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**ORIGINAL RESEARCH**

# What are the determinants of change in walking fitness in patients with a history of depression following cardiac rehabilitation?

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**Aims** This study aims to investigate the demographic, clinical, and service-level factors determining change in walking fitness in cardiac rehabilitation (CR) patients with a history of depression following the CR programme.

**Methods and results** The National Audit of Cardiac Rehabilitation clinical data were used to identify 1476 patients with a history of depression who had their pre- and post-incremental shuttle walk test (ISWT) recorded between 1 January 2016 and 31 January 2020. A multiple linear regression was conducted to examine the determinants of change in walking fitness (m) following CR. Mean age was 61 (SD 10.45), and mean ISWT distance at baseline and outcome was 352.06 m (SD 169.48) and 463.43 m (SD 197.65), respectively. Multivariate analysis revealed that change in walking distance reduced by 1.6 m for each year increase in age at baseline ($P < 0.001$). Females and unemployed patients had less improvement in walking fitness (23.1 and 21.5 m, respectively). Having a body mass index (BMI) > 30 was associated with lower improvement (24.2 m, $P < 0.001$), while physically active patients had 14.6 m higher change. Higher baseline ISWT quintiles were associated with less improvement, and increased waiting time to start CR was associated with reduced change in walking fitness following CR.

**Conclusion** Older age, female gender, unemployment, higher baseline BMI, longer waiting time, and lower physical activity were associated with reduced walking fitness improvement in patients with a history of depression. Targeted intervention and prompt access to CR can optimize outcomes.



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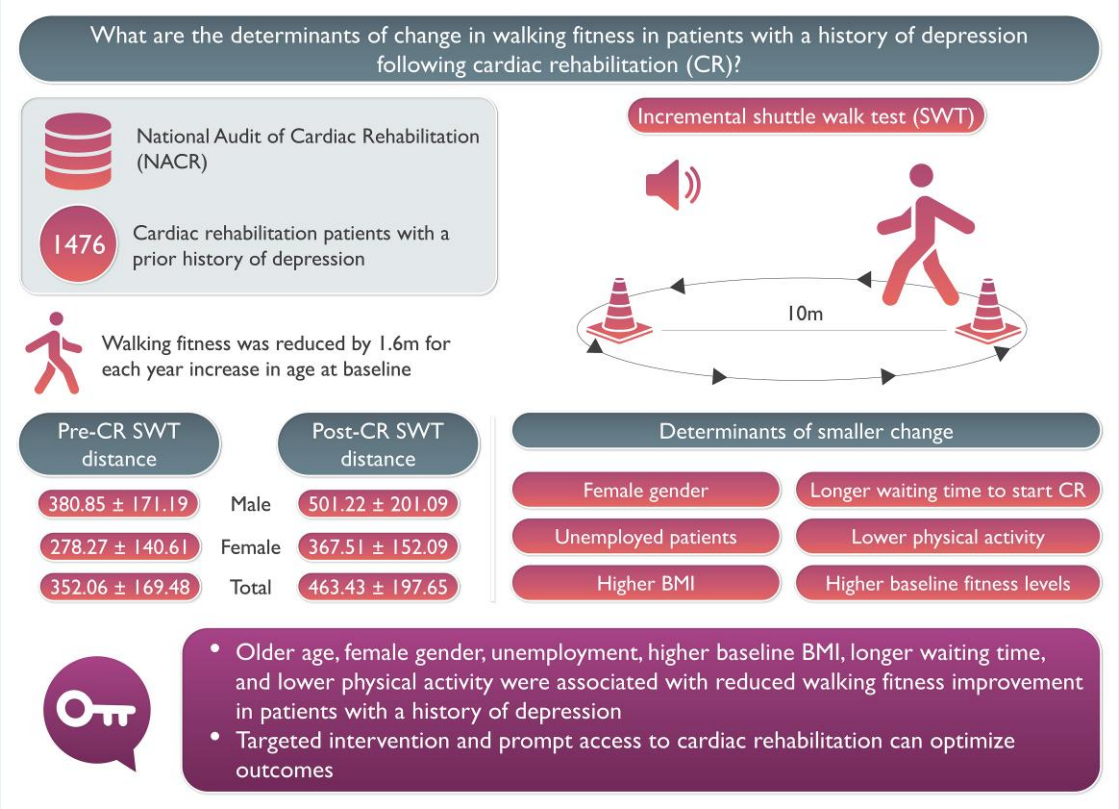
## Graphical Abstract




