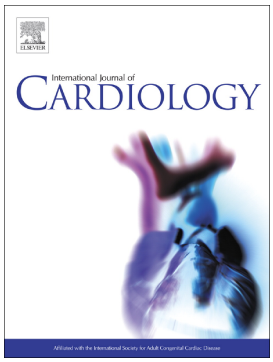

Beyond the heart: The role of psychological factors and coping strategies in cardiovascular rehabilitation

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Beyond the Heart: The Role of Psychological Factors and Coping Strategies in Cardiovascular Rehabilitation

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ABSTRACT

Background: Cardiovascular disease (CVD) is associated with several risk and protective factors, including psychological variables, such as anxiety and depressive symptoms, stress and coping strategies. These factors may be either a cause or a consequence of CVD and are thought to influence the cardiac rehabilitation (CR) process after acute cardiac event, a multifaceted intervention that is crucial for reducing rehospitalisation and mortality. The main aim of this study was to correlate such psychological components with cardiac outcomes in a sample of 315 CVD referred to an in-hospital CR program.

Methods: Participants completed self-report questionnaires on perceived stress, anxiety and depressive symptoms, and coping styles.

Results: Females (36.51%) reported higher levels of depressive symptoms and turning to religion as a coping strategy compared to male. Perceived stress did not differ between male and female, but it was found to be significantly higher in heart failure patients, regardless of gender. Functional outcomes after a CR program were not predicted by any psychological variable, whereas clinical outcomes were predicted by depressive symptoms and coping strategies (social support and positive attitude). Finally, perceived health status was predicted by anxiety, depressive symptoms and avoidance.

Conclusions: These findings confirm the importance of conducting psychological screening in patients with CVD, as recommended by international guidelines, and highlight the need to provide them with adequate psychological support to reduce the adverse consequences of cardiac disease, and to promote protective attitudes and behaviours through tailored psychological interventions to improve outcomes after a CR program.

1. Introduction

Cardiovascular disease (CVD) is often associated with various mental disturbances, affecting approximately 40% of patients [1]. In particular, stress, depression, anxiety, and personality disorders represent possible independent risk factors for the development of CVD [2,3] and may reduce life expectancy in CVD patients [2,4] due to physiological and behavioural mechanisms that may worsen prognosis and increase the incidence of morbidity and mortality [1,5]. Conversely, the presence of CVD can heighten the risk of developing mental disorders, including anxiety and depression, due to the stress and life changes associated with managing a chronic illness [6].

Few studies have also suggested a link between negative (i.e. depression, anxiety and stress) and positive (i.e. coping style) psychological variables and cardiac rehabilitation (CR), a comprehensive, post-acute, multifaceted intervention that is effective in reducing re-hospitalisations and incidence of acute coronary syndromes and mortality [7–9], as well as for improving the patients' perceived health status and their exercise capability after an acute cardiac event [10]. Patients with severe anxious and depressive symptoms, and inadequate stress management strategies, seem to be less adherent to CR than those with milder symptoms [11]. In a study by Glazer and coll., the presence of depressive symptoms, but not their severity, was predictive of changes in aerobic capacity after CR [12]. Conversely, positive psychological factors protect individuals from the onset of CVD and improve prognosis by positively influencing cardiovascular health through healthier physiological functioning and promoting healthy behaviours [13]. Few studies have investigated their role in rehabilitation settings, showing, for example, that an effective coping style appears to be associated with faster and more efficient rehabilitation pathways compared to dysfunctional mental processes, such as denial and avoidance, which increase the risk of adverse somatic events[14,15].

With the present study, we aimed to deepen the knowledge about the link between psychological factors and outcomes after CR especially focusing on positive factors. To do so, we conducted a

screening of anxious, depressive, stress symptoms, and coping strategies, in a sample of patients admitted for an in-hospital CR to correlate these variables with rehabilitation outcomes. We also investigated the potential psychological predictors of the most common outcome measures. Finally, we analysed the degree of acceptance of an online psychological screening procedure, in order to test its feasibility in future studies and in everyday clinical practice.

2. Methods

2.1 Participants

All patients consecutively admitted to the CR Unit of the IRCCS ICS Maugeri of Milan (Italy), aged ≥18 years and able to complete the questionnaires independently, were assessed for eligibility. All patients were referred after an acute event, either congestive heart failure (HF), acute coronary syndrome, or coronary and/or valve surgery. Exclusion criteria were: no understanding of the Italian language; severe visual-perceptual deficits; cognitive deterioration preventing self-administration of the questionnaires; refusal to participate in the study.

Eligible patients were informed about the scope of the study and asked to sign the informed consent.

2.2 Procedure

Within the first two days of admission to the CR Unit, all patients included in the study underwent a self-administered psychological screening to assess the presence of anxiety, depressive and stress symptoms, and coping strategies.

Patients could choose to complete the assessment online by scanning a QR code using their own personal device (smartphone or tablet), or to use the traditional paper-and-pencil method. For the online version, data were collected using the REDCap (Research Electronic Data Capture) platform [16].

Patients' clinical [i.e., diagnosis, cardiac frequency, peripheral oxygen saturation (SaO2), blood pressure], and functional data (daily living autonomy and physical performance), and their perceived health status, previously collected by nurses and physiotherapists, were extrapolated from the hospital computerized medical records. The diagnoses were classified according to the International Statistical Classification of Diseases (ICD) and grouped into Diagnosis Related Groups (DRGs) as follows: DRG_127, which includes HF; DRG-144, which includes post cardiac surgery and post without complicated conditions; DRG-145, which includes post cardiac surgery and post with complicated conditions (e.g. arrhythmic events, infectious events, surgical wound complications). DRGs are an internationally used coding system based on principal diagnosis, secondary diagnoses, procedures and other factors (e.g. age and presence of complications) defined during the hospitalisation process. The study was approved by the Institutional Review Board and Central Ethics Committee of the ICS Maugeri SpA SB (approval number: CEC N. 2695).

In accordance with the European guidelines concerning CR [17], the rehabilitative pathway comprises the following elements: clinical assessment and titration of optimal medical care, physical activity assessment and exercise training (i.e. cycle ergometer/treadmill, arm ergometer, respiratory and strength exercises if indicated), individual and/or group educational interventions about the disease and the related risk factors, psychological counselling if recommended, and metabolic assessment with personalised diet if indicated. The exercise training was typically conducted twice a day for a total duration of one hour per day. Additionally, patients participated in group sessions dedicated to breathing exercises, aiming to enhance their respiratory function.

