Journal of Exercise Physiology**online**

Volume 14 Number 1 February 2011

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

JEPonline

External Nasal Dilator Strip Does Not Affect Heart Rate, Oxygen Consumption, Ventilation or Rate of Perceived Exertion during Submaximal Exercise

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ABSTRACT

Nunes VNG, Barbosa DCS, Damasceno WC, Fonseca MT, Andrade AG, Rocha-Vieira E, Pinto KMC. External Nasal Dilator Strip Does Not Affect Heart Rate, Oxygen Consumption, Ventilation or Rate of Perceived Exertion during Submaximal Exercise. **JEPonline** 2011;14(1): 11-19. This randomized crossover study investigated the effects of an external nasal dilator strip (ENDS) on heart rate (HR), oxygen consumption (VO_2), ventilation (V_E) and rate of perceived exertion (RPE) during submaximal exercise. Nine healthy men were submitted to three sessions of submaximal exercise (60% VO_2 max, 1 hour) while in use of an ENDS, placebo ENDS or without any device (control). Nasal volume increased with ENDS ($p<0.05$), whereas no effect was observed with the placebo. No differences ($p<0.05$) were found between an ENDS, the placebo ENDS and the control with respect to HR, VO_2, V_E or RPE. In addition, volunteers were asked during tests about which device they believed they were using. During the two exercise sessions with ENDS, 45% of volunteers believed they were using the ENDS, 11% believed they were using placebo and 45% were unsure. During the test with the placebo ENDS, 45% of volunteers were aware that they were using placebo, 33% believed they were using an ENDS and 22% were unsure. External nasal dilator strips do not affect the physiological parameters related to exercise performance, suggesting that the theoretical advantage of the decreased nasal resistance promoted by ENDS may be of little functional importance to most people during exercise.

Key Words: Ergogenic Effect, External Nasal Dilator Strip, Physiology

INTRODUCTION

External nasal dilator strips (ENDS) have been widely used by athletes to improve performance. The potential ergogenic effect of ENDS has been attributed to an increase in the nasal valve cross-sectional area (9,10,21,22). As a result of the reduction in nasal resistance (9,10,21,15,26) and the consequent decrease in effort involved in nasal breathing [8], ENDS could lead to an improvement in nasal inspiratory peak flow rate (6) that would be expected to generate an advantage in energy production during exercise.

The research findings on the effects of ENDS on exercise performance and physiological parameters are controversial. Many authors have reported no effect at all of ENDS on perceived exertion (RPE), heart rate (HR), ventilation (V_E), oxygen consumption (VO_2), exercise time to exhaustion or maximal work rate during either maximal or submaximal exercise (1,3,4,17-19,25). However, some reports have shown reductions in HR, RPE, and VO_2 during exercise performed with the strip in situ (10,16,24).

Psychological effects may account for some of these contradictory findings. Considering that most athletes believe that the device will improve performance, they may be induced to perform better during tests with the ENDS. Although most of the studies investigating the effects of ENDS on exercise have included a placebo ENDS, none has asked the subject which device they believed they were using during the exercise sessions. Therefore, the purpose of this study was to evaluate whether the ENDS is capable of improving physiological parameters during submaximal exercise, taking into consideration which device the subject believes he is using.

METHODS

Subjects

Nine healthy men were recruited for the present study, the protocol of which was approved by the Internal Review Board of the Centro Universitário de Belo Horizonte (UniBH). All volunteers signed an informed consent form, thereby agreeing to participate in the study. The volunteers were all non-smokers, had no respiratory or nasal disorders (nasal obstruction, nasal trauma or previous nasal surgery, rhinitis, nasal polyps or bronchitis) and all had an aerobic capacity greater than 35 $mL·kg^{-1}·min^{-1}$. None of the volunteers had ever used an ENDS prior to participating in this study.

Procedures

Maximal aerobic capacity

To establish the maximal aerobic capacity (VO_2 max) of each individual, the volunteers were submitted to the Balke cycle ergometer protocol. Briefly, the protocol consists of progressive exercise performed at 18-20 km/hour, with an initial load of 1.5 kg. The load was increased by 0.5 kg every two minutes until individual fatigue. During the Balke protocol, VO_2 was measured by indirect calorimetry using a VO2000 gas analyzer (Inbrasport®, Rio Grande do Sul, Brazil).