**Keywords** Cardiac rehabilitation • Cardiovascular disease • History of depression • Incremental shuttle walk test • Walking fitness

### Novelty

- This is the first study investigating the determinants of change in walking fitness in patients with a history of depression following CR.
- The gender-specific reference values for walking fitness are the first of their kind to consider gender in patients with a history of depression and are expected to assist clinicians in gaining a better understanding of the variations and anticipations of physical fitness among their patients.

# Introduction

It is widely recognized that depression is prevalent in ~20–30% of individuals diagnosed with cardiovascular disease.[1,2] Given that depression among individuals with cardiac ailments lead to diminished quality of life and increased rates of morbidity and mortality, these issues impose a significant burden on both society and the impacted patients.[3,4] A recent consensus statement from the European Society of Cardiology (ESC) highlights the significance of identifying and treating patients for depression in conjunction with their cardiac condition, as it is associated with poor adherence to treatment.[5]

Cardiac rehabilitation (CR) is a multifaceted approach that aims to enhance the physical ability, psychosocial health, and quality of life in individuals with cardiac illness.[6] One important aspect of CR is the assessment of physical function, which is often done using various tests, including the incremental shuttle walk test (ISWT).[7,8] The ISWT is the most frequently used field test for assessing functional capacity in CR patients in the UK,[9] and it is easy to conduct, cost effective, and is generally well tolerated by those being tested.[10] This objective test is widely used in clinical settings to determine the level of physical fitness.[11] Studies have shown that this type of test is reliable and has a strong correlation with the cardiopulmonary exercise test.[12–14]

Most of the previous research has primarily focused on measuring the psychosocial health impacts associated with a sudden cardiac event, with little attention given to the prior history of depression. A study revealed that nearly 50% of patients diagnosed with depression after experiencing a myocardial infarction (MI) also had comorbid history of depression.[15] Additionally, another study has indicated that individuals with heart failure (HF) who had a history of depression prior to the cardiac event were at a higher risk of mortality and had a poorer cardiac prognosis.[16] Furthermore, a meta-analysis demonstrated that cardiovascular disease patients with a history of depression, as well as those who developed depressive symptoms following the cardiac event, faced an increased risk of mortality and cardiac morbidity.[17] However, our

previous research has shown that the characteristics of participants associated with higher levels of depressive symptoms may differ in patients with a prior history of depression and those with new onset depressive symptoms following CR.[18,19] It is important to note that walking fitness is one of the main outcomes of CR and holds particular importance since exercise-based CR plays a significant role in reducing mortality.[20] Therefore, the aim of this study is to examine the sociodemographic and clinical determinants of the ISWT performance following CR in patients with a prior history of depression. Moreover, we seek to enhance the understanding of these determinants and their implications for the assessment of physical function in the UK CR practice. The findings of this article will provide valuable insights for CR practitioners and researchers, enabling them to understand the determinants of improvement in walking fitness outcome and tailor CR interventions to meet the specific needs of patients with a prior history of depression.

# Methods

This research adhered to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for its reporting.[21] The study utilized an observational approach to examine how the individual patient characteristics might impact the changes in physical fitness among patients who have a history of depression and undergone CR.

