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ESSENTIAL OIL OF EUCALYPTUS AND CARDIOVASCULAR RESPONSES IN ELDERLY AFTER ACUTE ISOMETRIC EXERCISE SESSION

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ABSTRACT: The aim was to investigate the acute effect of eucalyptus essential oil (EEO) in cardiovascular responses of rest and after isometric resistance exercise (IRE). Twenty elderly individuals, after being submitted to experimental sessions with inhalation of EEO or control condition, remained in recovery for 60 min (Rec-60') and then performed three sets of 1 min (1 min recovery between sets) in IRE, for dominant upper limb in handgrip, with intensity of 30% of maximum voluntary contraction (IRE-30%). R-R intervals (RRi) and measurements in the frequency domain (low frequency – LF and high frequency – HF) in addition to blood pressure (BP), heart rate (HR) and rate product pressure (RPP) were evaluated. There were no differences ($p > 0.05$) when comparing the sessions (EEO *vs.* control) in Rec-60' and IRE-30%. Differences were found in the time factor of rest to Rec-60' in HR and RRi variables and of rest to IRE-30% in systolic BP, diastolic BP and RPP. Inhalation of EEO did not provided significant changes in cardiovascular and autonomic responses on rest and after IRE-30% in elderly individuals.

KEY WORDS: Arterial pressure; Eucalyptus; Isometric exercise; Nervous system.

ÓLEO ESSENCIAL DE EUCALIPTO E RESPOSTA CARDIOVASCULAR EM IDOSOS APÓS SESSÃO AGUDA DE EXERCÍCIO ISOMÉTRICO

RESUMO: O objetivo do trabalho foi investigar o efeito agudo do óleo essencial de eucalipto (OEE) nas respostas cardiovasculares de repouso e após sessão de exercício resistido isométrico (ERI). Vinte idosos, após serem submetidos a sessões experimentais com inalação de OEE ou condição controle, permaneceram em recuperação durante 60 min (Rec-60') para depois realizaram três séries de 1 min (1 min de recuperação entre séries) no ERI, para membro superior dominante em aparelho de preensão manual, com intensidade de 30% da contração voluntária máxima (ERI-30%). Intervalos R-R (iRR) e medidas no domínio da frequência (low frequency – LF e high frequency – HF) além da pressão arterial (PA), frequência cardíaca (FC) e duplo produto (DP) foram avaliados. Não ocorreram diferenças ($p > 0,05$) quando comparadas as sessões (OEE *vs.* controle) na Rec-60' e ERI-30%. Diferenças foram encontradas no fator tempo do repouso para Rec-60' nas variáveis FC e iRR e do repouso para ERI-30% na PA sistólica, PA diastólica e DP. A inalação do OEE não proporcionou alterações significativas nas respostas cardiovasculares e autonômicas de idosos no repouso e após sessão de ERI-30%.

PALAVRAS-CHAVE: Eucalipto; Exercício isométrico; Pressão arterial; Sistema nervoso.

INTRODUCTION

The aging process represents a potential risk in the prevalence of systemic arterial hypertension and, therefore, of other risk factors for cardiovascular diseases, having an important impact on the cause of death in Brazil, especially in populations over the age of 60[1]. Environmental strategies with changes in lifestyle, through the practice of physical exercises, can minimize the impact of aging and associated risk factors, such as heredity, sedentarism, obesity and hypercholesterolemia, by up to 40%[2] and their control can represent a reduction of up to 50% in the mortality rate[3].

In addition, studies have shown the therapeutic potential of natural essential oils (EO)[4-9]. One of the highlights in this therapy has been the monoterpene eucalyptol (1,8-cineol) in the immune responses through the anti-inflammatory action and inhibition of the production of pro-inflammatory cytokines (IL-4, IL-6 and TNF-)[10]. The relationship between eucalyptol and the cardiovascular system has been investigated and increases in cerebral blood flow suggest a vasodilating action with increases in vagal tone, which can decrease cardiovascular demand[11,12]. Inhalation of EO produces psychophysiological changes in the body[13,14], with greater electrical activity in higher centers and adjustments in the parameters of autonomic tone[4].

