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Original Article

Reliability and validity of the DISQ® device on cardiometabolic parameters in healthy subjects.

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Abstract
Different equipment has been built as alternative strategies to maximize training effect, such as THE DISQ® device. However, there is a lack of physiological information about this equipment effectiveness on cardiometabolic responses. The purpose of this study was to compare the influence of DISQ® device on cardiometabolic effect in adults. Fifteen healthy subjects were randomized and submitted to two maximal treadmill incremental cardiopulmonary exercise test with (DISQ® GROUP-DG) and without (CONTROL GROUP-CG) DISQ® device. It was determined the anaerobic threshold (AT), respiratory compensation point (RCP) and exercise exhaustion point (EP), velocity (V), time to reach the ventilatory thresholds (T), maximal heart rate (HR), oxygen consumption (Ox: L/min and ml/kg.min^{-1}) and energy expenditure (EE). Results evidenced that DG presented lower ($p<0.001$) V at RCP and EP than CG. No differences were found at AT between groups. The Time of DG was lower ($p<0.001$) at AT and RCP than CG. On the other hand, EP were similar between groups. No differences were found on AT, RCP and EP respectively to HR. In the Ox, no differences were found to AT and RCP between DG and CG. However, the EP was different ($p<0,05$) to Ox. The EE was significantly lower ($p=0.03$) in EP between the CG and the DG. Although our data indicates that velocity, time to reach the T and EE were lower to DG (in EP), the maximal heart rate and oxygen consumption did not differ with DISQ® device, suggesting that higher peripheral neuromuscular fatigability should be concerned to data explanation.
Keywors: Oxygen Consumption, Incremental Test, Cardiorespiratory exercise, Training Effect, Energy Expenditure.

Introduction

Running is one of the most popular forms of physical activity in the world, being practiced by individuals who seek to improve health, quality of life, weight loss, and the improvement of physical fitness (Hespanhol Junior et al., 2015). In addition, other factors favor the popularity of running, such as being a natural and inherent activity in humans, being easy to practice, having independence in the use of equipment and presenting low cost (Ooms et al., 2013).

Due to the feasibility of performing the activity, the most frequently used ways to increase total physical work in running practice are by increasing volume (distance) or intensity (speed, incline, type of terrain), although factors such as lack of time, musculoskeletal restrictions or geographic aspects may make it impossible to manipulate the volume and intensity, compromising the effectiveness of the adaptations resulting from the practice of the activity.

In view of this reality, alternative equipment has been proposed with the intent of increasing the magnitude of the stimuli and potentiating caloric expenditure in supervised and unsupervised training programs. The proposal of this equipment is to provide greater stimuli and, consequently, better adaptations to the training without it being necessary to increase the volume and/or the absolute intensity of the activity (Sedano et al., 2013, Lesinski et al., 2014).

Work by Rhea et al. (2008) examined the effects of a 12-week VERTIMAX® training program on high school athletes. The protocol was performed once or twice a week, in a manner complementary to traditional race training. At the end of the study, the authors observed that the training protocol performed with the equipment was effective in improving functional performance (ES = 0.54) in relation to the group that

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participated exclusively in traditional training (ES = 0.09). The data from the study allow us to conclude that this type of intervention is an efficient strategy as a way to enhance results associated with the functional capacity of the individuals analyzed.

The impact of the use of alternative equipment that increases the caloric expenditure in the exercises has been observed in different studies. According to Panza et al. (2014), strength exercises performed on an unstable basis (Swiss ball) generated an approximate increase of 28% in total caloric expenditure in relation to the same exercise performed on a stable basis, suggesting that greater muscle activation generated by the instability provided by the accessory generates an increase in demands metabolic diseases.

In this perspective, we highlight that the equipment denominated DISQ®, allows the execution of a series of multiplanar exercises, with a system that generates additional resistance to the movements of the upper and lower limbs, without restricting the freedom of movement, enabling to potentiate the neuromuscular and cardiorespiratory requirement in the exercise, as well as the caloric expenditure during the activity. It is also the advantageous description, in which the equipment transfers the adaptations for the sports activities, due to the three-dimensional freedom in the execution of motor gestures, being a tool for prescription of the integrated training (Distefano et al., 2013). However, to the best of our knowledge, there are no studies available in the literature that evaluated cardiometabolic responses during the use of DISQ® in activities involving running.