External Nasal Dilator Strips

The external nasal dilator strips (ENDS) used in the present study are commercially available on the market in Brazil (ClearPassage®, Brazil) in two different adult sizes: large (for adults with a large nose) and small (for adults with a small or medium-sized nose). Subjects were evaluated while in use of an appropriately sized ENDS.

Placebo External Nasal Dilator Strips (Placebo ENDS)

The placebo external nasal dilator strips (placebo ENDS) were made from adhesive and plastic strips with no spring tension. The device was similar in appearance (color and shape) to the ENDS.

Application of Nasal Strips
Each subject's nasal dorsum was wiped with an alcohol-moistened pad prior to affixing the ENDS or placebo ENDS in situ. The ENDS application was performed in accordance with the manufacturer's instructions, which specify that the device should be positioned midway over the nose, with the tape-covered springs extending down the external lateral nasal walls along the nasal crease, and the tabs at each end of the nasal strip should be adhered to the flare of the nostril. The investigators placed the ENDS or placebo ENDS on the volunteers, who were not allowed to touch or see the device they were using.

Acoustic Rhinometry
To evaluate the effects of ENDS and the placebo ENDS on the nasal valve area, volunteers were submitted to acoustic rhinometry using an Eccovision Acoustic Rhinometer, model AR 1003 (Hood Laboratories, Pembroke, MA, USA), as described by Fonseca et al. [7]. Nasal patency was assessed at rest and the procedure was conducted according to the Acoustic Rhinometry Standardization Committee of the European Society of Rhinology (12).

Exercise Protocol
Subjects were evaluated during exercise on a stationary cycle ergometer with a mechanical brake system (Monark®), performed at 60% of VO_2 max for 1 hour. Each subject was submitted to three exercise sessions on non-consecutive days, one using an ENDS, one using a placebo ENDS and one session without the use of any device (control). The sessions were performed in random order. Environmental temperature on the test days was maintained between 20 and 24^{o} C.

Main Outcome Measures
Heart rate was monitored during exercise using a HR monitor (Polar®, USA) at 20-second intervals. Oxygen consumption and VE were measured using an indirect calorimeter in an open-circuit respirometry system (VO2000, Inbrasport®, Rio Grande do Sul, Brazil). The volunteers were tested while wearing a face mask (Pneumo-mask®). The rate of perceived exertion was measured every 5 minutes during exercise using the Borg scale (2), which is designed to describe individuals' perception of physical exertion in a wide variety of types of exercise. Perception of the device during the tests was performed using ENDS or placebo ENDS in which the volunteers were asked about the device they believed they were using. As previously mentioned, volunteers were not allowed to see or touch the device during the exercise tests.

Statistical Analyses
The effects of ENDS on heart rate, oxygen consumption and ventilation were assessed using analysis of variance for Latin square design, with significance established at $p<0.05$. The chi-square test was used to evaluate the effect of ENDS on the rate of perceived exertion and to analyze the participants' perception of placebo use.

RESULTS

Volunteers' characteristics are shown on Table 1. The ergogenic effect of ENDS has been attributed to the resulting increase in nasal valve area. The effect of the use of ENDS and placebo ENDS was evaluated at rest using acoustic rhinometry. Nasal volume increased significantly ($p<0.05$) with the use of ENDS (14.2 ± 2.3 cm^3 vs. 12.6 ± 2.0 cm^3, ENDS vs. control). No effect of the placebo ENDS on nasal volume was found (13.2 ± 2.7 cm^3).

Table 1. Volunteers' characteristics

Variable	*Mean ± SD*
Age (years)	26.2 ± 3.2
Weight (kg)	72.9 ± 6.0
Height (cm)	175.6 ± 4.8
Fat percentual	14.92 ± 2.88
VO_2 peak ($mL \cdot kg^{-1} \cdot min^{-1}$)	46.72 ± 6.57

To investigate whether the increase in nasal volume promoted by the ENDS could affect exercise performance, HR was monitored during the three tests (Figure 1A). These data showed that HR was unaffected by the use of ENDS compared to the control session ($p>0.05$). Also, the data showed that HR was unaffected by the use of the placebo ENDS ($p>0.05$).