There is a consensus in the literature about the importance of physical exercise in maintaining cardiovascular integrity[15]. On the other hand, it appears that during the performance of the isometric resistance exercise (IRE), which has currently been suggested for the control of blood pressure (BP) in different populations[16-17], may occur important increases in BP, heart rate (HR), rate product pressure (RPP) and sympathetic nervous system[18,19]. The cardiovascular stress produced in the elderly during the performance of the maximum and especially submaximal resistance exercise (RE) can expose these individuals to the risk of a cardiovascular event[20]. In addition to this, besides the imbalances in the autonomic nervous system, aging process produces changes in both structure and vascular function, which makes it difficult to control and adapt to the stress of imposed physical exercise[21]. Although cardiovascular risk is present in some types of acute physical exercises, at certain intensities, the importance of such a strategy is observed in the health of an individual and from that, the adoption of therapies that can act in the state of autonomic balance and cardiovascular control during the practice of physical exercise has been studied[11].

Although the literature already discusses issues related to physical exercise, natural EO inhalation and attenuation of cardiovascular demand, results on the integration of these practices are still scarce. No study has investigated the effect of inhalation of Eucalyptus EO (EEO) on cardiovascular responses of BP, HR, RPP and autonomic nervous tone during the performance of IRE in the elderly.

In view of the possibility of increased cardiovascular demand during physical exercise in the elderly, this study is justified in the sense of contributing to the investigation of strategies to attenuate the cardiovascular response through a non-pharmacological alternative, of low cost and easy adoption. Therefore, the aim of the present study was to investigate the effect of EEO inhalation on cardiovascular and autonomic responses at rest and after IRE in the elderly.

METHODOLOGY

SAMPLE

The recruitment and randomization of volunteers in the study are shown in Figure 1, in which volunteers were assessed for eligibility (n = 23) and excluded according to the established criteria. Randomization took place by means of a drawing to initially allocate each volunteer to one of the sessions (control or EEO), alternating with each other and alternating for 7 days, respecting the washout period. Twenty elderly people participated in the study, in which the sample calculation was performed using the partial Eta squared of Castinheiras-Neto[21] study using GPower 3.1 software. The level of physical activity was determined by the IPAQ (International Physical Activity Questionnaire), which divides and conceptualizes the categories: Sedentary - does not perform any physical activity for at least 10 continuous minutes during the week; Insufficiently Active

- practices physical activities for at least 10 continuous minutes a week, however, insufficiently to be classified as active. The duration and frequency of the different types of activities are added (walking + moderate activity + vigorous activity). This category is divided into two groups: Insufficiently Active A - performs 10 continuous minutes of physical activity, following at least one of the criteria mentioned: frequency being 5 days a week or duration being 150 minutes a week and; Insufficiently Active B - does not meet any of the recommendation criteria for insufficiently active individuals A; Active - meets the following recommendations: a) vigorous physical activity: ≥ 3 days a week and ≥ 20 minutes per session; b) moderate physical activity or walking: ≥ 5 days a week and ≥ 30 minutes per session; c) any combined activity: ≥ 5 days a week and ≥ 150 minutes a week; Very Active - meets the following recommendations: a) vigorous activity: ≥ 5 days a week and ≥ 30 minutes per session; b) vigorous activity: ≥ 3 days a week and ≥ 20 minutes per session + moderate activity and or walking ≥ 5 days a week and ≥ 30 minutes per session. Participants were recruited from leisure parks, public places for physical activity and churches. The study was approved by the Ethics and Deontology Committee in Studies and Research (CEDEP) of the Federal University of Vale do São Francisco under nº 0003/200813 - CEDEP, in accordance with resolution 466/12 - CNS. All participants signed an informed consent form to participate in the study. Male volunteers aged between 60 and 80 years and without known serious illness (for example, decompensated hypertension and diabetes) were included in the study, meeting the criteria for stratification of cardiopulmonary risk of the American College of Sports Medicine[22]. The exclusion criteria consisted of non-follow-up, for some reason (withdrawal, injury, surgery, illness) after being selected for recruitment to participate in the study.