The entire rehabilitative pathway was personalised according to the individual patient characteristics.

2.3 Materials

All participants were asked to complete a preliminary questionnaire about sociodemographic variables, smoking habit and psychiatric comorbidities at anamnesis. The psychological screening included the following validated questionnaires:

- Generalised Anxiety Disorder-7 (GAD-7) that measures the severity of anxiety symptoms over the past two weeks. It consists of 7 items on a 4-point Likert scale corresponding to the severity of symptoms. Scores range from 0 to 21. Scores of 5, 10 and 15 are cut-offs for mild, moderate and severe anxiety respectively [18].
- Patient Health Questionnaire-9 (PHQ-9) to assess the presence of depressive symptoms. Consisting of 9 items with a total score ranging from 0 to 27, it can be divided into clinical ranges of variability according to a continuum of symptom severity, with scores of 5, 10, 14 and 19 representing cut-offs for subthreshold, mild major, moderate major and severe major depression [19].
- Perceived Stress Scale (PSS-10) that measures perceived stress. It is a 10-item questionnaire rated on a 5-point Likert scale. The total score ranges from 0 to 40 and can be categorised into 3 levels: low perceived stress (0-13), moderate perceived stress (14-26) and high perceived stress (27-40) [20].
- COPE-New Italian Version (COPE-NVI-25) that measures coping styles. It consists of 25 items that assess how often the individual uses a coping style. The item scores range from 1 to 6. This instrument allows the assessment of 5 independent dimensions: social support, avoidance strategies, positive attitude, problem solving and recourse to religion [21].

Functional variables and perceived health status were routinely collected by the nurses and physiotherapists upon admission and discharge. They included:

- Barthel Index (BI) to assess patients' functional status and ability to perform activities of daily living (ADLs). It is a 10-item scale that assesses the following abilities: feeding, bathing, grooming, dressing, bowel and bladder, toileting, transferring, mobility and stair climbing. The total score ranges from 0 (total dependence) to 100 (total independence) [22].
- Braden Scale to measure risk factors for higher intensity and duration of pressure or lower tissue tolerance to pressure. It is composed of 6 subscales including; sensory perception,

wetness, activity, mobility, friction and shear. Each item is accompanied by a descriptor and a score between 1 and 4. The lower the score, the greater the risk [23].

- Morse Fall Scale (MFS) to assess the patient's risk of falling. The scale examines the patient's history of falls, medical history, use of walking aids, use of intravenous fluids, gait pattern and cognitive status. Scores range from 0 to 125, with higher scores indicating a higher risk of falling. Scores can be categorised into 3 levels: low fall risk (0-24), moderate fall risk (25-44) and high fall risk (≥45) [24].
- Short Physical Performance Battery (SPPB) to examine the relationship between physical performance and self-reported disability. The SPPB assesses functional capacity of the lower limbs and consists of three different tests (balance, walking and chair stand) with subscores ranging from 0 to 4. The total score ranges from 0 (worst performance) to 12 (best performance) [25].
- 6-minute walk test (6MWT), a standardized test to measure functional exercise capacity in people with HF, stable coronary syndrome. In this test, the patient is asked to walk as fast as possible for 6 minutes, consistent with their clinical condition. The score is derived from the number of metres walked [26].
- EQ-VAS is a generic quality of life tool consisting of a visual analogue scale (VAS) ranging from 0 (worst imaginable health) to 100 (best imaginable health) [27].

2.4 Statistical analysis

The Shapiro-Wilk statistic was used to test the normality of the distribution of all continuous variables examined. Several variables violated the normality assumption; therefore, descriptive statistics were reported as mean ± standard deviation (SD), but hypothesis testing was based on nonparametric statistics. Between-group comparisons were made using the Mann-Whitney U test. The association between pairs of variables was assessed using the Spearman correlation coefficient.

Descriptive statistics for categorical variables were reported as N (percentage frequency), and between-group comparisons were performed using the chi-squared test or the Fisher exact test, as appropriate.

For each outcome measure considered (BI, Braden, MFS, SPPB, 6MWT, and EQ-VAS), the change from admission to discharge was calculated by subtracting the value at admission from the value at the end of rehabilitation. Multiple linear regression with stepwise model selection was used to determine the independent predictors of these changes. The criterion for adding or removing terms was the change in the value of the Bayesian information criterion. The significance level for entering the model was 0.15 and the significance level for remaining in the model was 0.05.

For each delta in the outcome measures, we considered as candidate predictors their values at admission, Diagnosis Related Groups (DRG), age, sex, education, heart rate, PHQ9, GAD7, PSS-10, and COPE-NVI-25. Multicollinearity was assessed by calculating the variance inflation factor (VIF).

All statistical tests were two-tailed and statistical significance was set at $p < 0.05$. All analyses were performed with the SAS/STAT statistical software.

3. Results

A total of 315 participants were enrolled in the present study. All of them, were referred to the CR program according to the European guide lines [17], after having been affected by one of the following acute events: 19.36% with HF, 70.47% after cardiac surgery, 3.18% after myocardial infarction, 6.03% with pulmonary arterial hypertension and the remaining 0.96% with other CVD. Patients were clustered in three groups: HF (DRG-127) (19.36%), CVD with CC (DRG-145) (21.27%) or without CC (DRG-144) (58.41%). Given the diagnostic heterogeneity between DRGs, comparative analyses were performed within each DRG based on diagnoses. These analyses showed no statistically significant differences between diagnosis-related groups for the considered measures, indicating that the DRGs could be considered homogeneous for the purpose of this study.

Two hundred participants were male (63.5%), 190 were married (60.3%), 176 were retired (55.9%) and 97 were employed (30.8%). One hundred and forty-two patients reported being current (10.5%) or former (34.6%) smokers. In the psychological screening, 144 patients (45.7%) presented anxiety symptoms and 78 (24.8%) had depressive symptoms.

Compared to males, the female sample reported more psychiatric diseases at anamnesis (6.2% vs 3.1%, p=0.017) and a higher use of antidepressants (18.3% vs 10%, p=0.055). Table 1 shows data on psychological, functional and health perception variables for the whole sample and for men and women separately.

