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Step counts on different days of the week and times of day during COVID-19 pandemic in older adults with hypertension: A longitudinal study

Número de passos em diferentes dias da semana e horários na pandemia covid-19 em pessoas idosas com hipertensão arterial: Um estudo longitudinal

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ABSTRACT

Objective: To analyze the number of steps taken on different days of the week and at different times of day during the COVID-19 pandemic in older adults with hypertension. Methods: Older adults with hypertension and no major cardiovascular diseases (n = 32; 67 ± 4 years) were analyzed longitudinally (16-18 months follow-up; pre-pandemic: January/March-2020; social distancing: June/2020; post-vaccination: July/2021). Step count was measured using accelerometry (one week). Results: There was a decrease in the number of steps on weekdays and weekends during social distancing (vs. pre-pandemic: β = 1,183 steps/day; p = 0.018; β = 1,947 steps/day; p < 0.001). After vaccination, on weekends, step count remained lower (vs. pre-pandemic: β = 1,152; p = 0.005), although an increase was observed compared to the social distancing period (β = 796; p = 0.027). There was no change in the morning period (p > 0.05). In the afternoon period, a decrease was observed during social distancing (vs. pre-pandemic: β = 629 steps/day; p < 0.001), and an increase post-vaccination (vs. social distancing: β = 485 steps/day; p = 0.001). In the evening period, a decrease was observed during social distancing (vs. pre-pandemic: β = 360 steps/day; p = 0.001) and post-vaccination (vs. pre-pandemic: β = 310 steps/day; p = 0.002). Conclusion: During the social distancing period, there was a reduction in step count on both weekdays and weekends, concentrated in the afternoon and evening periods. A lower number of steps in the evening was still observed post-vaccination, although increases were noted on weekends and in the afternoon compared to the social distancing period.

Keywords: Coronavirus; Aging; Physical activity; Sedentary behavior; Risk factors.

RESUMO

Objetivo: Foi analisar o número de passos em diferentes dias da semana e horários durante a pandemia covid-19 em pessoas idosas com hipertensão arterial. Métodos: Pessoas idosas com hipertensão arterial sem doenças cardiovasculares maiores (n = 32; 67 ± 4 anos) foram analisadas longitudinalmente (seguimento de 16-18 meses; pré-pandemia: janeiro/março-2020; distanciamento social: junho/2020; pós-vacinação: julho/2021). O número de passos foi mensurado por acelerometria (uma semana). Resultados: Houve diminuição do número de passos nos dias da semana e final de semana no distanciamento social (vs. pré-pandemia: β = 1.183 passos/dia; p = 0,018; β = 1.947 passos/dia; p < 0,001). Após vacinação, no final de semana, o número de passos permaneceu menor (vs. pré-pandemia: β = 1.152; p = 0,005), embora tenha aumentado pós-vacinação (vs. distanciamento social; β = 796; p < 0,027). Não houve mudança no horário da manhã (p > 0,05). No horário da tarde, houve diminuição no distanciamento social (vs. pré-pandemia: β = 629 passos/dia; p < 0,001), e aumento pós-vacinação (vs. distanciamento social: β = 485 passos/dia; p = 0,001). No horário da noite, houve diminuição no distanciamento social (vs. pré-pandemia: β = 360 passos/dia; p = 0,001) e pós-vacinação (vs. pré-pandemia: β = 310 passos/dia; p = 0,002). Conclusão: No distanciamento social, houve redução do número de passos na semana e final de semana, concentrada nos horários da tarde e noite. Ainda houve menor número de passos no horário da noite pós-vacinação, embora tenha se observado aumento nos finais de semana e horário da tarde em relação ao distanciamento social.

Palavras-chave: *Coronavírus; Envelhecimento; Atividade física; Comportamento sedentário; Fatores de risco.*

Introduction

The COVID-19 pandemic was declared a national public emergency in March 2020[1]. Various containment measures were implemented worldwide to control the spread of COVID-19, with a primary emphasis on social distancing. This strategy resulted in the closure of all non-essential services and establishments, such as schools, malls, cultural and sports venues, and

introduced the public health message "stay at home"[2]. The mobility restrictions imposed by the pandemic significantly disrupted daily routines and had a detrimental effect on people's movement behavior[3]. The preventive mobility restrictions were more pronounced on older adults and individuals with chronic conditions, such as hypertension and diabetes[4], who faced an increased risk of severe COVID-19 infection[5].