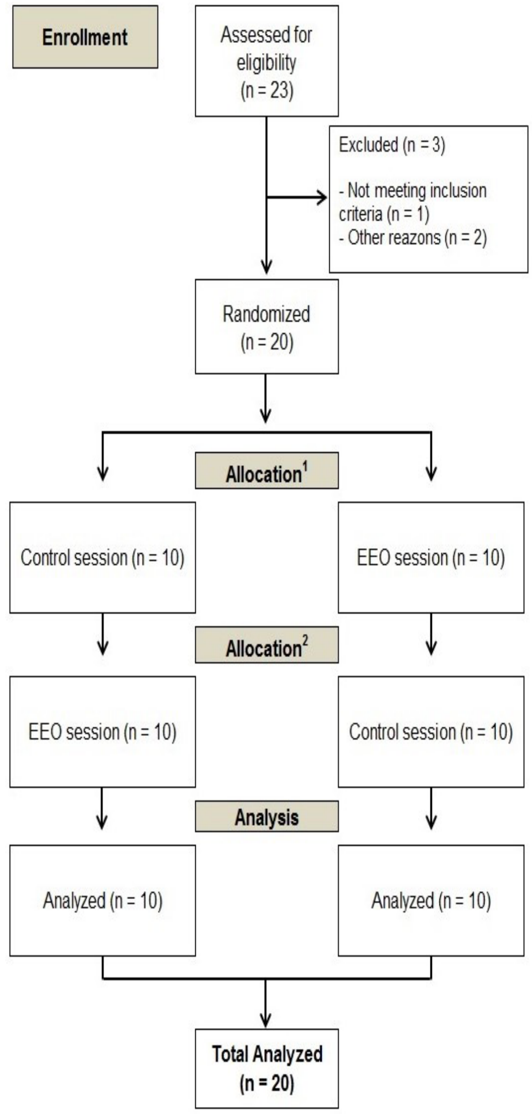

Figure 1. Flowchart. EEO: Eucalyptus essential oil.

COLLECTION OF PLANT MATERIAL AND EXTRACTION OF EUCALYPTUS ESSENTIAL OIL (EEO)

The extraction of EEO was performed from 500 g of *Eucalyptus globulus* leaves through the hydrodistillation method in Clevenger system[23]. The EEO was collected in a 2 mL flask and anhydrous sodium sulfate was added to absorb water molecules present in the oil. Through the analysis using the gas chromatography technique coupled to mass spectrometry (GC-MS) the major component contained in the EEO, eucalyptol (1,8-cineol), presented a percentage of 69.8% in the sample composition. All procedures for accessing genetic heritage and associated traditional knowledge were carried out and the project was registered in the SisGen (Registration No. AB4E9B3).

GENERAL PROCEDURES

The same volunteers randomly performed two experimental sessions separated by 48 hours, being: 1) Control and 2) EEO inhalation. The volunteers were randomized in the sessions by drawing lots. The sessions were always held in the morning, at the same time of day and in a room with a temperature controlled between 22-24 ºC[24]. In moments of pre-session rest, recovery of EEO inhalation or Control (Rec-60 ') and after the performance of the IRE (post-sessions) through the dominant upper limb with hand grip exercise, we obtained measures of BP, HR, RPP and estimated autonomic tone fluctuation through the RR intervals (RRi) records of HR variability.

MAXIMUM VOLUNTARY CONTRACTION (MVC)

All volunteers participated in the MVC test in a handgrip device (*Saehan Hydraulic Hand Dynamometer* mod. SH5001) with a variation of 0-90 kgf of grip and precision of 2 kgf[25]. To measure the MVC, the volunteers were instructed not to drink alcohol and / or caffeinated substance within 24 hours before the test. Previously to MVC, the volunteers were submitted to a familiarization session containing two series of 10 seconds each with the minimum load allowed by the equipment, with the series separated by a recovery period of 2 minutes. The MVC value for each volunteer was determined by the highest value obtained in three attempts of 10 seconds each with demand on the dominant upper limb, with an interval of 2 minutes between each attempt[26].

CONTROL SESSIONS AND EEO INHALATION

During a 10-minute period through a disposable face mask, participants inhaled 0.25 mL of quantified EEO through a pipettor (Kacil® mod. ASD 100/1000 μL). Inhalation of the substance occurred immediately after the 20-minute rest period in the EEO session. In the control session, the volunteers remained similarly, with the face mask installed, however, inhaling fresh air, in agreement with the study by Dayawansa et al.[27].

ISOMETRIC RESISTANCE EXERCISE (IRE)

The experimental IRE sessions were performed after a 48 h interval of the MVC test and on the same equipment as this test. The highest value obtained in kgf in the MVC test was used as a reference to calculate the absolute intensity in the IRE. In the experimental sessions, the volunteers were instructed not to ingest alcohol and / or caffeinated substance in the previous 24 h. After inhaling EEO or fresh air (Control) the volunteers remain comfortably seated in recovery for 60 minutes (Rec-60'). Soon after, an IRE session was performed in both experimental sessions (EEO and Control). The IRE, performed on the handgrip device as required by the dominant upper limb, was composed of three series with 1 minute duration each, with an intensity of 30% of MVC (IRE-30%) and with recovery intervals of 1 minute between sets. The protocol and the consequent handgrip exercise was chosen due to its practicality and low cost of application in isometric methods, which can be seen in most controlled and randomized clinical trials (66%) presented in a representative systematic review in the area[16], as well as for being a possible tool in the non-pharmacological treatment of cardiovascular responses[17]. In the IRE-30%, the volunteers were seated comfortably and with the shoulder adducted, the elbow flexed at 90º and the forearm in a neutral position, with the position of grip handle self-selected[26].

