PERCEPTION OF AEROBIC EXERCISE, FLEXIBILITY, AND POWER OUTPUT IN FEMALES THROUGHOUT THE OVARIAN CYCLE

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The purpose of this study was to observe how the ovarian cycle affects women’s perceived exertion during a fixed bout of aerobic exercise, overall anaerobic power, and hamstring flexibility. Presently, females did not perceive submaximal aerobic exercise at a fixed intensity differently between the follicular versus luteal phases nor was hamstring flexibility significantly different. However, females produced more overall power during the luteal phase opposed to the follicular phase. Therefore, anaerobic athletes (sprinters, power lifters, etc.) may benefit by timing their maximal effort training days to avoid the follicular phase. Additionally, researchers may consider including women in their exercise-based studies when observing variables other than maximal power.
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CHAPTER I
INTRODUCTION

Females are often excluded from exercise-based studies because the menstrual cycle may impact the results. Previous research has strategically analyzed the effects of the ovarian and menstrual cycles on physical performance and the results vary as much as the methods used in these experiments (1, 2, 3). For example, some researchers tend to use the term menstrual cycle interchangeably with the term ovarian cycle when indeed they are not the same. The ovarian cycle refers to the follicular phase (days 1-13), ovulation (day 14), and the luteal phase (days 15-28) (4) and is regulated by fluctuating levels of the pituitary gonadotropins follicle-stimulating hormone (FSH) and luteinizing hormone (LH). These phases are divided as such depending on the maturation of the female egg and whether or not it has been fertilized within an average of typically 28 days. The cycle begins on the first day when the woman observes blood (menses). Menses signals the onset of the follicular phase. This phase may also be broken down further into early-follicular (days 2-9) and late-follicular (days 9-13). It is important to note that the follicular phase lasts longer than menses, which consists of typically 5-7 days. A female with a typical 28 day ovarian cycle will eject an immature egg (oocyte) from the ovary on day 14. This is called ovulation. Finally, the luteal phase lasts post ovulation until the onset of another menses and may also be subdivided into mid-luteal (days 18-24) and late-luteal (days 25-28+) stages (5).
Figure 1. Ovarian Cycle with the depicted maturing egg (6).
Dr. Jason Karp, author of “Running for Women” argues that the best time for a female aerobic athlete to train is during the latter portion of the menstrual cycle, the luteal phase (7). By exercising for longer durations at a time other than menses (actively bleeding), female runners have greater quantities of iron-rich blood available and thus more oxygen carrying capacity to the working musculature and a possible decrease in fatigue. The ratings of perceived exertion (RPE), however, during aerobic exercise throughout menstruation is an area that has been fairly unexamined. It stands to reason that loss of blood and iron throughout menses results in less oxygen available for muscular contraction in conjunction with less iron availability to carry such oxygen which subsequently results in, greater perceived exertion during a given bout of exercise. However, when Hooper et al. examined the RPE of formerly sedentary women throughout the menstrual cycle when jogging at 65% of a previously determined VO$_{2\text{max}}$ for 30 minutes at each session, women subjectively reported greatest RPE scores the closer they tested to day 1 of menses (8). They concluded that timing of exercise interventions is important when aiming at increasing physical activity among sedentary women. This could also be important for developing exercise interventions and/or making exercise recommendations to women.

Even more conflicting results are present when testing the effects of the ovarian/menstrual cycles relating to anaerobic activities such as sprinting by foot or
cycling (9, 10, 11). This is mainly because the effect the menstrual cycle has on blood lactate accumulations remains unclear. For example, two studies reported a higher blood lactate concentration in response to exercise during the mid-follicular phase opposed to other times of testing during the month (12, 13). McCracken et al. speculated that estrogens were responsible for spared glycogen use and enhanced lipid oxidation thus lowering the lactate response during the mid-luteal phase. This is supported by the known evidence that estrogens influence nitric oxide (NO), a potent vasodilator which could increase the amount of blood available for circulation and thus improve overall cardiovascular health (14). Estrogen hormones are observed to be at their peak blood concentrations during ovulation, which falls in the luteal phase of the ovarian cycle.

