Innovative exercise device that simulates horseback riding: cardiovascular and metabolic responses

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Abstract
An innovative exercise machine, which mimics the movement of horseback riding, has been made available in the market. As an initial step in characterizing this device, we determined the cardiovascular and metabolic responses to exercise. Twenty apparently healthy subjects rode the device (Equus) on day 1. The upper body exercises were added on day 2, to see whether cardiac and metabolic demands were further elevated (Equus + aerobics). After 10 min of continuous exercise, oxygen consumption increased significantly. In the Equus + aerobics condition, increase in oxygen consumption was significant as early as 4 min into the graded exercise test. Overall oxygen consumption was greater in the Equus + aerobics condition than in the Equus condition \((P < 0.05)\). Oxygen consumption returned to baseline levels within 1 h after the Equus \((190 \pm 58–188 \pm 50 \text{ ml min}^{-1})\) and Equus + aerobics \((198 \pm 54–194 \pm 43 \text{ ml min}^{-1})\) conditions. Heart rates increased gradually during the graded exercise tests in both conditions \((64 \pm 11–78 \pm 15 \text{ and } 65 \pm 11–83 \pm 12 \text{ bpm in the Equus and Equus + aerobics conditions, respectively})\). Both systolic and diastolic blood pressure (BP) increased significantly 6 min into the graded exercise tests and remained elevated throughout exercise in both the conditions. There were no significant differences in BP responses between the two conditions. These results indicate that the cardiac and metabolic stresses achieved with this exercise device are small.

Keywords: exercise machine; metabolic equivalent; equestrian

Introduction
The use of horseback riding for health and fitness dates back to the fifth century BC when horses were used in the rehabilitation of wounded soldiers\(^1\). Since then, horseback riding has been demonstrated to improve coordination, balance, postural control, muscle strength and range of motion\(^1\). Recently, an innovative exercise machine, the ‘Equus’ Core Trainer (Fig. 1), has been introduced. A major premise of the Equus Core Trainer is that users can achieve the benefits of horseback riding in a home setting without actually riding a horse. While the underlying concept is very innovative, little research has been conducted to characterize an exercise machine that imitates the movement of horseback riding.

With any new exercise modality, it is of fundamental importance to characterize its effects on the cardiovascular system, since this serves as a reference for exercise professionals and clinicians to gauge the intensity of physical activities\(^2\). As an initial step in characterizing physiological responses to this exercise machine, the primary purpose of this study was to determine the cardiovascular and metabolic responses to exercise on the Equus Core Trainer. A common option for this exercise mode is to perform upper body exercises while the machine moves. In effect, this would simulate the use of reins as in actual horseback riding. Accordingly, we also determined how much additional cardiovascular demand would be added with the addition of upper body exercise.

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Methods

Subjects
Twenty healthy subjects aged 20–67 years were studied. All subjects were free of overt chronic diseases as assessed by a medical history questionnaire. None of the subjects were smokers or taking any medications, and they were either sedentary or recreationally active. Most of the subjects (18 out of 20) had no previous horseback riding experience. The Human Research Committee reviewed and approved all the procedures, and written informed consent was obtained from all the subjects.

Experimental protocol
Each subject came to the laboratory twice. In the first session, the subject rode the ‘Equus’ Core Trainer (Panasonic, Secaucus, NJ). Like a horse, the Core Trainer constantly moves users slightly off their centre of balance to the left, right, up, down, backwards and forwards, forcing them to continually readjust their body position to maintain their balance. Upper body aerobic exercises were added to the exercise routine in the second session. Subjects performed the calisthenic type of upper body exercises involving a combination of various arm movements (rotating arms, biceps curls, etc.) as instructed by the Equus Core Trainer DVD.

Fig. 1 The Equus Core Trainer used in the present study
These sessions were conducted on different days, and the order of these two sessions was randomized.

Before each testing session, subjects were fasted for at least 4 h and abstained from caffeine. Both the sessions were initiated around the same time of day to minimize possible diurnal changes in dependent variables. Subjects rested in supine position for at least 30 min in a quiet, temperature-controlled (22–24°C) room, before oxygen uptake, carbon dioxide production, heart rate and blood pressure (BP) were measured for 10 min. After these pre-exercise measures to estimate resting metabolic rate (RMR), subjects were exercised on the Core Trainer for a total of 23 min. Subjects did not perform any warm-up or stretching exercises prior to the testing sessions. Each testing session consisted of 8 min of graded exercise, where the intensity setting was increased every 2 min from the lowest to the highest intensity (a total of four different intensity settings) followed by 15 min of continuous exercise at the highest intensity setting. The ‘Equus’ Core Trainer has four ‘built-in’ levels of speed and position adjustments so that the speeds and tilt positions can be modified based upon the individual level of core muscle development. Heart rate (via ECG), BP (via auscultation) and oxygen consumption (via metabolic cart; Max-1, Physio-dyne, Quogue, NY) were measured throughout the exercise session. To determine the extent of oxygen consumption elevation post-exercise (i.e. excess post-exercise oxygen consumption), oxygen consumption was monitored for up to 2 h following exercise completion. Oxygen consumption returned to baseline within 1 h after the Equus and Equus + aerobics conditions. No significant changes were observed in respiratory exchange ratio (RER) throughout the exercise conditions (data not shown).

