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INFLUÊNCIA DO USO DE MEIAS DE COMPRESSÃO NAS RESPOSTAS FISIOLÓGICAS, PERCEPTUAIS E AFETIVAS DURANTE A CORRIDAS EM CORRIDORES RECREACIONAIS

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Resumo:

Este estudo objetivou comparar a influência do uso de polainas de compressão nas respostas fisiológicas, perceptuais e afetivas durante a corrida em corredores recreacionais. Dez corredores recreacionais (31,5 ± 9,7 anos) participaram deste estudo. Todos os sujeitos completaram três visitas ao laboratório: (a) familiarização e teste incremental até a exaustão (b) duas sessões de exercícios realizadas em dias diferentes. Cada sessão envolveu o mesmo protocolo de exercícios (20 minutos continuamente a uma intensidade de 80% da velocidade máxima da esteira alcançada no teste incremental até a exaustão), com ou sem o uso de meias de compressão. A Felt Arousal Scale (FAS), Feeling Scale (FS), percepção subjetiva de esforço (PSE), o consumo de oxigênio (VO2) e a frequência cardíaca (FC) foram registradas durante cada sessão experimental. Os resultados não mostraram diferenças entre as condições fisiológicas (% VO2máx: 88,1 ± 8,3 vs 87,1 ± 11,32; % HR: 91,8 ± 2,8 vs 90,8 ± 3,2), e as respostas perceptuais (PSE: 6,4 ± 1,2 vs 6,2 ± 1,4) e afetivas (FS: 0,35 ± 2,4 vs 0,37 ± 2,3; FAS: 4,3 ± 0,7 vs 4,3 ± 1,1) durante cada sessão de exercício. Os resultados do presente estudo indicam que o uso de polainas de compressão não promove benefícios fisiológicos, perceptuais e afetivas durante a corrida em corredores recreacionais.

Palavras-chave: Corrida; Percepção Subjetiva de Esforço; Polaina de Compressão; Afeto

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INFLUENCE OF THE USE OF COMPRESSION STOCKINGS ON PHYSIOLOGICAL, PERCEPTUAL, AND AFFECTIVE RESPONSES DURING RUNNING IN RECREATIONAL RUNNERS

Abstract:

This study aimed to compare the influence of wearing compression stockings on physiological, perceptual, and affective responses during running in recreational runners. Ten recreational runners (31.5 ± 9.7 years) participated in this study. All subjects completed three visits to the lab: (a) familiarization and incremental test until exhaustion (b) two exercise sessions conducted on different days. Each session involved the same exercise protocol (20 min continuously at an intensity of 80% of the maximum treadmill speed achieved in the incremental test until exhaustion), with or without the use of compression stockings. The Felt Arousal Scale (FAS), Feeling Scale (FS), Rating of Perceived Exertion (RPE), oxygen consumption (VO2), and heart rate (HR) were recorded during each experimental session. Results showed no differences between the conditions of physiological (% VO2máx: 88.1 ± 8.3 vs 87.1 ± 11.32; % HR: 91.8 ± 2.8 vs 90.8 ± 3.2), perceptual (RPE: 6.4 ± 1.2 vs 6.2 ± 1.4) and affective (FS: 0.35 ± 2.4 vs 0.37 ± 2.3; FAS: 4.3 ± 0.7 vs 4.3 ± 1.1) responses during each exercise session. The results of the present study suggest that wearing of compression stockings does not promote physiological, perceptual, and affective benefits during running of recreational runners.

Key words: Running; Rating of Perceived Exertion; Compression Stockings; Affect

Introduction

Compression stocking are used by professional or recreational runners as an aid in performance and for recovery of competition or trainings (1, 2). Originally, antecedent from the medical area, compression stocking is used in the treatment of patients with venous disorders. In sport, your objective is to improve the venous blood flow from the legs to the heart and to diminish the feeling of fatigue in the lower limbs during and after the exercise (3, 4). In the last decades, investigations of runners suggest that wearing compression stockings can provide physiologic (lower heart rate, oxygen uptake), perceptual (lower rating of perceived exertion), comfort, and well-being sensation benefits to its users (5, 6); however, controversies still exist on its use.

