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Original Research Article

Evaluation of a Stationary Cycle that Allows the Rider to Lean from Side to Side

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Abstract

Introduction: Indoor cycling classes has become a popular form of group exercise. Classes are typically conducted on stationary cycles that have a fixed frame. A new stationary cycle on the market (Bowflex® VeloCore) has a frame that can be "unlocked," allowing the rider to lean from side to side during a workout. **Purpose:** The main purpose of this study was to evaluate the physiological responses and muscle activation (EMG) patterns to riding a stationary cycle that can tilt from side to side compared to riding in a fixed, upright position. **Methods:** Fourteen healthy, regularly exercising adults between 25-39 years of age participated in this study. Subjects completed two days of testing. On the first day, subjects completed three 5-minute exercise bouts on the VeloCore (Fixed Mode, Free Mode – No Lean, Free Mode– Lean) and one on a Peloton bike, while HR, VO_2 and energy expenditure were recorded. All exercise bouts were conducted at identical power output. On the second day, EMG data were recorded from the upper and lower abs, obliques, radialis, triceps, biceps, anterior deltoid, and upper trapezius under similar conditions. **Results:** HR was 8-12 bpm higher and energy expenditure was 14% higher during the Free Mode - Lean protocol compared to all other conditions. Muscle activation during the Free Mode - Lean protocol was significantly higher in the obliques, radialis, triceps, biceps, anterior deltoid, and upper trapezius compared to riding in a fixed position on the VeloCore or the Peloton. **Conclusion:** Based on the results of this study, riding a stationary bike with the ability to lean from side to side increases overall energy expenditure and muscle activation during stationary cycling.

Key Words: EMG, Peloton, VeloCore.

Introduction

Indoor cycling classes has become a popular form of group exercise over the past decade.[1,2] Indoor cycling classes are conducted on a stationary cycle and instructors use variations in cycling cadence, resistance, body position, and music to help vary the intensity of the workout. Some studios also incorporate dumbbells or resistance bands in attempts to provide a total body workout.

One drawback of a stationary cycle is that it does not require balance to ride (i.e., because the frame of the bike is fixed and unable to move). This detracts from the realism of riding a “normal” road bike. On a normal road bike, the upper body and trunk muscles get called into play to steer and stabilize the bike.[3,4] In 2009, a company called RealRyder© developed an indoor bike that mimicked the tilt and lean of a road bike. The frame of the bike unlocked, which allowed the rider to experience the natural full body movement associated with riding a bike. The company advertises that riding the RealRyder© increases muscle activation and burns 20% more calories compared to riding a conventional stationary cycle.[5] However, there is no published data in support of these claims.

A new stationary cycle on the market, the Bowflex® VeloCore (Nautilus, Inc., Vancouver, WA), is similar to the Real Ryder© in that the frame can be “unlocked.” This allows the bike’s frame to pivot from side to side, relative to the frame’s support structure, with changes in the rider’s body position. The VeloCore can be ridden in 1) Fixed Mode (the bike frame is locked in place and cannot move), 2) Free Mode – No Lean (the bike frame is unlocked and can pivot as the rider pedals, but the rider does not purposely lean from side to side), and 3) Free Mode – Lean (the bike frame is unlocked, and the rider purposely leans from side to side to pivot the bike frame up to 15 degrees to the right and left). To our knowledge, there has not been any research published on the physiological or muscular effects of leaning from side to side when riding an indoor stationary cycle. The purposes of this study were to compare 1) the physiological responses, and 2) muscle activation patterns under several different riding conditions on two different indoor cycles, a Bowflex® Velocore bike and a Peloton bike (Peloton, New York, NY). A Peloton bike has a fixed frame which cannot be unlocked; thus the rider only rides in one plane.

Methods

Participants

Subjects for this study were 14 healthy, regularly exercising adults between 25-39 years of age. Sample size estimation determined that a minimum of 10 subjects would be adequate to detect a 10% difference in energy cost and muscle activation (%MVIC) with a power of .80 and an alpha level of .05. The study was approved by the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects and all subjects provided written informed consent prior to undergoing any testing or training procedures. Descriptive characteristics of the subjects are presented in Table 1.

Table 1. Descriptive characteristics of subjects (N=14).

