Evaluation of cardiovascular function and quality of life in patients with heart failure with and without sedentary behavior

Luíz Antônio Souza Araújo[1], Stella Maris Firmino[2], Emílio Martins Curcelli[1], Márcio Junior Ventura Martins[1], Andréia Agraso Gusmão[1], Maria Carolina Derêncio Oliveira[2], Juliana Cristina Milan-Mattos[2], Polianna Baptista Santos[2], Renan Shida Marinho[2], Tainá Fabri Carneiro Valadão[3], Letícia Vecchi Leis[1], Silméia Garcia Zanati Bazan[4], Aparecida Maria Catai[5], Ângela Mérice Oliveira Leal[6], Meliza Goi Roscani[6]

ABSTRACT

Purpose: Despite the recognized benefits of practicing physical activity in patients with cardiovascular disease, it is believed that patients with heart failure and reduced ejection fraction with non-sedentary behavior may present an improvement in cardiovascular function and quality of life compared to sedentary patients, even if they do not practice regular physical exercise. The aim of the present study was to compare functional capacity, systolic and diastolic cardiac function and quality of life of sedentary and non-sedentary patients with heart failure and reduced ejection fraction**. Methods:** Patients with heart failure and ejection fraction below 50% were divided into two groups, Sedentary (n = 45) and Non-Sedentary (n = 36), using the IPAQ questionnaire. These two groups were evaluated with clinical evaluation, quality of life SF-36 questionnaire, Cooper walking test and transthoracic echocardiography. They were compared by Chi-Square test for categorical variables or Test T or Man-Whitney for continuous variables; the level of significance adopted in the statistical analysis was 5%. **Results:** The groups were homogeneous in relation to the baseline characteristics and etiology. The Non-Sedentary Group had fewer patients with severe symptoms ($p < 0.01$), less necessity of digitalis ($p = 0.02$) and better left ventricle fractional shortening ($p = 0.03$). There was no apparent difference in the walk-test data between groups. Additionally, there was a greater impairment in the functional capacity of the SF-36 Questionnaire in the Sedentary Group. **Conclusion:** Considering the sample limitation, patients with heart failure and non-sedentary behavior have greater tolerability to exercise because they have fewer limiting symptoms and better quality of life in the functional capacity domain than sedentary patients.

Key words: Diastolic Dysfunction; Dyspnea; Exercise Tolerance.

INTRODUCTION

Heart failure with reduced ejection fraction (HFREF) is characterized by an impairment in left ventricular (LV) systolic function. It is the most frequently diagnosed clinical form or the most easily recognizable[1]. Among its leading causes, there are diseases that cause loss of myocytes due to necrosis or apoptosis with the consequent fibrosis in cardiac muscle tissue, such as myocardial infarction and chagasic cardiomyopathy.[1,2]

The main symptoms present in ICFER are dyspnea, fatigue and exercise intolerance. These symptoms lead to significant impairment in functional capacity (FC) and quality of Life (QoL). The limitation caused by HF, when performing physical exercise (PE), may be seen as a product of multiple factors, which include changes in the cardiac structure, sympathetic hyperactivity, endothelial dysfunction and muscle changes[2].

The transthoracic echocardiogram, associated with signs and symptoms in the clinical evaluation, is used to evaluate cardiovascular function e LVEF.[3,4]A simple and inexpensive method to assess exercise tolerance in patients with HF is the 6-minute walk test[5,6] or 12 minutes - modified Cooper test[7]. Cooper walk-test has been widely used in patients with lung disease and can provide more information on exercise tolerance, the sensation of dyspnea, the rate of recovery of heart rate in the first minute (TRFC) and oxygen consumption through the

1 Graduated in Medicine in São Carlos Federal University - UFSCar, São Carlos, (SP), Brazil.
2 Post-Graduated student in São Carlos Federal University – UFSCar, São Carlos, (SP), Brazil.
3 Post-Graduated student in Botucatu Medical School -UNESP, Botucatu, (SP), Brazil.
4 Professor in the Internal Medicine Department, Botucatu Medical School - UNESP, Botucatu, (SP), Brazil.
5 Professor in the Physiotherapy department, São Carlos Federal University- UFSCar, São Carlos, (SP), Brazil.
6 Professor in the Medicine Department, São Carlos Federal University - UFSCar, São Carlos, (SP), Brazil.