In a systematic review, Engel, Holmberg (7) demonstrated that wearing compression clothes might promote an ergogenic effect in some variables such as improving the exhaustion time and reducing the muscle pain, damage, and inflammation; however, on the perceptual (perceived effort) and physiological responses (heart rate, consumption oxygen uptake, etc.), the compression clothes exert a trivial effect. Da Silva et al. (8) complement that the use of compression clothes during high-intensity exercise did not change the performance, vertical jump, VO_{2max}, $VO_{2submax}$, or perceptual responses. In the original investigation by Brophy-Williams et al. (9) its results conclude that wearing compression stocking during high-intensity running does not promote immediate performance, neither improves physiological and perceptual responses, however, it can be a positive impact on subsequent running performance.

Although studies have reported that wearing compression stockings provides highest comfort sensation, investigation of affective responses during the exercise, measured by Feeling Scale (FS) and Felt Arousal Scale (FAS), is limited to trained athletes (5, 10). Affective responses have been shown to be important in choosing factors that can improve the feeling of comfort and well-being during or after exercise among non-athletes (11, 12). Wearing compression stockings involving affective responses, in addition to the physiological and perceptual aspects, has not been investigated in recreational runners. The results obtained in this study can help understand wearing compression stockings and their relationship with psychophysiological variables during running.

To understand the relationship between the use of compression stockings and the exertional mediators during exercise, this study aimed to compare the influence of wearing compression stockings on physiological, perceptual, and affective responses during running in recreational runners.

Methods

Participants

Ten recreational runners (31.5 ± 9.7 years) participated in this study. The inclusion criteria were as follows: (a) males between 20 and 50 years of age; (b) participation in regular training including running

thrice a week (3 month); (c) negative responses to all questions in the Physical Activity Readiness Questionnaire (PAR-Q); (d) running time in 10 km·h below 45 min. The exclusion criteria included the presence of cardiovascular, metabolic, or orthopedic diseases or any other contraindications as determined by the medical history in the preceding 12 months. Previous investigations have shown that a priori statistical calculations estimated that 10 participants would provide a power >80% in detecting large differences (>0.9) between measurements (13, 14). This study was approved by the Research Ethics Committee of the Department of Health Sciences at the Federal University of Parana (UFPR) CAAE: 48246715.9.0000.0102.

Protocol

Experimental design: All subjects completed three visits to the lab: (a) familiarization and incremental test until exhaustion (b) two exercise sessions conducted on different days, with at least 48 h between sessions, in a counterbalanced order. Each session involved the same exercise protocol, with or without the use of compression stockings (high compression, 23–32 mmHg, 88% polyamide and 12% elastane). The FAS, FS, rating of perceived exertion (RPE), oxygen consumption (VO_2), and heart rate (HR) were recorded during each experimental session. Subjects were advised not to consume alcohol, caffeine, or practice vigorous physical activity 24 h prior to each test.

Familiarization session: To facilitate understanding of the experimental procedures, the subjects performed one familiarization session, during which they were instructed on the appropriate usage of the scales and the procedures for the exercise sessions.

Incremental test until exhaustion: Participants completed an incremental test until exhaustion on a treadmill. Before the test, a warm up of 8 km·h was performance during 5 min. After warm up, the treadmill speed was to 10km·h. The test started with to 10km·h, and each minute the treadmill speed increased 1 km·h until the exhaustion. All participants were verbally encouraged to continue the exercise until exhaustion. HR (beats·min^{-1}) was continuously measured using a Polar monitoring system (Polar Electro ™, Oy, Finland). A portable analyzer (CosmedK4b2, Rome, Italy) was used to measure O_2, CO_2, and pulmonary ventilation (V_E, STPD). The expired gases were collected and analyzed breath-by-breath. The VO_{2peak} was determined by the average of the last 30 s of the test. The criteria required to achieve $\dot{V}O_{2\,max}$ were as follows: (a) a plateau of $\dot{V}O_2$ (changes <150 mL·min^{-1}), (b) respiratory exchange ratio ≥1.10, and (c) HR within 10 bpm of the maximum level expected for the subject's age.

Physiological responses: during the exercise sessions, the VO_2 was collected breath-by-breath and was released every minute. The HR was collected in the last 5 s of each minute.

Affective responses: Affective valence was determined by the use of the scale of Hardy and Rejeski (15). This instrument comprises an 11-point scale, ranging from +5 ("very good") to −5 ("very bad"). The FAS was used to measure the perception of activation (16). The scale comprises six levels of activation, ranging from low activation (1) to high activation (6). The high perception of activation can be characterized in the following ways: excitement, anxiety, or anger. Low activation appears as relaxation, boredom, or quiet. The affective responses were analyzed by the circumplex model (17, 18). Quadrant 1 corresponds to the sense of calmness (low activation and pleasure); Quadrant 2 to the sense of tiredness (low activation and displeasure); Quadrant 3 to the sense of tension (high activation and displeasure); and Quadrant 4 to the sense of energy (high activation and pleasure) (19, 20).

