-item Motivation for Physical Activity and Exercise/Working Out questionnaire (RM 4-FM). The scale has four subsections, namely, external regulation, introjected regulation, identified regulation, and intrinsic motivation. According to the SDT, motivation to perform an activity may be intrinsic (sheer pleasure of performing the activity) or extrinsic. Extrinsic motivation is further classified into integrated regulation (derived from consciously valued goals integrated into self), identified regulation (somewhat integrated), introjected regulation (activity performed from a position of compulsion, guilt, contingent self-esteem), and external regulation (driven by reward or punishment).[13,29] Built on the constructs of the SDT, the questionnaire identifies if PA is performed from a point of intrinsically or extrinsically motivated via external regulation, introjected regulation or identified regulation. For each question, the scale ranges from 1 to 7 with a score of 4 being 'somewhat true' indicating that for a particular question a person is either completely intrinsically or extrinsically motivated. The scale has a relative autonomic index of −8.3 and 11.3. A negative number indicated that the activity is driven by extrinsic factors, and a positive number indicates the performance of the activity is intrinsically motivated. However, it is to be noted that not much of human activity is performed from a point of intrinsic motivation.[30] Therefore, we categorized the questionnaire into intrinsic (M_{int}) and extrinsic (M_{ext}) motivation with the mean score of integrated regulation, identified regulation, and external regulation indicating the total extrinsic motivation.

3 Physical activity: PA was measured with the International Physical Activity Questionnaire Short form (s-IPAQ). The s-IPAQ contains seven questions for identifying the frequency and duration of light [<600 metabolic equivalent of task (MET)-minutes/week; walking at work and at home, walking from place to place, and any other walking that might be done solely for recreation, sport, exercise, or leisure], moderate (between 600 and 3000 MET-minutes/week; carrying light loads, cycling at a regular pace, or doubles tennis), and vigorous (>3000 MET-minutes/week; lifting, digging, aerobics, or fast cycling) PA as well as inactivity during the past week. The total PA score is the sum of vigorous, moderate, and walking in MET-minute in the past week. Typical s-IPAQ correlations with an accelerometer were 0.80 for reliability.[31]

4 Depression: The Hospital Anxiety and Depression Scale (HADS) was used to measure depression. The HADS is a valid and reliable instrument used to assess the prevalence of emotional distress among cardiac patients including patients with HF.[32,33] The scale consists of 14 items in 2 sections, where 7 items measure anxiety (HADS-A) and the remaining 7 items depression (HADS-D). These are rated on a 4-point scale with different response options for each question, and with a theoretical range of 0 and 21 in each group. We considered the questions that were related to depression, that is, HADS-D. Participants was categorized as not experiencing depressing symptoms (score < 7) and experiencing depressing symptoms (score > 7).

Procedure

Participants were invited to complete the questionnaires, after providing informed consent, during their regular visit to the cardiology clinic at the Hospital Universitari i Politècnic La Fe, Spain.

Analysis

Descriptive statistics for patient demographics and clinical characteristics, physical limitation categories, psychological readiness (self-efficacy and motivation), depression categories, and PA levels were analysed. In analysing the data from the PAR-Q, we excluded q6 from the analysis as it was uniform for all participants. Including this item for analysis would have categorized all participants as 'not ready' for PA. Mediation analysis was performed to test the mediating effect of depression on readiness (both physical and psychological) and PA. As described by Baron and Kenny, the following steps involved in the mediation analysis were followed[34]:

1 Test the significance of Path A by analysing the effect of the independent variable (Readiness) on the dependent variable (PA score). Model: $y = \beta_{0A} + \beta_{1A}x + eA$, where y is the PA score and β_1 is the coefficient of the readiness variable x = *physical activity readiness* (*PR*) *categories*; *selfefficacy* (*SE*) *and motivation* (*Mint and Mext*).

2 If Path A is significant, test the significance of Path B by analysing the effect of the independent variable on

depression categories (mediator variable). Model: $M = \beta_{0B} + \beta_{1B}x + eB$, where M is depression and β_1 is the coefficient of the readiness variable (x).

3 Finally, for analysing Path C, if Path B is significant, the effect of both the independent variable and the mediator variable (depression) on PA scores is analysed. $y = \beta_{0C} + \beta_{1c}x + \beta_{2c}depression + eC$

After analysing Step 3, if the independent variable becomes non-significant, it can be concluded that the mediator variable mediated the effect on the outcome variable. If both the readiness and depression categories have a significant effect on PA, partial mediation was concluded if introduction of depression categories leads to the lowering of the effect of the independent variable.

Results

A total of 163 patients classified with New York Heart Association (NYHA) Class I and II with mean age 66 ± 16 years responded to the questionnaires. Demographic and clinical characteristic of our sample is provided in *Table 1*. The description of PA readiness, depression, and PA levels are provided in *Table 2* (*Figure 2*).