distance covered. TRFC is a parameter that can measure autonomic activity in the cardiovascular system in a non-invasive and low-cost way and is also a predictor of morbidity and mortality in patients with HFREF.[7,8]

The prescription of muscle strengthening exercises (EFM), associated with aerobic physical training, has been recommended[8,9]and studies have shown an improvement in both QoL and FC and a significant reduction in mortality and hospitalization of patients who adhered to these PE strategies.[8-10]

Although regular PE prescription and supervision are essential in patients with HFREF, current data show that patients considered to be completely inactive have a higher risk of developing cardiovascular disease and an increased risk of morbidity and mortality[10-12]. A study showed that the number of hours driving, watching TV and not practicing physical activity are additional predictors of mortality[13]. Another study showed that sedentary behavior in HF patients may be related to impaired QoL and increased rates of depressive symptoms[14]. However, investigations comparing patients with HFREF with and without sedentary behavior, in relation to cardiovascular function, QoL and CF are scarce.

Patients with HFREF and non-sedentary behavior may present an improvement in cardiovascular function and quality of life compared to sedentary patients, even if they do not practice regular PE.

Thus, considering the above-exposed scenario, the aim of the study was to compare FC, systolic and diastolic cardiac function and QoL of sedentary and non-sedentary patients with HFREF**.**

METHOD

Cross-sectional study. This was conducted with consecutive patients with HFREF followed at the cardiology outpatient clinic of the São Carlos Federal University, São Carlos, Brazil. The sample was obtained by convenience. Patients eligible for the study were invited to participate in accordance with the informed consent form (IC) under ethical guidelines (CAE: 55010516.1.0000.5504).

Inclusion criteria: patients over 18 years of age, of both sexes, with HF and LVEF <50% and optimized drug therapy.

Exclusion criteria included patients with HF grade IV NYHA, stage D, with decompensation in the last three months, biomechanical limitation or artificial pacemaker rhythm.

Study protocol. Patients were submitted to the following steps:1. Application of the IC; 2.Transthoracic echocardiogram for eligibility of patients with LVEF <50% and assessment of ventricular systolic and diastolic function[3]; 3. Application of the International Physical Activity Questionnaire (IPAQ)[15] for division into Sedentary (S) and non-sedentary (NS) groups. In the NS group, patients were classified in the questionnaire as irregularly active and active; 4. Clinical Evaluation and Physical Examination; 5. Application of the SF-36 QoL Questionnaire[16]; 6. Cooper or 12-minute Walk Test[7-9] with HR assessment after 1 minute of the walk test.

The methods performed are described in the following paragraphs.

Transthoracic echocardiogram: performed on the Philips HD 11 device using adult probe, with the purpose of obtaining cuts to measure morphological variables and evaluate systolic function, by the LV shortening fraction, LVEF Simpson method and S' wave of the Mitral tissue Doppler. For the analysis of diastolic function, the indexed left atrium volume, the E' wave of the mitral tissue Doppler E Mitral Doppler Inflow/E' ratio were performed. The criteria used are in accordance with the American guidelines for echocardiography[3].

Clinical and Physical Evaluation: The patients were investigated by basal characteristics, HF symptoms, classification according to NYHA, medications in use, associated risk factors, anthropometric data, systolic blood pressure and heart rate.

Cooper test. The patients were instructed to walk as far as possible, walking or even running in 12 minutes, preferably without interruption at their own pace. The venue was a 20-meter corridor with tapes marking the distance every two meters and with chairs at both ends. To assess the HR recovery rate, the participant used a frequency meter that records HR beat by beat throughout the protocol. In addition, the blood pressure was

measured after resting for 10 minutes and before starting the test, right after the test, after six minutes and after 12 minutes.[12]

SF 36 questionnaire: this questionnaire was applied to assess the SF 36 QoL, which has already been validated in these patients[16-18].

