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Oxygen uptake, heart rate and energy expenditure during slideboard routines at different cadence.

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Source

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Abstract

AIM: Little is known about the physiological response during slideboard exercise (SE). The aim of the present study was to analyse the oxygen uptake (V.O2), the heart rate (HR) and the energy expenditure (EE) during a typical slideboard exercise session and investigate differences on these variables when performing the same choreography at two different cadences (130 e 145 beats per minute - bpm). METHODS: The sample comprised 13 female university students (21,77+/-0,97 years), apparently healthy and physically active, with past training in SE and mastering the technical levels 1 and 2. The subjects performed randomly exercise sessions at 130 bpm and 145 bpm. The ventilatory response was measured by an open air circuit system (COSMED K4b2, Rome, Italy) and HR was measured by a portable monitor (Polar Wireless Double Electrode, Kempele, Finland). HR and V.O2, during SE at 130 bpm, were 179.88+/-834 bpm and 37.95+/-3.71 mL/kg/min respectively. At 145 bpm SE mean values were 182.08+/-9.58 bpm and 39.67+/-3.82 mL/kg/min respectively. EE during 130 bpm exercise was 10.60+/-1.69 kcal/min and at 145 bpm was 10.90+/-1.36 kcal/min. No differences were found between 130 and 145 bpm in none of the variables. We conclude that slideboard exercise cardio respiratory response does not seem affected by the rhythm of execution. Moreover the EE associated with this type of exercise is above the literature reports for other types of group aerobic exercises.

OXYGEN UPTAKE, HEART RATE AND ENERGY EXPENDITURE DURING SLIDEBOARD ROUTINES AT DIFFERENT CADENCE

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Abstract

Little is known about the physiological response during slideboard exercise (SE). The aim of the present study was to analyse the oxygen uptake (VO_2), the heart rate (HR) and the energy expenditure (EE) during a typical slideboard exercise session and investigate differences on these variables when performing the same choreography at two different cadences (130 e 145 beats per minute - bpm).The sample comprised 15 female university students (21,77±0,97years), apparently healthy and physically active, with past training in SE and mastering the technical levels 1 and 2. The subjects performed randomly exercise sessions at 130bpm and 145bpm. The ventilatory response was measured by an open air circuit system

(COSMED® K4b^2, Rome, Italy) and HR was measured by a portable monitor (Polar Wireless Double Electrode, Kempele,Finland). HR and VO_2, during SE at 130bpm, were 179,9±7,7bpm and 36,95±4,74ml/kg/min respectively. At 145bpm SE mean values were 182,1±11,3bpm and 39,66±4,38ml/kg/min respectively. EE during 130bpm exercise was 10,33±1,69kcal/min and at 145bpm was 10,89±1,36kcal/min. No differences were found between 130 and 145bpm in none of the variables. We conclude that slideboard exercise cardio respiratory response does not seem affected by the rhythm of execution. Moreover the EE associated with this type of exercise is above the literature reports for other types of group aerobic exercises.

Key Words: Oxygen uptake, Heart rate, Energy expenditure, Cadence, Slideboard exercise.

INTRODUCTION

Cycle ergometer, treadmill, rowing ergometer and stepper, are some equipments that turned aerobic training diverse, safe and effective. In addition, group aerobic activities (i.e. aerobic dance, slideboard exercise, step exercise) contributed to enlarge the possibilities for different populations to be engaged in aerobics. Indeed, the slideboard exercise (SE) as a means for cardio respiratory conditioning has been progressively increased. The SE was originally designed as specific off-ice training device for speed ice-skaters. More recently, it has been used for conditioning and functional rehabilitation of individuals participating in activities involving lateral movements.

Despite the fact that aerobic exercises do contribute positively to physical fitness, it has been demonstrated that exercises with high intensities (i.e. above the anaerobic threshold) are warranted to develop optimal cardio respiratory ability.[1] In fact, a common strategy to increase the intensity during a continuous

training session is to perform sequences of high and low-intensity bouts of exercise. A typical SE session comprises a sequence of sliding movements executed at various cadences on a slideboard, thereby able to address the intermittent high-intensity requirements. During choreographed SE, the cardio respiratory load may vary with different factors such as: movement cadence, execution speed, length of the board, magnitude of lower limb flexion, arm movements, leg length, use of additional weights and previous motor skill experience.