Table 1 Demographic and clinical characteristics (n = 163)

Age (years) (mean ± SD)	66 ± 16
Female gender (n %)	82 (50%)
Time since diagnose in months (mean ± SD)	96 ± 126
Educational level (n %)	
Primary school	101 (62%)
Secondary school	38 (23%)
University	24 (15%)
Civil state (n %)	
Married	134 (82%)
Widow/Divorced/Single	29 (18%)
Occupation (n %)	
Retired	101 (62%)
Working	31 (19%)
Unemployed	16 (10%)
Work disability	8 (5%)
New York Heart Association Class (n %)	
NYHA I	102 (63%)
NYHA II	61 (37%)
Weight in kg (mean ± SD)	73 ± 10
BMI (mean ± SD)	27 ± 3
Comorbidity (n %)	
Arterial hypertension	63 (39%)
Diabetes	57 (35%)
Dyslipidaemia	47 (29%)
Renal insufficiency	16 (10%)
COPD	12 (7%)
Heart attack	5 (3%)
Arteriosclerosis	5 (3%)

BMI, body mass index; COPD, chronic obstructive pulmonary disease; NYHA, New York Heart Association.

Table 2 Description of readiness, depression, and physical activity levels

Readiness	
Physical limitation (PAR-Q)	
Ready (%)	35.6%
Not ready (%)	64.4%
Psychological readiness	
Self-efficacy (ESES) (M ± SD)	12.6 ± 3.7
Motivation (RM 4-FM) (M ± SD)	0.3017 ± 2.4
Depression	
Depressed (%)	40%
Not depressed (%)	60%
Physical activity (M ± SD)	768.7 ± 393.7 MET-minutes
Light (n = 57) (M ± SD)	363.49 ± 18.87 MET-minutes
Moderate (n = 106) (M ± SD)	86.613 ± 29.35 MET-minutes
Vigorous (n = 0) (M ± SD)	N/A

ESES, Exercise Self-Efficacy Scale; MET, metabolic equivalent of task; PAR-Q, Physical Activity Readiness Questionnaire.

Path A

Physical limitation categories (β_{PR} = 132.83; P = 0.039), self-efficacy (β_{SE} = 25.237; P = 0.002), intrinsic motivation (β_{Mint} = 153.48; $P < 0.0001$), and extrinsic motivation (β_{Mext} = 143.18; $P < 0.0001$) had a significant effect on PA. This indicates that higher physical limitation will lead to lower levels of PA while higher levels of self-efficacy and motivation will positively impact PA in patients with HF.

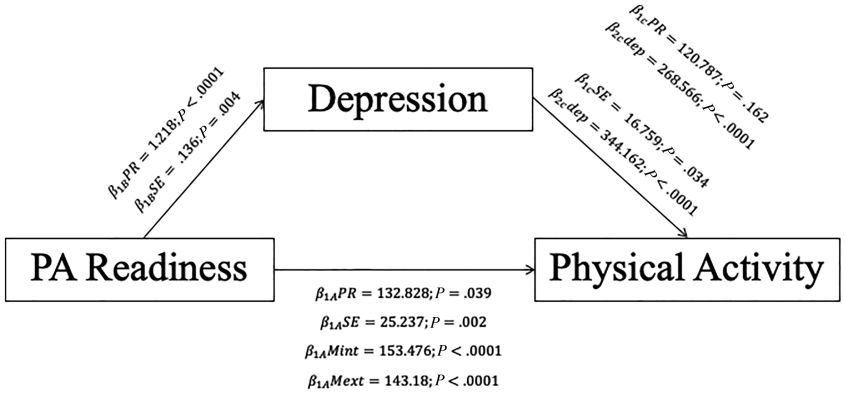
Path B

Physical limitation (β_{PR} = 1.218; $P < 0.0001$) and self-efficacy (β_{SE} = 0.136; P = 0.004) had a significant effect on depression categories. This indicates that a person with higher levels of physical limitation and lower self-efficacy will experience higher levels of depression. Both intrinsic and extrinsic motivation did not significantly impact depression.

Path C

With physical limitation becoming non-significant (β_{PR} = 120.79; P = 0.162), depression categories had a completely mediating effect (β_{dep} = 268.57; $P < 0.0001$) on physical readiness and PA level. The complete mediation indicates that a patient with HF who is also depressed is likely to have lower levels of PA irrespective of their physical limitation. Path C analysis also shows that although self-efficacy has a significant on PA, the effect of the regression coefficient is reduced (β_{SE} = 16.76; P = 0.034) when compared with Path A. Hence, depression has a partially mediating effect (β_{dep} = 344.16; $P < 0.0001$) on the relationship between self-efficacy and PA meaning that a higher level of depression will have some influence on the person's confidence to engage and participate in PA.