CARDIOVASCULAR VARIABLES

In both experimental sessions (EEO and Control), during periods of 20 minutes at rest (pre-experimental session) and Rec-60' (post-experimental session), the volunteers remained comfortably seated in a chair in an air-conditioned environment with a temperature of 22-24 ºC[24]. BP and HR measurements were obtained every 5 minutes at rest (total of 20 minutes) and every 15 minutes in recovery after inhalation of EEO or fresh air (total of 60 minutes). For analysis, the averages of rest, recovery and IRE were considered. The autonomic nervous system was evaluated using HR variability indicators (HRV), which were continuously monitored over time from the beginning of both experimental sessions to the ERI-30% series. Measurements of systolic (SBP) and diastolic (DBP) blood pressure and HR were performed using the Microlife automatic monitor (mod. BP3AC1–1PC). RPP was obtained by multiplying SBP by HR.

The fluctuation of the autonomic tone was investigated from the RRi records of HRV, using the Polar mod. RS800CX28. RRi records were analyzed using the Kubios HRV v. 2.0. After editing the RRi in 5-minute periods, the analysis took place using linear methods in the domain of time (mean of the RRi) and frequency (high frequency - High Frequency: HF 0.15 to 0.4 Hz, low frequency - Low Frequency: LF 0.04 and 0.15 Hz and the relationship between LF:HF: sympathovagal balance)[29].

STATISTICAL ANALYSIS

The data were presented with mean ± standard deviation. The normality of the data was tested using the Shapiro-Wilk test. Two-way ANOVA for repeated measures, reporting the 'F-ratio', degrees of freedom and the 'p' value, was used to verify the main effects of time in the pre- and post-inhalation moments of EEO and Control session. When 'time X session' interaction was found, Bonferroni's post-hoc interaction was used to identify the pairs of difference and the 'p' value was reported. The alpha adopted was 5% and the software used for analysis was SPSS 22.0 for Windows (SPSS, Inc., Chicago, IL).

RESULTS

Table 1 presents the general descriptive characteristics of the investigated sample and accumulated cardiovascular risk factors.

Table 1. Characteristics of the sample with mean ± standard deviation and absolute and percentage amounts of cardiovascular risk factors (n = 20)

Anthropometry and functional performance	
Age (years)	69.1±5.7
Weight (kg)	75.3±12.3
Heigh (cm)	168.0±6.0
BMI ($kg.m^{-2(-1)}$)	26.6±3.8
MVC (kgf)	39.8±5.9
Physical activity level ($min.week^{-1}$)	336.0±21.0
Cardiovascular risk factors	
1 (age)	20 (100%)
2 (age + 1)	10 (50%)
3 (age + 2)	4 (20%)
4 (age + 3)	3 (15%)
5 (age + 4)	3 (15%)

Cardiovascular risk factors: age, controlled hypertension, compensated diabetes, family history, smoking and/or hypercholesterolemia. BMI: Body mass index; MVC: maximum voluntary contraction.

Table 2 shows the results of BP, HR and RPP in addition to the cardiac autonomic variables in the experimental sessions (EEO and Control) in the moments of Rest, Rec60' and IRE-30%.

According to the two-way ANOVA, there was no time-session interaction at Rest, Rec60' and IRE-30% moments in any of the analyzed variables. In this sense, Table 2 shows that no significant differences were found when comparing the Control *vs.* Experimental sessions. EEO [SBP ($F_{[2,76]} = 0.128$; $p = 0.879$), DBP ($F_{[2,76]} = 0.544$; $p = 0.582$), HR ($F_{[2,76]} = 0.486$; $p = 0.616$), RPP ($F_{[2,76]} = 0.356$; $p = 0.701$), RRi ($F_{[2,76]} = 0.137$; $p = 0.871$), LF ($F_{[2,76]} = 0.162$; $p = 0.850$), HF ($F_{[2,76]} = 0.163$; $p = 0.849$) and LF:HF ratio ($F_{[2,76]} = 0.001$; $p = 0.998$)].

