HSJ Health Sciences Journal

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ORIGINAL ARTICLE

Physical inactivity and sedentary behavior profiles in individuals with heart failure: comparison with healthy subjects and determinant factors

Perfis de inatividade física e comportamento sedentário em indivíduos com insuficiência cardíaca: comparação com indivíduos saudáveis e fatores determinantes

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KEYWORDS

Accelerometer
Sedentary Behavior
Motor Activity
Heart Failure
Matched-pair Analyses

ABSTRACT

Objective: Quantify the extent of inactivity and sedentarism in HF in comparison with matched controls; and explore the determinants of variables of inactivity and sedentarism in these individuals.

Method: Individuals with HF and matched controls had their physical activity (PA) in daily life cross-sectionally monitored for one week using an activity monitor. Steps/day, sedentary time/day (ST/day) and time spent/day in light PA and moderate-to-vigorous PA (MVPA) were recorded. Functional capacity, symptoms, quality of life and anthropometric data were evaluated as potential determinant factors of PA in daily life in HF.

Result: Individuals with HF (n=44) presented lower time/day in MVPA and steps/day than controls (n=30) (60% and 33% lower, respectively). Further, individuals with HF were even more inactive on weekends than weekdays (MVPA: (6[3-12] vs. 9[4-21]min/day, P=0.005; step count: 4055±2228 vs. 4550±2366 steps/day, P=0.02). Regression models indicated functional capacity as the sole determinant of time spent/day in MVPA (r2=0.23) and one of the determinants of steps/day together with age and body mass index (r2=0.52). Depression symptoms and exertional dyspnea were determinants of ST/day (r2=0.32) and time spent/day in light PA (r2=0.21).

Conclusion: Individuals with HF are 60% less active than healthy individuals, and even more markedly on weekends. Functional capacity was the main determinant of variation in steps/day and time spent/day in MVPA, whereas exertional dyspnea and depression symptoms helped explaining variation in ST/day and time spent/day in light PA.

PALAVRAS-CHAVE

Acelerômetro
Comportamento Sedentário
Atividade Motora
Insuficiência Cardíaca
Análise Pareada

RESUMO

Objetivo: Quantificar a extensão da inatividade e do comportamento sedentário em indivíduos com IC em comparação com controles pareados; e explorar os determinantes das variáveis de inatividade e comportamento sedentário nesses indivíduos.

Método: Indivíduos com IC e controles pareados tiveram sua atividade física (AF) na vida diária monitorada transversalmente durante uma semana por meio de um

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The study was conducted at the Univiersidade Estadual de Londrina.
Conflicts of interest: No conflicts of interest declared concerning the publication of this article.
Funding information: CAPES (88887.613453/2021-00), CNPq (303131/2017-9).
Submitted 17 Dec 2024, revised 10 Feb 2025, accepted 18 Feb 2025, published 2 Apr 2025

How to cite this article: Dias KL, Belo LF, Pitta F, Hernandes NA. Physical inactivity and sedentary behavior profiles in individuals with heart failure: comparison with healthy subjects and determinant factors. HSJ. 2025;15:e1583. https://doi.org/10.21876/hsjhci.v15.e1583

monitor de atividade. Foram registrados os passos/dia, tempo sedentário/dia (TS/dia) e o tempo gasto/dia em AF leve e AF moderada a vigorosa (AFMV). Capacidade funcional, sintomas, qualidade de vida e dados antropométricos foram avaliados como potenciais fatores determinantes da AF na vida diária em indivíduos com IC.
Resultado: Indivíduos com IC (n=44) apresentaram menor tempo/dia em AFMV e passos/dia em comparação com os controles (n=30) (60% e 33% a menos, respectivamente). Além disso, os indivíduos com IC foram ainda mais inativos nos fins de semana em comparação com os dias úteis (AFMV: 6[3-12] vs. 9[4-21]min/dia, P=0,005; contagem de passos: 4055±2228 vs. 4550±2366 passos/dia, P=0,02). Modelos de regressão indicaram a capacidade funcional como o único determinante do tempo gasto/dia em AFMV (r^2=0,23) e um dos determinantes dos passos/dia junto com a idade e o índice de massa corporal (r^2=0,52). Os sintomas de depressão e a dispneia ao esforço foram determinantes do TS/dia (r^2=0,32) e do tempo gasto/dia em AF leve (r^2=0,21).
Conclusão: Indivíduos com IC são 60% menos ativos que indivíduos saudáveis, sendo ainda mais inativos nos fins de semana. A capacidade funcional foi o principal determinante da variação nos passos/dia e no tempo gasto/dia em AFMV, enquanto a dispneia ao esforço e os sintomas de depressão explicaram a variação no TS/dia e no tempo gasto/dia em AF leve.