Numerous studies have documented a reduction in the number of steps per day during the period of social distancing policy imposed due to the COVID-19 pandemic[3,6–9]. A systematic review with meta-analysis indicated a decrease of 2,000 steps per day during social distancing in both adults and older individuals[10]. Our previous research also found a decrease in steps per day among older individuals with hypertension during social distancing[4,11]. This reduction was notably dependent on the day of the week[4]. For example, there was a 15% reduction in step volume on weekdays, equivalent to 700 steps per day, while on weekend days, this reduction was 30%, or 1,700 steps per day[4]. It is well-documented that the movement behaviors of older individuals vary throughout the day[12–14]. However, no study has explored whether the change in steps per day during the pandemic is similar (or not) on different times of the day, i.e., in the morning, afternoon, or evening. Additionally, there is a lack of information on whether step volume has returned to pre-pandemic levels following the implementation of COVID-19 vaccination in older individuals with hypertension.

Walking is a repetitive ambulatory behavior that occurs throughout various activities in the day, serving as an objective and easy-to-monitor parameter of physical activity. For example, 10 minutes of walking at moderate intensity represents approximately 1,000 steps[15]. Analyzing steps per day during the epidemiological phases of the COVID-19 pandemic and how it is distributed across different times of the day as well as days of the week is pivotal for a better understanding of the impact of social distancing policies on physical activity levels among at-risk groups and for guiding protective actions in the event of further mobility restrictions. This approach is particularly relevant for older adults with hypertension, who represent a highly prevalent clinical group in Brazil and are at greater risk of severe outcomes from COVID-19. Therefore, the aim of this study was to analyze the number of steps taken on different days of the week (weekdays and weekend days) and at different times of day (morning, afternoon, and evening) during the COVID-19 pandemic in older adults with hypertension.

Methods

Study design

This exploratory longitudinal study monitored steps/day using accelerometry in older adults with hypertension across different phases of the COVID-19 pandemic: before the pandemic (January-March 2020), during social distancing and before vaccination (June 2020), and after vaccination (July 2021). Initial assessments occurred at the Department of Physical Education, Federal University of Rio Grande do Norte, Natal, Brazil, while later assessments were conducted at participants' homes using sterilized accelerometers with video call instructions. The study was approved by the Research Ethics Committee of Onofre Lopes University Hospital (protocol 3.180.310/2019) and followed the Helsinki Declaration, and participants provided written informed consent.

Participants and exposure periods

The older adult participants were selected from the Hypertension EXercise Approaches Study (HEXA), which is a clinical trial that was suspended due to the COVID-19 pandemic. Eligibility criteria for HEXA study can be accessed on the Brazilian Clinical Trials Registry (http://ensaiosclinicos.gov.br/rg/RBR-4ntszb/). Key inclusion criteria encompassed individuals aged 60-80 with a hypertension diagnosis, no prior involvement in a regular physical activity program for the past three months, and physical inactivity (i.e., < 150 minute/week of moderate to vigorous physical activity). Exclusion criteria included prior cardiovascular events or diseases, uncontrolled hypertension (>160/105 mmHg), contraindications for exercise per the cardiopulmonary exercise test, musculoskeletal injuries limiting exercise capacity, and a diagnosis of progressive neurological disorders.

Before social distancing (January-March 2020), 41 participants underwent the first assessment (screening). However, it was interrupted shortly after the first confirmed COVID-19 case in Natal city on March 12, 2020. Nevertheless, we maintained weekly phone contact with these individuals. After 11 weeks of social distancing during a period of high mobility restrictions without vaccines, in June 2020, we invited all 41 participants via phone for the second assessment (after 11 weeks). Five individuals declined to participate, and

one was excluded due to technical accelerometer data issues. The third evaluation occurred in July 2021 (13 months after the second evaluation, and 16-18 months after the first evaluation), with all participants having received at least one dose of the COVID-19 vaccine and under less severe social distancing policies. Out of the 35 older adults who participated in this evaluation, 32 were included. As reported during weekly phone calls, most participants were not engaged in an exercise program during this period. However, 10 reported walking on average five days per week. See Figure 1 for the participant flowchart, and for additional details, consult Browne et al.[4,11,16].

Health screening (potential confounders)

Before the COVID-19 pandemic, we conducted face-to-face interviews to collect additional information from participants. This included their medical history, medication use, sociodemographic details (e.g., age, sex), and behavioral information (e.g., smoking, alcohol consumption). We also measure daily steps using accelerometers. Anthropometric data (body mass and height), and resting blood pressure were measured. Body mass index was calculated by dividing weight by height squared and categorized as 'normal weight' (< 27.0 kg/m^2), 'overweight' (27.0–29.9 kg/m^2), and 'obese' (≥ 30.0 kg/m^2)[17]. Resting BP measurements followed standard guidelines[18] using an oscillometric device (Omron HEM-780-E, Kyoto, Japan). blood pressure was categorized as "controlled" (<140/90 mmHg) or "uncontrolled" (≥ 140/90 mmHg). To assess cardiovascular disease risk, we categorized participants as "low", "moderate", or "high" risk using the Framingham risk score, considering age, sex, smoking status, body mass index, systolic blood pressure, treatment for hypertension, and diabetes[19]. In classifying the participants' physical activity level, we considered the weighted total accumulation of PA measured by the accelerometer over seven days. Older individuals were categorized as "physically active" (≥ 150 minute/week of moderate to vigorous physical activity) or "physically inactive" (< 150 minute/week of moderate to vigorous physical activity)[20].