However, a major effect of time occurred for some variables analyzed, demonstrating statistical differences from the time of rest for Rec60' and IRE-30% [SBP ($F_{[2,2]} = 1616.4$; $p < 0.001$), DBP ($F_{[2,2]} = 478.2$; $p < 0.01$), HR ($F_{[2,2]} = 81.1$; $p < 0.05$), RPP ($F_{[2,2]} = 570.9$; $p < 0.01$), RRi ($F_{[2,2]} = 100.7$; $p < 0.01$), LF ($F_{[2,2]} = 58.7$; $p < 0.05$), HF ($F_{[2,2]} = 58.0$; $p < 0.05$) and LF:HF ratio ($F_{[2,2]} = 408.2$; $p < 0.001$)].

Table 2. Mean ± standard deviation of BP, HR, RPP and cardiac autonomic variables during Rest, Rec60’ and IRE-30% of EEO and Control sessions (n=20)

	Session	Rest	Rec60’	IRE-30%
SBP (mmHg)	EEO	126±14	126±13	155±17*
	Control	126±13	127±14	155±18*
DBP (mmHg)	EEO	77±7	78±8	98±10*
	Control	78±8	79±8	97±12*
HR (bpm)	EEO	71±9	67±8*	72±8
	Control	68±9	65±8*	70±8
RPP (mmHg.bpm)	EEO	8927±1748	8445±1564	11171±2055*
	Control	8609±1526	8315±1439	10823±197*
RRi (ms)	EEO	844±115	879±106*	867±100
	Control	878±123	914±114*	895±110
LF (u.n.)	EEO	68.3±17.3	74.4±16.1	63.3±20.3
	Control	64.6±16.5	71.6±17.3	57.3±24.1
HF (u.n.)	EEO	31.7±17.3	25.5±16.1	36.7±20.3
	Control	35.4±16.5	28.4±17.3	42.7±24.1
LF:HF	EEO	3.7±3.6	5.7±5.6	4.2±5.2
	Control	3.2±3.5	5.2±5.9	3.6±3.9

*p < 0.01 in relation to rest. EEO: eucalyptus essential oil; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; RPP: rate product pressure; RRi: R-R interval of heart rate variability; LF: *low frequency indicator*; HF: *high frequency indicator*; LF:HF: sympathovagal balance of heart rate variability.

DISCUSSION

The main finding of the present study was that EEO inhalation did not provide significant changes in the responses of BP, HR, RPP and cardiac autonomic variables during rest from inhalation, as well as during the performance of the IRE-30% in elderly individuals. The mechanisms of control of cardiovascular variables when inhaling natural essential oils still deserve clarification, especially in elderly populations. Although the present study has not shown differences between experimental sessions, studies are still needed to investigate the central pathway of EEO’s action in the recovery of its inhalation and even during physical exercise on hemodynamic and autonomic responses, since the current literature makes it possible to generate hypotheses as to the possible effects on the modulation of these variables[4,11].

Dayawansa et al.[27] showed a reduction in sympathetic nerve activity and an increase in parasympathetic activity in healthy humans when inhaling aromatic components, which improved baroreflex sensitivity even in stressful situations. Lahlou et al.[11] when describing the cardiovascular effects produced by eucalyptol, suggested that a hypotensive action occurs due to the decrease in peripheral vascular resistance. Although not fully understood, it is speculated that central and peripheral pathways may explain the action of aromatic components in the modulation of variables in the cardiovascular system. However, these effects were not evident in the elderly in the present study, which suggests further investigations on the subject.

Soares et al.[30] identified a reduced inotropic effect on the papillary muscle of rats when exposed to an isometric tension against the action of eucalyptol. This study also highlights that eucalyptol-induced bradycardia appears to be dependent on autonomic control at a central level. In the present study, in the condition Rec60’ (rest of 60 min) when compared to the condition Rest (20 min rest before Rec60’), there was an increase in RRi (cardiac autonomic indicator) with a decrease in HR in the elderly evaluated in both experimental sessions (Table 2). In fact, the answer seems to be in a physiological context and not due to EEO dependence. On the other hand, because the moments Rec60’ and Rest, in both experimental sessions, are in similar conditions (period of the day, body position and controlled temperature), however, with different variation in the measurement time (20 minutes previous *vs.* 60 minutes), it would be reasonable to have statistically similar responses. The statistical variation was discreetly reduced from three (Control session) to four (EEO session) beats per minute of HR at Rec60' when compared to Rest (Table 2). It is speculated that just the fact that the sample remains seated for 60 minutes, still being later than the initial time of 20 minutes, is already sufficient for a reduction in the body demand with discreet adjustment in cardiovascular variables such as RRi and HR. Physiologically, HR is mediated primarily by the autonomic nervous system activity and reflects the amount of work that the heart does according to the body's demands[31]. Quer et al.[32] in a relevant research on HR responses, demonstrated that individuals of different ages can present small adjustments in HR even at rest, with such changes occurring in a normal range of variation of 10 beats per minute, which is still above the variation found in the present study (Table 2).