INTRODUCTION

Individuals with heart failure (HF) have been shown to be physically inactive and highly sedentary[1-3], a fact apparently influenced by the symptoms of exercise intolerance, fatigue, and dyspnea[4]. However, it is yet unclear what is the magnitude of this reduction in comparison to matched healthy (i.e., non-HF) subjects[5].

Current literature presents a considerable number of studies investigating the level of physical activity in daily life (PADL) in individuals with HF[2,3,6,7]. While most of them describe associations, just a few presented comparison with healthy matched peers[3,8] whereas also only a few compared differences of PADL behavior between week and weekend days[5]. Furthermore, these studies present quite different methodological characteristics such as the type, time of use and body location of the activity monitors (i.e., accelerometers). Accurate information on the PADL level is important since it is known, for example, that a low number of steps per day in this population increases mortality risk.[9] Moreover, the clinical impact of other variables and outcomes can be further explored, such as the time spent in sedentary behavior and in different intensities of physical activity, as well as the day-to-day variability in these outcomes.

Moreover, looking beyond the PADL profile, the determinants of inactivity and sedentarism in individuals with HF are not yet fully clear. In fact, only a few studies[10,11] investigated the influence of variables such as age, sex, body mass index, quality of life, presence of ischemic HF and type 2 diabetes mellitus, and therefore the role of these factors in determining the PADL profile has been previously described[8,10,12,13]. However, the role of many other outcomes such as left ventricle ejection fraction (LVEF), anxiety, depression, dyspnea, fatigue and functional exercise capacity as determinants of the PADL profile has not been studied in depth, so that the extent to which they influence inactivity/sedentarism in this population is still unknown. Therefore, the literature of this field might benefit from further studies which are able to add novel and detailed information on the understanding of the magnitude of inactivity and sedentarism in this population, and in special a deeper understanding of the determinants of their PADL profile. This could be useful to help establishing individualized goals in rehabilitation programs and interventions aiming to promote physical activity (PA) and reduce sedentary time of those individuals.

With more detailed knowledge on these patients' PADL level, interventions aimed at reducing physical inactivity and sedentary behavior can be proposed in a more personalized and assertive way, and rehabilitation programs can generate more clinically relevant and meaningful results to patients.

With that in mind, the aims of this study were: i) to quantify the extent to which individuals with HF are more inactive and sedentary in daily life in comparison to matched controls, both on weekdays and on weekends; and ii) to explore the determinants of variables of inactivity and sedentarism in individuals with HF.

METHODS

The present cross-sectional study was conducted from January to October 2023 at the Laboratory of Research in Respiratory Physiotherapy of the Universidade Estadual de Londrina (UEL), Brazil. A convenience sample comprised individuals with HF attending the cardiology outpatient clinic of the university hospital and healthy adults matched by age, gender and body mass index recruited from the community through social media advertisements. Volunteers were formally contacted by telephone and invited to take part in the research. Following their acceptance, assessments were scheduled. The study obtained approval from the Research Ethics Committee of the institution (No. 6.133.450), and all participants provided consent by signing an informed consent form.

The inclusion criteria for the individuals with HF were as follows: clinical diagnosis of HF (with reduced, preserved or intermediate LVEF), 18 years or older, clinical stability in the last three months (i. e., no hospitalization in the previous three months and current pharmacological optimization, as gathered in the medical records), absence of any musculoskeletal and/or neurological disorders and/

or severe disease (e.g., cancer) that could limit PADL, and at least 4 valid days of activity monitoring (see below). Inclusion criteria for subjects in the control group were the same, except for the diagnosis of HF. Exclusion criteria for both groups included failure to complete the assessment protocol for any reason (e.g., allergy to the physical activity monitor strap, expressed desire to withdraw from the study).

All participants had their PADL measured using an activity monitor (Actigraph wGT3X, Actigraph, USA), which they were instructed to wear above their right hip (attached to a strap) during waking hours (except during water activities) for seven consecutive days. Data were recorded in 1-minute epochs. Data processing involved several steps on the per-minute accelerometer records. First, non-wear time, defined as 60 minutes or more of consecutive zeroes in activity counts, was excluded for each recorded day. Records were also removed if data reliability was flagged in the original dataset, including extreme activity count values. The total number of valid minutes for each recorded day was assessed, and only days with at least 8 valid hours were included. A minimum of four valid days was required for analysis.

PADL variables were step count (steps/day), time spent/day (in minutes) in sedentary postures (i.e., sitting, reclining and lying positions) and time spent/day (in minutes) at different intensities based on published intensity thresholds:[14,15] sedentary activities (≤1.5 metabolic equivalents of task [MET]), light PA (1.6 to 2.9 MET) and moderate-to-vigorous PA (≥3 MET [MVPA]). In addition to showing sedentary time in minutes/day, it was also calculated as percentage of the total assessment time during the day. All variables were averaged over all valid assessment days. Further, total MVPA was described as the sum of MVPA in all valid days (min/week). The averages of weekdays and weekends were separately considered for subanalysis.