The effects of ENDS on VO_2 and V_E during exercise were also investigated. The data presented in Figure 1B show no differences in VO_2 during exercise on the cycle ergometer while using an ENDS compared to exercise without the use of one or the use of the placebo ENDS. Moreover, V_E remained unaffected by the use of ENDS (Figure 1C), suggesting that even if resistance to airflow through the nose is decreased, it does not result in a significant change in V_E during submaximal exercise. In addition, V_E was unaffected during use of the placebo ENDS. No differences in RPE were found when the data from exercise with the ENDS, placebo ENDS, and the control were compared (Figure 2).

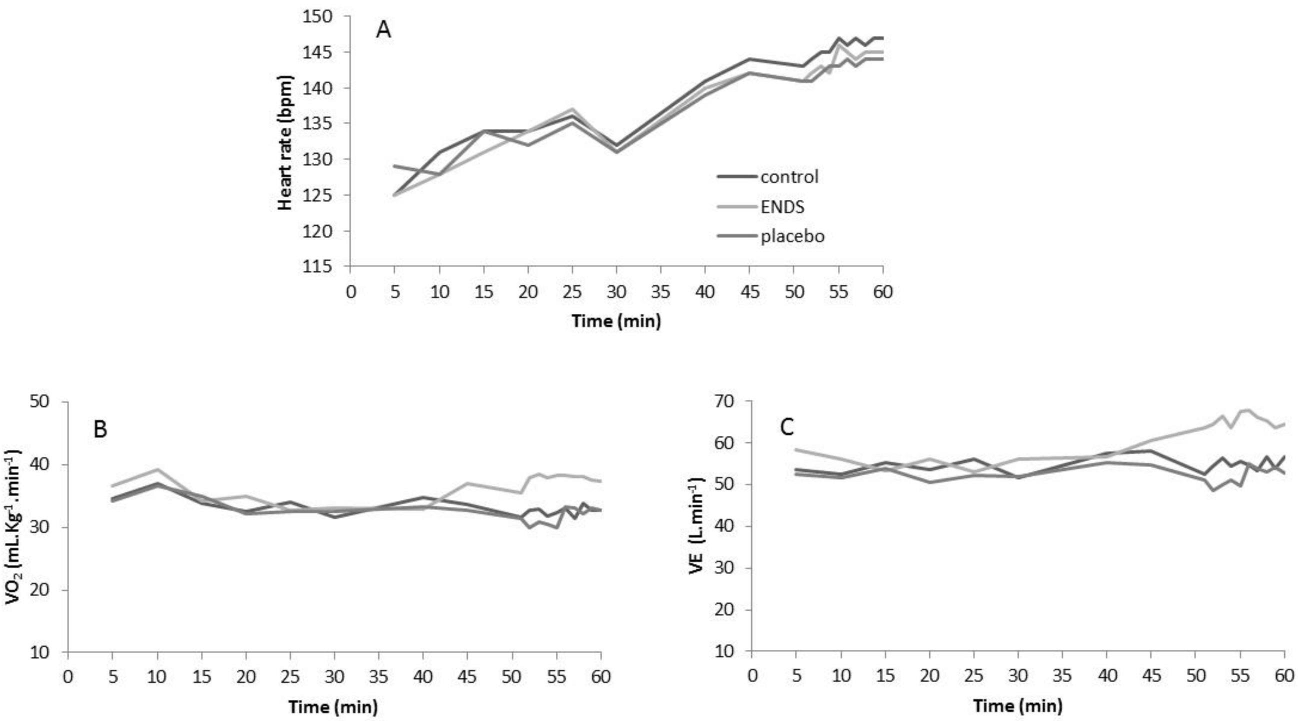

Figure 1. Heart rate (A), oxygen consumption (B) and ventilation (C) of volunteers during exercise on a cycle ergometer using an ENDS, a placebo ENDS or no device at all.

