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Cardiovascular demand of recreational beach tennis in normotensive and hypertensive middle-aged women

Demanda cardiovascular do beach tennis recreacional em mulheres normotensas e hipertensas de meia-idade

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ABSTRACT

Objective: The objective of the study was to analyze and compare the cardiovascular responses of a single beach tennis (BT) session in middle-aged women with normal pressure (NTN) and hypertension (HTN). **Methods:** The sample consisted of 26 women (13 NTN and 13 HTN; ≈ 47 ± 7 years) that were submitted to a BT session composed of 5-min warm-up, followed by 3 matches of 12-min with 2-min intervals between them. All matches were played in a regular BT court and rules. The blood pressure (BP) and heart rate were assessed before (Pre), during the session (immediately after each match), and after the session for 30-min. **Results:** For heart rate, there was no difference between the groups at any of the moments evaluated ($p > 0.050$). Compared to baseline, systolic BP in NTN increased following the first (23mmHg, $p < 0.001$), second (23mmHg, $p < 0.001$), and third matches (14mmHg, $p = 0.013$). In contrast, HTN experienced a systolic BP increase only after the first match (19mmHg, $p = 0.009$). After exercise, in NTN, systolic BP decreased at post-30' (-11mmHg, $p = 0.025$). In HTN, systolic BP decreased both at post-15' (-19mmHg, $p < 0.001$) and post-30' (-19mmHg, $p < 0.001$). When comparing delta values between groups at each recovery point, HTN exhibited lower systolic BP than NTN at both post-15' (-16mmHg, $p < 0.001$) and post-30' (-9mmHg, $p = 0.046$). **Conclusion**: In conclusion, during exercise, HTN and NTN women exhibited a increase in cardiovascular demand compared to pre-session values. Furthermore, a single BT session acutely reduces BP in HTN and NTN women, with a greater reduction observed in HTN.

Keywords: Racquet sports; Cardiovascular system; Post-exercise hypotension.

RESUMO

Objetivo: *O objetivo do estudo foi analisar e comparar as respostas cardiovasculares de uma única sessão de beach tennis (BT) em mulheres de meia-idade com pressão normal (NTN) e hipertensão (HTN).* **Métodos**: *A amostra foi composta por 26 mulheres (13 NTN e 13 HTN; ≈ 47 ± 7 anos) que foram submetidas a uma sessão de BT composta por 5-min de aquecimento, seguidos por 3 jogos de 12-min com intervalos de 2-min entre elas. Todas os jogos foram realizados em uma quadra de BT regular e com regras oficiais. A pressão arterial (PA) e a frequência cardíaca foram avaliadas antes (Pré), durante a sessão (imediatamente após cada jogo) e após a sessão por 30-min.* **Resultados:** *Para a frequência cardíaca, não houve diferença entre os grupos em nenhum dos momentos avaliados ($p > 0,050$). Em comparação com o valor basal, a PA sistólica nas NTN aumentou após o primeiro (23 mmHg, $p < 0,001$), segundo (23 mmHg, $p < 0,001$) e terceiro jogo (14 mmHg, $p = 0,013$). Em contraste, nas HTN, a PA sistólica aumentou apenas após o primeiro jogo (19 mmHg, $p = 0,009$). Após o exercício, nas NTN, a PA sistólica diminuiu pós-30' (-11 mmHg, $p = 0,025$). Nas HTN, a PA sistólica diminuiu tanto no pós-15' (-19 mmHg, $p < 0,001$) quanto no pós-30' (-19 mmHg, $p < 0,001$). Ao comparar os valores delta entre os grupos em cada ponto de recuperação, as HTN apresentaram uma PA sistólica inferior às NTN no pós-15' (-16 mmHg, $p < 0,001$) e pós-30' (-9 mmHg, $p = 0,046$).* **Conclusão:** *Em conclusão, durante o exercício, as mulheres HTN e NTN apresentaram um aumento na demanda cardiovascular em comparação aos valores pré-sessão. Além disso, uma única sessão de BT reduziu agudamente a PA em mulheres HTN e NTN, com uma redução mais acentuada observada nas HTN.*

Palavras-chave: *Esportes de raquete; Sistema cardiovascular; Hipotensão pós-exercício.*

Introduction

Cardiovascular disease is the leading cause of death in women[1]. Sedentary behavior and physical inactivity are major modifiable cardiovascular risk factors[2,3]. Regular

physical activity is linked to a lower risk of cardiovascular disease and widespread health benefits[4]. More specifically, regular exercise can improve blood pressure levels, the most prevalent and important cardiovascular risk factor[5].