Functional exercise capacity was assessed using the six-minute walking test (6MWT) according to international guidelines[16]. Reference values for the Brazilian population were used[17]. The Borg scale was used to assess dyspnea and fatigue during the test. In order to assess the health-related quality of life in individuals with HF, the Brazilian version of the Minnesota Living with Heart Failure Questionnaire (MLHFQ) was used[18].

The presence of comorbidities was assessed using a list developed by the authors, relying on both Charlson and Elixhauser indices[19,20], as well as other comorbidities more prevalent among patients with HF[21]. They were self-reported and verified in medical records. Additional clinical information such as medication, the New York Heart Association (NYHA) functional classification and LVEF were also recorded. Finally, other assessments included anthropometric (body mass index, BMI) and socio-demographic aspects (sex, age, work status, marital status), and anxiety and depression symptoms (Hospital Anxiety and Depression scale, HADS)[22].

Normality in data distribution was checked with the Shapiro-Wilk test. Continuous variables were described as absolute and relative frequency (%), mean±standard deviation or median [interquartile range 25-75%]. The Mann-Whitney or the non-paired Student *t* test were applied for intergroup comparisons. PADL variables were correlated with age, BMI, 6MWT, exertional dyspnea and fatigue, NYHA class, LVFE, MLHF and HADS scores using the Pearson or Spearman correlation coefficients, according to the normality in data distribution. Variables with a correlation coefficient (r) of at least, 0.30 were included in multiple linear regression models to predict each variable of PADL (dependent variables). Statistical significance was set at *P*≤0.05. All statistical analyses were performed by the SPSS® Statistics 22.0 software (IBM Corporation, USA).

Power was calculated *post hoc* using the software G*Power 3.1.9.7 (Heinrich-Heine University Duesseldorf, Germany) with a *t* test comparison between two independent means for the variable step count (steps/day), since it is a broad reflection of PADL of different intensities.

RESULTS

In total, 76 individuals were included in the study (46 with HF and 30 controls). Two outliers among individuals with HF were identified in the PADL analyses and excluded; hence, 44 individuals with HF were analyzed. The power *post hoc* analysis for the outcome step count (α=0.05 and effect size=0.80) showed that the studied sample had a power of 0.95 (95%).

Characteristics of the studied individuals, as well as the intergroup comparisons, are described in Table 1. As expected, individuals with HF presented more comorbidities and worse functional exercise capacity than controls.

Concerning the PADL profile, individuals with HF were considerably less physically active than healthy controls (Table 2). They spent less than half of the time in MVPA in comparison to the control group, considering both time/day and total time/week (60 and 70% less, respectively). Similarly, they presented one third less steps/day than controls. On the other hand, there were no statistically significant differences between individuals with HF and healthy controls in terms of sedentary time/day and time spent/day in light PA.

Further analyses showed that individuals with HF were even less active during weekends in comparison to weekdays (Figure 1), as evidenced by the time spent/day in MVPA (6 [3 – 14] vs.10 [4 – 22] min/day, respectively; *P*=0.014) and step count (4187±2368 vs. 4615±2377 steps/day; *P*=0.060). Furthermore, there were no significant differences between weekends and weekdays in time spent/day in light PA (252±115 vs. 260±99 min/day; *P*=0.477) and sedentary time (498±93 vs. 509±92 min/day; *P*=0.329).

Table 3 shows that the distance covered in the 6MWT, exertional dyspnea and fatigue, age, NYHA class, MLHFQ and HADS scores correlated weakly to moderately (and significantly) with different PADL variables in individuals with HF. Conversely, sex and LVEF did not correlate significantly with any of the PADL variables. Sedentary time in minutes/day only correlated significantly with the Borg dyspnea scale at the end of the 6MWT, although only weakly (r= 0,31; *P*=0,044). No significant correlation of sedentary time in minutes/day with any other variable was found (r<0.28 and *P*>0.07 for all). For this reason,

Table 1 – Characteristics of the groups.