Accelerometry (outcomes)

We measured steps per day using the ActiGraph GT3X+ accelerometer (ActiGraph LLC, Pensacola, FL, USA). These accelerometers were worn on the right hip for seven consecutive days, covering both waking and sleeping periods. Participants were instructed to remove the accelerometer during water-based activities. The accelerometers were programmed to collect data at a sampling rate of 60 Hz, with raw acceleration data integrated over 60-second epochs, and default filter settings enabled. For data analysis, we included participants who had at least four valid days of accelerometer wear time (i.e., ≥ 600 minutes per day), with a minimum of three weekdays and one weekend day[21]. Non-wear time was defined as ≥ 90 minutes of zero counts, with a two-minute allowance[22]. Steps per day were calculated individually as the sum of steps per day divided by the number of valid accelerometer days. For analysis by time of day, we defined the following intervals: morning (06:00-11:59), afternoon (12:00-17:59), and evening (18:00-23:59). Additionally, we considered values for weekdays, weekend days, and waking periods (morning, afternoon, and evening) for data analysis. We analyzed steps per day using ActiLife software, version 6.13.3.2.

Statistical analysis

Descriptive participant characteristics are presented as mean ± standard deviation (SD) for continuous variables and as absolute and relative frequencies (%) for categorical variables. To analyze changes in steps per day by time periods, we employed generalized linear mixed models. These models treated the subject as a random effect, while the time period and relevant covariates were considered as fixed effects. We adjusted for potential confounders: a) daily accelerometer wear time; and b) age, sex, education, income, employment status, and daily accelerometer wearing time. The inclusion of the subject as a random effect was necessary due to the observed high intra-subject variability. Robust estimation techniques were applied for the fixed effects model. To ensure the validity of the models, the distribution of residuals was assessed using normal Q-Q plots. The results of the models are expressed as estimated marginal means, contrast estimates (β), and 95% Wald confidence intervals (CI). We considered p-values from two-tailed tests, with statistical significance set at < 0.05 for all analyses. All statistical analyses were conducted using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, USA). No missing data were found in the final sample.

Results

A total of 32 individuals were included in the analysis

(Figure 1). Table 1 presents the characteristics of the participants. The majority were women (66%), retired (69%), and living with a partner (50%). Approximately 41% had type 2 diabetes, and 47% were classified as having overweight or obesity. Most participants were physically inactive (78%). Between May 2020 and May 2021, 10 (31%) participants were infected with the COVID-19 virus, but none experienced severe symptoms or required hospitalization. By the third data collection stage, all participants had received at least one dose of the COVID-19 vaccine, with 34% being partially vaccinated and 66 % fully vaccinated.

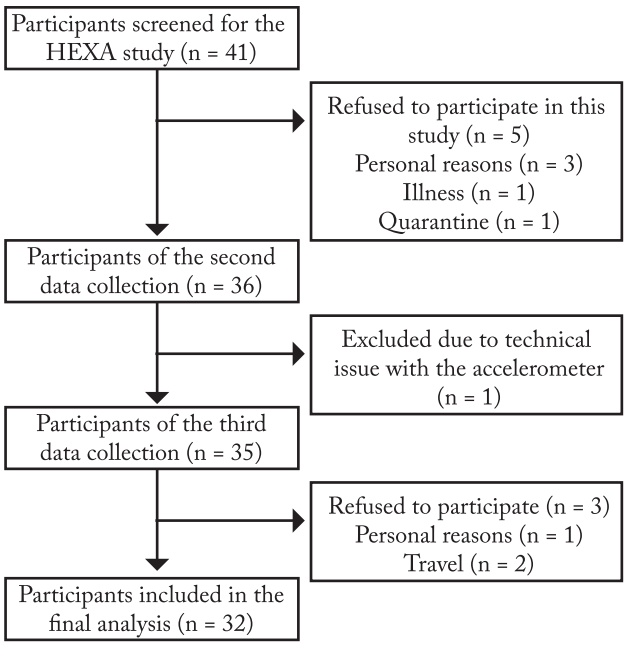

Figure 1 – Flowchart of study participants.

Figure 2 (and Table 2 and Supplementary Table 1) illustrates the changes in steps per day on different days of the week during the COVID-19 pandemic. Regarding weekdays, there was a significant reduction in steps per day during the period of social distancing policies (β = –1,183 steps/day, p = 0.018) compared to the period before the pandemic. On weekend days, there was a significant reduction in steps per day during the social distancing period (β = –1,947 steps/day, p < 0.001) and after receiving the vaccination (β = –1,152 steps/day, p = 0.005) compared to the pre-pandemic period. Additionally, there was a significant increase in steps per day after receiving the vaccination (β = 796 steps/day, p = 0.027) compared to the social distancing period on weekend days.