Despite the well-recognized importance of physical exercise on blood pressure management, the adherence to conventional exercise modalities remains low[6]. Recreational sports, particularly team sports, are accompanied by enjoyment and a social environment and have emerged as new exercise options that may enhance adherence to physical activity for extended periods of time[7]. Among such sports, beach tennis (BT) is experiencing a rapid increase in popularity. BT is a sport played on a smaller sand court compared to a traditional tennis court. It involves technical moves similar to those in tennis, such as the serve, forehand, backhand, volleyball, and smash. Due to the nature of the sand court, the technical moves in BT tend to be shorter and faster. Players must react quickly to these moves, displaying agility as they cover the court and return the ball. BT matches can be played by individuals of all ages and varying levels of fitness and skill. This sport exhibits a lower risk of injury compared to traditional sports[8,9]. These characteristics of BT serve as potential facilitators, considering that physical limitation and fear of injury also act as barriers to engaging in more vigorous physical activities. These aspects can be particularly beneficial for women who face important barriers when it comes to adhering to exercise programs[10].

While the evidence supporting the benefits of regular exercise is undeniable, it is worth noting that acutely, exercise temporarily increases blood pressure and the risk for myocardial infarction and sudden death[11,12]. After the exercise session is ended, there is a marked reduction in blood pressure that can persist up to 24 hours and protects the cardiovascular system, underscoring the importance of exercise, particularly among those with high blood pressure[13,14]. Recent studies reported that a BT session can acutely reduce blood pressure and its variability after exercise in adults with hypertension[15,16]. Due to the ease of learning and high level of enjoyment during BT sessions[17], there has been a notable increase in participation among middle-aged women, including those with no prior sports experience and those with or without cardiovascular conditions. Therefore, the evaluation of a female sample is particularly important, given that only 6% of research in sport and exercise science focuses exclusively on women[18], contributing to their significant underrepresentation in scientific studies. Therefore, the purpose of the present study was to evaluate the acute effects of a single BT session in middle-aged women with normal blood pressure and hypertension.

Methods

Study design and participants

This cross-sectional study was conducted to assess the effects of a single BT session on cardiovascular parameters in middle-aged women (35–59 years old) who had been playing BT recreationally. One half of the participants (n = 13) had a previous diagnosis of hypertension (HTN) and were taking antihypertensive medications, and the other half (n = 13) nonmedicated normotensive women (NTN). The participants were recruited through telephone calls and social media. Exclusion criteria included previous diagnosis of cardiovascular disease, including ischemic heart disease, stroke, or heart failure in the last 24 months, current smoking, and musculoskeletal problems that restrained participants from exercising.

All participants read and signed an informed consent form before the start of the study. Participation was voluntary, and all ethical principles of data confidentiality and protection were followed. The study protocol was conducted according to the principles of the Declaration of Helsinki and in compliance with the Brazilian legal and regulatory framework for research involving human beings (resolution number 466/12). The study protocol was approved by the Institutional Review Board of Porto Alegre Clinical Hospital (*Hospital de Clínicas de Porto Alegre*), Brazil (GPPG-FIPE registry: 2021-0449, CAAE: 5.309.930). The study was conducted from July 2022 to December 2022 at Porto Alegre Clinical Hospital (preliminary session 1 and data analyses) and at Beach Company Club (familiarization and intervention sessions), both in Porto Alegre, southern Brazil. The protocol followed the STROBE guidelines[19] for observational study.

Preliminary session

Each participant underwent screening, including standardized office blood pressure and anthropometric measurements. Height and body weight were assessed using a stadiometer and an analog scale (FILIZOLA, Brazil), and body mass index (BMI) was calculated (weight (kg)/height (m^2). An electrocardiogram was also performed on participants with hypertension.

Office blood pressure was assessed using an au-

tomated oscillometric device (Omron Hem 705 CP, Illinois, USA), according to the Brazilian National Guidelines of Hypertension[20], in two visits. Participants were instructed to remain silent and use no electronic devices (i.e., smartphones, notebooks) during the measurement, performed on both arms. Two additional measurements were performed on the arm with the highest value to define baseline average blood pressure, with a 1-min interval between each measures. The arm with the highest blood pressure was also used for the subsequent assessments.

During a subsequent visit, within 24–48h following the initial visit, all participants completed a familiarization session with the study protocol [BT rules and the rating of perceived exertion (RPE)] scale[21]. After that, each participant was categorized into one of three skill levels: beginner (poorly coordinated racket movements and little movement on the court), intermediate (more agile and coordinated movements), or advanced (broad dominance in all aspects of the game) in order to organize the schedule of BT sessions by matching players of the same performance level, as ensuring optimal motivation and intensity levels during sports practice is imperative.

Beach tennis session

Participants were instructed to avoid any physical exercise for 24 hours before the experimental sessions, keep their usual dietary intake, and avoid alcohol, coffee, and other stimulant substances on the same day of the experimental session. The participants with hypertension maintained their current antihypertensive medications.