The SE cardio respiratory profile may differ from other typical aerobics (i.e. running or cycling), as far as the VO2 – HR relationship. Indeed, it has been shown that when upper and lower limbs are simultaneously involved in aerobic exercise, the relationship between VO2 and HR may not follow the usual pattern.[2,3] Studies on other group aerobic activities have shown a moderate to severe exercise intensity. The literature presents mean values of ≈81% of peak VO_2, corresponding to an accumulated energy expenditure (EE) of 386,4kcal, during a Jump Fit session[4] and lower intensities of ≈30-40% of peak VO_2 during Body Pump exercise classes [5]. In SE, the exercise intensity is also believed to be from moderate to severe, attaining more than 80% of peak VO_2.[6]

To date, despite the existence of some studies that examined the cardio respiratory responses [6,7,8,9,10,11,12,13] and assessed energy expenditure [8,13,14,15] during SE, the cardio respiratory differences induced by different movement cadences in SE is still poorly understood. Therefore, it seems necessary to better understand the effects of varying movement cadence during SE in the cardio respiratory response.

The nature of skeletal muscle metabolic and contract properties suggests that during the contraction the speed of shortening will influence energy production and muscle oxygen uptake and energy production rate is greater when the exercise is performed with a high frequency for the same work. [16] Moreover, raising the muscle contraction speed may cause a reduction in mechanical efficiency. [16] Scott *et al*. [17] referred that differences in pattern of muscle recruitment may involve differences in aerobic and anaerobic contribution to EE. Kimura *et al*. [15] have suggest a positive linear relationship between energy expenditure and slide cadence in SE.

The aim of the present study was to assess and compare the cardio respiratory response and energy expenditure during choreographed SE routines performed at different cadences (130 vs 145 beats per minute)

METHODS AND MATERIALS

Subjects

Fifty female, students of Physical Education and Sport, apparently healthy, aged 21.8±1.0 years, height of 1.64±0.05 m, body mass of 56.16±6.04 kg and estimated body fat of 12.83 ± 2.75% volunteered for this study. The subjects were physically active, regularly engaged in aerobic exercise (aerobic dance, body-combat, step exercise or resistance group classes). All subjects had past experience in SE and ceased that activity for more than one year prior to the engagement in the present study.

To select the subjects, the following inclusion criteria were established: (i) technical domain of the selected slideboard core movements; (ii) absence of counter-indications for physical activity practice as suggested by a medical history questionnaire and ParQ test; (iii) non drug-users. The selected subjects signed a written consent form to participate in the study. The procedures herein were approved by the Ethics Committee of the Institution and were in accordance with the Helsinki Declaration of 1975.

Procedures

After certification that the selected subjects met the requirements for its inclusion, they were programmed for six visits to the premises (Laboratory of Physical Fitness and Health and Laboratory of Exercise Physiology) with intervals between visits ranging from 48 to 96 hours.

All testing were performed under controlled environmental conditions (temperature 20º to 21º C and humidity 50 to 55%). Measurement resting of blood pressure (Dinamap 8800 Bp, Berlin, Germany) preceded each testing, in order to discard abnormal values.

The first visit aimed to clarify information about the procedures to be carried out in the study. After that, subjects signed the consent form. During the second visit, anthropometric and morphological measures were performed. In the third and fourth visits, two exercise sessions of familiarization with the SE routines were performed. In the fifth and sixth visits, the subjects were submitted to the SE routines that were compared in the present study. Both during the familiarization sessions and the experimental sessions, the order of the two

routines was randomly assigned for each subject. Each subject performed each SE routine individually and under the guidance of the same experienced instructor. The subjects were encouraged to meet the routine demands, despite signs of fatigue. [18]

Height was measured in orthostatic position and at the end of a deep inspiration, in a stadiometer coupled to an electronic balance Seca 220 (Seca, Hamburg, Germany). Soon after, to assess body mass and estimated fat mass, the subjects were submitted to analysis using Inbody 720 tetrapolar bioimpedance device (Biospace, Seoul, Korea).