Figure 3 (and Table 2 and Supplementary Table 1) displays the changes in steps per day at different times of day (morning, afternoon, and evening) during the COVID-19 pandemic. No changes in steps per day were observed during the morning period in any epidemiological phase of the COVID-19 pandemic (p > 0.05). There was a significant reduction in steps per day during the afternoon period during the social distancing period (β = –629 steps/day, p < 0.001) compared to the period before the pandemic. Furthermore, there was a significant increase in steps per day during the same period after receiving the vaccination compared to the social distancing period (β = 485 steps/day, p =

Table 1 – Characteristics of the participants included in the study (n = 32)

	Mean ± standard deviation or n (%)
Age, years	67.0 ± 4.0
Women, n (%)	21 (65.6)
Post-secondary education, n (%)	7 (21.9)
Living with a partner, n (%)	16 (50.0)
Ex-smoker, (%)	8 (25.0)
Physically inactive, n (%)	25 (78.1)
Employment status, n (%)	
Active (working from home)	10 (31.3)
Retired	22 (68.8)
Per capita income, n (%)	
< 1 minimum wage salary	8 (25.0)
1–2 minimum wage salary	14 (43.8)
> 2 minimum wage salary	10 (31.3)
Body mass index, kg/m^2	27.3 ± 3.4
Overweight, n (%)	11 (34.4)
Obesity, n (%)	4 (12.5)
Type 2 diabetes, n (%)	12 (37.5)
Dyslipidemia, n (%)	20 (62.5)
Hypertension diagnosis, years	13.3 ± 9.3
Resting systolic blood pressure, mmHg	136 ± 18
Resting diastolic blood pressure, mmHg	74 ± 9
Framingham risk, n (%)	
Moderate risk	12 (37.5)
High risk	20 (62.5)
COVID-19 infected, n (%)	10 (31.3)
COVID-19 vaccines, n (%)	
CoronaVac	21 (65.6)
AstraZeneca/Oxford	10 (31.3)
Pfizer	1 (3.1)
Partially vaccinated, n (%)	11 (34.4)
Fully vaccinated, n (%)	21 (65.6)

The values are presented as mean ± standard deviation (SD) or absolute and relative frequencies (%).
COVID-19 = Coronavirus Disease 2019.

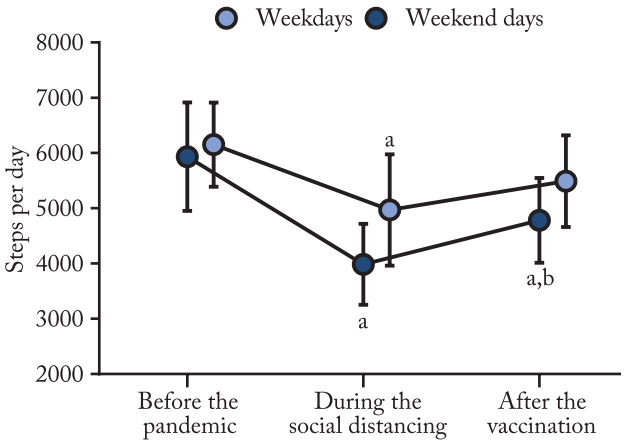

Figure 2 – Step counts on different days of the week during different epidemiological moments of the COVID-19 pandemic in older adults with hypertension: before the pandemic (January to March 2020), during the period of social distancing policy (June 2020), and after receiving the vaccination (July 2021). The values are presented as estimated marginal means and 95% Wald confidence intervals (CI). The analyses were performed using the generalized linear mixed model, adjusted for daily accelerometer wear time.
a = Significantly different from the pre-pandemic period in the same subgroup ($p < 0.05$); b = Significantly different from the social distancing period in the same subgroup ($p < 0.05$).

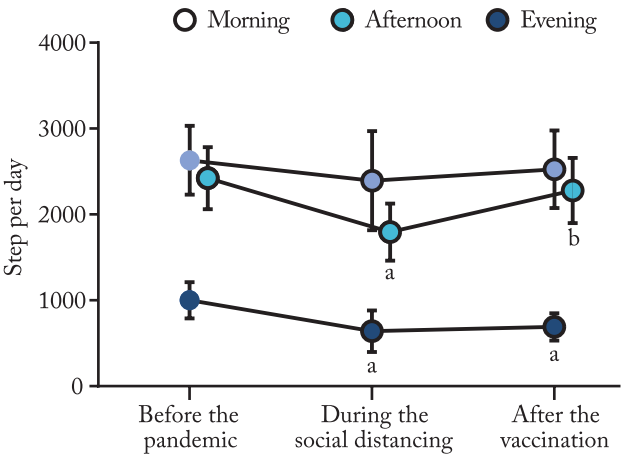

Figure 3 – Step counts at different times of day during different epidemiological moments of the COVID-19 pandemic in older adults with hypertension: before the pandemic (January to March 2020), during the period of social distancing policy (June 2020), and after receiving the vaccination (July 2021). The values are presented as estimated marginal means and 95% Wald confidence intervals (CI). The analyses were performed using the generalized linear mixed model, adjusted for daily accelerometer wear time.
a = Significantly different from the pre-pandemic period at the same time of day ($p < 0.05$); b = Significantly different from the social distancing period at the same time of day ($p < 0.05$).