## Data collection

The aim of the National Audit of Cardiac Rehabilitation (NACR) is to monitor CR programmes across the UK to enhance the standard of service delivery and outcomes in CR centres. The patient data were extracted and analysed at an individual level using NACR data that were routinely collected. The research method used was observational and relied on the data that were gathered under section 251 of the NHS Act 2006, which allowed for the collection of individual patient data and its submission to the NHS Digital data storage system. Since NHS Digital has the authorization to collect patient-identifiable data, which are then de-identified and made accessible to NACR, it was not mandatory to obtain explicit consent from each patient. As the research falls under the scope of the 251 exemption, ethical approval was not required before conducting and submitting this study. There are 205 CR programmes accessible for NACR in the UK, encompassing centres from England, Northern Ireland, and Wales, with 185 of them having electronic NACR registration for data submission, allowing for better audit coverage.[9] Individuals who participate in CR in the UK have their data recorded, which include demographic information, medication, risk factors, and treatment. The NACR provides comprehensive reports that describe its operations in detail.[9,22]

## Participants

The data were extracted and analysed from the NACR for the study time period from 1 January 2016 to 31 January 2020. The study enrolled patients who had MI or HF and had undergone percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG) treatment, as recommended in the clinical guidelines of the National Institute for Health and Care Excellence (NICE).[23,24] During the study period, the eligible patient population for the sample was determined by identifying patients with a prior history of depression who had valid pre- and post-CR ISWT measures, using the NACR data set ($n = 1476$).

## Variables and measures

### History of depression

The history of depression is documented by referencing the patient's medical records and reviewing case notes that indicate any previous diagnoses of depression.

### Hospital Anxiety and Depression Scale

Psychosocial well-being, as measured by the Hospital Anxiety and Depression Scale (HADS) score at baseline assessment, provides insight into the patient's current state and levels of anxiety and depression at the commencement of the programme.[25] The HADS, a self-administered tool, is employed in healthcare settings to evaluate symptoms of anxiety and depression. It is recommended as a tool to assess the psychosocial well-being of patients undergoing CR, enabling the development of personalized CR programmes tailored to their individual requirements.[7] The HADS is particularly suitable for use with cardiac patients as it has been proven to be a reliable and valid tool for assessing both anxiety and depressive symptoms.[25,26] At the commencement of CR, patients were categorized based on a clinical threshold of 8, where a score of <8 indicated low levels of symptoms and a score of ≥8 indicated high levels of symptoms. A systematic review found that the HADS assessment tool consistently achieved an optimal balance between specificity and sensitivity when using a cut-off score of 8 for both depression and anxiety (with specificity and sensitivity scores around 0.80 for both scales).[26]

### Incremental shuttle walk test

The dependent variable of the study is the change in distance covered in metres during the ISWT test before and after CR as a component of the assessments. The ISWT is a walking test that is paced externally through an audio player and has 12 different speed levels, and this test has been verified as valid and reliable for cardiac and pulmonary rehabilitation groups.[11,27] During the ISWT, the patient is expected to walk along a 10-m course at a pace set by an external source. The patient may stop the ISWT if they can no longer keep up with the audio signal or if they feel too breathless to continue.[11,27] The results from the ISWT can be presented as levels, sublevels, or metres. For the purpose of this analysis, metres was chosen to give the highest level of detail in the data. The variable was the change in ISWT between the initial assessment of CR and the end assessment. By using metres as the unit of the test, it also allowed us to pursue reference values using a metric (distance walked in metres) that is more applicable and useful for both healthcare professionals and patients.

### Demographic variables

The variables included in the analysis were selected based on their relevance in the preliminary analyses or literature evidence. The study utilized patient demographics such as age (years), gender (male/female), partner status (single/partnered), employment status (employed or retired/unemployed), and the English Index of Multiple Deprivation (IMD), which is a metric used to measure deprivation in England.[28] The IMD metric is formulated by incorporating seven distinct factors: job prospects, health concerns, economic condition, crime rate, availability of housing and resources, general living conditions, and educational proficiency and training. A total of 32 844 specific areas are classified and arranged based on their level of disadvantage, ranging from the most disadvantaged to the least disadvantaged.[28] The current study utilized the IMD as a dichotomous variable, with patients categorized as residing in either the most deprived areas or less deprived areas, as described in previous studies.[18]

### Other variables

The study also assessed additional risk factors, including body mass index (BMI), self-reported physical activity (determining adherence to the UK's guideline by inquiring about engagement in moderate physical activity totalling 150 min weekly),[29] and total number of comorbidities. The study also investigated service-level factors, such as the time from referral to the start of CR (days) and the duration of core CR (days). These factors were included because they are routinely reported by the NACR as variables that can impact patient outcomes.[9,30] In addition, as part of the regression analysis, the baseline results of the ISWT were categorized into five quintiles. This was done to provide readers with a more informative understanding of how baseline ISWT levels may impact changes in walking fitness outcome.