Statistical analysis: Categorical variables were expressed as number and percentage and continuous variables with or without normal distribution were presented, respectively, as means and standard deviations or medians and interquartile ranges. The normality test used was Shapiro-Wilk. The groups were compared using the Chi-square test for categorical variables. For continuous variables, the unpaired T test was used for normal distribution variables and Mann-Whitney for non-normal variables distribution. The level of significance adopted was 5%.

RESULTS

Patients who met the inclusion criteria were divided into two groups, S = 45 individuals and NS = 36. As shown in Table 1, there was no significant difference between baseline and clinical variables. The predominant etiology of HF was ischemic heart disease due to previous myocardial infarction, present in 58% of the S and 75% of the NS, with no difference between the groups (p = 0.13).

Regarding functional classification by the New York Heart Association (NYHA), as shown in Table 2, patients in the S group had more limiting symptoms (class III) than those in group NS Group (p < 0.01).

Table 3 presents the data regarding the drugs used by patients to treat HF. It was observed that more patients of S Group required greater use of digitalis than patients of NS Group (p = 0.02).

Regarding echocardiographic variables, as can be seen in Table 4, the S Group had worse LV fractional shortening and greater left atrium indexed volume when compared to NS Group, indicating worse in systolic function (p = 0.03) and impairment in LV diastolic pressure (p = 0.004). No differences were found for other echocardiographic variables of cardiovascular function.

Table 5 summarizes the data of the Cooper walk-test (Table 5). There were no significant differences in the covered distance, estimated peak VO2 , blood pressure and TRFC between the groups.

Figure 1 is presenting the values obtained from the SF-36 QoL questionnaire. The NS Group showed improvement in the Functional Capacity domain compared to the S Group.

Table 1

Comparison between groups according to the baseline and clinical characteristics

Variables		Sedentary Group (N = 45) Mean ± SD or N (%)	Non-Sedentary Group (N = 36) Mean ± SD or N (%)	P
Age (years)		64 ±11	63 ±11	0.87
Gender	M	25 (56)	27 (75)	0.07
	F	20 (44)	9 (25)	
Race	W	22 (49)	14 (39)	0.50
	NW	23 (51)	22 (61)	
SAH		27 (60)	20 (59)	0.60
DM		16 (35)	15 (42)	0.63
Known CAD		27 (60)	28 (78)	0.07
Dyslipidemia		17 (38)	20 (56)	0.07
Smoking		18 (40)	18 (50)	0.41
SBP (mmHg)		123 ±14	124 ±16	0.78
HR (bpm)		72 ±14	69 ±9	0.39
BMI (kg / m 2)		28 (24-32)	28 (25-32)	0.58

Values expressed as Mean and Standard Deviation (SD) or Number (N) and Percentage (%). M = Male; F = Female; W= White; NW = Non-White; SAH = Systemic Arterial Hypertension; DM = Diabetes Mellitus; CAD = Coronary Artery Disease; SBP = Systolic Blood Pressure; HR = Heart Rate; BMI = Body Mass Index. Significance level adopted: 5%.

Table 2

Comparison between groups according to the NYHA classification

NYHA Functional Class	Sedentary Group (N = 45) N (%)	Non-Sedentary Group (N = 36) N (%)	P
I	9 (20)	14 (39)	**0.01**
II	15 (33)	17 (47)	
III	21 (47)	5 (14)	

Values expressed as Number (N) and Percentage (%). NYHA: Classification by the New York Heart Association. Functional Class: I- Asymptomatic patient in his usual physical activities; II: Symptoms are triggered by habitual physical activity; III: Asymptomatic patient at rest. Less than usual activity causes symptoms. Significance level adopted: 5%.

Table 3

Comparison between groups of the main classes of medications used for the treatment of heart failure

Class of Medication	Sedentary Group (N = 45) N (%)	Non-Sedentary Group (N = 36) N (%)	P
ACEI	27 (60)	22 (61)	0.92
ARA II	15 (33)	11 (31)	0.80
Beta blockers	40 (89)	33 (92)	0.68
Aldosterone Inhibitor	20 (44)	12 (33)	0.38
Digital	16 (36)	5 (14)	**0.02**
Diuretics	33 (73)	22 (61)	0.25

Values expressed as Number (N) and Percentage (%). ACEI: Angiotensin I converting enzyme inhibitor; ARA II: Angiotensin II receptor antagonist . Significance level adopted: 5%.