Thus, the objective of this study was to compare the cardiorespiratory and metabolic responses of adults submitted to treadmill maximal stress test with and without the use of DISQ®.

Material & methods

Fifteen young, healthy, physically active college students (> 150 min. of weekly physical activity) were recruited to participate in the study. All volunteers met the inclusion criteria: a) age between 25 and 40 years; B) regular activity/physical activity practitioners in the last three months; C) not having any type of physical and/or psychological limitation/restriction that would prevent them from performing the proposed exercises or tests; D) abstaining from using ergogenic nutritional and pharmacological resources throughout the duration of the study. This research was performed in accordance with the ethical guidelines outlined in the Declaration of Helsinki and all procedures are approved by the institution's ethics committee. All the people participating in the study were volunteers and had given their written informed consent before the commencement of the study.

The volunteers were submitted to two maximal tests on treadmill for determining the maximal oxygen consumption (VO2max), separated by one week. The tests were performed in a randomized manner, one of which was performed without the use of DISQ® (CG) and the other with DISQ® (DG). The volunteers were instructed not to practice any kind of physical exercise within 48 hours prior to the tests.

All volunteers participated in familiarization sessions with DISQ®, which is a portable device, consisting of a belt and a pair of ankle and arm bands, both connected by a nylon cable that offers additional resistance to the movements of the limbs, according to adjustment of the load selector (fig.1 and 2). The evaluated volunteers were submitted to incremental treadmill test until exhaustion, which allowed to determine the AT, RCP, EP, V, T, HR, Ox, and EE. In addition, the substrates (CHO, fat) and total energy expenditure (TCE) were also analyzed. During the test, the DISQ® equipment was coupled and adjusted to the subjects following the recommendations of the product manufacturer. After adjusting the device to the body of each participant, the tests were performed using the maximum load of the equipment, through the load selector.

Fig 1,2

For determining the cardiorespiratory capacity, the subjects performed a continuous and progressive exercise session until exhaustion in ATL 10200 treadmill model (Inbramed®). The initial velocity was 6.0km / h, with an increase of 1.0km / h every minute, with the slope being set at 1%.

The VO2MAX and leads were measured continuously throughout the evaluation protocol by the Vista CPX ® system, Vacumed. The system allows the concentration of expired O2 and CO2 to be measured using the Oxygen Analyzer OM-11 and Carbon Dioxide Analyzer LB-2 mixing chamber and analyzers, respectively. The volume of exhaled air was determined by the flow meter K-520. Equipment signals were properly processed and analyzed in the Vista CPX system software, providing oxygen consumption (VO2), CO2 production, respiratory exchange ratio (R) and pulmonary ventilation (VE btps) every 20 seconds.

The determination of VO2max occurred when it reached at least three physiological validation criteria (A-VO2 plateau, when there was no increase in VO2 greater than 2.0 mL.kg-1.min-1 due to the increase of the running velocity at each stage of the test; (B) maximum respiratory quotient (QR) equals to or greater than 1.10; C) heart rate (HR) equals to or greater than 95% of the predicted maximum chronotropic response for age, according to the Tanaka equation [208 - (0.7 x age)]; D) value equals to or greater than 18 on Borg's subjective perception of effort scale (2000); E) signs of extreme tiredness such as: hyperpnea, excessive sweating, facial flushing or difficulty in maintaining motor coordination with increasing speed of the treadmill).

Statistical analysis was used The D'Agostino-Pearson test was applied in the analysis of the distribution of normality, whereas the student T test in the comparison between the use of DISQ® and without DISQ®. The agreement between the parameters was analyzed by Student's t-test for paired data, Pearson correlation coefficients and D Cohen as needed. Statistical analyzes were performed using PRISMA program for Windows (version 6.01) and significance of $p < 0.05$. Data were expressed as means ± standard error of the mean.

Results

Table 1 describes the anthropometric characteristics of the evaluated individuals.

Table 1. Anthropometric data of the participants.

Parameters	Mean ± dp
Age (years)	28 ± 6
Body weight (Kg)	79 ± 9
Height (cm)	174 ± 9
BMI (kg/m^2)	25 ± 4
Body fat (%)	15 ± 7
Fat mass (kg)	23 ± 2
Lean mass (kg)	56 ± 22

Values expressed as mean ± SD.