## Statistical analysis

The statistical software IBM SPSS version 28 was utilized to analyse the data (New York, USA). A significance level of $P < 0.05$ was established for the statistical analysis and considered statistically significant. To provide a concise overview of the data, percentages, means, and standard deviations were utilized. The study employed *t*-tests and Pearson's correlation to compare

**Table 1 Baseline incremental shuttle walk test distance metres (m) for included variables**

| Continues baseline characteristics | Mean ± SD | *n* | Pearson's correlation (PC) | *P* value |
|---|---|---|---|---|
| Baseline ISWT distance (m) | 352.0 ± 169.48 | 1476 | | |
| Age | 60.78 ± 10.45 | 1476 | −0.28 (PC) | <0.001 |
| Total number of comorbidities | 4.54 ± 2.00 | 1476 | −0.20 (PC) | <0.001 |
| Time from referral to start CR (days) | 31.26 ± 28.66 | 1379 | −0.06 (PC) | <0.001 |
| Duration of core CR (days) | 92.49 ± 41.62 | 1449 | −0.12 (PC) | <0.001 |
| | **ISWT distance (m)** | | | |
| **Categorical patient characteristics** | **Mean ± SD** | ***n* (%)** | **Mean difference (MD)** | |
| Gender | | | | |
| Male | 380.85 ± 171.19 | 1050 (71.4) | 102.58 (MD) | <0.001 |
| Female | 278.27 ± 140.61 | 421 (28.6) | | |
| Body mass index (BMI) | | | | |
| <30 | 370.19 ± 176.39 | 865 (61.7) | 49.53 (MD) | <0.001 |
| >30 | 320.66 ± 149.02 | 537 (38.3) | | |
| 150 min a week physical activity | | | | |
| No | 325.52 ± 158.71 | 729 (55.8) | −66.73 (MD) | <0.001 |
| Yes | 392.25 ± 168.58 | 578 (44.2) | | |
| Marital status | | | | |
| Single | 346.35 ± 174.35 | 379 (28.8) | −9.21 (MD) | 0.365 |
| Partnered | 355.57 ± 164.08 | 939 (71.2) | | |
| Employment status | | | | |
| Employed | 434.08 ± 161.23 | 394 (30.3) | 120.13 (MD) | <0.001 |
| Unemployed | 313.94 ± 155.93 | 908 (69.7) | | |
| HADS anxiety score | | | | |
| Low anxiety levels | 362.24 ± 167.42 | 567 (44.9) | 21.95 (MD) | 0.020 |
| High anxiety levels | 340.29 ± 165.01 | 696 (55.1) | | |
| HADS depression score | | | | |
| Low depression levels | 364.99 ± 162.99 | 756 (59.8) | 36.22 (MD) | <0.001 |
| High depression levels | 328.76 ± 169.39 | 509 (40.2) | | |
| IMD score | | | | |
| Less deprived | 369.59 ± 174.52 | 703 (81.0) | 54.44 (MD) | <0.001 |
| Most deprived | 315.14 ± 186.41 | 165 (19.0) | | |

HADS, Hospital Anxiety and Depression Scale; SD, standard deviation; IMD, Index of Multiple Deprivation; MD, mean difference; PC, Pearson's correlation.

groups and examine correlations between variables. To identify the covariates that were associated with change in walking fitness following CR, expressed as distance walked during assessments, a backward linear regression model was constructed. The study performed data model checking to ensure that the model was a good fit by assessing the assumptions associated with the regression.

# Results

A total of 1476 patients with a history of depression who had completed pre- and post-ISWT were included in the study (28.6% female). The mean age for the population was 60.78 (SD 10.45) years. The overall mean distance of baseline ISWT was 352.06 m (SD 169.48), and for the CR outcome, this was 463.4 m (SD 197.65). The average distances for ISWT in metres for the baseline characteristics are presented in *Table 1*.