HF patients reported higher perceived stress (15.7±7.0 vs 12.9±6.9, p=0.028) and lower perceived health status (14.0±16.7 vs 24.9±15.5, p=0.009) than CVD patients without CC. Regarding coping style, CVD patients without CC reported more positive attitude (21.3±7.1 vs 18.2±8.1, p=0.015) and problem solving (26.0±8.6 vs 22.5±9.8, p=0.010) compared to those with CC.

Table 1. Baseline characteristics of the patient sample and comparison by sex

	Total sample	Male sample	Female sample

Variables	n=315 Mean±SD	n=200 Mean±SD	n=115 Mean±SD	p-value
Age, years	66.2±13.1	65.1±12.5	68.3±13.8	0.022
BMI, #	25.5±4.6	26.0±4.3	24.5±5.0	0.003
Heart rate, bpm	77.2±13.8	75.9±13.7	79.3±13.9	0.039
SaO2, %	95.8±2.8	96.2±2.0	95.1±3.7	0.050
Systolic Blood Pressure, mmHg	116.5±16.0	116.1±15.7	117.3±16.5	0.66
Diastolic Blood Pressure, mmHg	69.8±9.3	70.3±9.3	68.9±9.3	0.38
Psychological variables				
GAD7	5.2±4.5	4.9±4.5	5.6±4.6	0.10
PHQ-9	6.5±4.9	6.1±4.9	7.3±4.8	0.016
PSS	13.5±7.0	13.0±6.8	14.4±7.4	0.11
COPE-NVI-25				
Social support	17.0±7.2	16.7±6.8	17.4±7.9	0.24
Avoidance strategies	10.6±5.3	10.9±5.0	10.0±5.6	0.15
Positive attitude	24.8±8.8	24.7±8.6	25.0±9.2	0.57
Problem solving	20.4±7.4	20.6±7.3	20.0±7.7	0.50
Turning to religion	12.1±7.8	10.8±7.5	14.4±7.9	0.00014
Functional variables and QoL				
Barthel Index	84.5±18.5	85.8±18.6	82.2±18.4	0.019

Braden Scale	20.1±2.1	20.2±2.2	20.0±2.1	0.21
MSF	23.0±17.2	22.2±17.3	24.2±17.0	0.23
SPPB	6.3±4.2	6.9±4.1	5.1±4.1	0.00028
6MWT	379.5±90.8	389.3±73.5	347.3±129.5	0.33
EQ VAS	57.6±14.5	59.2±14.9	54.6±13.5	0.09

Abbreviations: BMI, Body Mass Index; bpm, beats per minute; SaO2, peripheral oxygen saturation; GAD7, Generalized Anxiety Disorder; PHQ9, Patient Health Questionnaire – 9; PSS-10, Perceived Stress Scale; COPE-NVI-25, COPE-New Italian Version; MFS, Morse Fall Scale; SPPB, Short Physical Performance Battery; 6MWT, 6 Minutes Walking Test; EQ VAS, EuroQol Visual Analogue Scale.

Table 2 shows comparisons of psychological, functional and perceived health status variables by DRG.

Table 2. Comparison of psychological, clinical and perceived health status variables by DRG.

Variables	HF Mean±SD	CVD with CC Mean±SD	CVD without CC Mean±SD	p-value
GAD7	5.8±4.8	5.0±4.5	5.0±4.5	0.41
PHQ-9	7.5±5.4	7.0±5.6	6.0±4.4	0.08
PSS	15.7±7.0°	13.1±7.4	12.9±6.9	0.028
COPE-NVI-25				
Social support	16.2±6.8	15.6±7.4	17.7±7.3	0.08
Avoidance strategies	11.7±5.8	9.5±4.9	10.6±5.2	0.070
Positive attitude	19.9±7.2	18.2±8.1^	21.3±7.1	0.015
Problem solving	23.5±8.0	22.5±9.8 ^	26.0±8.6	0.010
Turning to religion	10.9±7.8	11.0±7.1	12.9±8.1	0.10
Δ Barthel Index	6.21±13.08	7.74±13.45	8.15±10.71	0.55
Δ Braden Scale	0.73±1.93	1.12±1.66	1.04±1.41	0.33
Δ MSF	-3.98±10.45	-5.31±14.58	-3.66±10.40	0.61
Δ SPPB	1.73±2.61	2.75±4.19	2.79±3.14	0.13
Δ 6MWT	89.3±87.8	43.7±79.5	115.2±72.9	0.07
Δ EQ VAS	14.0±16.7°	22.0±13.2	24.9±15.5	0.009

Note: ° significant differences between HF and CVD without CC; ^ significant differences between cardiovascular diseases with CC and CVD without CC.

Abbreviations: DRG, Diagnosis Related Group; BMI, Body Mass Index; SpO2, peripheral oxygen saturation; GAD7, Generalized Anxiety Disorder; PHQ9, Patient Health Questionnaire – 9; PSS-10, Perceived Stress Scale; COPE-NVI-25, COPE-New Italian Version; MFS, Morse Fall Scale; SPPB, Short Physical Performance Battery; 6MWT, 6 Minutes Walking Test; EQ VAS, EuroQol Visual Analogue Scale.

Figure 1 shows the correlations between the psychological variables assessed at admission and the Δs of the clinical, functional and perceived health status variables (calculated by subtracting the value of the variable at admission from the value obtained at the end of the rehabilitation) of the

clinical, functional and HRQoL variables. The only significant correlations were between problem solving and positive attitude coping style and the Barthel Index ($r=-0.12$, $p<0.05$ for both correlations), and between perceived stress and the SPPB ($r=0.12$, $p<0.05$).

Figure 1. Correlations between psychological variables and Δ of rehabilitation outcomes

Note: p, *<0.05; **<0.01; ***<0.001. The variables marked with white dots are those that assess psychological aspects, while those marked with black dots are Δs of rehabilitative outcomes. The solid lines indicate positive correlations, while the dashed lines indicate negative correlations.

Abbreviations: GAD7, Generalized Anxiety Disorder; PHQ9, Patient Health Questionnaire – 9; PSS-10, Perceived Stress Scale; COPE-NVI-25, COPE-New Italian Version; MFS, Morse Fall Scale; SPPB, Short Physical Performance Battery; 6MWT, 6 Minutes Walking Test; EQ VAS, EuroQol Visual Analogue Scale.

Table 3 shows the stepwise regression analysis models identifying predictors of the Δ of the outcome variables. In all the stepwise regression analysis models, the value of the dependent predictor at admission is included as an independent predictor.