	Males (n=7)	**Females (n=7)**
Age (yrs)	28.7±4.9	27.7±5.1
Height (cm)	183.4±7.1	169.6±3.9
Weight (kg)	88.0±7.7	71.7±9.8

Procedures

Initially, subjects completed between 1-3 practice sessions, depending upon their previous experience with riding a stationary cycle and their ability to maintain a constant power output under each condition. Each practice session was held on a separate day with a minimum of 24 hours between sessions. Subjects were instructed to choose a resistance setting on each bike (Velocore and Peloton) that would elicit a Rating of Perceived Exertion (RPE) value between 13-15 on the 6-20 Borg Scale.[6] An RPE of ~13 has been recommended as a pleasant and effective intensity for fitness exercise.[7] Both the VeloCore and the Peloton bikes were fitted with Garmin Vector 3 pedals (Garmin Ltd., Olathe, KS). The pedals were paired with a Garmin 530 head unit which displayed and stored cadence and power output data. The pedals were calibrated once per day per manufacturer's recommendations. Cadence for all conditions was targeted at 60 revolutions per minute (RPM), guided by an audio metronome.

Physiologic Testing

Once it was determined that subjects could replicate power output under each condition, they returned to the laboratory on a separate day for physiologic testing. Subjects completed three conditions on the VeloCore (Fixed, Free, Lean), and one condition on a Peloton bike. For the Fixed condition, the frame of the bike was locked in place. For the Free condition, the frame of the bike was unlocked, which allowed the frame to sway from side to side. During this condition, subjects were instructed to try and stay upright and not deliberately lean to either side. During the Lean condition, the frame of the bike was unlocked, and subjects were instructed to lean to the right for 5 seconds, ride in the center for 10 seconds, lean to the left for 5 seconds, and then return to the center. This sequence was repeated for the entire 5-minute work segment. One of the research assistants would instruct the subject when to lean to the right or left and when to return to the center position. For the Peloton condition, the bike was set up so that the seat height and seat position mimicked the body position on the VeloCore bike as closely as possible. The distance from the pedals to the top of the seat was measured, as was the distance from the seat to the handlebars.

For each condition, subjects began cycling and slowly increased their cadence until they achieved a cadence of 60 RPM. Once they were stable at that cadence, testing began. Subjects rode for 5 minutes under each condition, with 5 minutes of rest between conditions. The order of bikes was randomized between subjects as were the order of conditions on the VeloCore. At the conclusion of each condition, average RPM and power output (Watts) were recorded from the Garmin 530 unit.

During each 5-minute work segment, heart rate (HR) was recorded using radiotelemetry (Polar Instruments, Port

Washington, NY) and respiratory gas exchange (VO_2) was measured using a Parvo Medics metabolic cart (Sandy, UT). Prior to each test, the metabolic system was calibrated with gases of known concentrations (15.98% O_2 and 4.12% CO_2) and room air (20.93% O_2 and 0.03% CO_2) as per manufacture guidelines. Calibration of the pneumotachometer was done via a 3 Liter calibration syringe. Energy expenditure (kcal/min) was calculated from the VO_2 assuming a constant of 5 kcal per Liter of oxygen consumed. Heart rate, VO_2, and kcal/min were averaged for the last 2 minutes of each condition to represent steady-state data. Subjects were asked to rate their RPE at the end of the 4th and 5th minute of each 5-minute exercise condition using the Borg Scale. These values were averaged to represent RPE for each condition.

Muscle Activation Testing

On a separate day, subjects came to the laboratory to perform muscle activation (EMG) testing. Surface electrodes were placed on the upper and lower rectus abdominus, external obliques, radialis, biceps, triceps, anterior deltoid, and upper trapezius. All electrodes were place on the right side of the body and the skin was shaved, abraded, and cleaned with alcohol prior to electrode placement. For the EMG testing, subjects completed three conditions on the VeloCore (Fixed, Right Lean, Left Lean) and one on the Peloton. The order of bikes was randomized and as was the order of conditions on the VeloCore. For each subject, resistance settings on each bike were identical to those used for the energy cost portion of the study. For each condition, subjects slowly increased their cadence until they achieved a cadence of 60 RPM. They then rode for 1-2 minutes under each condition, with approximately 3 minutes of rest between conditions. At the conclusion of each condition, average cadence and power were recorded from the Garmin 530 head unit.

Raw EMG data were amplified and digitally sampled at 1000 Hz. Post-processing of the data included the use of the root mean squared (RMS) technique with a 125 ms window width and 62.5 ms overlap after any necessary DC offset cancelation. Three maximum voluntary isometric contractions (MVIC) were performed using manual muscle techniques on all muscles prior to testing so that the EMG data could be scaled as a percentage of MVIC (% MVIC) for each muscle. The average of the three trials represented peak muscle activity for that muscle. Normalization was performed by dividing the peak RMS of 5 seconds of EMG data during each condition by the reference EMG value obtained from the same muscle during the MVIC trials.