The BT sessions, each lasting 95 minutes, began between 8:00 and 10:00 AM (at the same time of the day to account for diurnal variations of blood pressure) with all sessions standardized as illustrated in Figure 1. In summary, the experimental session started with 20 minutes of rest before BT protocol, 45 minutes of BT protocol, and 30 minutes of passive recovery after the matches. The participants performed a standardized 5-min warm-up consisting of basic techniques (i.e., serve, volley, forehand, and backhand) followed by three 12-min BT matches with 2-min intervals between them. The regular BT rules were used during the match, which was played by 4 participants (2 vs. 2) on an official indoor BT court (16 m long by 8 m wide with a net placed at 1.70 m height). The same researchers participated in all BT sessions and did not regulate the game intensity, enabling participants to move freely during matches. They also did not participate in subsequent assessments and data analysis.

During the BT session, heart rate was continuously recorded using a heart rate monitor (Polar FT7, Finland). The heart rate reserve (HRR) was calculated using the formula: maximum heart rate (estimated by Tanaka's equation: 208 - 0.7 × age)[22] minus the resting heart rate. To assess exercise intensity at both the midpoint and the end of each match, the following formula was applied: [(exercise HR - resting HR) / heart rate reserve)].

The RPE was assessed using the CR-10 Borg Scale[21]. Blood pressure assessments were performed before exercise, during exercise at 12-min intervals, and during recovery at 15-min intervals for 30 minutes. Mean arterial pressure was calculated with a standard formula [diastolic blood pressure + 1/3 (systolic blood pressure – diastolic blood pressure)][23]. Rate pressure product was calculated using the blood pressure and heart rate values at the corresponding time points.

Statistical analyses

Data were entered in duplicate by two independent researchers to prevent typing errors, and data was checked for amplitude and consistency. The assumption of normality was assessed using the Shapiro-Wilk test, visual inspection of histogram, and Q-Q plots. Results were expressed as mean and standard error of the mean (SEM), and 95% confidence interval (95% CI). Delta values was calculated through the differences between the exercise and pre-exercise at each time-

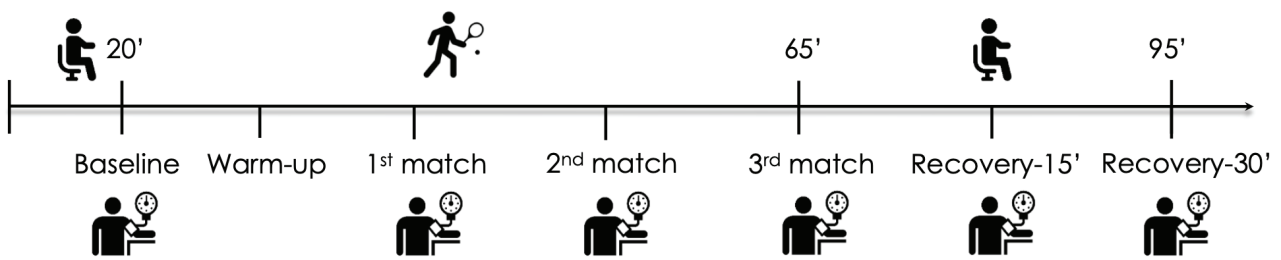


Figure 1 – Illustration of the experimental session procedures

point (i.e., 1st match, 2nd match, 3rd match, recovery-15', and recovery-30').

Generalized estimating equation (GEE) analysis was used to compare main effects between groups, assessing the condition (2 groups: HTN and NT) by time (timepoints) with adjustments for BMI and baseline blood pressure. This adjustment was made due to observed differences in BMI between HTN (28 kg/m^2) and NTN (23 kg/m^2), as BMI can influence blood pressure values, as well as differences in baseline blood pressure between groups.

Post hoc comparisons were performed using the Bonferroni test. Statistical significance was set at $p < 0.05$ and trend-toward interaction at $p < 0.10$. All statistical analyses were performed using SPSS Statistics for Windows version 22.0 (IBM, Armonk, NY, United States).

Results

A flowchart of the trial is shown in Figure 2. All participants successfully completed all the testing and experimental sessions throughout the study. There were no adverse events reported during the BT sessions. The characteristics of the participants are shown in Table 1. Body weight and body mass index were significantly different between NTN and HTN.

Table 1 – Characteristics of the participants

Variables	Women with hypertension (n = 13)	Women with normal blood pressure (n = 13)	p-value
Age, years	49.7 ± 8.7	44.1 ± 5.7	0.066
Body weight, kg	73.9 ± 9.8	64.9 ± 9#	0.024
Height, m	1.63 ± 0.1	1.67 ± 0.1	0.188
Body mass index, kg·m^2	27.8 ± 4.3	23.3 ± 3.1#	0.005
Anti-hypertensive medications, n (%)			
Combined therapy	6 (46.2)	0	-
Diuretics	5 (38.5)	0	-
β-blockers	2 (15.4)	0	-
Angiotensin converting enzyme inibitors	1 (7.7)	0	-
Angiotensin receptor antagonists	3 (23.1)	0	-
Calcium channel blockers	5 (38.5)	0	-

Values are Means ± SD; #indicates significant results between groups ($p < 0.05$).