Based on the Pearson correlation, there was a statistically significant negative relationship between age and ISWT [$r(1474) = -0.28$, $P < 0.001$]. There was also a similar relationship for total number of comorbidities [$r(1474) = -0.20$], duration of core CR [$r(1447) = -0.12$], and wait time from referral to start CR [$r(1377) = -0.06$, $P < 0.001$].

Considering baseline ISWT distance, males walked 102.6 m greater than females on average ($P < 0.001$). Being unemployed was associated with an average 120.1 m reduction in walking distance compared to being employed ($P < 0.001$). Patients who are moderately physically active for at least 30 min five times a week had on average a statistically significant 66.7 m greater distance than those who were not achieving this ($P < 0.001$). Patients with BMI > 30 had 49.5 m less walking distance recorded on average compared to patients with BMI < 30 ($P < 0.001$). Patients living in the most deprived areas had 54.4 m lower walking distance than patients living in the less deprived areas

**Table 2** Incremental shuttle walk test distance metres (m) at baseline and outcome by gender

| | Pre-ISWT distance (m) Mean ± SD | Post-ISWT distance (m) Mean ± SD | Change of >70 m *n* (%) |
|---|---|---|---|
| Male | 380.85 ± 171.19 | 501.22 ± 201.09 | 732 (69.7) |
| Female | 278.27 ± 140.61 | 367.51 ± 152.09 | 254 (60.3) |
| Total | 352.06 ± 169.48 | 463.43 ± 197.65 | 986 (67) |

**Table 3** Incremental shuttle walk test distance metres (m) at baseline in percentiles by gender

| Baseline ISWT (m) | Male | Female | Total |
|---|---|---|---|
| Percentile 20 | 250 | 160 | 200 |
| Percentile 40 | 330 | 240 | 290 |
| Median | 370 | 260 | 340 |
| Percentile 60 | 420 | 290 | 380 |
| Percentile 80 | 520 | 390 | 480 |

($P < 0.001$). In addition, patients with high levels of anxiety and depressive symptoms at baseline (HADS ≥ 8) walked lower distances compared to those patients with HADS < 8 ($P$ 0.02 and $P < 0.001$, respectively).

Baseline and outcome ISWT distances investigated by gender are shown in *Table 2*. This table demonstrates that males perform better in ISWT compared to females both at baseline and following CR. The average change in metres across the whole sample was over 110 m, with males having an extra 30 m change than their female counterparts (males 120.37 vs. females 89.24). Moreover, a higher percentage of males reached minimum clinical important difference of >70 m compared to females at the end of CR.[31] *Table 3* displays the suggested reference values for distance covered in the ISWT, split by gender and distributed among the percentiles for patients with a history of depression.

A multiple regression was run to investigate the association between changes in ISWT distance following CR with patient characteristics in patients with a history of depression. The residuals met the assumptions of linearity and others. The multiple regression model was statistically significant and of good fit, and the adjusted $R^2$ value was 0.086. Seven variables were statistically significantly associated with ISWT distance outcome. Regression coefficients and standard errors are found in *Table 4*.

Age was negatively associated with change in ISWT distance, based on the model, and for each year increase in age, there was a 1.66 m reduction in distance walked ($P < 0.001$). Gender was an influential determinant of walking fitness, and female patients had 23.13 m reduced improvement in walking distance accounting for other covariates ($P < 0.001$). Baseline fitness levels from the ISWT showed that patients residing in higher fitness quintiles were less likely to improve their walking fitness following CR. The greatest difference was between the lowest and highest quintiles with a reduction of 28.52 m change ($P = 0.003$). Having a BMI > 30 and being unemployed were significantly associated with reduced improvement in ISWT distance with 24.25 and 21.50 m ($P < 0.001$). Achieving moderate physical activity at baseline was significantly associated with improved ISWT score of 14.57 m following CR. Statistically non-significant variables such as duration of CR, IMD, and others were automatically removed from the backward analysis. Increased waiting time from referral to start of CR was also associated with reduced walking fitness outcome accounting for other covariates ($P < 0.001$).