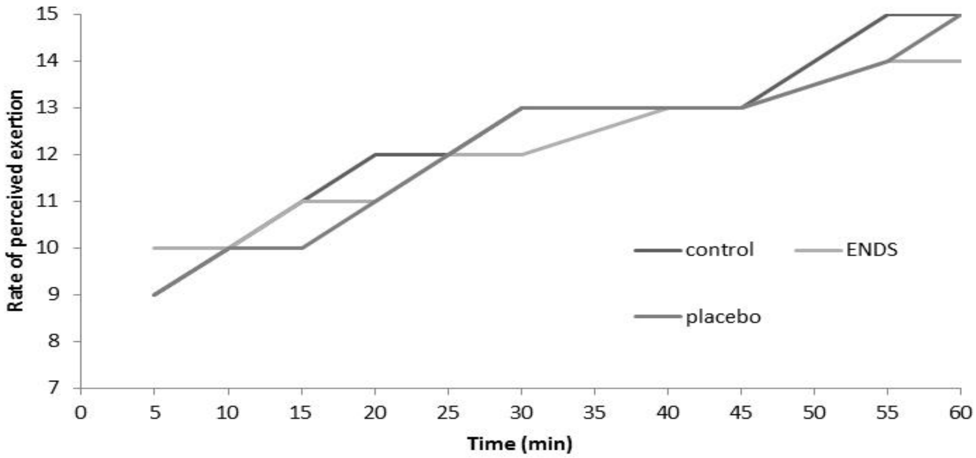

Figure 2. Effect of ENDS on the rate of perceived exertion during exercise on a cycle ergometer.

Following the exercise sessions with ENDS and placebo ENDS, the volunteers were asked which device they believed they had been using during the test. During exercise with the ENDS, 45% of volunteers believed that they had been using the ENDS, while 11% answered that they had been using the placebo ENDS (Figure 3A). Forty-four percent of the volunteers using the ENDS replied that they were not sure which device they were using. In the test performed using the placebo ENDS (Figure 3B), 45% of the volunteers answered correctly that they were using the placebo, while 33% said that they were using the ENDS and 22% of volunteers were unsure which device they were using.

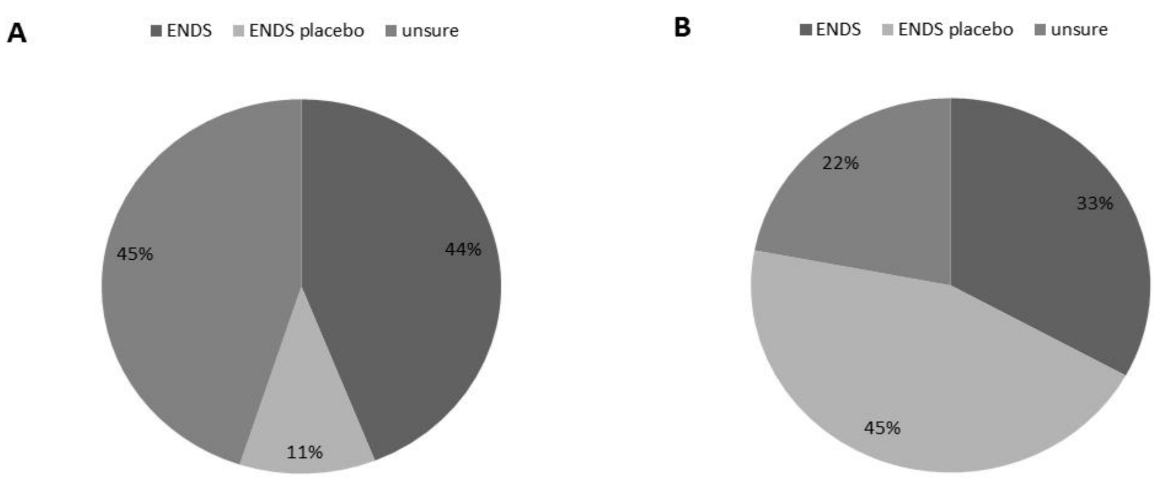

Figure 3. Volunteers' perception regarding whether they were using an ENDS or a placebo ENDS following exercise on a cycle ergometer during ENDS test (A) and placebo ENDS test (B).

DISCUSSION

External nasal dilator strips were initially developed for the relief of nasal obstruction associated with nasal congestion and/or deviated septum to reduce snoring and improve the quality of sleep

(13,14,23). Because the device was designed to increase airway flow and oxygenation, both elite and recreational competitors have been inclined to use ENDS.