Table 2 shows the heart rate, heart rate reserve, and RPE responses during a BT session. Time *vs.* intervention interaction was found for heart rate ($p = 0.029$) and RPE ($p = 0.003$), but not for heart rate reserve ($p = 0.839$). At all-time points during the matches, heart rate values were greater than pre-exercise values in both groups ($p < 0.001$). There were no group differences for heart rate and heart rate reserve. However, RPE was higher for HTN than NTN women.

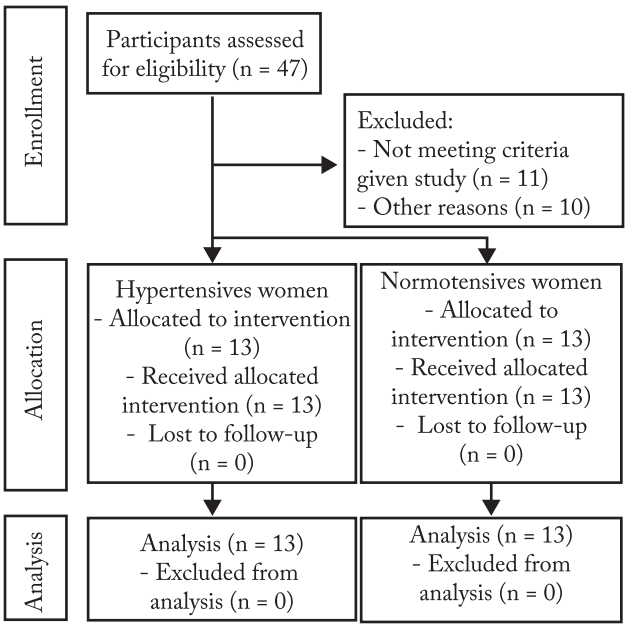


Figure 2 – Flow diagram of participants

Figure 3 shows the response of blood pressure and the rate-pressure product during and after the BT session. Time vs. intervention interaction was found for systolic blood pressure and rate pressure product ($p < 0.001$), mean arterial pressure, and a trend-toward interaction for diastolic blood pressure ($p = 0.075$). In the baseline, HTN had higher values for systolic (133 ± 4 vs. 117 ± 3 mmHg; $p < 0.001$) and diastolic blood pressure (80 3 ± vs. 72 ± 2 mmHg; $p = 0.024$), mean arterial pressure (97 ± 3 vs. 87 ± 2 mmHg; $p = 0.002$), and rate pressure product (9977 ± 418 vs. 8856 ± 369 mmHg*bpm; $p = 0.044$) than NTN.

Compared to baseline, systolic blood pressure and rate pressure product in NTN increased significantly after the first ($p < 0.001$), second ($p < 0.001$), and third match ($p < 0.014$). Mean arterial pressure also increased following the first and second matches ($p < 0.001$). In HTN, both systolic blood pressure and mean arterial pressure increased after only the first match ($p < 0.010$), and their rate pressure product increased after the first, second, and third matches ($p < 0.001$).

After exercise, in NTN, systolic blood pressure decreased at recovery-30' ($p = 0.025$) and rate pressure product increased at recovery-15' ($p = 0.001$). In HTN,

Table 2 – Heart rate and rating of perceived exertion responses during 45 min of beach tennis in hypertensive (n = 13) and normotensive women (n = 13).