Variables	Heart Failure (n=44)	Controls (n=30)	P value
Social demographics			
Age, years	65±11	62±10	0.200
Sex, female/male, n (%)	21(48%)/23(52%)	11 (37%)/19(63%)	0.160
Married/living together, n (%)	28 (64%)	20(67%)	0.197
Retired, n (%)	32 (72%)	8 (27%)	0.003
Clinical profile			
NYHA class, n (%)			
I/II	36 (82%)	N/A	-
III	8 (18%)	N/A	-
LVEF, %	47±15	N/A	-
BMI, Kg.m^{-2}	29.6±5.3	28.7±5.1	0.457
Comorbidities, n (%)			
Hypertension	25 (83%)	11 (37%)	0.0001
Diabetes	17 (57%)	4 (13%)	0.050
Obesity	13 (43%)	10 (33%)	0.165
Depression	19 (63%)	5 (17%)	0.173
Smoker / ex-smoker	20 (67%)	7 (23%)	0.0001
Medication, n (%)			
Diuretic	23 (53%)	N/A	-
Beta blocker	20 (47%)	N/A	-
ACEI/ARB	21 (49%)	N/A	-
ARNi	10 (23%)	N/A	-
Symptoms			
HADS anxiety, points	5 [2-10]	5 [3-6]	0.908
HADS depression, points	5 [2-7]	4 [2-7]	0.674
Functional capacity			
6MWT, % pred	80±16	104±11	0.001
Health-related quality of life			
MLHFQ total, points	42 [23-62]	N/A	-
MLHFQ-physical, points	21 [5-31]	N/A	-
MLHFQ-emotional, points	8 [3-15]	N/A	-

Results are shown as mean ± standard deviation, median [interquartile range] or absolute number (% of the sample). NYHA: New York Heart Association; LVEF: left ventricular ejection fraction; BMI: body mass index; ACEI: angiotensin-converting enzyme inhibitors; ARB: angiotensin II receptor blocker; ARNi: angiotensin receptor-neprilysin inhibitor; HADS: Hospital Anxiety and Depression Scale; 6MWT: six-minute walking test; MLHFQ: Minnesota Living with Heart Failure Questionnaire.

Table 2 – Variables of physical activity in daily life in individuals with heart failure and healthy matched controls.

	Heart Failure (n=44)	Controls (n=30)	*P* value *HF vs controls*	Δ control - HF*
Wearing time, min/day	774±97	804±79	0.165	30 (-13 – 72)
Sedentary Time, min/day	510±81	490±94	0.336	-15 (-57 – 28)
Sedentary Time, % day	66±11	61±12	0.076	-4 (-1 – 1)
Step Count, steps/day	4404±2259	6594±3163	0.001	2109 (845 – 3374)
Light PA, min/day	256±101	294±98	0.119	37 (-10 – 84)
MVPA, min/day	9 [4-17]	22 [7-31]	0.008	13 (2 – 15)
Total MVPA, min/week	41 [16-104]	118 [48-181]	0.001	82 (16 – 99)

Results are shown as mean ± standard deviation or median (interquartile range). * Δ control - HF represents the median (95% confidence interval) difference between groups control and heart failure. PA: physical activity; MVPA: moderate-vigorous physical activity.