# Discussion

The study aimed to investigate which patient characteristics determine the change in walking fitness in patients with a prior history of depression following CR. The results of our study, based on multivariate analysis, indicated that BMI, physical activity, gender, age, employment status, waiting time, and baseline ISWT levels are all significant factors that determine the change in walking fitness of patients with a history of depression following CR.

Our study found that for each year above the mean age of the study population (60.78 ± 10.45), there is a significant reduction of change in walking distance of ~1.7 m. The relationship between age and decreased walking ability is not a new discovery, and it has been previously observed in conventional CR patient populations.[32,33] However, our study provides a contribution by quantifying the degree of decline in walking ability with increasing age in patients with a history of depression.

The gender of the patients emerged as a significant factor influencing walking fitness. Female patients exhibited a decrease of 23.1 m in the improvement of walking distance compared to males ($P < 0.001$). Previous research indicates that, in comparison to males, females tend to have lower baseline walking fitness levels.[34,35] For instance, females walked 49.4 m less in one study[34] and 42.1 m less in another[35] among HF patients, which aligns with the findings of our study. However, these previous studies only analysed baseline walking assessments and did not investigate changes in walking fitness following CR.

Our study found that in patients with a history of depression, improvement in walking distance after CR was significantly associated with their baseline ISWT levels. Patients with lower quintiles were found to improve their walking fitness more following CR, whereas those with higher quintiles were less likely to show improvement. This finding suggests that patients with poorer baseline fitness levels tend to experience greater improvements after participating in CR. This can be attributed to the fact that patients who are already fitter at the start of CR may have less scope for improvement and may therefore benefit relatively less compared to those with lower baseline fitness levels. However, it is important to note that this statement does not imply that patients with higher baseline fitness levels should not participate in CR. In fact, all patients with a history of depression should be encouraged to participate in CR, regardless of their baseline fitness level, as CR has been shown to have numerous physical and psychological benefits.[7,8,20] Additionally, even if patients with higher baseline fitness levels do not see as much improvement in their walking fitness following CR, they may still experience other benefits such as improved cardiovascular health and reduced risk of future cardiac events.[7,8,20]

The study indicates that there is a significant negative association between BMI and the change in walking distance in patients with a history of depression. Despite patients with a higher BMI (>30) having poorer baseline performance, it could be expected that they would have greater potential for improvement. However, the study results demonstrate that a BMI above 30 is associated with a 24.2 m reduction in the improvement of walking distance after CR. Previous research has shown that patients with obesity may have a decreased adherence to CR.[36] It is plausible that patients with a higher BMI may require a more extended exercise programme or an additional intervention to decrease their BMI before experiencing a significant improvement in walking ability.

**Table 4 Multiple regression findings for change in incremental shuttle walk test metres (m) following cardiac rehabilitation by patient characteristics**

| Variable | *B* (95% CI) | SE | Significance |
|---|---|---|---|
| Age | −1.66 (−2.23, −1.09) | 0.29 | <0.001 |
| Gender (female) | −23.13 (−35.20, −11.06) | 6.15 | <0.001 |
| 150 min a week physical activity (yes) | 14.57 (3.97, 25.17) | 5.40 | 0.007 |
| BMI (>30) | −24.25 (−35.18, −13.32) | 5.57 | <0.001 |
| Employment (unemployed) | −21.50 (−34.29, −8.72) | 6.52 | <0.001 |
| Time from referral to start CR (days) | −0.31 (−0.49, −0.13) | 0.09 | <0.001 |
| Baseline ISWT quintiles (reference: first quintile) | | | |
| Second quintile | −18.09 (−34.58, −1.60) | 8.40 | 0.032 |
| Third quintile | −20.57 (−37.35, −3.78) | 8.55 | 0.016 |
| Fourth quintile | −25.36 (−42.67, −8.04) | 8.82 | 0.004 |
| Fifth quintile | −28.53 (−47.14, −9.93) | 9.48 | 0.003 |

$R = 0.307$. $R^2 = 0.094$. Adjusted $R^2 = 0.086$.
*B*, regression coefficient; SE, standard error; CI, confidence interval; BMI, body mass index; ISWT, incremental shuttle walk test.