Table 4

Comparison between groups according to morphological and cardiac function echocardiographic variables.

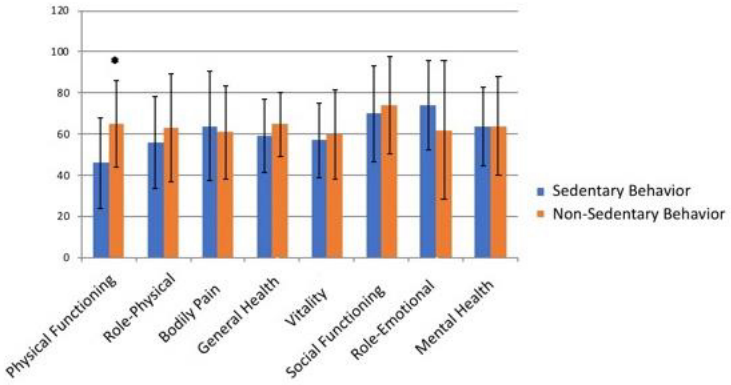
Variables	Sedentary Group (N = 45) Mean ± SD	Non-Sedentary Group (N = 36) Mean ± SD	P
MORPHOLOGICAL VARIABLES			
LVDD(mm)	59 ± 8	60 ± 7	0.71
LV mass index (g / m 2)	153 (135-209)	182 (146-226)	0.20
SYSTOLIC FUNCTION VARIABLES			
LV Shortening Fraction	0.21 (0.17-0.26)	0.24 (0.22-0.29)	**0.03**
S'	6.10 ± 1.70	6.11 ± 1.50	0.98
DIASTOLIC FUNCTION VARIABLES			
E/A Mitral	0.68 (0.58-0.88)	0.86 (0.65-1.26)	0.09
E' (cm / s) Mitral	7.0 (5.0-8.0)	6.7 (5.0-7.8)	0.39
E/E' Mitral	10.0 (7.2-12.1)	9.6 (7.9-14.1)	0.51
LA indexed volume (ml / m 2)	29.68 ± 13.67	18.73 ± 14.05	**0.004**

Values expressed as mean ± standard deviation (SD). LVDD = Left Ventricular Diastolic Diameter; S' wave: Systolic excursion velocity from the mitral annulus Tissue Doppler; E / A: Mitral flow velocity in the rapid filling phase (E) / Mitral flow velocity in the atrial contraction phase (A); E': average of excursion velocities of the lateral and medial mitral annulus tissue Doppler; LA = Left Atrium. Significance level adopted: 5%.

Table 5
Comparison between groups of Cooper walk-test

	Sedentary Group (N = 45) Mean ± SD	Non-Sedentary Group (N = 36) Mean ± SD	P
VO2 peak (ml/Kg.min)	13 ± 7	12 ± 7	0.70
End HR (BPM)	82 ± 9	81 ± 12	0.84
HR 1' (BPM)	76 ± 19	73 ± 13	0.82
VARIATION HR (BPM)	9 ± 14	12 ± 11	0.76

Values expressed as mean and standard deviation (SD) VO2 : Oxygen Volume; HR: heart rate. Significance level adopted: 5%.



*Values expressed as mean and standard deviation. * = Significance level adopted: p<0.05 when comparing domains between groups.*

Figure 1: Comparison of the SF-36 Quality of Life domains between the groups

DISCUSSION

The favorable effect of a PE program on FC and QOL in a patient with HFREF is already widely recognized in the literature.[17-20] Regular PE and cardiac rehabilitation programs may improve both systolic and diastolic cardiovascular function.[3-5,17-20]

Nevertheless, there are few reports in literature investigating patients with HFREF and non-sedentary behavior, even if they do not practice regular physical activity, may already have beneficial cardiovascular effects compared to sedentary patients. Dontje et al[20] showed that patients with HF could walk more than 10,000 steps during the day had lower NYHA functional class. Parker et al[21] observed that rural patients with HF and sedentary style had higher mortality, regardless of depression, compared to patients considered actives.

The present study observed a very homogeneous sample in relation to baseline and clinical characteristics of patients with HFREF. Most patients had moderate systolic dysfunction, with a predominance of NYHA functional class II and III.