Table 3. Stepwise regression models

Variables	β	tstat	*p*
Δ BI Predictors			
Admission BI	-0.39	-13.68	<0.0001
Social support	-0.18	-2.39	0.017
Δ Braden Predictors			
Admission Braden	-0.56	-17.16	<0.0001
Age	-0.013	-2.50	0.013
PHQ9	-0.033	-2.46	0.015
Δ MFS Predictors			
Admission MFS	-0.44	-13.86	<0.0001
Age	0.09	2.52	0.012
PHQ9	0.24	2.38	0.018
Positive Attitude	0.16	2.87	0.004
Δ SPPB Predictors			
Admission SPPB	-0.41	-9.14	<0.0001
Cardiac Frequency	0.035	2.69	0.008
Δ 6MWT Predictors			
Admission 6MWT	-0.33	-3.21	0.002
Age	-2.29	-3.27	0.002
Δ EQ VAS Predictors			
Admission EQ VAS	-0.75	-10.40	<0.0001
CVD without CC	8.45	3.04	0.003
PHQ9	-1.58	-4.30	<0.0001
GAD7	1.14	3.36	0.001
Avoidance strategies	-0.44	-2.29	0.024

Note: BI: model adjusted R2=0.414 (F-statistic: 98.2, p <0.0001); Braden: model adjusted R2= 0.519 (F-statistic: 101, p <0.0001); MSF: model adjusted R2= 0.441 (F-statistic: 54.1, p <0.0001); SPPB: model adjusted R2= 0.259 (F-statistic:

43.6, p <0.0001); 6MWT: model adjusted R2= 0.227 (F-statistic: 43.6, p=0.0004); EQ VAS model adjusted R2= 0.521 (F-statistic: 23.1, p <0.0001).

Abbreviations: GAD7, Generalized Anxiety Disorder; PHQ9, Patient Health Questionnaire – 9; PSS-10, Perceived Stress Scale; COPE-NVI-25, COPE-New Italian Version; MFS, Morse Fall Scale; SPPB, Short Physical Performance Battery; 6MWT, 6 Minutes Walking Test; EQ VAS, EuroQol Visual Analogue Scale.

Finally, regarding the level of acceptance of the online data collection procedure, only 56 patients chose to complete the questionnaires on their own device. These patients were found to be younger (57.59±15.32 vs 68.28±11.60, p<.001), more positive (27.09±5.92 vs 24.32±9.27, p=.006) and more problem-solving (22.73±5.01 vs 19.91±7.75, p=.001) than those who preferred the paper-based method.

4. Discussion

The aim of this observational study was to correlate protective and negative psychological factors (i.e. coping strategies, anxiety, depressive and stress) with rehabilitation outcomes, in a cohort of cardiovascular inpatients. In addition, the potential predictors of the rehabilitation outcome measures and the acceptability of an online data collection procedure were investigated.

The sample was characterized by a prevalence of males. Almost half of the total sample had a past or current smoking history. These data are consistent with existing literature, showing that male gender and smoking are risk factors for the development of CVD [28]. Furthermore, the observed differences in gender distribution may also be due to the underuse of cardiac rehabilitation services by women [29,30], despite the fact that they are characterised by a worse physical performance after cardiac events compared to men [31,32] and despite the evidence of a more significative improvement of physical performance in older women [33].

Regarding the incidence of mental disorders, the observed presence of depressive symptoms in about a quarter of our sample is consistent with the existing literature, which shows that patients with various CVD present depressive symptoms in the range of 15-30% [34]. On the other hand,

our data show a slightly higher percentage of anxiety symptoms (45.7%) compared to what observed in the literature after the occurrence of cardiovascular events (13% to 40% depending on the diagnosis) [35]. This may be due to the overlap between anxiety and clinical symptoms related to cardiac disease, such as chest pain or palpitations, making it difficult to distinguish between them using self-administered questionnaires [34]. While, according to the literature [35,36], women reported significantly higher levels of depressive symptoms and recourse to religion as a coping strategy compared to men, stress levels did not depend on gender, but were significantly higher in HF patients compared to those with other heart diseases. This link between HF and stress has already been found in previous studies, highlighting HF itself as a source of stress, being a chronic and life-threatening condition [37].

As for the relationship between psychological variables and post-CR outcomes, we found that coping strategy related to social support negatively predicted Barthel Index on the elderly population and patients with stroke in keeping [38,39]. On the other hand, some clinical features of depressive symptoms, such as reduced self-care and lack of motivation, as well as some clinical comorbidities (e.g. diabetes) may also increase the likelihood of complications such as infection, pressure ulcers [40], as suggested by the negative correlation between the Braden scale and PHQ-9 scores. Interestingly, we found a positive correlation between stress and improvement in SPPB, while positive attitude and problem solving were negatively correlated with BI scores. Interestingly, we found a positive correlation between stress and improvement in SPPB, while positive attitude and problem solving were negatively correlated with BI scores. Similar results were reported in a review published in 2014 [41], that included 17.2% of experimental studies indicating a bidirectional relationship between stress and physical activity in which the presence of stress improves physical performance.

Concerning the negative correlation between positive attitude, problem solving and BI, we can notice that the observed BI value of 84.49 shows a moderate level of dependency in ADLs, and so a partial loss of function possibly associated with an increased perceived stress [42]. We can argue

that the higher the level of dependency, the higher the use of coping strategies to deal with stress induced by the partial inability to carry out ADLs.

Interestingly, we found that depressive symptoms and positive attitudes positively predicted the risk of falls. The relationship between depressive symptoms and falls, which is poorly investigated in the existing literature, could reasonably be related to psychomotor retardation and gait alteration, or cognitive difficulties in attention, executive function and processing speed, which are common in depressed patients as well as in patients with HF [43], which may contribute to the increased risk of falls [44,45]. The positive influence of the positive attitudes on the risk of falling could also be related to a reduced perception of illness and/or to the desire to regain independence with the consequent engagement in risk-taking behaviours that increase the risk of falling [46].