In each of the SE sessions, the subjects performed a specific 4min warm-up on the Slideboard. The SE routines were characterized by a sequence of 8 standardized skills (sliding movement and movements in static position after sliding trough the board) performed in frontal position, grouped in the form of choreography: Slide-front touch, Slide-back touch, Slide-front leg raises, Slide-back leg raises, Slide-squat, Slide-knee raise, Slide-bending femoral, Slide-athletic posture and Slide-lateral lunge. Subjects performed SE routine at two different musical cadence with a exercise duration of 8min. In the SE routine performed at 130bpm the subjects maintained 28.5 slides per minute (spm) cadence throughout the exercise. In the SE routine performed at 145bpm the subjects maintained 32.75 slides per minute (spm) cadence. The slideboard was 1.83 m long.

During baseline and exercise duration expired gases were continuously measured by a portable open air circuit system (COSMED® K4b^2, Rome, Italy). The expired gases were collected breath-by-breath, and then averaged in 20s

intervals. The rest values were obtained by average in the last 4 minutes of rest period and for determining the exercise values we used the ones obtained during the SE choreography. Heart Rate was also continuously monitored and recorded by a Wireless Double Electrode (Polar, Kempele, Finland). The HR registration was beat-by-beat and then averaged in 20s intervals. Prior to each SE routine session, resting metabolic rate (RMT) was assessed with gas measurements during a period of 15min with the subjects lying in a supine position. The last 4min measurements of the 15min period were averaged to represent RMT. Before each test, time delay and reference air calibration of the device was performed using a gas sample with a 16% O2 concentration and a 5% CO2 concentration. The flowmeter was also calibrated before each testing with a 3000 ml syringe, according manufacturing recommendation.

Statistics

Statistical software SPSS 15.0 was used for data analysis. After confirmation of the normality assumption (Shapiro-Wilk test) the comparisons between the two exercise routines (130 and 145 bpm) were made with repeated measures T-test and statistical significance was set at $p \leq 0.05$. The following data are presented as means ± standard deviations (SD).

Results

The cardio respiratory responses at rest and during the SE routines are presented in Table I. Time response of VO2 ad HR is depicted, respectively, in figures 1 and 2. There were no significant differences in any of the comparisons

that were performed. Nevertheless, data showed a tendency towards higher mean values in the 145bpm SE for all variables.

Table I: Cardio respiratory responses in the two SE routines (130 vs 145 bpm). Values are means (± SD).

Figure 1: Heart Rate (Hr) response to the 8 min SE at different cadences (130 vs 145bpm). Values are means (± SD).

Figure 2: Oxygen uptake (VO_2) response to the 8 min SE at cadences (130 vs 145bpm). Values are means (± SD).

DISCUSSION

The literature is scarce on the physiological responses during SE. The present study may contribute to better understand the physiological stress involved in this type of exercise. Moreover, we found in the literature little information about the cadence issue in choreographed SE routines. [14] Therefore, the aim of the present study was to assess and compare the cardio respiratory response and energy expenditure during choreographed SE routines performed at different cadences (130 vs 145 beats per minute). No significant differences were found between the two SE routines in the cardio respiratory responses, though a tendency for higher values was present at the 145 bpm routine.

It is stated that HR increases linearly with exercise intensity. [19,20] From the results of Kimura *et al* [15] it appears that the metabolic demands of SE exercise are related to cadence. However, its expression may be also related with exercise mode, individual differences, environmental and external factors and even emotions. Therefore, the extension to which HR reflects energy demand is exercise mode dependent.