Interestingly, the S group, although with controlled systolic pressure and optimized medications and without significant differences in relation to the NS group, presented worsening of symptoms in relation to the NYHA functional class. This group also needed more digitalis medication to improve symptoms. The distribution suggests that the presence of more patients in the NYHA III class in group S compared to NS may reflect the improvement in exercise tolerability of patients who practice some degree of physical activity, even if irregularly, according to the IPAQ results. Similar results of better functional class and lower cardiovascular risk in active patients have been described previously[21,22]. Howden et al[23] showed that patients with sedentary behavior, who participated in a regular PE program, have improved

diastolic function and FC. It is speculated that the mechanisms involved in this improvement are the reduction in sympathetic and renin angiotensin aldosterone system activation[11].

Although there were no differences in diastolic function between the groups, perhaps due to the small sample size, it was observed that the NS group had a lower left atrium indexed volume when compared to group S, in the absence of significant mitral valve pathology or congenital heart disease. This may reflect an improvement in the filling pressure of the left ventricle, which may be associated with the active behavior of the NS group. These results corroborate the findings by Matta et al.[24] They presented evidence that sedentary behavior associated with increased LV mass are independent predictors of diastolic dysfunction. The NS group showed an improvement in the LV shortening fraction, probably due to the beneficial hemodynamic effects of improving cardiac output and decreasing peripheral vascular resistance[11].

There was, in addition, a significant improvement in QoL in the FC domain, reinforcing our hypothesis that simple active behavior in everyday life may already have favorable effects on limiting symptoms and QoL, especially in the perception of greater tolerance to physical effort in patients with HFREF in agreement with the literature findings[14,25].

The main limitation considered in this study was the small sample size.

CONCLUSION

Considering the small sample studied, patients with HF and non-sedentary behavior have fewer limiting symptoms for daily physical activity, better ventricular function and FC domain of QoL than sedentary patients.

REFERENCES

1. Braunwald E. Heart failure on overview. In: Fishman AP, ed. Heart failure. New York: McGraw-Hill, 1978.
2. Jessup M, Brozena S. Heart Failure. The New England Journal of Medicine 2003; 348(20): 2007-2018.
3. Lang RM, et al. Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Journal of the American Society of Echocardiography 2015; 28(1):1-39.
4. Lester SJ, Tajik J, Nishimura RA, et al. Unlocking the mysteries of diastolic function. J Am Coll Cardiol. 2008; 51: 679-89.
5. Rubim VSM, Drumond CN, Romeo JLM, et al. Valor prognóstico do teste de caminhada de seis minutos na insuficiência cardíaca. Arquivos Brasileiros de Cardiologia 2006; 86(2): 120-125.
6. Cipriano G, Yuri D, Bernardelli GF, et al. Avaliação da segurança do teste de caminhada de 6 minutos em pacientes no pré-transplante cardícaco. Arquivos Brasileiros de Cardiologia 2009; 92(4): 312-319.
7. Cox NJM, Hendricks JC, Brinkhorst RA, et al. A pulmonary rehabilittion program for patients with asthma and mild chronic obstructive pulmonary diseases (COPD). Lung 1993; 171: 235-244.
8. Fraga R, Franco FG, Roveda F, et al. Exercise training reduces sympathetic nerve activity in heart failure patients treated with carvedilol. European Journal of Heart Failure 2007; 9: 630-636.
9. Coats AJS. The "Muscle Hypothesis" of Chronic Heart Failure. Journal of Molecular and Cellular Cardiology 1996; 28(11): 2255-2262.
10. Lavie CJ, Arena R, Swift DL, et al. Exercise and the cardiovascular system: clinical science and cardiovascular outcomes. Circ Res. 2015; 117(2): 207-219.
11. Carl J. , Cemal Ozemek, Salvatore Carbone, et al. Sedentary Behavior, Exercise, and Cardiovascular Health. Circulation Research. 2019;124:799–815.
12. Vasankari V, Husu P, Vähä-Ypyä H, et al. Association of objectively measured sedentary behaviour and physical activity with cardiovascular disease risk. Eur J Prev Cardiol. 2017; 24(12): 1311-1318.
13. Warren TY, Barry V, Hooker SP, et al. Sedentary behaviors increase risk of cardiovascular disease mortality in men. Med Sci Sports Exerc. 2010; 42(5): 879-85.
14. Chen MF, Ke SR, Liu CL, et al. Associated factors and impacts of sedentary behaviour in patients with heart failure: A longitudinal study [published online ahead of print, 2020 Apr 27]. Eur J Cardiovasc Nurs.
15. Matsudo S, Araújo T, Marsudo V, et al. Questionário internacional de atividade física (IPAQ): estudo de validade e reprodutibilidade no Brasil. Rev. Bras. Ativ. Fís 2001; 6(2): 5-18.
16. Ciconelli RM, Ferraz MB, Santos W, Meinão I, et al. Brazilian portuguese version of the SF-36, a reliable and valid quality of life outcome measure. Rev Bras Reumatol. 1999; 39 (3): 143-50.
17. Matsudo SM, Matsudo VK, Neto TLB. Atividade física e envelhecimento: aspectos epidemiológicos. Revista Brasileira de Medicina do Esporte 2001; 7: 2-13.