Rating perceived exertion (RPE) was determined using the RPE OMNI-RES scale (21). This instrument consists of a 10-point scale in which 0 indicates "extremely easy" and 10 indicates "extremely difficult."

Exercise sessions: Each exercise session consisted of 5 min of warm up at a treadmill speed of 8 km·h. After warm up, the participants were asked to run for 20 min continuously at an intensity of 80% of the maximum treadmill speed achieved in the incremental test until exhaustion. Recovery started with 2 min of walking at 4 km·h, followed by 10 min rest. HR and VO_2 were collected continuously during the exercise sessions and recovery. The RPE were collected at 5, 10, 15, and 20 min of exercise. The FS and FAS were collected at 5, 10, 15, 20 min, pre-exercise and after 5 and 10 min of exercise.

Statistical Analysis

Descriptive data are expressed as mean ± standard deviation (SD). For the analysis of the data distribution, Shapiro–Wilk test was used and paired student's t-test was used to compare the conditions (compression stockings vs. no compression stockings). Hedges' g effect size (0.2, 0.5, and 0.8 for small, medium, and large effects, respectively) were computed to estimate the size of differences after the paired t tests. ANOVA for repeated measures was used for analyze the time effect during the running in FS and FAS. The main effects and interactions were analyzed using the post-hoc Bonferroni test. For any violations in the sphericity assumptions, Greenhouse–Geisser corrections were employed. The magnitude of effect was calculated by the partial eta square (η^2_p). The significance level was $p < 0.05$. All data were analyzed using SPSS for Windows version 21.0.

Results

Table 1 shows the anthropometric and physiological characteristics of participants.

Table 1. Anthropometrics and Physiological characteristics.

Variables	Mean ± SD	Minimum	Maximum
Age (years)	31.5 ± 9.7	20	47
Body Mass (kg)	68.2 ± 9.2	48	77
Height (cm)	174.2 ± 8.7	159	185
BMI ($kg \cdot m^2$)	22.4 ± 1.9	19	25
VO_{2max} ($ml \cdot kg \cdot min$)	57.7 ± 7.8	39.5	68.5
HR_{max} ($b \cdot min^{-1}$)	182 ± 13.5	153	202
Treadmill $speed_{max}$ ($km \cdot h$)	18.2 ± 1.7	16	21
Treadmill speed ($km \cdot h$)	14.5 ± 1.4	13	17

BMI: Body Mass Index; VO_{2max}: Maximal Oxygen Consumption; HR_{max}: Maximal Hate Rate; Treadmill $speed_{max}$: Maximal Treadmill Speed achieved in Incremental Test.

There were no differences between the conditions of physiological (Table 2), perceptual and affective responses (Table 3) during each exercise session.

Table 2. Physiological responses during exercise and recovery.

Variables	Compression Stockings	No Compression Stockings	$p < \mathbf{0,05}$	Hedges' g
VO_2 ($ml \cdot kg \cdot min$)	50.4 ± 5.5	49.8 ± 6.2	0.68	0.09
HR (bpm)	166.7 ± 12.6	165.4 ± 13.2	0.54	0.09
EE minute (Kcal)	17.1 ± 2.5	16.7 ± 2.2	0.37	0.15
% VO_{2max}	88.1 ± 8.3	87.1 ± 11.3	0.68	0.09
% HR_{max}	91.8 ± 2.8	90.8 ± 3.2	0.38	0.30
VO_2 R2 ($ml \cdot kg \cdot min$)	27.7 ± 3.1	28.2 ± 7.7	0.82	-0.07
HR R2 (bpm)	139.0 ± 13.4	136.9 ± 18.3	0.57	0.11
VO_2 R10 ($ml \cdot kg \cdot min$)	9.0 ± 0.9	8.8 ± 1.8	0.68	0.12
HR R10 (bpm)	101.4 ± 11.4	99.9 ± 13.6	0.49	0.10

VO_2: Oxygen Consumption; HR: Hate Rate; EE: Energy Expenditure; % VO_{2max}: Percentage Maximal Oxygen Consumption; % HR_{max}: Percentage Maximal Heart Rate; VO2 R2: Oxygen Consumption in Recovery post exercise on 4 $km \cdot h$ (2 minutes); HR R2: Heart Rate in Recovery post exercise on 4 $km \cdot h$ (2 minutes); VO_2 R10: Oxygen Consumption in Recovery (10 minutes); HR R10: Heart Rate in Recovery (10 minutes).