Variables	Women with hypertension (n = 13)	Women with normal blood pressure (n = 13)	Δ	p-value
Baseline				
Heart rate (bpm)	82 ± 3 (76 to 88)	77 ± 2 (73 to 80)	5 ± 4 (-2 to 12)	0.154
Heart rate reserve (bpm)	-	-	-	-
Ratings of perceived exertion	-	-	-	-
1st match—middle				
Heart rate (bpm)	138 ± 4 (130 to 147)*	144 ± 5 (133 to 155)*	6 ± 7 (-20 to 7)	0.364
Heart rate reserve (bpm)	65 ± 3 (58 to 72) (vigorous)	68 ± 5 (59 to 78) (vigorous)	3 ± 6 (-15 to 14)	0.596
Ratings of perceived exertion	4 ± 0 (3 to 4) (moderate)	3 ± 0 (2 to 3) (moderate)	1 ± 0 (0 to 2)#	0.010
1st match—end				
Heart rate (bpm)	136 ± 5 (128 to 145)*	148 ± 6 (137 to 160)*	12 ± 8 (-27 to 3)	0.111
Heart rate reserve (bpm)	63 ± 4 (56 to 70) (vigorous)	72 ± 5 (62 to 83) (vigorous)	9 ± 6 (-22 to 4)	0.164
Ratings of perceived exertion	4 ± 0 (3 to 5) (moderate)	3 ± 0 (3 to 4) (moderate)	1 ± 1 (0 to 2)	0.070
2nd match—middle				
Heart rate (bpm)	141 ± 5 (132 to 150)*	152 ± 6 (141 to 164)*	11 ± 7 (-26 to 3)	0.135
Heart rate reserve (bpm)	69 ± 4 (60 to 77) (vigorous)	74 ± 5 (63 to 85) (vigorous)	5 ± 7 (-19 to 8)	0.419
Ratings of perceived exertion	4 ± 0 (3 to 5) (moderate)	3 ± 0 (2 to 3) (moderate)	1 ± 1 (0 to 2)#	0.017
2nd match—end				
Heart rate (bpm)	141 ± 6 (131 to 152)*	150 ± 5 (140 to 161)*	9 ± 8 (-24 to 6)	0.254
Heart rate reserve (bpm)	69 ± 5 (60 to 79) (vigorous)	73 ± 5 (64 to 82) (vigorous)	4 ± 7 (-17 to 9)	0.554
Ratings of perceived exertion	5 ± 0 (4 to 5) (vigorous)	3 ± 0 (2 to 4) (moderate)	2 ± 1 (1 to 3)#	0.021
3rd match—middle				
Heart rate (bpm)	144 ± 5 (133 to 155)*	153 ± ± 7 (140 to 166)*	9 ± 9 (-26 to 8)	0.282
Heart rate reserve (bpm)	72 ± 5 (62 to 81) (vigorous)	75 ± 6 (64 to 86) (vigorous)	4 ± 7 (-18 to 11)	0.635
Ratings of perceived exertion	5 ± 0 (4 to 5) (vigorous)	3 ± 0 (2 to 4) (moderate)	2 ± 0 (1 to 3)#	<0.001
3rd match—end				
Heart rate (bpm)	142 ± 5 (133 to 151)*	151 ± 4 (143 to 159)*	9 ± 6 (-21 to 3)	0.142
Heart rate reserve (bpm)	69 ± 4 (62 to 76) (vigorous)	66 ± 8 (50 to 82) (vigorous)	3 ± 9 (-14 to 21)	0.718
Ratings of perceived exertion	5 ± 0 (4 to 6) (vigorous)	3 ± 0 (2 to 4) (moderate)	2 ± 1 (1 to 4)#	<0.001

Values: mean ± SEM (95% confidence interval). Verbal descriptor of intensity according to the American College of Sports Medicine and Gunnar Borg; *indicates significant results from baseline ($p < 0.05$). #indicates significant results between groups ($p < 0.05$).

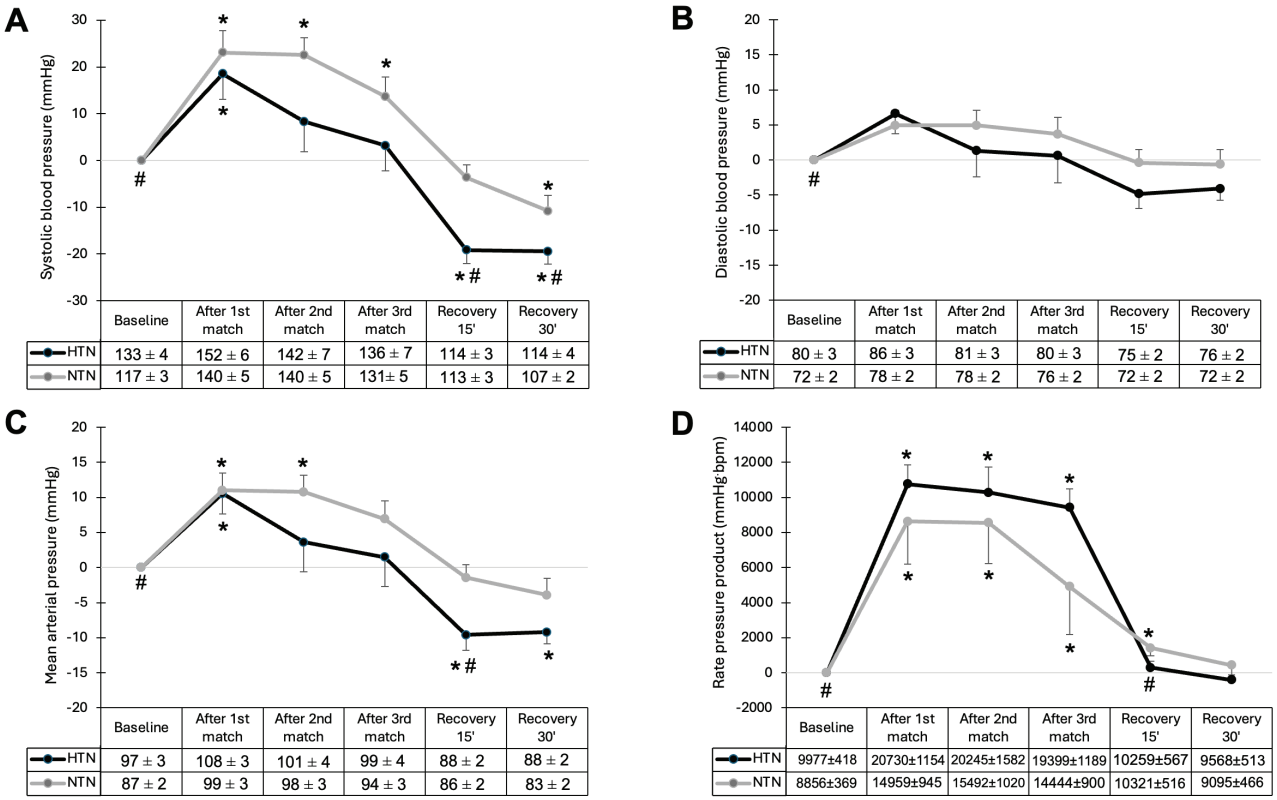
systolic blood pressure and mean arterial pressure decreased at recovery-15' and recovery-30' ($p < 0.001$). Diastolic blood pressure did not change in both groups.

