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Cardiac rehabilitation for heart failure and atrial fibrillation: a propensity-matched study

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ABSTRACT

Background Atrial fibrillation (AF) is common in individuals with heart failure (HF). Individuals with HF and AF may have a reduced functional capacity and quality of life (QoL) which leads to hospital admission and burden on clinical services. Evidence supported the effect of exercise training in individuals with HF. However, there is no existing data on the effectiveness of comprehensive cardiac rehabilitation (CR) in individuals with coexisting HF and AF.

Aim To explore the effect of CR in individuals with HF and AF compared with those with HF and no-coexisting AF.

Methods Using CR database, individuals with HF and AF were identified and propensity matched to those with no coexisting AF. The change in incremental shuttle walking test, Heart Disease Quality of Life questionnaire, Hospital Anxiety and Depression Scores were compared between groups pre-CR and post-CR.

Results 149 individuals were propensity matched from each group. The mean±SD age of the matched sample was 73.4±8 years, body mass index 29±5.5 kg/m^2, left ventricular ejection fraction 35.2±9.8% and 56% were male.

A statistically significant improvements in exercise capacity, heart disease QoL, anxiety and depression scores were observed within each group. There were no significant differences between groups for any of these outcome measures.

Conclusions Individuals with HF and AF gain a similar improvement in exercise capacity and health related QoL outcomes as individuals with no coexisting AF following CR. The presence of AF did not compromise the effectiveness of CR.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Cardiac rehabilitation (CR) is effective programme in improving clinical outcomes and exercise capacity in individuals with cardiac diseases.
⇒ Evidence supported the effect of exercise training in individuals with heart failure (HF). However, there is no existing data on the effectiveness of comprehensive CR in individuals with coexisting HF and atrial fibrillation (AF).

WHAT THIS STUDY ADDS

⇒ Individuals with HF and AF gain a similar improvement in exercise capacity and health related quality of life (QoL) outcomes as individuals with no coexisting AF after CR.
⇒ The presence of AF did not compromise the effectiveness of CR for those with HF.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ We believe that CR could be an effective intervention to manage individuals with coexisting AF by improving their clinical outcomes and exercise capacity.
⇒ In turn, this could improve QoL and reduce future cardiovascular events.

INTRODUCTION

Atrial fibrillation (AF) is considered the most common type of cardiac arrhythmias (irregular heart beat) that occur in ageing population.[1] In addition to age, chronic diseases such as heart failure (HF) are associated with development of AF.[2 3] The prevalence of AF among individuals with HF is about 10%–30%, whereas in severe HF cases with reduced ventricular ejection fraction (EF<35%) and New York Heart Association (NYHA) functional class (≤II), it presents more often.[4] The development of AF in individuals with HF is correlated with an increase risk of stroke and other cardiovascular events which leads to increased hospitalisation and mortality.[5]

The common symptoms associated with AF are palpitations, chest pain, breathlessness, fatigue, dizziness, diaphoresis, sleep disturbance, exercise intolerance that could result in reduced functional capacity and impaired quality of life (QoL).[6–9] Individuals living with AF can experience anxiety and depression. Inevitably, there is a huge burden of this condition to both the individuals, in terms of reduced QoL, and to the community in terms of medical services and costs of care. It has been estimated that AF- related medical services to the National Health Services (NHS) is in the region of £1.9 billion annually, with additional clinical services cost of total £329 million.[10]

The management of AF has been catalogued in different international and national organisational guidelines including the National Institute for Health and Care Excellence and European Society of Cardiology.[11 12] The outlined management plans of these guidelines concentrated mainly on pharmacological treatments, or invasive medical interventions such as catheter ablation procedure to control heart rate and maintain normal sinus rhythm, reduce symptoms, cardiovascular and thromboembolic complications related to the disease.

Despite the positive effect of current AF treatments in managing heart arrhythmia, reducing risk of stroke and disease related symptoms, they do not focus on improving exercise capacity and health related quality of life (HRQoL) which are commonly reduced in individuals with AF.