However, other studies (9, 11, 15) found no significant changes over the menstrual cycle in lactate response to induced anaerobic exercise. The decrease in lactate response to exercise during the mid-luteal phase was suggested to have been due to differences in subject’s nutritional status, such as time and substance of feeding prior to testing and the positive observed effects on consuming carbohydrates prior to anaerobic exercise. In contrast to the studies mentioned above, many have used oral contraceptives as a hormonal control rather than relying on the menstrual/ovarian cycles as the sole independent variable(s) when studying anaerobic effects and have yielded either lactate threshold or blood lactate concentrations vary dependent upon menstrual phase of testing as well (13, 16). Therefore, according to this controlled research, it seems most likely
that the menstrual cycle does not affect blood lactate concentration in response to anaerobic exercise.

Recent research has attempted to link female anterior cruciate ligament (ACL) injuries to the menstrual cycle as well (17, 18, 19, 20). Vescov et al. suggests that subtle menstrual disturbances are common in athletic women and go undetected with regular menses. These disturbances have the potential to either expedite or delay the onset of the ovarian luteal phase and make the stage in which an ACL tear occurs inaccurately identifiable by a health history questionnaire or blood sample (21). Sang-Kyoon et al. in particular looked at knee joint loading during the two phases of the ovarian cycle and saw no difference in risk to ACL injury. Zazulak and colleagues performed a meta-analysis on this topic and concluded that greater knee laxity did correlate to a higher number of ACL injuries and was related to the fluctuating hormonal status of the menstrual cycle. One factor that has been related to this injury is stiffness of the muscles that stabilize the knee and tissue compliance of the quadriceps and hamstrings. Bell et al. examined hamstring compliance throughout the menstrual cycle and observed that hamstring extensibility increased from menses to ovulation by nine percent (a non-statistically significant finding) and suggested future research include a greater sample size and verification that this increase was due to progesterone and estrogen concentrations (17).

The purpose of the present study was to fill in some of the gaps relating to how the ovarian cycle affects women’s perceived exertion during a fixed bout of aerobic exercise, anaerobic power, and hamstring flexibility. It was hypothesized that women
would report overall greater RPE values while exercising for 15 minutes at a fixed intensity during the follicular phase (first day of menses) and that flexibility and overall anaerobic power output would be greater during ovulation versus menses because during ovulation, women were no longer losing blood and iron.
CHAPTER III

METHODOLOGY

Participants

Ten non-pregnant apparently healthy females between the ages of 19-24 years old who had regular menstrual cycles (28-30 days for the past three months) were recruited for this study. They each had a minimum aerobic capacity (VO$_{2\text{max}}$) of 40ml·kg$^{-1}$·min$^{-1}$, no known metabolic diseases or menstrual abnormalities, and either did not use prescription birth control or had been on the same medication for at least 6 months. Less than six months of the incorporation of prescription birth control was chosen as the exclusion criteria so all subjects would be at a hormonal steady state during the study. Participants were recruited through flyers and word of mouth. Before participation, all subjects read and signed informed consent contracts. This study was approved by the University of Mount Union Institutional Review Board.

Procedures

Subjects were invited to University of Mount Union’s Clay Exercise Science Lab for 3 separate visits. During the first visit, height and weight were assessed and the subject completed a progressive exercise test on a treadmill to assess VO$_{2\text{max}}$. Ovarian phase was not controlled during this test because previous research has shown no difference in VO$_{2\text{peak}}$ or VO$_{2\text{max}}$ throughout the cycles (22). During the VO$_{2\text{max}}$ protocol, participants walked for 3 minutes at 3.5 mph and then jogged at a self-selected pace
between 5.5mph-7.5mph for the duration of the test. Every two minutes after the 3 minute warm-up, the technician increased the grade of the treadmill by 2%. The protocol was completed when the subject could no longer continue to run and subjectively terminated the test. The VO$_{2peak}$ was utilized in conjunction with the American College of Sports Medicine’s metabolic jogging equation, \( VO_2 = 3.5 + (0.1 \cdot \text{speed}) + (1.8 \cdot \text{speed} \cdot \text{grade}) \), to calculate the speeds necessary to achieve 30%, 50%, and 70% of the VO$_{2peak}$. While exercising on a treadmill with the grade set at 0%. These speeds were utilized at the fixed aerobic intensities visits 2 and 3.