Figure 2 Mediation model with effects. PA, physical activity.



Discussion

We found depression to completely mediate the effects of physical limitation on PA and partially mediate the effect of self-efficacy on PA. This indicates that HF patients' mental state (depression) affects their already existing physical limitation and psychological readiness (confidence) to overcome barriers to perform PA. A diagnosis of HF and knowing that one's cardiac function has been compromised can be terrifying to many HF patients. Not believing in one's ability to engaging in PA along with fear of causing self-harm are major deterrents to engaging in PA and exercise in patients with HF.[35] As such, it is important for HF patients to feel confident that their physical limitation does not exclude them from participating in regular exercise. Our study found that participants who reported of physical limitation for exercise are also less likely to engage in PA and exercise. We found that depression will likely cause HF patients to be less physically active even if the patient did not report of any physically limitation to perform PA. We also found a significant relationship between self-efficacy for exercise and reported activity levels. The finding is consistent with previous studies reporting of a positive relationship between self-efficacy and exercise and PA levels among cardiac patients,[20] healthy adults,[36] diabetics,[37] older adults,[38] and breast cancer survivors.[39] It can be inferred that HF patients who report to having fewer physical limitations for PA are also likely to be more confident in their ability to overcome barriers to achieve their exercise goals. Our inference is supported by the fact that older adults who report of no or moderate mobility limitations are more open to health promotion activities and find engagement in exercise as a positive experience.[10] With depression categories partially mediating the impact of self-efficacy on PA, HF patients' confidence to overcome barriers to achieve the desired level of PA will be lowered in the presence of depression. Long-term adherence to exercise and higher levels of PA is important from a perspective of non-pharmacological management of HF as well for patients to live a higher quality of life. Our study shows that not all patients are physically and/or psychologically ready to participate in these programmes. We recommend screening for physical readiness, self-efficacy, as well as depression when recommending PA and exercise for patients with HF and tailoring the intervention to meet the needs of the patient with depression.

Although both intrinsic and extrinsic motivation had a significant effect on PA levels, we found that depression categories did not mediate the relationship. Whereas depression may in itself have an effect on PA in patients with HF, in our study, we found that it does not mediate the relation between motivation and PA. This indicates that irrespective of the level of depression, strong motivation (both intrinsic and extrinsic) for PA and exercise are likely to have a positive effect on PA levels in patients with HF. In other words, a person who is depressed may engage in PA and exercise if the motivation for exercise is strong. This finding suggests that research interventions to improve PA and exercise in patients with HF need to focus on study designs that enhances motivation for the activity. A lack of sustained motivation has been highlighted as a major reason for the decline in adherence for exercise in intervention studies lasting greater than 12 months.[8,9] As described and supported by the SDT, PA interventions should specifically focus on the internalization of the behaviour as the likelihood of sustaining the activity, the value of which has been internalized by the person to be beneficial, is higher. The motivation for PA in our sample was barely driven by intrinsic motivation for PA or exercise indicated by a positive value of 0.30 in the RM 4-FM questionnaire. This corresponds with the SDT that most of human activity is not driven by intrinsic motivation for the activity.[30] We also find that our sample, comprising of NYHA Class I and II patients with HF, was not driven by a strong extrinsic motivation for PA and exercise as well. This is indicated in the fact that the overall self-reported PA of 986.613 ± 29.35 MET-minutes, which could have been overestimate,[40] is only

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slightly above light activity (>600 MET-minutes) but much lower than the upper range of moderate activity (3000 MET-minutes).

Our study is among the first to investigate the mediating effect of depression on readiness (physical and psychological) and PA in patients with HF. The finding of the study is however limited to the sample consisting mainly of Class I and II HF patients in Spain, and any generalizations should be cautioned. The outcomes are self-reported and may be prone to errors with interpretation and under or over estimation. From our cross-sectional study, causal relationship should not be drawn from our findings. Also, longitudinal trials are needed to further corroborate our findings. Based on published literature and a decent sample size, we are confident of our findings and they are supported by previous studies on the topic.

Heart failure has the highest rehospitalization rate among all chronic diseases,[5] and during the trajectory of the disease, HF patients are likely to experience periods of worsening HF. It is also likely that a depressive mental state can develop as patients experience worsening symptoms and frequent rehospitalization. With depression mediating the relationship of physical limitation and self-efficacy with PA, it will likely that HF patients' mental states during the course of the disease affect their PA levels as well. The mediating effect of depression on physical and psychological readiness among NYHA Class III and IV HF patients should be investigated to verify the inference.

In conclusion, we recommend that screening for depression should be performed during the patients' hospital stay and during regular clinic visits. Healthcare professionals working with patients with HF should provide encouragement and motivation for PA/exercise. Future clinical trials to improve PA and exercise in HF patients should consider incorporating motivational strategies in their intervention.

Conflict of interest

None declared.

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