Regarding the IRE-30%, it is speculated that during the contraction force performed by the elderly in both sessions (Control and EEO), there is an input of muscle afferents that release neurotransmitters (P substance) to the hypothalamus, which when they bind its receptors (NK_1R) promote greater interaction of gabaergic activity and consequent baroceptive interneurons inhibition in the nucleus of the solitary tract. This cascade of events during exercise promotes an increase in nerve activity in the rostral ventrolateral medulla and ultimately an increase in sympathetic nervous tone, which could explain elevations in BP and HR[33]. In the present study, there was an increase in BP and RPP during the performance of the IRE-30% in both experimental sessions, with no significant changes in HR and in the investigated cardiac autonomic variables (Table 2). Such responses seem to demonstrate a physiological behavior after isometric resistance exercise, which was not adjusted due to EEO inhalation.

Taylor et al.[34] investigated pre-hypertensive men between 30 and 65 years of age using isometric squat exercise at submaximal intensity, with 4 sets of 2 minutes each interspersed with 2 minutes of recovery between sets. These authors demonstrated that when comparing with the resting values, during the isometry in the squat there were significant reductions in RRi with increases in HR and BP ($p < 0.05$) and without changes in the autonomic indicators LF, HF and LF:HF ratio ($p > 0.05$). These results, although being in a squat exercise for lower limbs, partially corroborate the findings of the present study, except for the variables HR and RRi, which during both sessions of the IRE-30%, remained similar to the rest values of pre-exercise. The 60-minute rest time prior to the IRE-30% in the present study may be explaining the divergence between the studies, since this period allowed a significant reduction in HR and an increase in RRi when compared to previous values of pre-exercise. This condition may have enabled, even during the requirement of the IRE-30%, values similar to the pre-exercise in the variables HR and RRi (Table 2).

From the point of view of safety and exercise application, it is important to highlight the significant increases, of physiological magnitude in diastolic BP and modest amplitude in RPP (myocardial overload rate) during IRE-30% in both experimental sessions of the present study (Table 2). Millar et al.[18] emphasize that isometric exercise at submaximal intensity is associated with equal or lesser increase in HR and systolic BP when compared, for example, to continuous aerobic exercise of moderate intensity, however, with increased diastolic BP to promote a higher blood perfusion pressure in the coronary arteries is possible, which would be positive and would suggest a reduced oxygen demand to the myocardium of the isometric resistance exercise user. In conjunction with a less pronounced RPP in isometric exercise, with an increase of only 25% compared to rest for both sessions (Table 2), it is speculated that the IRE-30% does not significantly increase the chance of myocardial ischemia induced by exercise in the practitioner who has some cardiovascular risk factor. Although they are not linked to the main objectives of the study, these results associated with the findings of Numata-Filho et al.[35] where the IRE did not present acute adverse responses, Assche et al.[17] demonstrating that only one low intensity isometry session acts in the BP control and the chronic effects observed in the study by Araújo et al.[36] and systematically studied by Carlson et al.[16], strengthen the recommendation of isometric training for healthy individuals or those with some cardiovascular risk factor and who need this type of method, aiming beyond safety, adaptations both in physical performance and in cardiovascular aspects.

The present study had limitations regarding the non-use of an EEO placebo substance for inhalation in the control session, however, a face mask was kept in that session and the individuals breathed fresh air, as it can be demonstrated from other investigations[27]. Another point to consider as a limitation was the failure to perform analyzes based on non-linear HRV indices. Further research is recommended investigating the effects of EEO against IRE, however, considering both a placebo substance in EEO inhalation and the analysis of non-linear indices of cardiac autonomic modulation.

CONCLUSION

It is concluded that the inhalation of EEO by the elderly did not provide significant adjustments in the cardiovascular and autonomic responses at rest and after the IRE-30%. It is suggested that further studies are carried out with a longer duration of EEO inhalation, as well as in different populations such as young people of both sexes and in sedentary conditions, in addition to elderly people affected or not by some chronic-degenerative disease in order to elucidate responses to the effects of EEO inhalation.