As depicted in Fig. 2, heart rates were not different at baseline between the Equus and Equus + aerobics conditions and increased gradually during the graded exercise tests in both the conditions (P < 0.05). There was a modest increase in heart rate from sitting to the end of exercise (64 ± 11–78 ± 15 and 65 ± 11–83 ± 12 bpm in the Equus and Equus + aerobics conditions, respectively). There were no significant differences in heart rate responses between the two conditions.

**Statistical analyses**

Data were analysed using ANOVA with repeated measures. In the case of a significant F-value, a post hoc test using the Newman–Keuls method was used to identify significant differences among mean values. Statistical significance was set *a priori* at P < 0.05 for all comparisons. Data are expressed as mean ± SEM unless stated otherwise.

**Results**

Selected subject characteristics are shown in Table 1. All the subjects were apparently healthy with clinically normal BP and body fat.

Oxygen consumption increased significantly 10 min into continuous exercise under the Equus condition (Fig. 2). In the Equus + aerobics condition, increase in oxygen consumption was significant as early as 4 min into the graded exercise test. Overall oxygen consumption was significantly greater in the Equus + aerobics condition compared with the Equus condition and it returned to baseline within 1 h after the Equus and Equus + aerobics conditions. No significant changes were observed in respiratory exchange ratio (RER) throughout the exercise conditions (data not shown).

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### Table 1  Selected subject characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>20</td>
</tr>
<tr>
<td>Male/female</td>
<td>10/10</td>
</tr>
<tr>
<td>Age (years)</td>
<td>39 ± 16</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169 ± 7</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>66 ± 16</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>20 ± 5.3</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>117 ± 16</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>65 ± 12</td>
</tr>
<tr>
<td>Heart rate at rest (bpm)</td>
<td>58 ± 11</td>
</tr>
</tbody>
</table>

BP, blood pressure.
Both systolic and diastolic BP increased significantly 6 min into the graded exercise tests and remained elevated during exercise in both the conditions (Fig. 3). There were no significant differences in BP responses between the two conditions. The highest rate-pressure product achieved during exercise was 9750 U (units), and with the addition of upper body exercises it increased to 10 624 U.

**Discussion**

Despite the recognized public health and economic benefits of regular physical activity, a significant proportion of the US population remains sedentary or occasionally active. Primary barriers for adapting physical activity include a lack of time, injury and pain associated with weight-bearing activities, neuropathy and osteoporosis.

The horseback riding machine examined in the present study may have a number of advantages over more traditional exercise modes. This exercise device may provide a convenient ‘home-based’ exercise option that could improve exercise adoption and maintenance. Additionally, because this exercise is non-weight bearing, it may be better adapted for special populations, including patients with obesity, diabetes or arthritis, who are prone to orthopaedic injuries. Despite these potential benefits, scientific studies evaluating the effectiveness of this exercise machine are limited. As an initial step to better characterize this machine, we determined the cardiovascular and metabolic responses to this type of exercise.

Oxygen consumption on the exercise device was very similar to oxygen uptake collected during actual horseback riding at a walk, suggesting that this machine can achieve a similar cardiovascular workout to the actual horseback riding. However, peak oxygen consumption achieved on this machine was fairly small even with the addition of upper body exercises. Furthermore, we sought to determine the extent by which oxygen consumption might be elevated for a prolonged period of time following the horseback riding exercise. We found that oxygen consumption returned to baseline within 1 h after the cessation of exercise, and the amount of excess post-exercise oxygen consumption was rather small. Taken together, these results indicate that this device may not be suitable for those whose primary objective for exercise is to burn calories and to elevate metabolic rate.

The rate-pressure product or double product during exercise reflects myocardial oxygen demand. Even at peak exercise, the highest rate-pressure product achieved during exercise was 9750 U, and with the addition of upper body exercises it increased to 10 624 U. Since the cardiac demand is very small, exercise on this device can be safely performed by cardiac patients. On the other hand, it also indicates that users may not obtain cardiovascular benefits from this exercise machine. Therefore, this exercise mode may be better suited for those who seek to improve core muscle strength, balance and coordination, since regular horseback riding on actual horses has been demonstrated to improve these important musculoskeletal functions. Intervention studies are needed to examine whether exercise training on horseback riding machines, such as this one, is capable of improving core muscle strength, balance and coordination.

The potential health benefits of this machine remain to be elucidated. Kubota et al. recently reported that the glucose infusion rate, as assessed during the euglycaemic clamp technique, increased 50% during exercise and that insulin sensitivity improved by 42% after a 12-week training programme on the Equus Core Trainer. Chronic activation of large core muscle groups on the horseback riding machine may have acted to induce the insulin-like effects in working muscles. Since this exercise mode is non-weight bearing and requires small cardiac demand, diabetic patients may derive health benefits from this exercise.

In summary, exercise on the Equus Core Trainer increased heart rate, BP and oxygen consumption significantly, but mildly. Performing upper body exercises on the Equus Core Trainer elevated oxygen consumption above exercising on the machine alone. However, the magnitude of increases achieved with the addition
of upper body exercise was small. Thus, cardiovascular adaptations may not be the target for this device, and this machine may be better suited for improving core muscle strength, balance and coordination.

Acknowledgements

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References