Statistical analyses

Differences between conditions for each variable were compared using a one-way ANOVA with repeated measures. If there was a significant difference between conditions, pairwise comparisons were made using Fisher's LSD post-hoc tests. Alpha was set at p<.05 to achieve statistical significance. Data are presented as mean ± standard deviation. All analyses were conducted using SPSS version 27.0 (Chicago, IL).

Results

Data for the energy cost portion of the study are presented in Table 2. There were no significant differences in pedaling cadence (RPM) or power output (Watts) between conditions. HR, VO_2, and energy expenditure (kcal/min) were significantly higher for Lean compared to all other conditions. HR, VO_2, and energy expenditure for Fixed, Free, and Peloton were not significantly different from each other. For RPE, Lean was significantly higher than Fixed. There was no significant difference in RPE between Free, Lean, or Peloton.

Table 2. Physiological responses to the four different exercise conditions.

	Fixed	Free	Lean	Peloton
RPM	60±.7	60±.6	61±1.0	60±.6
Watts	144±32.3	143±32.7	142±32.4	145±36.0
Heart rate (bpm)	136±17.3*	140±18.6*	148±19.7	140±19.3*
VO_2 (ml/kg/min)	24.3±4.3*	25.0±4.6*	27.7±4.6	24.4±3.8*
kcal/min	9.6±2.3*	10.0±2.3*	11.0±2.3	9.7±1.9*
RPE	13.4±.6*	14.0±.7	14.2±.9	13.8±.7

***Significantly different than Lean (p<.05).

Data for each muscle under each riding condition are presented in Table 3. Data for each muscle are also graphically presented in Figure 1. There was no significant difference in pedaling cadence or power output between conditions: Fixed = 60±.65 RPM, 146±41.0 Watts; Right Lean = 60±.79 RPM, 146±41.0 Watts; Left Lean = 60±.79 RPM, 146±41.0 Watts; Peloton = 60±.60 RPM, 148±40.3 Watts).

For the upper and lower abs, there was no significant difference in muscle activation between conditions. For the obliques, there was significantly greater muscle activation during Right and Left Lean compared to both Fixed and Peloton. For both the radialis and biceps, muscle activation during Right and Left Lean was significantly greater than Fixed and Peloton; Left Lean was also significantly greater than Right Lean. For the triceps, muscle activity was significantly greater during Right Lean compared to all the other conditions. For the anterior deltoid, muscle activation during Right and Left Lean was significantly greater than Fixed and Peloton. For the upper trapezius, muscle activation was significantly greater during Right and Left Lean compared to Fixed and Peloton. In addition, Left Lean was significantly greater than Right Lean.

Table 3. Normalized EMG data (%MVIC) for each muscle under the various riding conditions.

	Fixed	Right Lean	Left Lean	Peloton
Upper Abs	15.6±15.3	24.2±22.8	25.3±24.3	19.1±14.9
Lower Abs	12.6±14.1	20.1±19.7	20.2±17.4	14.5±8.6
Obliques	18.6±9.7	37.0±24.0[ad]	33.6±15.8[ad]	20.9±10.4
Radialis	8.9±6.4	22.0±13.4[ad]	47.8±22.5[abd]	9.6±6.1
Biceps	3.3±2.2	9.4±9.0[ad]	47.9±29.6[abd]	4.3±3.4
Triceps	22.1±15.6	95.2±42.6[acd]	34.8±21.2	26.4±21.3
Anterior Deltoid	6.9±2.4	26.2±16.3[ad]	17.6±13.1[ad]	8.3±3.4
Upper Trapezius	10.0±5.3	34.2±22.9[ad]	45.8±23.4[abd]	12.0±12.3

[a]Significantly greater than Fixed (p<.05).
[b]Significantly greater than Right Lean (p<.05).
[c]Significantly greater than Left Lean (p<.05).
[d]Significantly greater than Peloton (p<.05).