When comparing delta values between groups at each time point, HTN showed lower systolic blood pressure at recovery-15' ($p < 0.001$) and recovery-30' ($p = 0.046$) than NTN. The behavior was similar to mean arterial pressure, which was lower at recovery-15' ($p = 0.005$) with a trend in recovery-30' ($p = 0.068$). Additionally, rate pressure product values was also lower in HTN at recovery-15' ($p = 0.046$).

Discussion

Although BT has gained popularity worldwide, its cardiovascular demand is largely unknown. We observed significant increases in heart rate, systolic blood pressure, RPE, and rate pressure product during BT matches, indicating that typical recreational BT can be considered a moderate intensity physical activity. After the BT matches, systolic blood pressure decreased to levels below the baseline in both groups, with a greater reduction observed in the HTN. To our knowledge, this is the first study that compared the cardiovascular and perceptual demands of a BT session in middle-aged women.

In the present study, we found a significant increase in heart rate, systolic blood pressure, and rate pressure product in HTN and NTN, respectively, and no increase in diastolic blood pressure during the BT session. The scarcity of studies assessing the cardiovascular demands of recreational sports in women limits our ability to compare the present findings with previous



	Baseline	After 1st match	After 2nd match	After 3rd match	Recovery 15'	Recovery 30'
HTN	133 ± 4	152 ± 6	142 ± 7	136 ± 7	114 ± 3	114 ± 4
NTN	117 ± 3	140 ± 5	140 ± 5	131± 5	113 ± 3	107 ± 2

	Baseline	After 1st match	After 2nd match	After 3rd match	Recovery 15'	Recovery 30'
HTN	80 ± 3	86 ± 3	81 ± 3	80 ± 3	75 ± 2	76 ± 2
NTN	72 ± 2	78 ± 2	78 ± 2	76 ± 2	72 ± 2	72 ± 2

	Baseline	After 1st match	After 2nd match	After 3rd match	Recovery 15'	Recovery 30'
HTN	97 ± 3	108 ± 3	101 ± 4	99 ± 4	88 ± 2	88 ± 2
NTN	87 ± 2	99 ± 3	98 ± 3	94 ± 3	86 ± 2	83 ± 2

	Baseline	After 1st match	After 2nd match	After 3rd match	Recovery 15'	Recovery 30'
HTN	9977±418	20730±1154	20245±1582	19399±1189	10259±567	9568±513
NTN	8856±369	14959±945	15492±1020	14444±900	10321±516	9095±466

Figure 3 – Absolute and delta values (mean ± SEM each timepoint – baseline) of systolic blood pressure (panel a), diastolic blood pressure (panel b), mean arterial pressure (panel c), and rate pressure product (panel d) during and after beach tennis session in women with hypertension - HTN (n = 13) and women with normal blood pressure - NTN (n = 13). *indicates significant results from baseline ($p < 0.05$). #indicates significant results between groups ($p < 0.05$).

studies. However, this behavior was the same as that found in studies that demonstrated that hemodynamic values increased during aerobic exercise at different intensities in middle-aged adults with normal blood pressure and hypertension[24,25]. Still, the magnitudes of increases in cardiovascular variables are consistent with the notion that BT can be considered a moderate physical activity in middle-aged women. Interestingly, increases in RPE are fairly mild at best. Collectively, these results indicate that BT can provide substantial cardiovascular demand without much perceived effort.

Post-exercise hypotension is a recognized physiological phenomenon that is closely linked to chronic regulation of blood pressure via regular exercise[13] since the acute response following exercise serves as an indicator for predicting the magnitude of blood pressure reduction following long-term training interventions[26]. We found that BT produced significant decreases in blood pressure following exercise in both groups, with more pronounced reductions in HTN. The reductions in systolic blood pressure were -11 mmHg in NTN and -19 mmHg in HTN, which surpass those reported in a previous study[27,28]. The earlier study found reductions of -9 mmHg in NTN and -8 mmHg in HTN women following a 30-minute aerobic exercise session[27]. In individuals with hypertension, there is only one previous study investigating post-exercise hypotension following a BT session in individuals with controlled hypertension[15]. They reported a reduction in systolic blood pressure (-16 mmHg) that is highly comparable to our present study. Further studies with larger numbers of participants and longer follow-up should be conducted to ratify our findings.