In agreement with the findings of Pinto et al. (20), the results presented in the present study indicate that ENDS had no effect on the more common physiological parameters that help to describe the physiology of a submaximal exercise performance. Heart rate, VO_2, and V_E during the submaximal exercise performance on a cycle ergometer were not significantly different, despite the increase in nasal volume promoted by the ENDS.

Other investigators have also failed to find any effect of the use of ENDS on exercise performance. Boggs et al. (1) found no effect of ENDS on blood lactate level at the lactate threshold following moderate to high-intensity exercise on a cycle ergometer performed by sedentary and aerobically trained women. O'Kroy et al. (17) also reported no change in oxygen consumption or power output with the use of ENDS during exercise at 70% of VO_2 max compared to the use of a placebo ENDS. Moreover, no changes were found in VO_2, HR, or V_E with the use of ENDS during submaximal exercise (18). Similar findings were reported by Chinevere et al. (4) who reported no difference in VO_2 max or V_E during maximal exercise with and without the use of ENDS. In addition, no effect of ENDS on VO_2 max, maximal respiratory exchange ratio, maximum work output or the duration of the test was found following maximal exercise (17-19).

On the other hand, Griffin et al. (10) showed ENDS to be associated with significantly lower VO_2 and VE during exercise performed on a cycle ergometer at two submaximal work rates. These investigators also showed that HR was lower at the higher work rate during exercise performed with ENDS, and it was also associated with a lower RPE at both work rates. These data conflict with the present findings and with results presented by other investigators. In the present study, ENDS had no effect on RPE. Similar results were obtained by O'Kroy (18), suggesting that subjects failed to perceive any benefit with respect to total body exercise effort as a result of using an external nasal dilator strip, irrespective of which device was used.

It has been suggested that the individual's perception of using an ENDS is that breathing is perceived as easier during exercise, thus producing a performance-enhancing effect. Even if performance is not enhanced with the device, the decreased perception of dyspnea may lead subjects to believe that the nasal dilator is enhancing their exercise performance. In fact, given the endorsement by prominent professional athletes, many athletes and recreational competitors believe that the device will improve their performance. To address this point, both the present study and other studies (17-19) used a placebo ENDS during the exercise sessions. Also, and especially important in addressing this point, no other study has asked the opinion of the subjects regarding which device they believed they were using. In other words, in order to ensure that the placebo ENDS had no effect on nasal resistance, it could not exert the same pressure exerted by the authentic ENDS, which could have allowed the volunteer to identify which device he was using. The data from the present study show that 45% of the subjects were aware of which device they were using during tests. No placebo was used in the study conducted by Griffin et al. (10), which raises the question regarding whether the participants perform better during tests when they are aware of the expected result.

ENDS has been clearly shown to reduce nasal resistance to airflow when used at rest or during moderate exercise (8,10,26). Wilde and Ell (26) reported, however, that during isotonic exercise the improvement in nasal airway flow promoted by ENDS is not sustained, as the exercise itself is a more potent decongestant, suggesting that use of an external nasal dilator by a normal subject is of no use in isotonic exercise. Harms and colleagues (11) and Coast et al. (5) showed that increases in respiratory muscle work led to increases in oxygen demand by the respiratory muscles, thus requiring a greater proportion of the available cardiac output. It was therefore suggested that a nasal dilator would reduce the amount of oxygen needed by the respiratory muscles (8). This would reduce the effort of breathing. Nonetheless, O'Kroy et al. (17) found no difference in the total breathing work of respiration during maximal and submaximal exercise between ENDS and a placebo ENDS. These findings are in agreement with the results published by our group and by others on the lack of effect of ENDS on physiological parameters and exercise performance.

CONCLUSIONS

The external nasal dilator strip (ENDS) does not affect HR, VO_2 or V_E during submaximal exercise on a cycle ergometer, despite the increased nasal volume promoted by the device. This may be an explanation for the lack of effect on exercise performance previously reported by our group and by others. Explanations for this may include the fact that nasal resistance decreases naturally during exercise and the lack of a ventilatory exercise limitation in healthy, untrained humans. Therefore, the theoretical advantage of the decreased nasal resistance promoted by the external nasal dilator strip may be of little functional importance to most individuals during exercise.

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