Cardiac rehabilitation (CR) is a multidisciplinary comprehensive programme targeting individuals with cardiovascular diseases. The programme includes patient assessment, education, individualised exercise training, behaviour modification and risk factor management.[13] A meta-analysis conducted by Taylor *et al* included 13 randomised clinical trials, indicated that exercise training alone is a beneficial intervention on improving exercise capacity assessed by 6 min walking test and QoL in individuals with HF with reduced EF.[14] In addition, a recent systematic review supported the positive effect of exercise training on both exercise capacity and HRQoL in individuals with AF.[15] There is a constant guidance on the delivery of CR to those with HF, but these recommendation does not extend to those with AF or those with combined disease.[12 16]

Despite the current evidence supporting the programme as an effective intervention for individuals with HF or AF, there is a lack of real-world data on the effectiveness of CR in individuals with HF with a documented diagnosis of AF. Therefore, the aim of this study was to compare the effect of supervised outpatient CR programme in individuals with HF and AF compared with a matched control group of those with no coexisting AF.

METHODS

Participants

We performed a retrospective analysis of data collected from individuals with HF who enrolled into the CR programme at Glenfield Hospital, University Hospitals of Leicester NHS Trust between January 2015 and February 2020. Inclusion criteria included individuals with a confirmed diagnosis of HF determined by Cardiac Physician, with documented evidence of AF and low ventricular EF (<50%), those with no documented evidence of coexisting AF were considered as a control group. Those who enrolled into the programme underwent an individual clinical assessment. Baseline outcome measures were assessed including measurements of the body mass index (BMI), Hospital Anxiety and Depression Score (HADS),[17] Heart Disease Health Related Quality of Life (MacNew) questionnaire[18] and the incremental shuttle walking test (ISWT),[19] which is a valid and reliable field test used to assess cardiopulmonary fitness.

The MacNew questionnaire contains 27 items which categorised into three domains: physical limitations domain, emotional function and social function domain scales. There are also five items that asking about disease symptoms including: chest pain, fatigue, shortness of breath, dizziness and legs pain in the previous 2 weeks. The maximum expected score in each domain is seven which considered a high HRQoL, and the minimum possible score is one which considered a low HRQoL.

Measures of BMI, ISWT, HADS and MacNew questionnaires were repeated after the completion of CR programme.

CR programme

The CR programme was a comprehensive 6-week outpatient programme delivering two supervised sessions a week (total of 12 sessions) supervised by qualified physiotherapists and nurses. The supervised sessions consisted of 1 hour of exercise training and 45–60 min of educational session. The exercise training consisted of aerobic exercises (walking, cycling and treadmill walking), and resistance exercise (free weight lifting, step ups, upper and lower body strength training). Intensity of these exercises was individually tailored. The educational sessions were delivered by a qualified multidisciplinary team. The sessions offered specific topics to enhance individuals understanding of their disease and how they manage their symptoms. It also focuses on the importance of exercise and physical activity, medication use, nutritional advice and self-management plans. An additional home-exercise session to be completed independently each week.

The programme was conducted according to the British Association for Cardiovascular Prevention and Rehabilitation standards and the Association for Charted Physiotherapists in Cardiovascular Rehabilitation guidelines.[20]

Data analysis

Data analyses were performed using the SPSS V.25.0 and Prism V.7.0.[21 22] Analyses was initially descriptive which is presenting of means and SD. Paired t-tests or Wilcoxon signed-rank tests were used to compare clinical outcome measures before and after CR within groups and independent t-test or Mann-Whitney tests were used to compare between groups. P value of <0.05 represented a statistically significant improvement.

Propensity score matching was conducted using R program V.3.0.3 between individuals with HF and AF compared with HF individuals with no coexisting AF.[23] MatchIt package was installed to perform a 1:1 nearest-neighbour propensity score matching using age, gender, BMI and left ventricular ejection fraction (LVEF).

Individuals enrolled in CR provided an informed consent to participate into the programme and for their data to be recorded and used anonymously for clinical evaluation and audit purposes. As per guidelines from the NHS Health

Research Authority, this study did not require an ethical approval as it considered as a part of clinical audit.

RESULTS

Between January 2015 and March 2020, 783 individuals with a primary diagnosis of HF were referred to our CR programme. Two hundred and ninety-nine of these individuals were excluded from our study due to missing reported measures. The resulting 484 individuals were divided into two groups: (1) individuals with HF and AF; (2) individuals with no coexisting AF. Medical history data including risk factors, comorbidities and previous cardiac events were collected from individuals medical records.