The cardiovascular demand during the BT was assessed through the heart rate and systolic blood pressure values (i.e., rate pressure product) and revealed that HTN presented a higher rate pressure product pre-exercise, however, during exercise the response was similar to NTN, with increases compared to pre-exercise values in both groups. It is important to highlight that the highest systolic blood pressure value achieved during the BT session was 152 mmHg, ~40 mmHg below the value that is considered an exaggerated response during exercise for women (190 mmHg)[29]. After session, rate

pressure product returned to the baseline values in both groups, with a higher reduction in hypertensives in recovery-15' than normotensive. Considering that women are at higher risk for heart failure and heart attack death than men[30], it is crucial for them to attenuate the cardiovascular demand during the exercise. Thus, to be engaged in BT practice seems to be a safe and effective strategy for middle-aged HTN women.

Strengths of our study include the use of a researcher blinded to group allocation who performed outcome assessments and data analysis, minimizing measurement bias. Additionally, we employed standardized protocols and validated measurement tools to enhance the consistency and accuracy of data collection. Furthermore, the research team refrained from regulating the game intensity, allowing participants to move freely and naturally during matches, following the official rules of the sport that has gained popularity in Brazil. Some limitations of the present study should be considered to properly interpret the results. The absence of a sample size calculation, which may affect the generalizability and statistical power of the findings. Another limitation is the lack of control over menstrual cycle phases, menopausal status, and contraceptive use among participants, which could potentially influence results. However, a recent meta-analysis[31] found no significant differences in blood pressure responses across these conditions, supporting our decision not to control for them in this study. The relatively short-time period of blood pressure measurements after the BT session and the absence of ambulatory blood pressure monitoring to record for longer periods could also be limitations, although a study analyzing the relationship between acute and chronic blood pressure reductions have found the highest correlations when blood pressure is assessed after 20-30 minutes of exercise cessation[26]. The lack of a control session is a possible limitation. However, a previous study by our research group[15] compared the effects of a BT session with a non-exercising control session, demonstrating significant reductions in 24-hour systolic and diastolic ambulatory blood pressure after the exercise session. For this reason, the present study aimed to determine the potential differences between HTN and NTN matches.

In summary, both HTN and NTN women exhibited an increase in cardiovascular demand during exercise compared to pre-session values, with no significant differences in this response between the groups. Notably, a single session of BT elicited an acute reduction in blood pressure in both HTN and NTN, with a more pronounced reduction observed in the HTN. These findings highlight the potential of BT as an effective strategy for controlling and preventing high blood pressure in middle-aged women.

Conflict of interest

The authors declare no conflict of interest.

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Author's contributions

Carpes LO: Conceptualization; Methodology; Validation; Formal Analysis; Investigation; Supervision; Funding acquisition; Writing – original draft; Writing review & editing; Approval of the final version. Jung N: Methodology; Investigation; Supervision; Funding acquisition; Writing – original draft; Writing review & editing; Approval of the final version. Domingues LB: Methodology; Investigation; Funding acquisition; Writing – review & editing; Approval of the final version. Fuchs SC: Investigation; Writing – review & editing; Approval of the final version. Tanaka H: Investigation; Writing – review & editing; Approval of the final version. Ferrari R: Conceptualization; Methodology; Validation; Formal Analysis; Investigation; Supervision; Project administration; Visualization; Funding acquisition; Writing – original draft; Writing review & editing; Approval of the final version.

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

The authors did not use artificial intelligence tools for preparation of the manuscript.

Availability of research data and other materials

The data used in this study will be made available upon formal request to the authors. This decision was based on the fact that

the Informed Consent Form signed by the participants did not include the possibility of making the data, even if anonymized, publicly available in repositories.

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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

Anonymous

Format

- Does the article meet the manuscript preparation guidelines for submission to the Brazilian Journal of Physical Activity and Health?
  Yes
- The manuscript is well-structured, containing the sections: introduction, methods, results, and discussion (conclusion as part of the discussion)?
  Yes
- Is the title brief, sufficiently specific, and descriptive of the work? (up to 100 characters)
  Yes
- Is the language appropriate, is the text clear, precise, and objective?
  Yes
- Was any indication of plagiarism observed in the manuscript?
  No

Suggestions/Comments:
None

Abstract

- Is the abstract adequate (including: objective, information about study participants, variables studied, main results, and a conclusion) and do they reflect the manuscript's content?
  Partially

Sugestions/Comments:
Authors should specify what the delta change means (lines 24-26). Is it a) comparing pre- to during-match? Or b) Is it the differences between groups? If b), is it towards to what direction? This should be clarified.