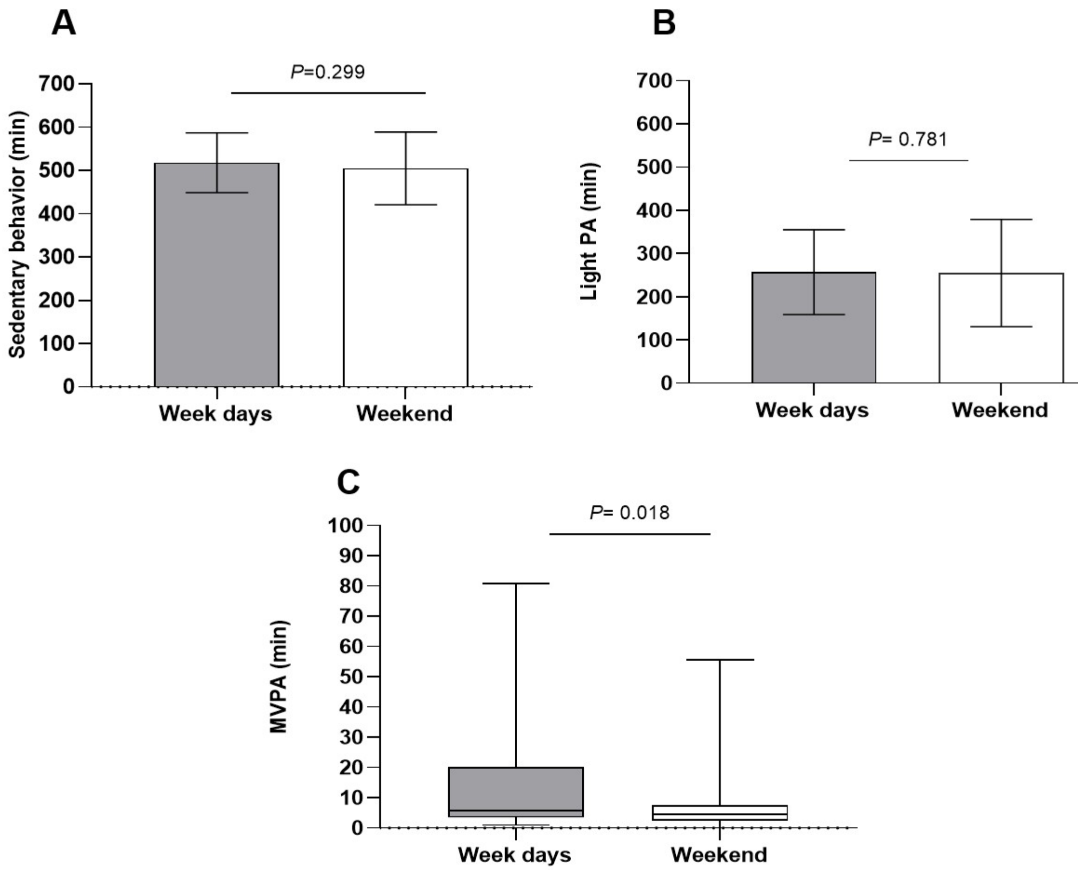

Figure 1 – Comparison of the PADL variables between weekdays and weekends in patients with HF. A) sedentary time; B) light physical activity; C) moderate-vigorous physical activity.

Table 3 – Correlations between the variables of physical activity in daily life and other outcomes in individuals with heart failure.

	Sedentary Time (% day)	Step Count (steps/day)	Light PA (min/day)	MVPA (min/day)
Age, yrs	0.41*	-0.49*	-0.30*	-0.51*
Sex	0.11	0.20	-0.10	0.28
BMI, Kg.m^{-2}	0.13	-0.36	-0.12	-0.17
LVEF, %	0.20	-0.17	-0.24	-0.03
NYHA class	0.28	-0.33*	-0.20	-0,19
MLHFQ total, pts	0.33*	-0.38*	-0.25	-0.23
HADS Anxiety, pts	0.31*	-0.22	-0.25	-0.08
HADS Depression, pts	0.40*	-0.26	-0.33*	-0.16
6MWT, %pred	-0.38*	0.50*	0.33*	0.51*
Dyspnea_6MWT, pts#	0.39*	-0.48*	-0.31*	-0.43*
Fatigue_6MWT, pts#	0.17	-0.32*	-0.07	-0.32*

Dyspnea_6MWT and Fatigue_6MWT correspond to the Borg scale (0-10 points) for dyspnea and fatigue at the end of the test. *$P < 0.05$.
PA: physical activity; MVPA: moderate-vigorous physical activity; BMI: body mass index; LVEF: left ventricle ejection fraction; NYHA: New York Heart Association; MLHFQ: Minnesota Living with Heart Failure Questionnaire; HADS: Hospital Anxiety and Depression Scale; 6MWT: six-minute walking test.

correlations shown in Table 3 were performed with the sedentary time in % of the day, a variable that was better correlated to other outcomes.

After identifying significant correlations, Table 4 shows four multiple regression models developed to ascertain the factors that could effectively be determinant factors of step

Table 4 – Stepwise multiple linear regression models for four variables of physical activity in daily life in individuals with heart failure.

Model	R^2	B (95% CI)	Standardized coefficients	*P* value
Dependent variable: Step count, steps/day	**0.52**			
Constant		112,226.373 (4,696.857 - 17,482.890)	-	0.001
6MWT, % pred		17.548 (15.274 – 86.208)	0.352	0.006
BMI, $Kg.m^{-2}$		47.753 (-277.302 - -84.276)	-0.419	0.001
Age, yrs		26.671 (-138.114 - -30.307)	-0.386	0.003
Dependent variable: MVPA, min/day	**0.23**			
Constant		-9.415 (-21.529 – 2.699)	-	0.124
6MWT, % pred		0.252 (0.104 – 0.400)	0.478	0.001
Dependent variable: Light PA, min/day	**0.21**			
Constant		374.944	-	< 0.0001
HADS Depression, pts		-7.982 (-14.842 - -1.122)	-0.328	0.024
Dyspnea_6MWT#, pts		-7.652 (-15.037 - -0.267)	-0.292	0.043
Dependent variable: Sedentary Time, % day	**0.32**			
Constant		0.488	-	<0.0001
Dyspnea_6MWT#, pts		0.011 (0.004 – 0.019)	0.385	0.005
HADS Depression, pts		0.010 (0.003 – 0.018)	0.380	0.005

Dyspnea_6MWT corresponds to the Borg scale (0-10 points) for dyspnea at the end of the test. MVPA: moderate-vigorous physical activity; PA: physical activity; BMI: body mass index; HADS: Hospital Anxiety and Depression Scale; 6MWT: six-minute walking test.