Furthermore, our data suggest that patients' functional mobility is not predicted by the psychological variables assessed. These findings are not consistent with the limited existing literature on the effects of psychological variables on functional variables such as the 6MWT and SPPB, which shows that anxiety and depressive symptoms negatively affect physical performance and alter exercise tolerance in rehabilitation outpatients [47]. Similarly, Ricci et al. (2024) found significant negative correlations between anxiety and depression and the 6MWT. A possible explanation for our negative results may be related to the wide range of different main diagnoses that characterises our sample, which is not limited to cardiac surgery for valvular or coronary disease as in Ricci's study [48]. Finally, our data confirm that the improvement in the patients' perceived health status in a rehabilitative setting can be predicted not only by the specific cardiac disease itself, but also by the observed and cross-sectional psychological variables, such as depressive and anxious symptoms, and avoidant coping strategy, as reported by Schneider et al. in patients with HF [49].

Given the many advantages of using technological tools to collect data from patients - including, but not limited to, cost-effectiveness by eliminating the need for dedicated staff to distribute and collect paper questionnaires, resources for manual database completion, and transcription errors

during compilation - we offered patients the opportunity to complete the screening questionnaires online using their own mobile devices, but acceptance was very low. This finding may be explained by the barriers to adoption and access to digital health technologies reported by Tromp and colleagues (2022) [50], such as those related to health system governance constraints, including limited hospital internet facilities, and/or those related to patient characteristics, such as older age and poor digital and health literacy. It is therefore not surprising that patients who chose the online option were younger and had higher levels of positive attitudes and problem-solving skills, which helped them to overcome the above-mentioned barriers.

Strengths of this study include the systematic implementation of psychological screening in all CVD patients admitted to a rehabilitation hospital, as suggested by the recent European Society of Cardiology (ESC) guidelines [51], which can provide useful insights from both a clinical and a research point of view, allowing the development of personalised rehabilitation strategies that take into account the patients' psychological profile, in addition to the clinical and functional condition. To underline that the evaluation of psychological protective factors, although not yet specified in any of the international guidelines, provides important information about the role of mental positive attitudes on the patients' rehabilitation journey that should be considered and integrated into the existing multidisciplinary rehabilitation programs.

4.1 Limitations

This study has a number of limitations. The most critical is the lack of psychological follow-up, which would have been useful to verify possible changes in psychological symptoms related to the impact of time elapsed since the acute event and the rehabilitation pathway itself on patients' mental well-being and, consequently, on physical outcomes. This limitation is mainly due to the fact that it is quite difficult to monitor the exact discharge date of patients and therefore to carry out psychological follow-up in a timely manner. Similarly, the lack of the individual risk profile upon admission in CR unit limits the prognostic profile of these patients. However, it is well known that CR improves outcomes [17,52] therefore the managing of psychological variables could represent

one of the effective interventions in reducing the individual residual risk. However, these limitation needs to be overcome in future studies.

5. Conclusions

This study confirms a significant presence of depression, anxiety and perceived stress, especially in female, in inpatients with different CVD diagnoses, and highlights the possible negative impact that these psychological risk factors could have on the rehabilitation process. Conversely, these findings add new insights about the importance of protective coping strategies in positively influencing rehabilitation outcomes. Taken together, these data emphasise the importance of a multidisciplinary approach to rehabilitation that focuses not only on the clinical and functional characteristics of the different cardiac diseases, but also on psychological aspects associate with them. Monitoring the presence of risk and protective psychological factors allows clinicians to provide adequate psychological interventions to support patients with mental disorders and promote protective attitudes and behaviours through tailored psychological interventions to improve rehabilitative outcomes.

CRediT authorship contribution statement

Martina Vigorè: Writing – original draft. **Davide Sattin:** Conceptualization; Writing – review and editing. **Roberto Maestri:** Formal analysis. **Maurizio Bussotti:** Resources. **Luca Ranucci:** Investigation. **Chiara Parma:** Investigation. **Roberta Maioli:** Investigation. **Alessia Triffiletti:** Investigation. **Raffaele Simone Scuotto:** Investigation. **Paolo Parazzoli:** Resources. **Laura Adelaide Dalla Vecchia:** Writing – review and editing. **Alessandra Gorini:** Conceptualization, Writing – review and editing.

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Declaration of competing interest

None.

References

[1] M. Michal, M. Beutel, Mental disorders and cardiovascular disease: what should we be looking out for?, Heart 107 (2021) 1756–1761. https://doi.org/10.1136/heartjnl-2019-316379.

[2] D. Krupchanka, K. Mladá, P. Winkler, Y. Khazaal, E. Albanese, Mortality in people with mental disorders in the Czech Republic: a nationwide, register-based cohort study, Lancet Public Health 3 (2018) e289–e295. https://doi.org/https://doi.org/10.1016/S2468-2667(18)30077-X.

[3] F. Starace, F. Mungai, F. Baccari, G.M. Galeazzi, Excess mortality in people with mental illness: findings from a Northern Italy psychiatric case register, Soc Psychiatry Psychiatr Epidemiol 53 (2018) 249–257. https://doi.org/10.1007/s00127-017-1468-8.

[4] M. Härter, H. Baumeister, K. Reuter, F. Jacobi, M. Höfler, J. Bengel, H.-U. Wittchen, Increased 12-Month Prevalence Rates of Mental Disorders in Patients with Chronic Somatic Diseases, Psychother Psychosom 76 (2007) 354–360. https://doi.org/10.1159/000107563.

[5] W.Y. Zhang, N. Nan, X.T. Song, J.F. Tian, X.Y. Yang, Impact of depression on clinical outcomes following percutaneous coronary intervention: a systematic review and meta-analysis, BMJ Open 9 (2019) e026445. https://doi.org/10.1136/bmjopen-2018-026445.

[6] K.M. Harris, D.L. Jacoby, R. Lampert, R.J. Soucier, M.M. Burg, Psychological stress in heart failure: a potentially actionable disease modifier, Heart Fail Rev 26 (2021) 561–575. https://doi.org/10.1007/s10741-020-10056-8.

[7] A. Salzwedel, K. Jensen, B. Rauch, P. Doherty, M.I. Metzendorf, M. Hackbusch, H. Voller, J.P. Schmid, C.H. Davos, Effectiveness of comprehensive cardiac rehabilitation in coronary artery disease patients treated according to contemporary evidence based medicine: Update

of the Cardiac Rehabilitation Outcome Study (CROS-II), Eur J Prev Cardiol 27 (2020) 1756–1774. https://doi.org/10.1177/2047487320905719.