A total of 149 individuals with HF and AF were matched 1:1 to the nearest individuals with no coexisting AF. Baseline characteristics of gender, age, LVEF and NYHA classification for both groups are displayed in table 1. Both groups were well matched based on their age, gender, BMI and LVEF, the distributions of propensity score matching are shown in figure 1. There was no significant difference between groups in those measures. However, in individuals with HF and AF, the LVEF was lower than individuals with no coexisting AF (table 1).

For the matched individuals, each group made a significant improvement in exercise capacity (ISWT), HRQoL (MacNew overall score), HADS after successfully completing the programme (table 2). There were no differences found in levels of HRQoL, exercise capacity, anxiety and depression between groups. However, baseline exercise capacity (ISWT) was less in the group with coexisting AF (235±137) (table 2, figure 2).

Table 1 Baseline characteristics of groups prior to matching

	Patients with AF (n=149)	Patients with no AF (n=335)
Gender*		
Male, n (%)	83 (55)	196 (58)
Age*		
Mean±SD	73±8	66±11
BMI* (kg/m^2)		
Mean±SD	28±5	32±6.9
NYHA class*		
Median (IQR)	2 (2-3)	2 (2-3)
LVEF* (%)		
Mean±SD	35±10	39±9
Family history		
Yes, n (%)	46 (31)	157 (47)
Risk factors		
Smoking, n (%)	45 (30)	122 (36)
Hypertension, n (%)	112 (74)	196 (58)
Diabetes, n (%)	48 (32)	122 (36)
Hypercholestolaemia, n (%)	29 (19)	95 (28)
Dyslipidaemia, n (%)	18 (12)	36 (11)
Obesity, n (%)	36 (24)	94 (28)
Other factors, n (%)	32 (21)	63 (19)
Comorbidities		
Ischaemic heart disease, n (%)	24 (16)	79 (24)
Valvular disease, n (%)	18 (12)	34 (10)
Asthma, n (%)	22 (15)	65 (19)
Other comorbid complaints, n (%)	20 (13)	96 (29)
Previous cardiac events		
Stroke, n (%)	23 (15)	44 (13)
Angina, n (%)	29 (19)	69 (21)
MI, n (%)	45 (30)	85 (25)
Medication		
Beta blockers, n (%)	126 (84)	261 (78)
ACE, n (%)	83 (55)	169 (50)
Anticoagulants, n (%)	120 (80)	72 (22)
Aspirin, n (%)	30 (20)	204 (61)
Statin, n (%)	102 (68)	222 (66)
Diuretics, n (%)	121 (81)	219 (65)
Calcium channel blockers, n (%)	11 (7)	22 (7)
Antiarrhythmic, n (%)	64 (43)	28 (8)

Data are presented as n, n (%), mean±SD or median (IQR), unless otherwise stated. * Between group difference.
*Between group difference p<0.05.
AF, atrial fibrillation; BMI, body mass index; LVEF, left ventricular ejection fraction; MI, myocardial infraction; NYHA, New York Heart Association.

DISCUSSION

To the best of our knowledge, this is the first study to assess the benefits of a comprehensive CR programme in individuals with HF and coexisting AF compared with those with no coexisting AF using real-life data.

AF frequently coexists in individuals with HF, and there are no data to describe the effect of comprehensive rehabilitation programme in individuals with coexisting disease. In this real-life propensity-matched study, we investigated the effect of CR in HF individuals living with AF compared with those with no coexisting AF. Our study found that individuals with HF and AF had a significant improvement in clinical outcomes following completion of 6 week outpatient supervised CR. Despite a lower baseline levels of exercise capacity, we found that these improvements are similar to those matched control group of individuals with no coexisting AF.

Our data found that exercise capacity significantly improved following rehabilitation programme when assessed by ISWT. This show an early benefit from enrolling into the programme for those with coexisting AF. Although the baseline measures of exercise capacity were lower in this group, they show a meaningful improvement after completing the programme which exceeded the minimal clinical important difference for this population.[24] These findings are consistent with previous randomised clinical trials that examined the positive effect of exercise training in individuals with HF.[25] Although the previous data did not include those with coexisting AF, the