count and time spent/day in MVPA and light PA, as well as sedentary time (in % of the day, due to the abovementioned lack of relevant correlations of sedentary time in minutes/day with the other studied variables). Symptoms of depression and exertional dyspnea explained 32% of the variation in sedentary time ($R^2 = 0.32$: $P < 0.0001$), as well as 21% of the variation of light PA ($R^2 = 0.21$; $P < 0.0009$). Age, BMI and 6MWT explained 52% of the variation in step count ($R^2 = 0.52$; $P < 0.001$), whereas only the 6WMT was a significant predictor of MVPA, accounting for 23% of its variation ($R^2 = 0.23$: $P < 0.001$).

DISCUSSION

The present study showed that, in comparison to healthy marched controls, the PADL profile of individuals with HF is characterized by marked physical inactivity, especially in terms of time spent in MVPA (which was reduced by 60% - 70%) and steps/day. On the other hand, differences between individuals with HF and controls were much less pronounced in terms of sedentary behavior and light PA. Further, in individuals with HF, there is even more marked inactivity in weekend days than in weekdays. Symptoms of depression and exertional dyspnea were determinants of time spent in sedentary behavior and light PA. Functional exercise capacity (6MWT) was solely a main determinant of time spent in MVPA, whereas 6MWT, age and BMI were determinants of step count in these patients.

Although physical inactivity has been previously described in individuals with HF, the magnitude of this inactivity in comparison to healthy controls has not been thoroughly explored in the literature. Some previous results corroborate with the present research[2,3], whereas other studies presented different results[3,6,8]. In face of the challenge of physical inactivity, a possible way to improve the MVPA in these individuals is through exercise training, especially if performed according to guidelines (i.e., three times a week, at least 30 minutes of aerobic exercise)[4,23].

In general, individuals with HF in the present study did not reach the goal of steps/day recommended for people living with chronic illness in order to obtain health benefits, i.e., 6500 steps/day[24]. They also did not reach the mean of 5040 steps/day as in the study by Jordan et al.[7], although the present sample has a higher number of steps/day than other previous studies[8]. The number of steps/day is commonly linked with MVPA, although previous research[25] has suggested that its link with light PA is more likely to yield achievable goals in terms of improvement of PA level, perhaps impacting on mortality risk.

The profile of PADL of individuals with HF in this study was heterogenous throughout the week. Time spent in MVPA and number of steps/day were lower in weekends days. This result could be likely explained by the fact that some individuals with HF still had to work during weekdays, so in the weekends they may generally prefer lower motion activities in their free time to rest, as previously suggested in patients with Chronic Obstructive Pulmonary Disease[26]. On the other hand, the opposite may happen in healthy adults[27], in whom the free time on the weekends may be linked with activities of higher intensities. Schwendinger et al.[5] also found this pattern of more marked inactivity on weekend days in individuals with HF, although sedentary behavior and light PA were not the focus of their study. Researchers and clinicians might take these results into consideration for future interventions aiming to improve the level of PADL in individuals with HF.

In the present study, time spent in sedentary behavior was similar between the groups HF and control. A mean of approximately 8.5 hours/day in sedentarism was found for both groups, a result similar to other studies involving individuals with HF[3], although results up to an average of 12 hours/day in sedentary time for adults has been described[28]. This similar behavior among the groups raises questions about of the fact that sedentary behavior may be more a choice than a consequence of HF. A similar pattern can be seen in individuals with lung diseases such as bronchiectasis and severe asthma[29].

The present results on the determinants of PADL variables in HF are a new way to look at inactivity and sedentary behavior in this population. Table 4 shows that 21% of the variation of time spent in light PA and 32% of the variation of time spent in sedentary behavior were explained by symptoms of depression and dyspnea during exertion. Hence, light PA and sedentary behavior were closely connected to the functional limitation of these patients by dyspnea, whereas depression was already described as a limitation for motivation and readiness to PA in individuals with HF[30]. Conversely, number of steps/day and especially time spent in MVPA were significantly predicted by exercise capacity (6MWT), corroborating the concept that the performance of MVPA in daily life in individuals with chronic cardiorespiratory problems is strongly linked to better physical conditioning. In this sense, exercise training may be required in many patients in order to impact on improving MVPA, whereas symptom management (i.e., dyspnea and depression) may be one of the keys to reverse sedentary behavior.

Potential limitations of the present study are the small size and convenience nature of the sample, which may reduce its representativity. In addition to the single-center design in a country with considerable socioeconomic discrepancies, these factors can hinder the generalizability of the results. Further, the relatively preserved functional exercise capacity of the sample may also differ from previous reports, despite the fact that the majority had not been involved in cardiac rehabilitation programs. Finally, outcomes may differ among different types of activity monitor, and results from this study may not be applicable for comparison with other monitors from previous and future reports. These factors may eventually limit the external validity of the present findings.