The subjects that were analyzed in the present study showed an HR average of 179.9±7.7bpm at the 130bpm SE, while in the routine performed at 145bpm they presented mean values of 182.1±11.3bpm. These values correspond, respectively, to ≈90 and ≈92% of subjects' theoretical maximal HR. These cardiac loads could lead us to consider that the subjects would have been performing a sub-maximal effort, but probably above the anaerobic threshold (AT). However, the respiratory exchange ratio (RER) values that were observed (0.84±0.09 and 0.86±0.08, respectively at 130 and 145 bpm SE) do not support this suggestion. Indeed, those RER values are lower than those reported in the literature [21, 22] as representing the AT (0.95 and 1.0 respectively). Hence, either the subjects' true maximal HR is above the theoretical estimation or the HR at AT in SE is greater when compared with other physical activities (i.e. running or cycling). Indeed, Williford *et al*. [6] describe HR values during SE 15% above those observed during treadmill exercise for the same oxygen uptake. The same phenomenon has also been described for aerobic dance where a 10% larger HR was measured in SE performed at the same oxygen uptake that of a treadmill running. [2]

The HR values that we have observed are higher than the measurements by Black *et al.* [7], who reported HR values of 175,4±13.8 bpm at a 50spm cadence submaximal SE test. Our mean values are also higher than those by Williford *et al.* [6] during lateral sliding displacements. Interestingly, the latter have demonstrated that lateral sliding displacements induced higher HR when compared with forward or backward body displacements performed by the same subjects. Contrarily, Pies *et al* [11] have found maximal HR percentages up to ≈98% during SE at 80 spm. Thus, we may conclude that HR during SE does not seem to increase concomitantly with movement cadence; rather it may well be the opposite. Nevertheless, both our results and the literature seem to suggest a tendency for higher HR during SE when compared with other typical class group exercises, such as body pump, Step, body combat and RPM. [23]

Further research is warranted to better understand the possible mechanisms behind a higher cardiac load during SE.

The oxygen uptake (VO_2) attained during exercise in the present study was 36.95±4.74 ml/kg.min and 39.66±4.38 ml/kg.min, respectively during 130bpm (28.5spm) and 145bpm (32.75spm) SE routines. These values are higher than those reported using a single pattern SE movement at 50spm. [7] Note that in that study [7] VO_2 attained 71.9±9.1% of subjects' maximum VO_2 (VO_2max). We have not assessed our subjects' VO_2max. However, we do believe that relative VO_2 might have been higher in the present study, when compared with that by Black *et al*. [7]. We have also found higher VO_2 values in the present study, probably due to a differences in the choreography routine, when compared with that by

Williford *et al* [6], despite the higher movement cadence of SE in the latter (10min SE routine performed at 40, 50 and 60spm).

The energy expenditure (EE) in the two SE routines was also similar. Mean EE during the 130bpm routine was 10.33±1.69kcal/min or 10.75±1.33MET. As to the SE performed at 145bpm mean EE values were 10.89±1.36kcal/min or 11.28±1.26MET. In SE, using a single pattern of movement, Tolle *et al.* [14] have found a EE of ≈7.6MET and ≈9.1MET at 48 and 56spm, respectively. Kimura *et al.* [15] compared the EE during SE performed at 46spm and 56spm reporting mean values of ≈7,8MET and ≈9.7MET, respectively. Therefore, in the present study EE outscored the above as well as EE reported in the literature in other physical activities such as walking [8], jogging [23], aerobic dance [24], step exercise [23,25], body combat [23], RPM [23] and body pump [23].

CONCLUSION

In short, the HR and VO_2 responses during the SE routines tested in the present study did not show statistically different results in this subject cohort. Therefore, it is possible that during SE the increase of cadence may not be the best way to increase energy demand. Yet, it was possible to observe cardio respiratory outputs close to theoretical maximum values and an EE above that reported in the literature both for SE or other typical group class aerobics. A possible explanation for the higher cardio respiratory load in our subjects when compared with the literature could be a lack of familiarity and inefficiency, particularly when SE is performed at higher cadences. However, not only our

females presented mastery in the SE movements that were performed, but they also were young physically active adults. Therefore, further studies are warranted, especially on the cadence issue during SE.

According to our findings, SE seems appropriate for high-intensity aerobic training and may present, per time unit, an EE higher than other aerobic dance modalities. We also conclude that both SE routines tested in the present study are able to meet the typical guidelines.[26,27,28]

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