Table 3. Perceptual and affective responses during the running.

Variables	Compression Stockings	No Compression Stockings	$p < \mathbf{0.05}$	Hedges' g
FS	0.35 ± 2.4	0.37 ± 2.3	0.96	0.00
RPE	6.4 ± 1.2	6.2 ± 1.4	0.40	0.14
FAS	4.3 ± 0.7	4.3 ± 1.1	1.0	0.00

FS: Feeling Scale; RPE: Rating of Perceived Exertion; FAS: Felt Arousal Scale.

Figure 1 shows the time effect on physiological and perceptual responses during the running. It was observed a time effect on % HR: no compression stockings ($F_{(3,27)} = 132.051$, $p = 0.000$, $\eta^2_p = 0.936$), and compression stockings ($F_{(3,27)} = 97.948$, $p = 0.000$, $\eta^2_p = 0.916$); % $VO_{2\ max}$: no compression stockings ($F_{(3,27)} = 9.671$, $p = 0.000$, $\eta^2_p = 0.518$), and compression stockings ($F_{(3,27)} = 12.329$, $p = 0.002$, $\eta^2_p = 0.578$); RPE: no compression stockings ($F_{(3,27)} = 13.308$, $p = 0.000$, $\eta^2_p = 0.597$), and compression stockings ($F_{(3,27)} = 27.370$, $p = 0.000$, $\eta^2_p = 0.753$).

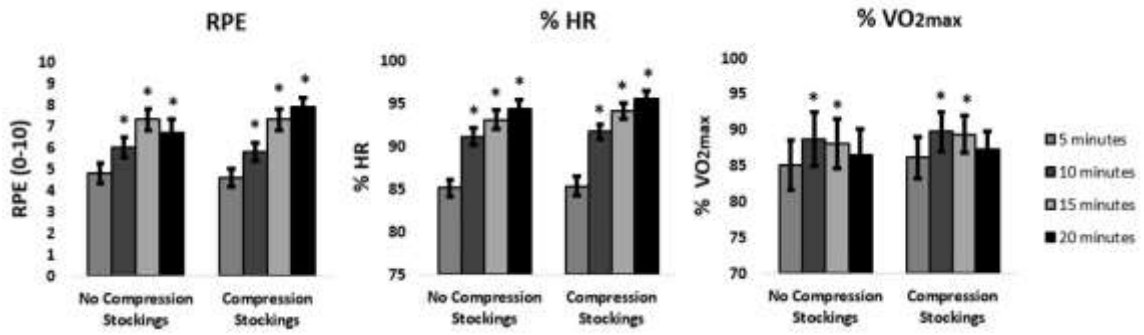

Figure 1. Physiological and perceptual responses during the running. (*) difference to the first 5 minutes.

The affective responses, shown by circumplex model (Figure 2), demonstrated a similar behavior during and after the running. The time effect was observed as; FS: no compression stockings ($F_{(6, 54)} = 19.920$, $p = 0.000$, $\eta^2_p = 0.689$), and compression stockings ($F_{(6, 54)} = 16.348$, $p = 0.000$, $\eta^2_p = 0.645$); FAS: no compression stockings ($F_{(6, 54)} = 8.167$, $p = 0.006$, $\eta^2_p = 0.476$), and compression stockings ($F_{(6, 54)} = 9.573$, $p = 0.000$, $\eta^2_p = 0.515$).