As a practical application, it is possible to link methodological strategies adopted in the present study associated with the discussion carried out on the results obtained. Therefore, it is suggested the adoption of isometric resistance exercise as a form of physical activity aimed at the health of the practitioner, both because it is safe and does not present acutely adverse cardiovascular responses when performed by upper limbs (Table 2) and for the whole body[35], as well as chronically demonstrate (frequent training) positive adaptations in strength performance[36] and cardiovascular responses[16]. In this sense, training programs with isometric resistance exercise for lower, upper limbs or for the whole body are recommended, which can be from three series of 1 to 2 minutes each in the hand grip or leg press with intensity of 30% to 50% of MVC and with a recovery interval of 1 to 4 minutes between sets. In this proposal, sessions lasting between 11 and 20 minutes are recommended at a frequency of 3 to 5 times a week for a period of 4 to 12 weeks[16].

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REFERENCES

1. Schmidt MI, Duncan BB, Hoffmann JF, Moura L, Malta DC, Carvalho RMSV. Prevalência de diabetes e hipertensão no Brasil baseada em inquérito de morbidade auto-refIREda, Brasil, 2006. Rev Saúde Pub. 2009;43:74-82.

2. Thijssen DH, Maiorana AJ, O'Driscoll G, Cable NT, Hopman MT, Green DJ. Impact of inactivity and exercise on the vasculature in humans. Eur J Appl Physiol. 2010;108:845-75.

3. Mansur AP, Favarato D. Mortalidade por doenças cardiovasculares no brasil e na região metropolitana de São Paulo: atualização 2011. Arq Bras Cardiol. 2012;99:755-61.

4. Sayowan W, Siripornpanich V, Piriyapunyaporn T, Hongratanaworakit T, Kotchabhakdi N, Ruangrungsi N. The effects of lavender oil inhalation on emotional states, autonomic nervous system, and brain electrical activity. J Med Ass Thailand. 2012;95:1-9.

5. Lei Y, Fu P, Jun X, Cheng P. Pharmacological Properties of Geraniol - A Review. Planta Med. 2019;85(1):48-55.

6. Montibeler J, Domingos TDS, Braga EM, Gnatta JR, Kurebayashi LFS, Kurebayashi AK. Effectiveness of aromatherapy massage on the stress of the surgical center nursing team: a pilot study. Rev Esc Enferm USP. 2018;23:03348.

7. Kim DS, Goo YM, Cho J, Lee J, Lee DY, Sin SM, et al. Effect of Volatile Organic Chemicals in *Chrysanthemum indicum* Linné on Blood Pressure and Electroencephalogram. Molecules. 2018;17;23: E2063.

8. Iokawa K, Kohzuki M, Sone T, Ebihara S. Effect of olfactory stimulation with essential oils on cardiovascular reactivity during the moving beans task in stroke patients with anxiety. Complement Ther Med. 2018;36:20-24.

9. Cho EH, Lee MY, Hur MH. The Effects of Aromatherapy on Intensive Care Unit Patients' Stress and Sleep Quality: A Nonrandomised Controlled Trial. Evid Based Complement Alternat Med. 2017;2017:285659.

10. Serafino A, Vallebona PS, Andreola F, Zonfrillo M, Mercuri L, FedIREci M, et al. Stimulatory effect of eucalyptus essential oil on innate cell-mediated immune response. BMC Immunology. 2008;9:1-16.

11. Lahlou S, Figueiredo AF, Magalhães PJC, Cardoso JHL. Cardiovascular effects of 1,8-cineole, a terpenoid oxide present in many plant essential oils, in normotensive rats. Can J Physiol Pharmac. 2002;80:1125-31.

12. Seol GH, Kim KY. Eucalyptol and Its Role in Chronic Diseases. Adv Exp Med Biol. 2016;929:389-398.

13. Hongratanaworakit T. Physiological effects in aromatherapy. Songklanakarin J. Sci. Technol. 2004;26:117-25.

14. Jaruzel CB, Gregoski M, Mueller M, Faircloth A, Kelechi T. Aromatherapy for Preoperative Anxiety: A Pilot Study. J PIREanesth Nurs. 2018;S1089-9472(18)30133-3.

15. Cornelissen VA, Smart NA. Exercise training for blood pressure: a systematic review and meta-analysis. J Am Heart Ass. 2013;2:1-9.

16. Carlson DJ, Dieberg G, Hess NC, Millar PJ, Smart NA. Isometric exercise training for blood pressure management: a systematic review and meta-analysis. Mayo Clinic Proceedings. 2014;8:327-34.