Table 2 – Changes in step count at different days of the week and times of day during different epidemiological moments of the COVID-19 pandemic in older adults with hypertension (n = 32): before the pandemic (January to March 2020), during the period of social distancing policy (June 2020), and after receiving the vaccination (July 2021).

	Social distancing vs. Before the pandemic		P	After the vaccination vs. Before the pandemic		P	After the vaccination vs. Social distancing		P
	β	CI 95%		β	CI 95%		β	CI 95%	
Day of the week									
Weekdays	−1183	−2155, −210	0.018*	−662	−1455, 132	0.101	521	−304, 1346	0.213
Weekend days	−1947	−2855, −1039	<0.001*	−1152	−1955, −348	0.005*	796	91, 1500	0.027*
Time of the day									
Morning	−238	−724, 248	0.334	−105	-471, 262	0.572	133	−255, 521	0.498
Afternoon	−629	−939, −317	<0.001*	−144	-456, 168	0.361	485	206, 763	0.001*
Evening	−360	−555, −164	<0.001*	−310	-499, −121	0.002*	50	−92, 192	0.488

The values are presented as estimated contrasts (β) and 95% Wald confidence intervals (CI). The analyses were performed using the generalized linear mixed model, adjusted for daily accelerometer wear time.
* Indicate statistical significance at $p < 0.05$.

0.001). In the evening period, there was a reduction in steps per day during the social distancing period (β = −360 steps/day, $p < 0.001$) and after receiving the vaccination (β = −310 steps/day, $p = 0.002$) compared to the pre-pandemic period.

Discussion

The main findings were as follows: i) on weekdays, there was a reduction in steps/day during the period of social distancing policy compared to pre-pandemic; ii) on weekend days, steps/day decreased during the social distancing period and increased after receiving the COVID-19 vaccination, but without a complete recovery to pre-pandemic levels; iii) in the morning period, steps/day did not change throughout the different moments of the pandemic; iv) in the afternoon period, steps/day decreased during the social distancing period and partially recovered after receiving the vaccination; and v) in the evening period, a lower step/day was observed during the social distancing period and after receiving the vaccination, compared to the period before the pandemic.

We observed that the epidemiological context of the COVID-19 pandemic, regardless of vaccination

status, led to reduced step volume among individuals at high risk for severe COVID-19. During the period of social distancing measures, we noted a significant decrease in step volume on both weekdays and weekend days. Prior to the pandemic, older adults typically averaged 6,150 steps per day on weekdays and approximately 5,900 steps per day on weekends, values that fell below the recommended threshold for considering individuals as physically active, which stands at over 7,500 steps per day[15]. Throughout the more restrictive phase of social distancing measures, which included the closure of parks, squares, clubs, non-essential businesses, and a stay-at-home recommendation, step volume witnessed a substantial reduction. Specifically, step volume decreased by 20% on weekdays and 33% on weekend days during this challenging period. The decrease in step count may can also be attributed to increased restrictions on leisure activities, such as shopping, cultural events, and religious gatherings, which are more common on weekends[23]. This observation aligns with a growing body of evidence highlighting the adverse impact of reduced daily steps on health outcomes. Lower step count has been linked to a heightened risk of metabolic syndrome and its associated components[24], greater arterial stiffness[25], and elevated mortality rates[26]. Additionally, it is associated with a decline in strength, muscle mass, insulin sensitivity, and an increase in systemic inflammation, affecting both young and older adults[27].

After vaccination, weekday step volume partially recovered, increasing by 796 steps per day compared to the social distancing period. This rise may be linked to eased mobility restrictions, business and leisure reopening's, and a greater sense of safety from vaccination. Of note, all participants in our study had received at least one dose of the COVID-19 vaccine during this period, and the rest of the population was also in the process of being vaccinated. However, during the post-vaccination period, step count on weekend days remained 15% lower compared to pre-pandemic levels. This finding could be partially explained by the persistent pandemic scenario during this period, marked by 28,632 recorded deaths in Brazil in July 2021, when data collection took place after vaccination[28]. A systematic review examining the psychological impact of social distancing policy has shown that the fear of infection is one of the negative psychological effects stemming from the pandemic, which may have limited the return to pre-pandemic activities[29].