[8] A. Gorini, M. Giuliani, C. L'Acqua, S. Barbieri, E. Sisillo, F. Veglia, E. Tremoli, Associations of Preoperative Self-rated Symptoms of Anxiety and Depression on Length of Hospital Stay and Long-term Quality of Life in Patients Undergoing Cardiac Surgery, Journal of Cardiovascular Nursing 37 (2022) 213–220. https://doi.org/10.1097/JCN.0000000000000792.

[9] A. Passantino, L.A. Dalla Vecchia, U. Corrà, S. Scalvini, M. Pistono, M. Bussotti, F.I. Gambarin, D. Scrutinio, M.T. La Rovere, The Future of Exercise-Based Cardiac Rehabilitation for Patients With Heart Failure, Front Cardiovasc Med 8 (2021). https://doi.org/10.3389/fcvm.2021.709898.

[10] R.S. Taylor, S. Walker, N.A. Smart, M.F. Piepoli, F.C. Warren, O. Ciani, D. Whellan, C. O'Connor, S.J. Keteyian, A. Coats, C.H. Davos, H.M. Dalal, K. Dracup, L.S. Evangelista, K. Jolly, J. Myers, B.B. Nilsson, C. Passino, M.D. Witham, G.Y. Yeh, Impact of Exercise Rehabilitation on Exercise Capacity and Quality-of-Life in Heart Failure: Individual Participant Meta-Analysis, J Am Coll Cardiol 73 (2019) 1430–1443. https://doi.org/https://doi.org/10.1016/j.jacc.2018.12.072.

[11] A. Rao, R. Zecchin, P.J. Newton, J.L. Phillips, M. DiGiacomo, A.R. Denniss, L.D. Hickman, The prevalence and impact of depression and anxiety in cardiac rehabilitation: A longitudinal cohort study, Eur J Prev Cardiol 27 (2020) 478–489. https://doi.org/10.1177/2047487319871716.

[12] K.M. Glazer, C.F. Emery, D.J. Frid, R.E. Banyasz, Psychological Predictors of Adherence and Outcomes Among Patients in Cardiac Rehabilitation, J Cardiopulm Rehabil Prev 22 (2002).

[13] G.N. Levine, B.E. Cohen, Y. Commodore-Mensah, J. Fleury, J.C. Huffman, U. Khalid, D.R. Labarthe, H. Lavretsky, E.D. Michos, E.S. Spatz, L.D. Kubzansky, C. on Clinical, T. on Arteriosclerosis, B. Vascular, C. Council on, N. Stroke, L. Council on, H. Cardiometabolic, Psychological Health, Well-Being, and the Mind-Heart-Body Connection: A Scientific Statement From the American Heart Association, Circulation (2021) CIR0000000000000947. https://doi.org/10.1161/CIR.0000000000000947.

[14] C. Chiavarino, C. Bianchino, S. Brach-Prever, C. Riggi, L. Palumbo, B.G. Bara, F.M. Bosco, Theory of mind deficit in adult patients with congenital heart disease, J Health Psychol 20 (2013) 1253–1262. https://doi.org/10.1177/1359105313510337.

[15] Z. Gardanova, A. Grachyova, V. Ilgov, A. Burma, V. Manina, A. Gardanov, The features of coping behaviour in patients with coronary heart disease, Psychiatria i Psychologia Kliniczna 19 (2019) 407–410. https://doi.org/10.15557/PiPK.2019.0044.

[16] P.A. Harris, R. Taylor, R. Thielke, J. Payne, N. Gonzalez, J.G. Conde, Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support, J Biomed Inform 42 (2009) 377–381. https://doi.org/10.1016/j.jbi.2008.08.010.

[17] Ambrosetti M, Abreu A, Corrà U, Davos CH, Hansen D, Frederix I, Iliou MC, Pedretti RFE, Schmid JP, Vigorito C, Voller H, Wilhelm M, Piepoli MF, Bjarnason-Wehrens B, Berger T, Cohen-Solal A, Cornelissen V, Dendale P, Doehner W, Gaita D, Gevaert AB, Kemps H, Kraenkel N, Laukkanen J, Mendes M, Niebauer J, Simonenko M, Zwisler AO. Secondary prevention through comprehensive cardiovascular rehabilitation: From knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. Eur J Prev Cardiol. (2021) May 14;28(5):460-495. doi: 10.1177/2047487320913379. PMID: 33611446.

[18] R.L. Spitzer, K. Kroenke, J.B.W. Williams, B. Löwe, A Brief Measure for Assessing Generalized Anxiety Disorder: The GAD-7, Arch Intern Med 166 (2006) 1092–1097. https://doi.org/10.1001/archinte.166.10.1092.

[19] K. Kroenke, R.L. Spitzer, J.B. Williams, The PHQ-9: validity of a brief depression severity measure, J Gen Intern Med 16 (2001) 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x.

[20] M. Mondo, C. Sechi, C. Cabras, Psychometric evaluation of three versions of the Italian Perceived Stress Scale, Current Psychology 40 (2021) 1884–1892. https://doi.org/10.1007/s12144-019-0132-8.

[21] L. Caricati, C. Foà, L. Fruggeri, A. Tonarelli, COPE-NVI-25: validazione italiana della versione ridotta della Coping Orientation to the Problems Experienced (COPE-NVI), PSICOLOGIA DELLA SALUTE (2015) 123–140. https://doi.org/10.3280/PDS2015-002007.

[22] F.I. Mahoney, D.W. Barthel, Functional evaluation: the Barthel Index., Md State Med J 14 (1965) 61–65.

[23] N. Bergestrom, B.J. Braden, A. Laguzza, V. Holman, The Braden Scale for Predicting Pressure Sore Risk, Nurs Res 36 (1987).

[24] J.M. Morse, R.M. Morse, S.J. Tylko, Development of a scale to identify the fall-prone patient, CANADIAN JOURNAL ON AGING-REVUE CANADIENNE DU VIEILLISSEMENT 8 (1989) 366–377. https://doi.org/10.1017/S0714980800008576.

[25] J.M. Guralnik, E.M. Simonsick, L. Ferrucci, R.J. Glynn, L.F. Berkman, D.G. Blazer, P.A. Scherr, R.B. Wallace, A Short Physical Performance Battery Assessing Lower Extremity Function: Association With Self-Reported Disability and Prediction of Mortality and Nursing Home Admission, J Gerontol 49 (1994) M85–M94. https://doi.org/10.1093/geronj/49.2.M85.

[26] ATS statement: guidelines for the six-minute walk test., Am J Respir Crit Care Med 166 (2002) 111–117. https://doi.org/10.1164/ajrccm.166.1.at1102.