17. Assche T, Buys R, de Jaeger M, Coeckelberghs E, Cornelissen VA. One single bout of low-intensity isometric handgrip exercise reduces blood pressure in healthy pre- and hypertensive individuals. J Sports Med Phys Fitness. 2017;57:469-75.

18. Millar PJ, McGowan CL, Cornelissen VA, Araujo CG, Swaine IL Evidence for the role of isometric exercise training in reducing blood pressure: potential mechanisms and future directions. Sports Med. 2014;44:345-56.

19. Bunsawat K, Baynard T. Cardiac autonomic modulation and blood pressure responses to isometric handgrip and submaximal cycling exercise in individuals with down syndrome. Clin Auton Res. 2016;26:253-60.

20. Lovell DI, Cuneo R, Gass GC. The blood pressure response of older men to maximum and sub-maximum strength testing. J Sci Med Sport. 2011;14:254-58.

21. Castinheiras-Neto AG, Costa-Filho IR, Farinatti PTV. Respostas cardiovasculares ao exercício resistido são afetadas pela carga e intervalos entre séries. Arq Bras Cardiol. 2010;95:493-01.

22. AmIREcan College of Sports Medicine: ACSM's guidelines for exercise testing and prescription. 5th ed. Baltimore: Williams & Wilkins; 1995.

23. Santos AS, Alves SM, Figueiredo FJC, Rocha Neto OG. Descrição de sistema e métodos de extração de óleos essenciais e determinação de umidade de biomassa em laboratório. Comunicado Técnico-Embrapa. 2004;99:1-6.

24. Souza JC, Tibana RA, CavagliIRE CR, Vieira DCL, Sousa NMF, Prestes J. Resistance exercise leading to failure versus not to failure: effects on cardiovascular control. BMC Card Disord. 2013; 13:105.

25. Reis MM, Arantes PMM. Medida de força de preensão manual – validade e confiabilidade do dinamômetro Saehan. Fisio e Pesq. 2011;18:176-81.

26. Fess EE. Grip strength. In: Casanova JS. Clinical Assessment Recommendations. 2nd ed. Chicago: Am Soc Hand Ther. 1992:41-5.

27. Dayawansa S, Umeno K, Takakura H, Hori E, Tabuchi E, Nagashima Y, et al. Autonomic responses during inhalation of natural fragrance of ''Cedrol'' in humans. Auton Neurosci. 2003;108:79-86.

28. Essner A, Sjöström R, Ahlgren E, Lindmark B. Validity and reliability of Polar® RS800CX heart rate monitor, measuring heart rate in dogs during standing position and at trot on a treadmill. Physiol & Beh. 2013;114:1–5.

29. Task Force of the European Society of Cardiology and North AmIREcan Society of Pacing and Electrophysiology. Heart rate variability: standards of measurement, physiological interpretation and clinical use. Eur Heart J. 1996;17:354-81.

30. Soares MCMS, Damiani CEN, Moreira CM, Stefanon I, Vassallo DV. Eucalyptol, an essential oil, reduces contractile activity in rat cardiac muscle. Braz J Med Biol Research. 2005;38:453-61.

31. Almeida MB, Araújo CGS. Efeitos do treinamento aeróbico sobre a frequência cardíaca. Rev Bras Med Esporte. 2003;9:104-12.

32. Quer G, Gouda P, Galarnyk M, Topol EJ, Steinhubl SR. Variabilidade inter e intraindividual na frequência cardíaca diária em repouso e suas associações com idade, sexo, sono, IMC e época do ano: Estudo retrospectivo de coorte longitudinal de 92.457 adultos. Plos One. 2020;15:e0227709.

33.Chen CY, Bonham AC. Postexercise hypotension: central mechanisms. Exe Sport Sci Rev. 2010;38:122-27.

34.Taylor KA, Wiles JD, Coleman DD, Sharma R, O'Driscoll JM. Continuous cardiac autonomic and hemodynamic responses to isometric exercise. Med Sci Sports Exerc. 2017;49:1511-9.

35. Numata Filho ES, Araujo FDS, Moreira SR. Acute response to dynamic and isometric resistance exercise in hemodynamic and autonomic cardiac variables in male adults. Rev Andal Med Deporte. 2019;12:93-8.

36. Araujo FDS, Dias RMR, Nascimento RLD, Numata Filho ES, de Moraes JFVN, Moreira SR. Effects of isometric resistance training on blood pressure and physical fitness of men. Motriz: Rev Educ Fis. 2018;24: e101803.