Step count exhibited varying patterns across different times of the day throughout the phases of the COVID-19 pandemic. No significant change in steps per day was observed during the morning period. However, in the afternoon and evening periods, step count decreased during the period of social distancing policy. Notably, a partial recovery in step count was observed in the afternoon period. It is well-documented that older adults exhibit a diurnal pattern of physical activity, characterized by higher activity levels in the morning and progressively lower levels in the afternoon and evening[30]. This pattern was consistent with the findings of our study, with a more pronounced reduction in physical activity levels during the epidemiological moments of the COVID-19 pandemic[12–14]. This diurnal activity pattern may be attributed to the fact that older adults tend to reach their peak activity levels earlier in the day[30]. Daily activities such as bathing, dressing, and voluntary physical exercise are typically carried out during the morning hours, with activity levels tapering off as the day progresses[30]. Interestingly, the step count did not decline during the morning period throughout the various epidemiological phases of the COVID-19 pandemic. This finding may be partly explained by the nature of activities commonly undertaken during this time by this population. During the morning, older adults engage in essential household tasks such as cleaning, cooking, gardening, and do-it-yourself projects. These activities are predominantly indoors and remain unaffected by the social distancing policies imposed during the COVID-19 pandemic[13]. Therefore, our results emphasize the importance of considering the distinct daily time periods, particularly during the afternoon and evening, when designing physical activity interventions during potential periods of social distancing and restrictions of mobility.

By elucidating the fluctuations in physical activity levels among older adults with hypertension throughout various epidemiological phases of the pandemic, we can better plan for future scenarios with the goal of increasing daily steps, particularly during critical periods. Here are some strategies to be considered: a) encouraging participation in home-based physical activity; b) promoting active transportation in safe areas; c) encouraging short walks for everyday errands (e.g., trips to the bakery, pharmacy, or market) always taking the necessary sanitary precautions against contamination with COVID-19; d) encouraging engagement in household activities such as sweeping, vacuuming, and

gardening; e) on weekends, promoting outdoor activities in parks and clubs with family members. Furthermore, incorporating breaks from prolonged sitting at home every 30 minutes with 3-5 minutes of light walking can help reduce sedentary behavior and boost daily step count. This practice has been associated with a decrease in postprandial glucose, insulin, and triglyceride levels[31]. The recommendation to be considered an active individual is 7,500 steps[15]; however, a recent meta-analysis has shown that from 3,000 daily steps, elderly individuals progressively exhibited a lower risk of mortality[32]. Additionally, a recent systematic review that examined the physiological consequences of intentionally reducing daily step count in both young and older adults highlight the importance of resistance training as a valuable countermeasure. Resistance training can help mitigate some of the detrimental effects associated with a reduction in habitual step count, such as muscle mass and strength loss in older adults[27].

This study has limitations that should be acknowledged. Firstly, it is important to note that the primary design of this study was not investigate the impact of the COVID-19 pandemic on step count in older adults with hypertension. We also did not control for climatic or seasonal conditions; however, the study was conducted in Natal (Northeastern Brazil), where temperature variation is low and sunny days predominate. Additionally, the study included individuals with hypertension who were physically inactive and aged 60-80 years without major cardiovascular diseases, such as coronary heart disease or chronic heart failure. Therefore, caution is needed when extrapolating these findings to other populations.

In summary, during the social distancing period, there was a reduction in step count on both weekdays and weekends, concentrated in the afternoon and evening periods. A lower number of steps in the evening was still observed post-vaccination, although increases were noted on weekends and in the afternoon compared to the social distancing period. By identifying the periods with the greatest reductions in step count, targeted public health strategies can be developed to help maintain physical activity in future social distancing scenarios, particularly among at-risk populations facing mobility restrictions.

Conflict of interest

The authors declare no conflict of interest.

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Author's contributions

Fonseca-Araujo MB: Conceptualization; Investigation; Project administration; Writing – original draft; Approval of the final version. Browne RAV: Methodology; Formal analysis; Data curation; Writing – original draft; Approval of the final version. Freire YA: Methodology; Data curation; Writing – review & editing; Approval of the final version. Lucena BEB and Sócrates J: Investigation; Writing – review & editing; Approval of the final version. Costa EC: Conceptualization; Supervision; Project administration; Funding acquisition; Writing – review & editing; Approval of the final version. Cabral LLP: Conceptualization; Methodology; Investigation; Data curation; Supervision; Project administration; Writing – original draft; Approval of the final version.

Declaration regarding the use of artificial intelligence tools in the article writing process

For the development of this manuscript, the artificial intelligence ChatGPT 5 was used for the following activity(ies): text revision, text translation, and/or text organization. The authors declare that all material derived from such process has been reviewed, and the authors assume full responsibility for all the content of the manuscript.

Availability of research data and other materials

After publication the data will be available on demand to the authors

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Supplementary Table

Supplementary Table 1 – Step per day at different times of the day and week during different epidemiological moments of the COVID-19 in hypertensive older adults: before the pandemic (January to March 2020), during the period of social distancing policy (June 2020), and after receiving the vaccination (July 2021).