[27] EQ-5D, No Title, (n.d.).

[28] Z. Gao, Z. Chen, A. Sun, X. Deng, Gender differences in cardiovascular disease, Med Nov Technol Devices 4 (2019) 100025. https://doi.org/10.1016/j.medntd.2019.100025.

[29] S. Khadanga, D.E. Gaalema, P. Savage, P.A. Ades, Underutilization of Cardiac Rehabilitation in Women: BARRIERS AND SOLUTIONS., J Cardiopulm Rehabil Prev 41 (2021) 207–213. https://doi.org/10.1097/HCR.0000000000000629.

[30] M.A. Sawan, A.E. Calhoun, Y.A. Fatade, N.K. Wenger, Cardiac rehabilitation in women, challenges and opportunities., Prog Cardiovasc Dis 70 (2022) 111–118. https://doi.org/10.1016/j.pcad.2022.01.007.

[31] K.N. Melsæter, G.G. Tangen, H.K. Skjellegrind, B. Vereijken, B.H. Strand, P. Thingstad, Physical performance in older age by sex and educational level: the HUNT Study, BMC Geriatr 22 (2022) 821. https://doi.org/10.1186/s12877-022-03528-z.

[32] R. Ramírez-Vélez, M.A. Pérez-Sousa, L.C. Venegas-Sanabria, C.A. Cano-Gutierrez, P.A. Hernández-Quiñonez, D. Rincón-Pabón, A. García-Hermoso, F. Zambom-Ferraresi, M.L. Sáez de Asteasu, M. Izquierdo, Normative Values for the Short Physical Performance Battery (SPPB) and Their Association With Anthropometric Variables in Older Colombian Adults. The SABE Study, 2015, Front Med (Lausanne) 7 (2020). https://doi.org/10.3389/fmed.2020.00052.

[33] D. Scrutinio, P. Guida, L.A. Dalla Vecchia, U. Corrà, A. Passantino, Cardiac Rehabilitation for Older Women with Heart Failure, J Pers Med 12 (2022) 1980. https://doi.org/10.3390/jpm12121980.

[34] P. Gundugurti, R. Bhattacharyya, A. Koneru, Management of psychiatric disorders in patients with cardiovascular diseases, Indian J Psychiatry 64 (2022) 355. https://doi.org/10.4103/indianjpsychiatry.indianjpsychiatry_42_22.

[35] A.M. Möller-Leimkühler, Gender differences in cardiovascular disease and comorbid depression., Dialogues Clin Neurosci 9 (2007) 71–83. https://doi.org/10.31887/DCNS.2007.9.1/ammoeller.

[36] D. Kobayashi, T. Shimbo, O. Takahashi, R.B. Davis, C.C. Wee, The relationship between religiosity and cardiovascular risk factors in Japan: a large–scale cohort study, Journal of the American Society of Hypertension 9 (2015) 553–562. https://doi.org/10.1016/j.jash.2015.04.003.

[37] K.M. Harris, D.L. Jacoby, R. Lampert, R.J. Soucier, M.M. Burg, Psychological stress in heart failure: a potentially actionable disease modifier, Heart Fail Rev 26 (2021) 561–575. https://doi.org/10.1007/s10741-020-10056-8.

[38] T.A. Glass, D.B. Matchar, M. Belyea, J.R. Feussner, Impact of social support on outcome in first stroke., Stroke 24 (1993) 64–70. https://doi.org/10.1161/01.STR.24.1.64.

[39] H. Pan, Y. Zhao, H. Wang, X. Li, E. Leung, F. Chen, J. Cabrera, K.L. Tsui, Influencing factors of Barthel index scores among the community-dwelling elderly in Hong Kong: a random intercept model, BMC Geriatr 21 (2021) 484. https://doi.org/10.1186/s12877-021-02422-4.

[40] S. Bhattacharya, R.K. Mishra, Pressure ulcers: Current understanding and newer modalities of treatment, Indian Journal of Plastic Surgery 48 (2015) 004–016. https://doi.org/10.4103/0970-0358.155260.

[41] M.A. Stults-Kolehmainen, R. Sinha, The Effects of Stress on Physical Activity and Exercise, Sports Medicine 44 (2014) 81–121. https://doi.org/10.1007/s40279-013-0090-5.

[42] Y.-Y. Chao, P. Zha, K. Yang, X. Dong, Association between physical function and perceived stress among U.S. Chinese older adults, Am J Aging Sci Res 1 (2020). https://doi.org/10.46439/aging.1.004.

[43] E. Dardiotis, G. Giamouzis, D. Mastrogiannis, C. Vogiatzi, J. Skoularigis, F. Triposkiadis, G.M. Hadjigeorgiou, Cognitive Impairment in Heart Failure, Cardiol Res Pract 2012 (2012) 1–9. https://doi.org/10.1155/2012/595821.

[44] H. Bu, S. Lu, L. Wang, D. Jiang, Z. Tian, Y. Ding, Q. Zhuang, Depressive symptoms increase the risk of falls and injurious falls in Chinese adults aged ≥ 45 years: A 3-year cohort study, Front Public Health 10 (2022). https://doi.org/10.3389/fpubh.2022.964408.

[45] W. Xiong, D. Wang, W. Ren, X. Liu, R. Wen, Y. Luo, The global prevalence of and risk factors for fear of falling among older adults: a systematic review and meta-analysis, BMC Geriatr 24 (2024) 321. https://doi.org/10.1186/s12877-024-04882-w.

[46] J. Nan, Z. Li, X. Zou, M. Sun, J. Gao, Y. Jiang, Fall risk perception in older adults: A concept analysis, J Clin Nurs (2024). https://doi.org/10.1111/jocn.17090.

[47] M. Sakamoto, Y. Suematsu, Y. Yano, K. Kaino, R. Teshima, T. Matsuda, M. Fujita, R. Tazawa, K. Fujimi, S. Miura, Depression and Anxiety Are Associated with Physical Performance in Patients Undergoing Cardiac Rehabilitation: A Retrospective Observational Study, J Cardiovasc Dev Dis 9 (2022) 21. https://doi.org/10.3390/jcdd9010021.

[48] M. Ricci, G. Pozzi, N. Caraglia, D.P.R. Chieffo, D. Polese, L. Galiuto, Psychological Distress Affects Performance during Exercise-Based Cardiac Rehabilitation, Life 14 (2024) 236. https://doi.org/10.3390/life14020236.