Introduction

- Was the research problem clearly stated and defined?
  Yes
- Is the research problem adequately contextualized in relation to the current knowledge, moving from general to specific?
  Yes
- Are the reasons justifying (including the authors' assumptions about the problem) the need for the study well established in the writing?
  Yes
- Are the references used to support the presentation of the research problem current and relevant to the topic?
  Yes
- Was the aim clearly stated?
  Yes

Suggestions/Comments:
None

Methods

- Are the methods appropriate for studying the research problem?
  Yes
- Are the methods sufficiently detailed?
  Partially
- Was the selection and recruitment appropriate and adequately described?
  Partially
- Were the inclusion and/or exclusion criteria for sample participants described and appropriate for the study?
  Partially
- Information about the instruments used in data collection, their psychometric qualities (e.g., reproducibility, internal consistency, and validity), and, when relevant, the operational definition of variables, were provided?
  Yes
- Is the data analysis plan appropriate and adequately described?
  Partially
- Did the authors provide clarification on the ethical procedures adopted for conducting the research?
  Yes

Suggestions/Comments:

- It is not clear how the menstrual cycle was managed in the study. Were included post-menopausal women or pre- too? For pre-menopausal women, was the menstrual cycle considered to conduct the

visits, such as a specific follicular phase? If an of these were considered, it must be described, if not, please include that in the limitations
- Page 6, line 15 – The reference number 20 are not the "Brazilian National Guidelines in Cardiology" – These are the "Brazilian Guidelines for In-office and Out-of-office Blood Pressure Measurement – 2023", sponsored by the Brazilian Society of Cardiology, Brazilian Society of Hypertension, and Brazilian Society of Nephrology. Authors must give credit to all organizations or to none of them.
- Page 7, line 12 – It needs to be specified whether all beach tennis session length was standardized. If they were not, it should be disclosed in the limitations.
- Line 13 – What is the 45 minutes of exercise about?
- Line 19 – BT acronyms started without warning in the text and went back to the full word afterward; please make it consistent in the manuscript.
- Line 22 – It needs to be better explained what was the period of data used to calculate heart rate reserve. Was it the average of every match.
- Groups are different as expected for BP, but also for BMI due to weight, and had a trend difference for Age. Authors should reanalyze the data using these variables as covariates to guarantee they are not affecting the results. For instance, we know that overweight impacts the hypotensive effect of exercise (PMID: 16625235).
- Particularly, postexercise BP must enter as a covariate, the no difference between groups seems to be masked by the different baseline levels. Looking at the BP pattern, change in BP pre- versus postexercise seems to be greater in the hypertensive than normotensive group. Using baseline BP as a covariate may reveal the interaction significance.

Results

- Is the use of tables and figures appropriate and does it facilitate the communication of the results?
  Partially
- Is the number of illustrations in the article in accordance with what is established by the journal's manuscript submission guidelines?
  Yes
- Are the number of participants at each stage of the study, as well as the number and reasons for losses and refusals, presented in the manuscript?
  Yes
- Are the characteristics of the participants presented and are they sufficient?
  Partially
- Are the results presented adequately, highlighting the main findings and avoiding unnecessary repetitions?
  Yes

Suggestions/Comments:
None.

Discussion

- The main findings of the study are presented?
  Yes
- Are the limitations and strengths of the study presented and discussed?
  Partially
- Are the results discussed in light of the study's limitations and the existing knowledge on the subject?
  Partially
- Do the authors discuss the potential contributions of the main findings to scientific development, innovation, or practice?
  Yes

Suggestions/Comments:
- Strengths – Page 12, line 12 – this reviewer is unsure what allocation means. The study has two groups determined diagnosis of HTN; please describe which this allocation stands for.
- The conclusion does not match the results in figure 2 where HTN group had increased RPP compared to baseline and that was different from normotensive group. Authors conclude that cardiovascular demand is not changing in HTN, that is not an accurate conclusion based on Figure 2 results. Authors must review their conclusion in terms of responses during BT session, and also post-BT session in case covariates reveals changes masked by different baselines.

Conclusion

- Was the conclusion of the study adequately presented and consistent with the study's objective?
- No
- The conclusion of the study is original
  Partially

Suggestions/Comments:
None

References

- Are the references up-to-date and sufficient?

Yes

- Is the majority composed of references to original articles?
  Yes
- Do the references comply with the RBAFS guidelines [quantity and format]?
  Yes
- Is the in-text citation appropriate, meaning the statements in the text cite references that actually substantiate those statements?
  Yes

Suggestions/Comments:
None.

Comments to the author:

- Overview
- This study aimed to investigate cardiovascular responses during and after a beach tennis session in women with and without hypertension. Although this is an interesting topic, this reviewer raises some concerns involving the methods, results and conclusion. Thus, this reviewer cannot support the current version of this manuscript for publication.

General comments

- English proofreading is necessary.
- Sometimes, it is called "arterial pressure," and other times, it is "blood pressure." please make it consistent.

Final decision

- Revisions Required