	Before the pandemic	During the social distancing	After the vaccination
	Estimated marginal means (95% CI)	Estimated marginal means (95% CI)	Estimated marginal means (95% CI)
Time of the week			
Weekdays	6151 (5389, 6913)	4969 (3962, 5975)[a]	5490 (4660, 6319)
Weekend	5933 (4951, 6915)	3985 (3252, 4719)[a]	4781 (4013, 5549)[a,b]
Time of the day			
Morning	2630 (2230, 3030)	2392 (1815, 2970)	2525 (2075, 2976)
Afternoon	2422 (2061, 2784)	1793 (1461, 2126)[a]	2278 (1898, 2658)[b]
Night	1000 (788, 1211)	640 (398, 882)[a]	690 (531, 849)[a]

The values are presented as estimated marginal means (EMM) and 95% Wald confidence intervals (CI). The analyses were performed using the generalized linear mixed model, adjusted for daily accelerometer wear time.
a = Significantly different from the before the pandemic period ($p < 0.05$); b = Significantly different from the social distancing period ($p < 0.05$)

Reviewers' assessment

The reviews of this article were originally conducted in Portuguese. This version has been translated using ChatGPT and subsequently reviewed by the Chief Editors.

Reviewer A

Euripedes Barsanulfo Gonçalves Gomide
Claretiano - Centro Universitário: Batatais, São Paulo, Brazil.

Letter from the Reviewer to the Authors

Dear Authors,

- Thank you for the opportunity to contribute to the manuscript entitled "Step volume during the COVID-19 pandemic in elderly individuals with hypertension", submitted to the *Revista Brasileira de Atividade Física & Saúde*.
- After a careful review of the manuscript, I present below some comments and suggestions that I hope will help improve the quality of the article toward its publication.

1. Title

- On page 1, part of the title, specifically on line 3, is not in bold.

2. Abstract

- On page 1, the final sentence (lines 17–18), "the change in step volume... was remarkable", is vague. It could be more assertive regarding the practical relevance of the findings.

3. Introduction

- In the Introduction, page 3, line 15, please include the author(s)' last name(s) and year of the citation.

4. Methods

- In "Methods," under "Study Design," page 4, lines 16, 18, and 19, replace the placeholders marked as "XXXX" with the complete information.
- Do the same in "Methods," page 5, line 1.
- In "Methods," under "Health screening," pages 5 (line 25) and 6 (line 1), for the classification "'normal weight' (<27.0 kg/m^2), 'overweight' (27.0–29.9 kg/m^2), and 'obese' (≥30.0 kg/m^2)," verify whether these cutoff points are correct and add the author(s)' last name(s) and year where this information was obtained.

5. Discussion

- In Discussion, page 9, lines 20–21, "...such as shopping, cultural events, and religious gatherings, which are more common on weekends," please include the author(s)' last name(s) and year.
- In Discussion, page 11, lines 14–15, "...a) encouraging participation in home-based exercises;" — is the recommendation to encourage exercise (which should be supervised, planned, structured, and repetitive) or physical activity? I believe the intention is to refer to physical activity.
- I suggest reorganizing the limitations section to make it more prominent and including a reflection on the absence of a control group and the potential sample selection bias.
- It is recommended to include explicit suggestions for future studies, such as investigations with different clinical profiles or interventions adapted to contexts of reduced mobility.

6. Conclusion

- The conclusion adequately summarizes the main findings.
- It is suggested to briefly reinforce the practical and public health implications of these results for the development of policies aimed at promoting physical activity among older adults during periods of isolation or health risk.

7. Formal Aspects

- Check the standardization of references according to the journal's guidelines, especially regarding the use of "et al." and journal title abbreviations.
- Recommendation:
- The article demonstrates scientific merit and methodological clarity and may be accepted after the revisions indicated above.
- I congratulate the authors for the proposal and for the work developed so far, and I appreciate the opportunity to contribute to improving the quality of the manuscript.

Final decision

- Mandatory Revisions

Reviewer B

Marcio Tasinafo Junior
Universidade de São Paulo Escola de Educação Física e Esporte de Ribeirão Preto. Ribeirão Preto, São Paulo, Brazil.

Hello, I hope you are doing well!

Congratulations on the manuscript — it is concise and well written.