[49] A. Schneider, M.H.T. Hartman, K. Nolte, S.M. Werhahn, R. Wachter, C. Herrmann-Lingen, Coping styles as predictors for quality of life and prognosis in patients at risk for or with a

diagnosis of heart failure: Results from the observational DIAST-CHF study, J Psychosom Res 170 (2023) 111384. https://doi.org/10.1016/j.jpsychores.2023.111384.

[50] J. Tromp, D. Jindal, J. Redfern, A. Bhatt, T. Séverin, A. Banerjee, J. Ge, D. Itchhaporia, T. Jaarsma, F. Lanas, F. Lopez-Jimenez, A. Mohamed, P. Perel, G.E. Perez, F. Pinto, R. Vedanthan, A. Verstrael, K.K. Yeo, K. Zulfiya, D. Prabhakaran, C.S.P. Lam, M.R. Cowie, World Heart Federation Roadmap for Digital Health in Cardiology, Glob Heart 17 (2022). https://doi.org/10.5334/gh.1141.

[51] F.L.J. Visseren, F. Mach, Y.M. Smulders, D. Carballo, K.C. Koskinas, M. Back, A. Benetos, A. Biffi, J.M. Boavida, D. Capodanno, B. Cosyns, C. Crawford, C.H. Davos, I. Desormais, E. Di Angelantonio, O.H. Franco, S. Halvorsen, F.D.R. Hobbs, M. Hollander, E.A. Jankowska, M. Michal, S. Sacco, N. Sattar, L. Tokgozoglu, S. Tonstad, K.P. Tsioufis, I. van Dis, I.C. van Gelder, C. Wanner, B. Williams, E.S.C.S.D. Group, 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice, Eur J Prev Cardiol 29 (2022) 5–115. https://doi.org/10.1093/eurjpc/zwab154.

[52] Kabboul NN, Tomlinson G, Francis TA, Grace SL, Chaves G, Rac V, Daou-Kabboul T, Bielecki JM, Alter DA, Krahn M. Comparative Effectiveness of the Core Components of Cardiac Rehabilitation on Mortality and Morbidity: A Systematic Review and Network Meta-Analysis. J Clin Med. (2018). https://doi.org/10.3390/jcm7120514

Highlights

- The study offers insights about protective coping strategies in cardiac rehab
- Psychological screening should be use in cardiac rehab to tailor interventions
- Coping strategies, and psychological factors may influence rehab outcomes and support

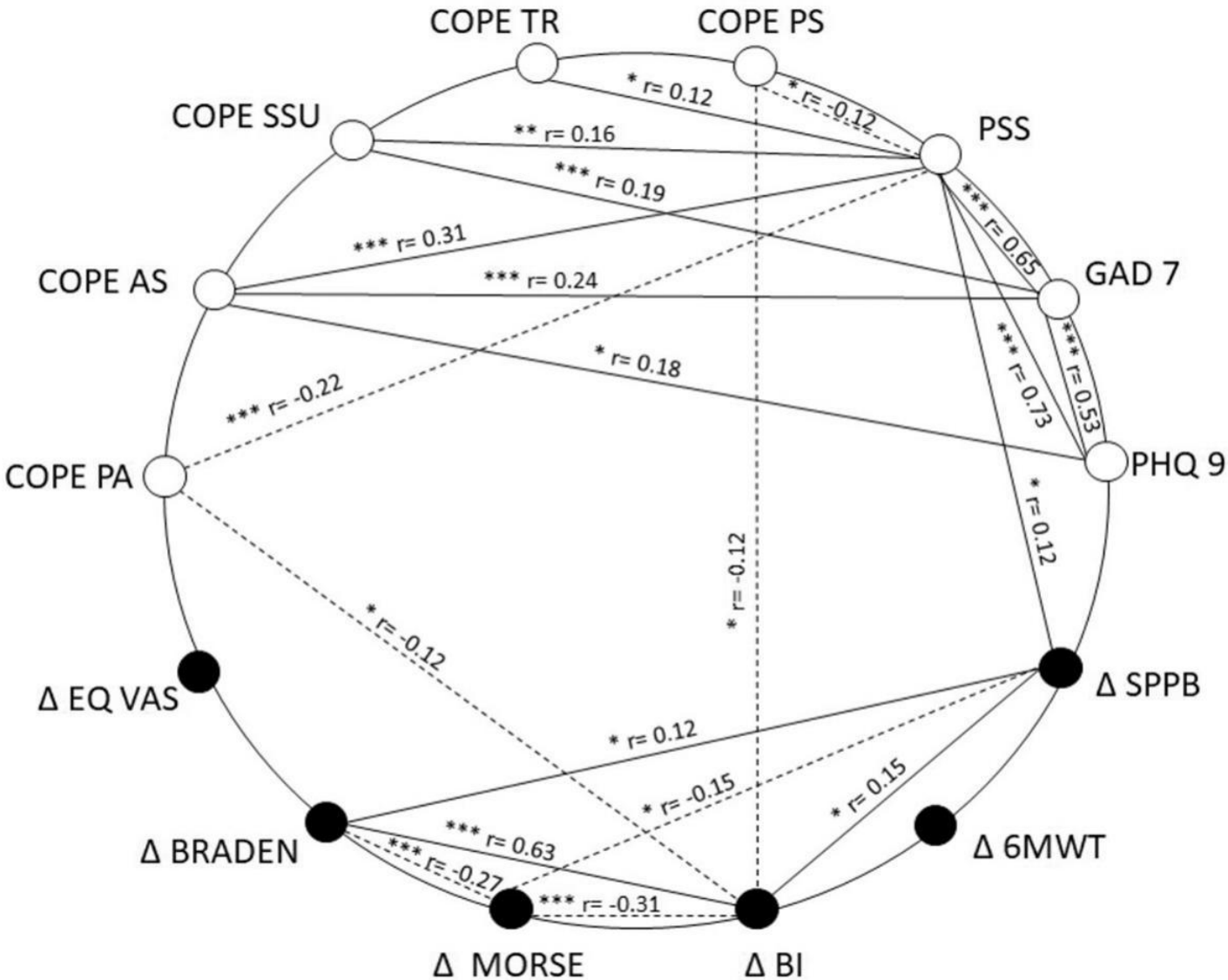
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Figure 1