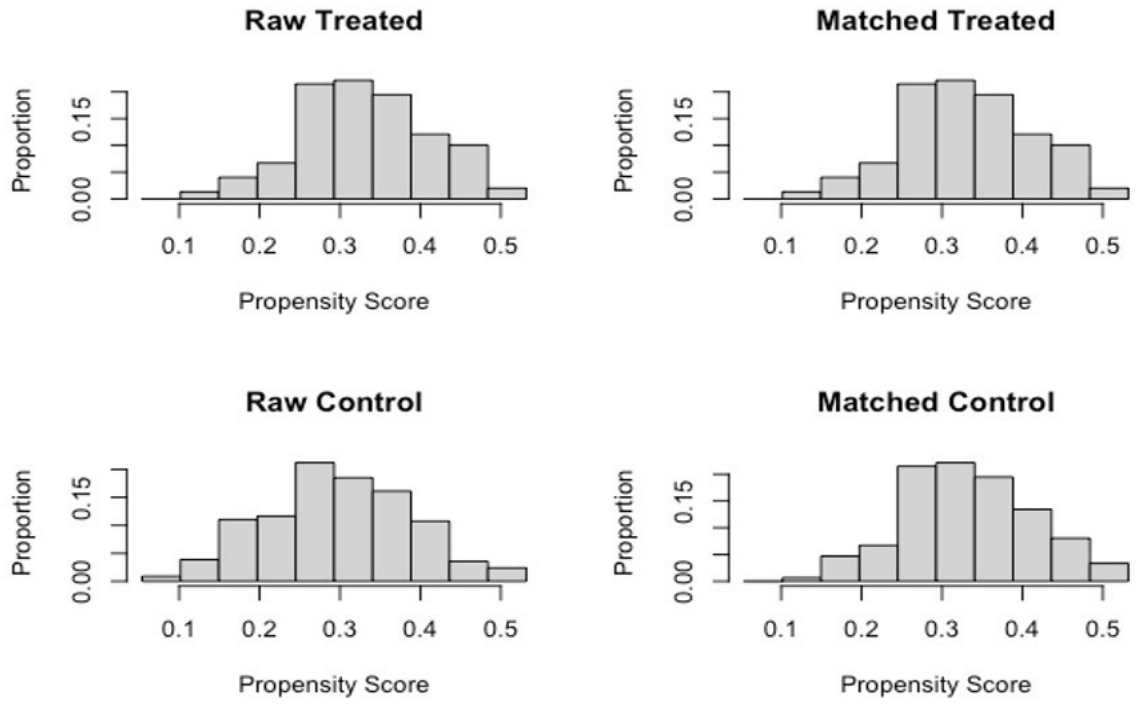

Figure 1 Distribution of propensity scores.

improvements in exercise capacity were reported in another review investigating the positive effect of exercise training in individuals with AF.[26–28] Our results demonstrated that the added burden of AF does not compromise the outcomes of CR.

Levels of anxiety and depression were assessed at baseline and after completion of the programme using the HADS scale.[29] This validated scale has been used extensively in individuals with cardiovascular disease including AF.[30 31] In our study, there were no difference in baseline scores of anxiety or depression between the two groups. Interestingly, the values are within the normal range. In addition, there was no between group difference in the scores postrehabilitation programme, but we observed a within group difference in those with coexisting AF. However, there is a lack of clinical data describing the psychological benefits of rehabilitation programmes in these population, and was not represented in the previous systematic review.[15]

In our analysis, we observed no important difference in gains of HRQoL between the two groups, but a significant clinical improvement were made within each group in overall HRQoL scores when assessed by MacNew questionnaire. In a previous observational study conducted by Hegbom *et al*,[28] they reported that short-term exercise training programme would result in a statistical significant improvement in HRQoL in

Table 2 Clinical outcome measures of two matched groups at baseline and after cardiac rehabilitation

	Patients with AF (n=149)			Patients with no AF (n=149)			Between groups difference p value
	Pre	Post	Mean difference (95% CI)	Pre	Post	Mean difference (95% CI)	
ISWT (m)	235.0±137.0	285.0±149.0*	50.0* (39.5 to 60.8)	285.0±158.0	332.0±168.0*	47.0* (33.7 to 60.6)	0.75
HADS anxiety score	5.0±3.0	3.0±2.0*	-2.0* (-1.8 to -0.8)	5.0±4.0	4.0±3.0*	-1.0* (-1.3 to -0.5)	0.21
HADS depression score	4.0±3.0	3.0±2.0*	-1.0* (-1.8 to -0.8)	4.0±4.0	4.0±3.0*	0.0* (-1.3 to -0.4)	0.40
MacNew overall score	21.0±4.0	23.0±3.0*	2.0* (1.4 to 2.8)	20.0±4.0	22.0±4.0*	2.0* (1.4 to 2.8)	0.18

Data are presented as mean±SD or mean change (95% CI) unless otherwise stated. P value represents comparison between group.
*Within group difference p<0.05.
AF, atrial fibrillation; HADS, Hospital Anxiety and Depression Scores; ISWT, incremental shuttle walking test; MacNew, Heart Disease Health Related Quality of Life questionnaire.