Table 2 shows the variables related to the external loads of the training, demonstrating significant differences ($p < 0.001$) in AT and CPR times; AT and RCP velocity and maximum effort with and without the device (DISQ® group-DG and Control Group-CG, respectively). The results showed that both Exercise Exhaustion Point and velocity were higher in CG.

Table 2. External load (ventilatory variables) with and without DISQ®

Parameters	DISQ® Group	Control Group	(Cohen's D)	r	P
Time (sec)					
AT	210.20 ± 28.06	266.7 ± 52.78	1.31	0.54	< 0.001
RCP	478.60 ± 50.72	552.2 ± 60.77	1.31	0.54	< 0.001
EP	650.60 ± 84.93	734.4 ± 89.11	0.93	0.43	< 0.001
Velocity (km/h)					
AT	8.00 ± 0.65	8.80 ± 0.77	1.12	0.48	<0.001
RCP	12.20 ± 0.86	13.53 ± 1.06	1.37	0.56	<0.001
EP	14.60 ± 1.12	16.20 ± 1.26	1.34	0.55	<.0001

Values expressed as mean ± SD.

AT- anaerobic threshold, RCP- Respiratory compensation point, EP- Exercise Exhaustion Point

Table 3 shows the results of oxygen consumption and heart rate during the test. There was no significant difference in absolute VO2 in AT and CPR ($p = .287$ and $p = .807$, respectively). On the other hand, at the time of maximal effort, VO2 (l.min-1) was higher in the DG compared to CG ($p = .003$), suggesting that the DISQ® printed higher intensity at maximum exercise, although in the performance relation the device was less effective.

Table 3. Internal load response with and without DISQ®

Parameters	DISQ® Group	Control Group	(Cohen's D)	r	P
HR (BPM)					
AT	134.13±6.35	133.27±8.46	0.11	0.05	0,68
RCP	172.13±8.91	170.80±7.74	0.15	0.07	0,32
EP	186.33±6.27	183.07±7.81	0.46	0.22	0,05
VO2 (L.min^{-1})					
AT	2.34 ± 0.34	2.23 ± 0.32	0.33	0.16	0.28
RCP	3.50 ± 0.39	3.49 ± 0.32	0.02	0.01	0.80
EP	3.97 ± 0.40	3.85 ± 0.31	0.33	0.16	0.003
VO2 (ml.kg.min.^{1})					
AT	29.60 ± 4.70	28.22 ± 4.34	0.30	0.15	0.28
RCP	44.07 ± 3.88	44.02 ± 4.08	0.01	0.01	0.09
EP	49.92 ± 4.37	48.59 ± 4.25	0.30	0.15	0.03

Values expressed as mean ± SD.
AT- Anaerobic Threshold, RCP- Respiratory Compensation Point, EP- Exercise Exhaustion Point

Relative VO2 (ml/kg/min) did not show differences between DG versus CG conditions at AT time (p = .287) and CPR (p = .092). Similarly, at absolute VO2, at the time of maximal effort significant difference was found between the conditions with DISQ® and no DISQ® (p = .003). The heart rate did not show any difference in the analyzed variables.

Table 4 details the caloric expenditure (AT, RCP and EP) as well as the derivations between the substrates used (carbohydrate, fat and totals), with and without the use of DISQ®. The results pointed out that without the use of the DISQ® there was a higher caloric expenditure than with the DISQ® in the maximum effort (p = 0.03). In the other analyzed variables there was no significant difference between the two conditions.

Table 4. Energy Expenditure with and without DISQ®

Parameters	DISQ® Group	Control Group	(Cohen's D)	r	P
ENERGY expenditure (Kcal/min)					
AT	11.70 ± 1.71	11.16 ± 1.58	0.32	0.16	0.28
RCP	17.49 ± 1.94	17.44 ± 1.58	0.02	0.01	0.80
EP	19.82 ± 2.01	19.23 ± 1.54	0.32	0.16	0.03
Calories (Kcal)					
CHO	138.94 ± 49.82	139.32 ± 32.01	-0.009	0.004	0.97
Fat	49.90 ± 43.84	46.81 ± 23.70	0.87	0.04	0.77
TCE	188.84 ± 37.30	186.13 ± 30.22	0.079	0.03	0.74

Values expressed as mean ± SD.
AT- Anaerobic Threshold, RCP- Respiratory Compensation Point, EP- Exercise Exhaustion Point, TCE- Total Caloric Expenditure.