CONCLUSION

Individuals with HF are 60%-70% less active than matched controls, and even more markedly on weekends. Functional exercise capacity was the main determinant of variation in MVPA and steps/day, whereas dyspnea and depression helped explain variation in ST/day and light PA. Future studies may take these results into account in order to finetune strategies to change these patients' profile of inactivity. For example, strategies to reduce physical inactivity on weekends or to properly address associated psychological factors may be useful ways to tackle the negative repercussions of these findings.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the members of the the Laboratory of Research in Respiratory Physiotherapy (LFIP) and the volunteers who participated in the study. This study received no specific funding. KLD was supported by a MSc grant from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Brazil) [Grant number 88887.613453/2021-00]. FP is supported by a personal grant from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, Brazil) [Grant number 303131/2017-9].

REFERENCES

1. Klompstra L, Jaarsma T, Piepoli MF, Ben Gal T, Evangelista L, Stromberg A, et al. Objectively measured physical activity in patients with heart failure: a sub-analysis from the HF-Wii study. Eur J Cardiovasc Nurs. 2022;21(5):499-508. http://doi.org/10.1093/eurjcn/zvab133. PMid:34993536.
2. Pozehl BJ, McGuire R, Duncan K, Hertzog M, Deka P, Norman J, et al. Accelerometer-measured daily activity levels and related factors in patients with heart failure. J Cardiovasc Nurs. 2018;33(4):329-35. http://doi.org/10.1097/JCN.0000000000000464. PMid:29538050.
3. Evenson KR, Butler EN, Rosamond WD. Prevalence of physical activity and sedentary behavior among adults with cardiovascular disease in the United States. J Cardiopulm Rehabil Prev. 2014;34(6):406-19. http://doi.org/10.1097/HCR.0000000000000064. PMid:25068393.
4. Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JGF, Coats AJS, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2016;37(27):2129-200. http://doi.org/10.1093/eurheartj/ehw128. PMid:27206819.
5. Schwendinger F, Wagner J, Infanger D, Schmidt-Trucksass A, Knaier R. Methodological aspects for accelerometer-based assessment of physical activity in heart failure and health. BMC Med Res Methodol. 2021;21(1):251. http://doi.org/10.1186/s12874-021-01350-6. PMid:34775952.
6. Dibben GO, Gandhi MM, Taylor RS, Dalal HM, Metcalf B, Doherty P, et al. Physical activity assessment by accelerometry in people with heart failure. BMC Sports Sci Med Rehabil. 2020;12(1):47. http://doi.org/10.1186/s13102-020-00196-7. PMid:32817798.
7. Jordan C, Charman SJ, Batterham AM, Flynn D, Houghton D, Errington L, et al. Habitual physical activity levels of adults with heart failure: systematic review and meta-analysis. Heart. 2023;109(18):1357-62. http://doi.org/10.1136/heartjnl-2022-321943. PMid:36849238.
8. Yavari M, Haykowsky MJF, Savu A, Kaul P, Dyck JRB, Haennel RG. Volume and patterns of physical activity across the health and heart failure continuum. Can J Cardiol. 2017;33(11):1465-71. http://doi.org/10.1016/j.cjca.2017.07.005. PMid:28985961.
9. Izawa KP, Watanabe S, Oka K, Hiraki K, Morio Y, Kasahara Y, et al. Usefulness of step counts to predict mortality in Japanese patients with heart failure. Am J Cardiol. 2013;111(12):1767-71. http://doi.org/10.1016/j.amjcard.2013.02.034. PMid:23540653.

10. Omar M, Jensen J, Frederiksen PH, Videbaek L, Poulsen MK, Brond JC, et al. Hemodynamic determinants of activity measured by accelerometer in patients with stable heart failure. JACC Heart Fail. 2021;9(11):824-35. http://doi.org/10.1016/j.jchf.2021.05.013. PMid:34509409.

11. Dibben GO, Hillsdon M, Salal HM, Metcalf B, Doherty P, Tang LH, et al. Factors associated with objectively assessed physical activity levels of heart failure patients. J Clin Exp Cardiolog. 2020;11:655.

12. Waring T, Gross K, Soucier R, ZuWallack R. Measured physical activity and 30-day rehospitalization in heart failure patients. J Cardiopulm Rehabil Prev. 2017;37(2):124-9. http://doi.org/10.1097/HCR.0000000000000204. PMid:27798506.