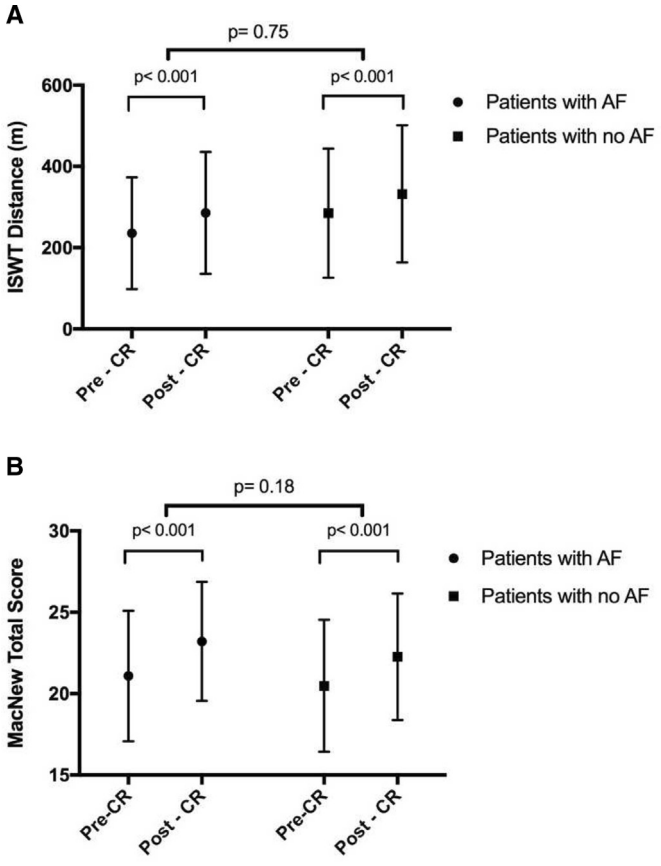

Figure 2 Response of (A) incremental shuttle walk (ISW) distance and (B) MacNew questionnaire—total score to cardiac rehabilitation (CR). AF, atrial fibrillation; MacNew, Heart Disease Health Related Quality of Life.

individuals with chronic AF measured by Short-Form 36.[28] Improvement in HRQoL has also been shown after exercise training programme in individuals with HF.[32] However, it is difficult to compare data because these clinical studies did not offer a comprehensive CR programme and the quality of data was low.

Our findings are important as individuals with HF with coexisting AF could benefit from a comprehensive rehabilitation programme and should not be excluded from CR.

Strengths and limitations

A propensity score matching was used as a formal statistical technique to ensure the similarity of baseline characteristics between groups, and the analysis included those who completed the programme with data collected pre-rehabilitation and postrehabilitation programme. Several factors must be addressed when interpreting the results. First, a propensity matching method was used in order to reduce the potential bias between the study groups. However, it may not completely eliminate this bias. Second, the data were pooled from a single centre which may affect the generalisability of our findings. Another key limitation is that the study cohort included only those who completed the programme without assessing those who did not complete the programme. Also, the small sample size and characteristics of the cohort could impact the applicability of the findings to other population.

Future work

Additional studies including large randomised controlled trails are needed to confirm and support these findings. Moreover, a long-term follow-up assessments would highlight the long-term viability of these improvements and the impact on clinical outcomes such as hospitalisation and mortality rate.

This study suggests that comprehensive CR programmes can significantly improve exercise capacity, QoL and psychological well-being for individuals with HF and coexisting AF. However, it is important to consider the study's limitations and await further research to fully understand CR's benefits and its long-term effects in this population.

CONCLUSION

This propensity matched study demonstrated that individuals with HF and coexisting AF have gained a significant improvement in exercise capacity, HRQoL, HADS after completion of a comprehensive CR programme. There was no significant difference in the HF group with coexisting AF compared with those with no coexisting AF. This supports the positive effect of rehabilitation programme as a promising therapeutic intervention for improving clinical measures in individuals with HF and coexisting AF.

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