The study revealed that achieving moderate physical activity at the start of CR was significantly associated with a 14.6 m improvement in walking distance following CR. This suggests that patients who engage in moderate physical activity at the start of CR may have a better chance of improving their walking fitness after the programme. This finding is consistent with a previous study conducted in patients with HF, which examined the determinants of walking fitness at the start of CR.[34] The study included 2047 patients with HF, with an average age of 64.43 (SD 12.39) and 27% females.[34] However, our study specifically aimed to investigate the factors that influence changes in walking distance after CR in patients with a history of depression, placing particular emphasis on the programme's outcome. Our findings underscore the significance of promoting physical activity among patients with a history of depression before and during CR, as this can optimize the programme's benefits in enhancing walking fitness. In addition, being unemployed was significantly associated with reduced improvement in walking fitness in patients with a history of depression. This suggests that being unemployed may have negative impacts on an individual's physical health and fitness, potentially due to factors such as decreased access to resources and opportunities for exercise or changes in daily routines and habits.[37]

The waiting time between referral and the start of a CR programme was found to be linked with a decrease in walking fitness outcome, after adjusting for other covariates. The present recommendations of guidelines and literature in the field of cardiac care advocate for the timely initiation of CR when it is deemed suitable.[7,8,38–40] Commencing CR early has been shown to lead to positive outcomes, such as improved cardiorespiratory measures, enhanced quality of life,[41,42] and improved cardiac functioning.[43] Reducing wait times and promoting early enrolment are critical to optimizing patient outcomes, especially in improving walking fitness, particularly for patients with a history of depression, as revealed by the presented study.

The influence of gender on the reference values for walking fitness was also investigated (*Table 3*). These reference values are the first of their kind to consider gender in patients with a history of depression and are expected to assist clinicians in gaining a better understanding of the variations and anticipations of physical fitness among their patients. This new information may contribute to the continuous evaluation of their walking fitness.

## Limitations

As far as the authors are aware, this is the first multicentre analysis that has examined the factors that determine changes in walking fitness in patients with a history of depression, using routinely collected patient data from the UK. The study's sample was nationally representative of patients in the UK who had a history of depression. However, as the ISWT is recording by clinicians routinely less well than other assessment components, it is important to be aware that not all patients with history of depression are represented in that analysis. Although 2927 patients with a history of depression underwent baseline ISWT assessments, only 50.4% of them (1476) also had post-ISWT recordings. Nevertheless, their characteristics were similar (mean age 60.01 ± 10.70 and 60.78 ± 10.45; female 30.5 and 28.6%, respectively). It is worth noting that thorough recording of ISWT assessments for each patient remains essential.

Another important limitation to acknowledge is that observational studies cannot establish causal relationships, only associations, and as such, significant factors are only determinants and not causes of the differing changes in ISWT. The analysis was unable to account for the use of antidepressant medication or sleep quality as these data were not recorded in the NACR data set. Lastly, although a statistically significant difference was observed in our analyses, the results should be interpreted with caution as they may not necessarily indicate clinical significance. Nevertheless, the results are still important as they highlight the determinants of change in physical fitness within a specific population, which is a novel contribution to the literature.

# Conclusions

The study is the first to conclude that patients with a history of depression do show improvements in walking fitness following CR, but the scale of improvement is determined by BMI, physical activity status, gender, age, employment, waiting time, and baseline ISWT fitness levels. The findings could help clinicians better understand the achievable levels of fitness in these patients, and the study also created a new set of reference values by gender to assist clinicians and patients in interpreting walking fitness.

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# Author contributions

S.S., P.D., and A.H. contributed to the conceptualization or design of the work; contributed to the acquisition, analysis, or interpretation of data for the work; and drafted and critically revised the manuscript. All authors gave final approval to be accountable for all aspects of the work, ensuring accuracy and integrity. All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

**Conflict of interest:** none declared.

## Data availability

The data that support the findings of this study are available from the National Audit of Cardiac Rehabilitation, but restrictions apply for the availability of these data, which were used under licence for the current study, as the data being link anonymized with NHS Digital under Section 251 approval cannot be shared publicly.

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