18. Maior AS, Lima LGM. Respostas agudas hemodinâmicas relacionadas ao teste de cooper em militares. Rev SOCERJ. 2008; 21(2): 80-87.

19. Rohde LEP, et al. Diretriz brasileira de insuficiência cardíaca crônica e aguda. Arquivos Brasileiros de Cardiologia 2018; 111(3): 436–539.

20. Dontje MLM; van der Wal MHL, Stolk R P, et al. Daily Physical Activity in Stable Heart Failure Patients. The Journal of Cardiovascular Nursing 2014; : 29(3): 218-226.

21. Park LG, Dracup K, Whooley MA, et al. Sedentary lifestyle associated with mortality in rural patients with heart failure. European Journal of Cardiovascular Nursing. 2019; 18(4): 318-324.

22. Vasankari V, Husu P, Vähä-Ypyä H, et al. Association of objectively measured sedentary behaviour and physical activity with cardiovascular disease risk. European Journal of Preventive Cardiology. 2017; 24(12): 1311-1318.

23. Howden EJ, Sarma S, Lawley JS, et al. Reversing the Cardiac Effects of Sedentary Aging in Middle Age-A Randomized Controlled Trial: Implications For Heart Failure Prevention. Circulation. 2018;137(15): 1549-1560.

24. Matta S, Chammas E, Alraies C, et al. Association Between Sedentary Lifestyle and Diastolic Dysfunction Among Outpatients With Normal Left Ventricular Systolic Function Presenting to a Tertiary Referral Center in the Middle East. Clin Cardiol. 2016; 39(5):269-275.

25. Doukky R, Mangla A, Ibrahim Z, et al. Impact of Physical Inactivity on Mortality in Patients With Heart Failure. Am J Cardiol. 2016;117(7):1135-1143.

Conflict of interest statement

The authors declare no conflict of interest.

Authors 'contribution

Conception and design of the research: Firmino SM, Roscani MG, Leal AMO; Data collection: Firmino SM, Roscani MG, Araújo LAS, Martins MJV, Gusmão AA, Curcelli EM, Oliveira MCD, Mattos JM, Valadão TFC; Analysis and interpretation of data: Firmino SM, Curcelli EM, Santos PB, Marinho RS, Oliveira MCD, Roscani MG; Statistical analysis: Firmino SM, Oliveira MCD, Milan-Mattos JC; Writing of the manuscript: Firmino SM, Roscani MG, Valadão TFC, Leis LV; Critical revision of the manuscript for important intellectual content: Bazan SGZ, Catai AM, Roscani MG, Leal AMO.

Financing source

Authors gratefully acknowledge financial support from São Paulo Research Foundation (FAPESP); M.G.R. Grant #2015-00275-5, L.A.S.A #2016/09834-0; CNPq-PIBIC (Conselho Nacional de Desenvolvimento Científico e Tecnológico).

Corresponding Author
Meliza Goi Roscani
meliza.roscani@gmail.com

Editor:
Prof. Dr Felipe Villela Gomes

Received in: July 31, 2020
Approved in: Oct 11, 2020