13. Melin M, Hagerman I, Gonon A, Gustafsson T, Rullman E. Variability in physical activity assessed with accelerometer is an independent predictor of mortality in CHF patients. PLoS One. 2016;11(4):e0153036. http://doi.org/10.1371/journal.pone.0153036. PMid:27054323.

14. Maddison R, Jiang Y, Foley L, Scragg R, Direito A, Olds T. The association between the activity profile and cardiovascular risk. J Sci Med Sport. 2016;19(8):605-10. http://doi.org/10.1016/j.jsams.2015.08.001. PMid:26320386.

15. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2008;40(1):181-8. http://doi.org/10.1249/mss.0b013e31815a51b3. PMid:18091006.

16. Holland AE, Spruit MA, Troosters T, Puhan MA, Pepin V, Saey D, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. Eur Respir J. 2014;44(6):1428-46. http://doi.org/10.1183/09031936.00150314. PMid:25359355.

17. Britto RR, Probst VS, Andrade AF, Samora GA, Hernandes NA, Marinho PE, et al. Reference equations for the six-minute walk distance based on a Brazilian multicenter study. Braz J Phys Ther. 2013;17(6):556-63. http://doi.org/10.1590/S1413-35552012005000122. PMid:24271092.

18. Carvalho VO, Guimarães GV, Carrara D, Bacal F, Bocchi EA. Validação da Versão em Português do Minnesota Living with Heart Failure Questionnaire. Arq Bras Cardiol. 2009;93(1):39-44. http://doi.org/10.1590/S0066-782X2009000700008. PMid:19838469.

19. Charlson MEPP, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40(5):373-83. http://doi.org/10.1016/0021-9681(87)90171-8. PMid:3558716.

20. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. Med Care. 1998;36(1):8-27. http://doi.org/10.1097/00005650-199801000-00004. PMid:9431328.

21. Uszko-Lencer N, Janssen DJA, Gaffron S, Vanfleteren L, Janssen E, Werter C, et al. Clustering based on comorbidities in patients with chronic heart failure: an illustration of clinical diversity. ESC Heart Fail. 2022;9(1):614-26. http://doi.org/10.1002/ehf2.13704. PMid:34796690.

22. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand. 1983;67(6):361-70. http://doi.org/10.1111/j.1600-0447.1983.tb09716.x. PMid:6880820.

23. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, et al. 2022 AHA/ACC/HFSA guideline for the management of heart failure: a report of the american college of cardiology/american heart association joint committee on clinical practice guidelines. Circulation. 2022;145(18):e895-1032. http://doi.org/10.1161/CIR.0000000000001063. PMid:35363499.

24. Tudor-Locke C, Craig CL, Aoyagi Y, Bell RC, Croteau KA, De Bourdeaudhuij I, et al. How many steps/day are enough? For older adults and special populations. Int J Behav Nutr Phys Act. 2011;8(1):80. http://doi.org/10.1186/1479-5868-8-80. PMid:21798044.

25. Kim Y, Canada JM, Kenyon J, Billingsley HE, Arena R, Lavie CJ, et al. Effects of replacing sedentary time with physical activity on mortality among patients with heart failure: national health and nutrition examination survey follow-up study. Mayo Clin Proc. 2022;97(10):1897-903. http://doi.org/10.1016/j.mayocp.2022.05.009. PMid:35753825.

26. Alahmari AD, Mackay AJ, Patel AR, Kowlessar BS, Singh R, Brill SE, et al. Influence of weather and atmospheric pollution on physical activity in patients with COPD. Respir Res. 2015;16(1):71. http://doi.org/10.1186/s12931-015-0229-z. PMid:26071400.

27. Matthews CE, Ainsworth BE, Thompson RW, Bassett DR Jr. Sources of variance in daily physical activity levels as measured by an accelerometer. Med Sci Sports Exerc. 2002;34(8):1376-81. http://doi.org/10.1097/00005768-200208000-00021. PMid:12165695.

28. Diaz KM, Howard VJ, Hutto B, Colabianchi N, Vena JE, Safford MM, et al. Patterns of sedentary behavior and mortality in U.S. middle-aged and older adults: a national cohort study. Ann Intern Med. 2017;167(7):465-75. http://doi.org/10.7326/M17-0212. PMid:28892811.

29. Cordova-Rivera L, Gardiner PA, Gibson PG, Winkler EAH, Urroz PD, McDonald VM. Sedentary time in people with obstructive airway diseases. Respir Med. 2021;181:106367. http://doi.org/10.1016/j.rmed.2021.106367. PMid:33831731.

30. Deka P, Almenar L, Pathak D, Klompstra L, Lopez-Vilella R, Marques-Sule E. Depression mediates physical activity readiness and physical activity in patients with heart failure. ESC Heart Fail. 2021;8(6):5259-65. http://doi.org/10.1002/ehf2.13609. PMid:34523268.

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