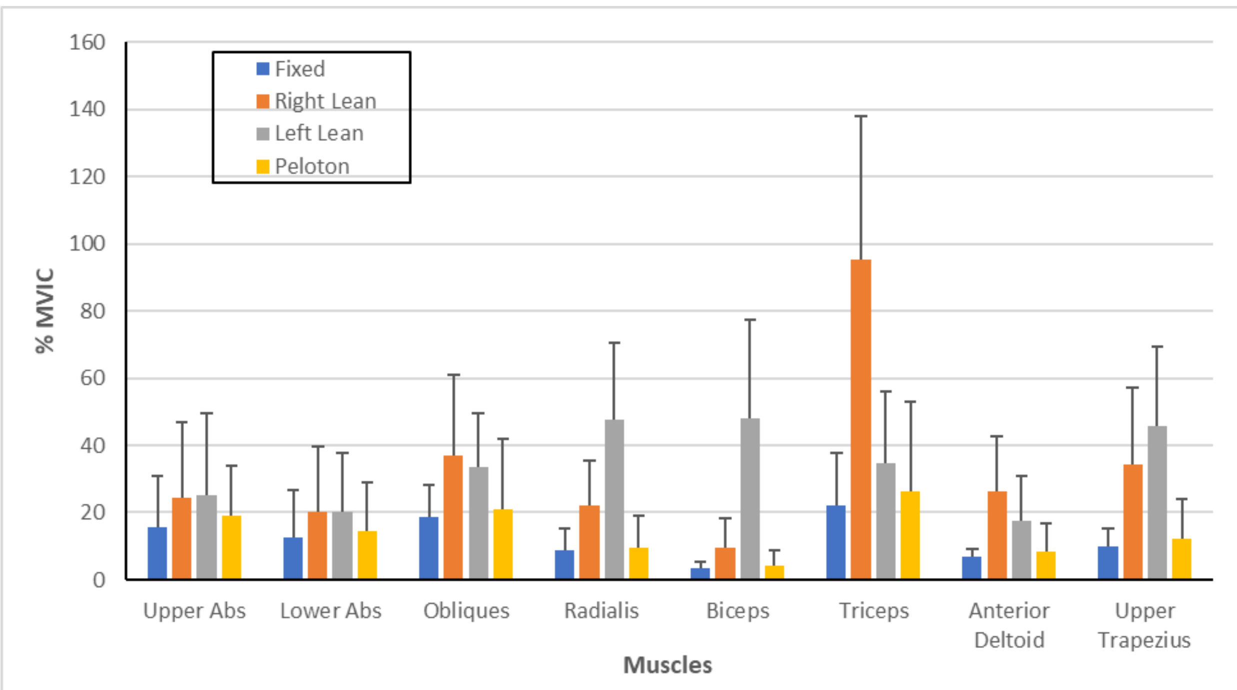

Figure 1. A comparison of muscle activation (EMG) during the various riding conditions.

Discussion

This study evaluated the physiological responses and muscle activation patterns consequent to riding a stationary cycle that allows the rider to lean from side to side. It was found that HR averaged 10 bpm higher and energy expenditure averaged 14% higher when subjects utilized the Lean protocol, compared to riding the VeloCore in the Fixed Mode or when riding the Peloton. The

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increase in energy expenditure is somewhat less that what is advertised for the RealRyder© (20%), however the 14% increase in energy expenditure would amount to an additional 70 calories expended during a typical 50-minute indoor cycling class. The increase in overall exercise intensity undoubtedly resulted from the increase in musculoskeletal effort needed to control the bike as the rider moved from side to side. Overall, muscle activation was significantly higher in the obliques, radialis, biceps, triceps, anterior deltoid, and upper trapezius during the Lean protocol compared to riding in the Fixed mode on the VeloCore or on the Peloton. There were also notable differences in EMG between the right and left sides of the body. All the EMG electrodes were placed on the right side of the body. When leaning to that side, the triceps was activated to a greater degree than when leaning to the left, as the body attempted to maintain a stable riding position. Leaning to the left resulted in greater activation of the right radialis, biceps, and upper trapezius, as the body sought to control the lean in the opposite direction. It is reasonable to assume that if the left side of the body were instrumented, muscle engagement would be symmetrical, with the results for the left and right lean being reversed.

The results of this study have positive implications in two different settings. For indoor cycling classes, the use of a stationary cycle that allows side to side movement can add variety to the class, in addition to providing a more intense workout. For cycling enthusiasts, riding such a bike can add a sense of realism to indoor training, especially for off-road cyclists. Because the upper body and trunk muscles are challenged to a greater degree, compared to when riding a traditional stationary cycle, this may contribute to a greater sense of balance and control of their bike when riding on uneven terrain.[4]

Conclusion

Riding a stationary cycle that allows the rider to lean from side to side resulted in a significantly more intense workout than riding in an upright and fixed position. Over time, this increase in exercise intensity may result in greater gains in aerobic fitness and have a positive effect on body composition. Deliberately leaning from side to side also increased muscle activation in the trunk and upper body. Thus, in addition to providing the rider with a more "realistic" riding experience, a stationary cycle that allows the rider lean from side to side may help to improve the rider's balance through an increase in kinesthetic awareness and muscular strength and endurance.

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