Discussion

The aim of this study was to compare the influence of the DISQ® device on cardiometabolic responses in healthy adults. The use of alternative equipment is considered when there is interest in helping the effect of training on physical performance and on the increase of caloric expenditure, as well as alternative of variation in fitness programs (Rhea et al. 2008). However, there is still a large gap in the literature regarding the effect of implements that may be effective in the training session. After reviewing the literature, we understand that this study is the first to present a controlled way of metabolic effects in specific equipment, such as DISQ®.

The results of the external load (table 2) showed that both the AT, RCP and EP time and the maximum velocity were higher when the DISQ® was not used, leading us to believe that the lower speed and duration of effort between the conditions are associated with the anticipation of muscular fatigue by the greater mechanical and metabolic stress in the DG condition. According to Vanderburgh & Flanagan et al. (2000);

Bilzon et al. (2001) and Lyons et al. (2005) endurance activities performed with external overload can impair the performance of the workforce because the increase in workload alters the movement pattern and reduces motor efficiency (Lyons et al., 2005).

In another study, Falola et al. (2000) analyzed the performance of 10 healthy individuals and at different walking speeds with and without additional load, demonstrating that the greater external overload resulted in a slower walking speed, demonstrating that increased load increased the metabolic demand, with a concomitant reduction of Coordinating capacity, facts that prevent the maintenance of physical performance.

At present, we observed a similar behavior, since the application of the DISQ® overload promoted greater metabolic demand by anticipating the occurrence of metabolic transition, fatigue and exhaustion during the test due to the significant reduction of speed and the time of yield at all moments Evaluated (AT, RCP, and EP). These data can be explained by the absolute and relative VO2 response by the internal load to the use of the equipment demonstrating that the use of DISQ® printed a greater internal demand of load, a fact that implied in the total training time. We emphasize that the changes in the movement pattern generated by the DISQ® seem to impair the maximum velocity and duration of the test, although these parameters have not been evaluated in this study. By performing experiments in walking and running mechanics in soldiers loading additional loads, Grenier et al (2012) reported important changes in gait stability and balance as the overload was increased, resulting in increased overload.

Thus, when analyzing the maximum load allowed in DISQ®, it is possible to hypothesize that the same effect was observed in this study, although we did not analyze the gait pattern and mechanical efficiency.

We emphasize that other variables can be considered in the analysis of gait alteration and its association with the internal load response. According to Lloyd et al. (2000) the difference between sex, load distribution at the moment of exertion, body composition, use of ergogenic resources, level of training, familiarization in the use of equipment, ambient temperature and neuromuscular capacity are important factors in the association with motor performance.

Although acute performance was compromised with the use of DISQ®, we imagined that the device could be recommended for individuals wishing to increase neuromuscular, cardiovascular, and metabolic demands without increasing speed, distance and incline during the race, a fact recommended for beginners with low level of physical fitness, overweight people and / or osteoarticular restrictions.

Caloric expenditure (AT, CPR, and EP) identified in this study, as well as total calories per substrate, showed that without the use of the DISQ® the caloric expenditure was higher in the maximum effort. These results can be explained by the fact of the higher speed and duration without the use of DISQ®. However, there is no consensus on the association of caloric expenditure and external load.

According to Patton et al. (1991) and Lyons et al. (2005), there are significant changes in energy expenditure due to the application of external load, although Kirk & Schneider (1992) and Entin et al. (2010) did not show differences between situations (with and without overload). We could point out that the great methodological variation and the type of overload applied prevent consistency in the analysis of the phenomenon. However, more intense activities generate a higher caloric expenditure per minute, in relation to less intense activities. However, if we consider the total time of activity, it may occur early interruption due to fatigue, a fact that will contribute to the total caloric expenditure. It should be emphasized that, although the caloric expenditure in PE was statistically higher in the condition without DISQ, the clinical relevance of this data may not be so significant, since the difference in means was small (19.82 vs. 19.23 for CG and DG, respectively).

Conclusions

Although our data indicates that velocity, time to reach the ventilatory thresholds and caloric expenditure (in EP) were lower with DISQ® wearing, the maximal heart rate and oxygen consumption did not differ with and without device condition. thus, we may address that higher peripheral fatigability induced by the equipment interrupted earlier the aerobic activity.

Conflicts of interest - The authors have any conflicts of interest to declare.

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