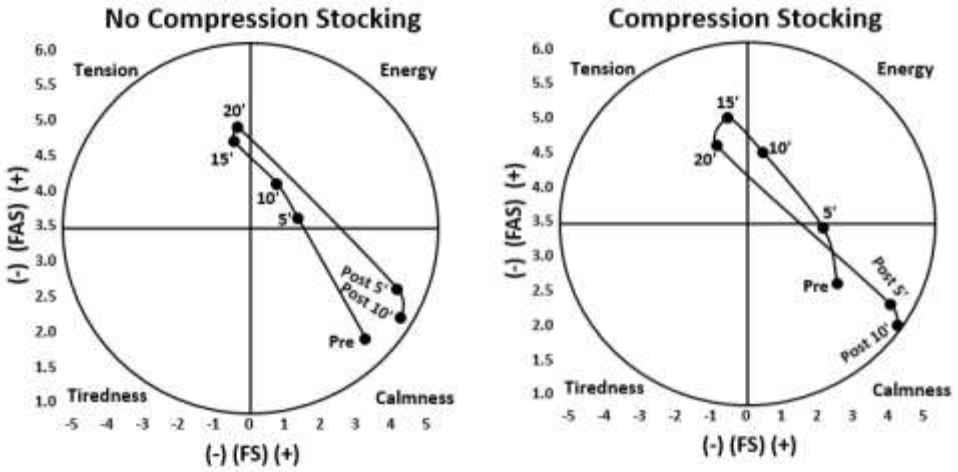

Figure 2. Circumplex model for affective responses.

Discussion

This study aimed to compare the influence of wearing compression stockings on physiological, perceptual, and affective responses during the running. Results observed a time effect of the exercise for both conditions (compression stockings and no compression stockings) on physiological, perceptual, and affective responses; however, no significant difference was observed for the use of compression stockings between all variables considered. The influence of wearing compression stockings on physiological and perceptual responses has been addressed in other studies with recreational runners and competitive athletes (9, 22); however, this study addressed the gap of the study on affective responses in recreational runners.

Our results demonstrate that physiological parameters, such as VO_2 and HR, are not modified during running, nor 10 minutes after the end, similar with others studies (6, 23). In Castilho Junior et al.'s (13) investigation, wearing compression stockings decreased the hemodynamic aspects, such as the venous filling index and the residual volume fraction in amateur runners; however, these changes did not improve the efficiency of the calf muscle pump and decreased HR in healthy and trained runners. On the other hand, these same changes in hemodynamic aspects are important physiological aspects that have been reported to have improved in people with chronic venous insufficiency (24, 25). The results of the above-mentioned study (13) demonstrated that the peripheral physiological changes occur with wearing compression stockings, helping in the treatment and quality of life of people with vascular diseases, but do not reflect on central physiological changes that can improve the performance aspects of active people or athletes.

Regarding the perceptual aspects, conflicting results have been found in different studies, which can be explained by their methodological aspects. Ali et al. (10), who investigated 40 minutes of running on the treadmill (80% of the maximum oxygen consumption) in competitive athletes (9 males and 3 females), found no differences in RPE, corroborating the findings of the present study. Faulkner et al. (22) observed significantly lesser RPE, in the 400-meter run for male runners, and Treseler et al. (6) found high RPE in the 5-km run performance in active women. Ali et al. (10) and Treseler et al.'s (6) methodological procedures were the closest to the ones used in this study, and their differences may be related to the use of active women in the investigation, since we used active men, showing different results compared to the women. Another important factor to be presented is that although the perceptual responses have shown differences between studies, HR and performance have no differences between themselves, reinforcing the physiological aspects discussed earlier.

Few studies investigating the relationship between wearing compression stockings and affective responses during running had been performed. Ali et al. (10) and Ali et al. (5) compared the effect of wearing different grades of graduated compression stockings on FS and FAS responses in treadmill and outdoor track in competitive runners, finding no differences on pleasure and displeasure responses and activation on either the control (0 mmHg), low (12–15 mmHg), or high (23–32 mmHg) grade of graduated compression stockings in both investigations. Our results corroborate with the findings of Ali et al. (10) and Ali et al. (5), adding similar responses of the recreational runner. Besides that, the circumplex model, used to show the affective responses before, during, and after the exercise session, demonstrated a similar behavior of the affective responses for the different pre-exercise conditions. Studies suggesting that psychological influence occurs by using the compression stockings in exercise are more related to sensation of comfort than affective responses (5, 6); however, other investigations on people used to wearing compression stockings and exercise protocols with more time duration need to be performed using the circumplex model.

Some limitations must be considered when generalizing the results. The sample was composed of active

men, regular practitioners of running activities; thus, inactive people, women, or practitioners of other exercise modalities may not yield the same results obtained in this investigation.

Conclusion

In conclusion, the results of the present study suggest that wearing compression stockings does not promote physiological, perceptual, and affective benefits during running in recreational runners. In addition, the circumplex model of affection demonstrates that even with different patterns of affective responses in the pre-exercise, during running, and at the end of running, affective responses tend to follow similar behaviors.

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