Below are my comments for revision:

- **Comment 1** – Consider mentioning in the title that the study examined different periods of the day and different epidemiological phases.
- **Comment 2** – Please complete the appropriate checklist based on international reporting guidelines, as required in the instructions for authors (www.equator-network.org). Your study fits the criteria for an observational study and should therefore follow the STROBE guideline. Fill out the checklist and include any missing information in the manuscript.
- **Comment 3** – According to the STROBE checklist, the study design should be mentioned in the title. Please revise the title accordingly.
- **Comment 4** – In the Portuguese abstract, I suggest replacing "diferentes horários" with "diferentes períodos." In Portuguese, this wording is more suggestive of the intended meaning.
- **Comment 5** – This comment refers to the sentence starting on line 25 of page 4. I understand that the document was anonymized for review, but I would like to verify the eligibility criteria. Please send me these criteria in a separate document in your reply to this review. There is no need to anonymize the document, as I am already aware of the authorship, but you may do so if you prefer.
- **Comment 6** – On lines 2 and 3 of page 5, the inclusion criteria regarding physical inactivity and no prior involvement in a regular physical activity program. It becomes clear that the original aim of the study "did not revolve around" investigating the pandemic's impact on step count. I believe the physical inactivity criteria limit the generalizability of the findings to other populations. Please consider adding a note on this in the limitations section (perhaps in the sentence between lines 7–9 on page 12).
- **Comment 7** – Between lines 3–6 of page 5, exclusion criteria are described that exclude less healthy older adults (e.g., contraindications for exercise per the cardiopulmonary exercise test, musculoskeletal injuries...), and this has already been discussed in the text. However, consider adding to the abstract that participants were healthy older adults with hypertension, so that readers have a clearer view of the population right away.
- **Comment 8** – On line 8 of page 5, please clarify that "Natal" refers to a city.
- **Comment 9** – In the sentence from lines 9–11 of page 5, I believe a comma is needed between "vaccines" and "in." Please check and correct if necessary.
- **Comment 10** – In the paragraph on line 7 of page 5, consider stating that the "screening" was the "first evaluation" (lines 7–9), and that the "second evaluation" occurred after 11 weeks (lines 9–12). This is clear from Figure 1, but it would help the reader to use these terms explicitly.
- **Comment 11** – On page 5, an interview is mentioned. Is there any document you can share that might contain additional relevant information collected during the interview?
- **Comment 12** – Please cite the document used to classify the BMI categories. Although widely used, some readers may find it important to have a reference.
- **Comment 13** – Please do the same as in the comment above for the classification of blood pressure (if it is reference 17, cite it again).
- **Comment 14** – I believe the blood pressure categories could also be included in Table 1. What do you think? If you prefer not to include them there, consider placing this information elsewhere — for example, in the first paragraph of the "Results" section.
- **Comment 15** – In the statistical analysis section, the adjustment for potential confounders is described. What is the reason for dividing them into a) and b)? Were these separate models? Why was "daily accelerometer wearing time" included in both a) and b)? If different models were used, which criteria were adopted to select the best one? Please try to clarify this section further.
- **Comment 16** – On line 1 of page 8, "supplementary table 1" is mentioned. I did not have access to this material. Is this correct? Please revise the text or provide the document if it exists (in your response to this review).
- **Comment 17** – "Supplementary table 1" is also mentioned on line 10 of page 8. Please confirm whether this is correct.
- **Comment 18** – In the sentence on line 12 of page

8, the meaning would be clearer if you added the word "afternoon" before "period before" on line 13. The meaning is understandable, but this addition would make the sentence more accessible to readers.
- **Comment 19** – In my opinion, the discussion section is very well written. However, the last sentence (lines 12–14 of page 12) seems slightly out of place. Consider adding "In addition" at the beginning of the sentence to improve flow.
- Wishing you all a great job!

Final decision
- Submit again for evaluation

Reviewer C
Anonymous
- This is an interesting study that provides an in-depth look at the step profile of older adults with hypertension throughout the pandemic. The manuscript is well-written and flows smoothly. The analyses are appropriate and well-presented, and the data are engaging. Below are some comments:
- The issue of hypertension is not clearly addressed in the study; it appears almost marginally. This study could have been conducted simply with older adults. It would be interesting to include something that justifies focusing on this specific group.
- The title could better reflect the focus on the time-of-day periods, which is one of the study's key aspects.
- In the Introduction, the sentence "Our previous research also found a decrease in steps per day among older individuals with hypertension during social distancing XXX" is missing a citation.
- In the Methods section, the sentence "Anthropometric data (body mass and height), and resting blood pressure (BP) was measured." should be corrected for proper verb agreement ("were").
- In the Methods, it is not reported how the time-of-day periods were defined.
- Along these lines, it would be interesting to relate the periods of daylight and darkness — was this considered?
- The study was conducted during different periods/seasons (before the pandemic: Jan–Mar; during social distancing and before vaccination: June; and after vaccination: July). How might this have affected the results? Were rainy weeks considered in the analysis in any way?
- Is it possible to identify to what extent the recorded activities have an exercise profile? Was any analysis performed considering longer bouts of activity?
- It would be valuable to report an estimate of wake and sleep times. Can this be estimated using the accelerometer?
- It would be important to provide a rationale for using step count as the main marker, since accelerometry allows for the extraction of other relevant indicators.

Final decision
- Mandatory Revisions