On the first day of menses, the time in which the onset of blood was visible, the subject contacted the principal investigator via text message, e-mail, or a phone call and scheduled their second visit to the lab to occur within 24 hours. Nonsteroidal anti-inflammatory medications (NSAIDs) and other pain relievers were prohibited 6 hours prior to testing. Ratings of perceived exertion (RPE) were assessed during the aerobic bout of exercise the second visit and pain relieving medications possess potential to impact such perception by dulling abdominal pain and body aches that are commonly observed during the onset of menses (23). Additionally, the subjects were instructed to record a food log of the day’s total caloric intake prior to testing in which they would repeat preceding to the third visit to mimic energy sources before exercise.

At the time of their second visit, weight was assessed via a digital scale and participants returned to the same treadmill in which they completed their VO$_{2max}$ test during visit 1. They began to walk at 30% of their calculated VO$_{2peak}$ for 5 minutes, then
50% of their VO\textsubscript{2peak} for 5 minutes, followed by a jog at 70% of VO\textsubscript{2peak} for 5 minutes. Participates were asked the question: “How hard do you feel you’re working?” after each stage and reported their perceived exertion using the Borg RPE scale. The scale was explained to the participants orally and also depicted visually on a poster located in front of the. The Borg RPE scale ranges from values of 6-20 and linearly increases with intensity. A rating of 6 would indicate “no exertion at all”, and the increase to 20 which was “maximal exertion”.

After completing the treadmill exercise, participants had 10 minutes to recover either walking at a slow pace on the treadmill or by resting in a chair. They were ad libitum access to water, but restricted from consuming any calories throughout the remainder of the visit because new energy sources may have impacted the later anaerobic power testing.

After the 10-minute rest period, participants completed the sit-and-reach flexibility test a total of three times utilizing a standardized sit-and-reach box. The sit-and-reach flexibility test requires subjects to remove their shoes and sit facing the flexibility box with knees fully extended and feet approximately 4 inches apart. The subjects then placed one hand over another and reached their hands straight up over their heads taking a deep inhale stretching their abdominal and back muscles. On the exhale, they reached forward as far as possible bending at the torso, palms down, and held the maximum reach for 1-2 seconds. The distance was measured to the nearest centimeter and the furthest trial was used for data analysis of flexibility (24).
Participants were then taken to a stairwell outside of the Clay Exercise Science Lab. There, they completed the Margaria-Kalamen test up to 5 fives and the fastest score was used for data analysis. This test requires a staircase with at least 9 steps, each stair being about 7 inches (18cm) high with a distance of 20 feet (6 meters) at the base of the staircase to be used as a lead-up area (24). Margaria-Kalamen testing equipment comes with two sensor pads and a box which records time to the nearest hundredth. The sensor pads were placed on the 3rd and 9th steps. An “x” was placed as a marker on the 6th step so that the subject could visualize the stairs 3 at a time. When ready, they took a running start and ascended the stairs as quickly as possible activating the timing pads on the 3rd and 6th steps. Power (p) in watts was then calculated using their weight (w) in newtons (pounds x 4.45 or kg x 9.807) times height (h) in meters (inches x 0.0254) from the third step to the ninth step divided by measured time interval (t) in seconds; \[ P = \frac{wh}{t}. \]

Lastly, the participants returned to the lab where they completed a single Wingate test (24) on a Velotron cycle ergometer that was manually adjusted to their height. This test was conducted within approximately 3 minutes after the Margaria-Kalamen test concluded. The subject peddled for one minute against zero resistance as they became familiarized with the bike and the peddling mechanics. After this familiarization, subjects were given a 20 second countdown followed by verbal instructions to “speed up”. These commands were given to ensure that the subject hit maximal revolutions per minutes immediately before the ultimate cue of “3-2-1-GO!” At this time, a mechanical
resistance of 7.5% of the subject’s body weight was applied to the workload and the subject pedaled as quickly as possible for 30 seconds against this resistance. The data from this maximal anaerobic test was used to assess overall power output and included: anaerobic power, peak watts, mean watts, fatigue index, and total work.

Exactly two weeks later, subjects were required to report back to the lab at the same time of day for visit number 3 and repeated all of the testing that took place during visit number 2 in the same order. At this time, they were no longer in the follicular phase based on an ovarian 28 day calendar from when we first met and were entering the luteal phase of the ovarian cycle.
CHAPTER IV
ANALYSIS OF THE FINDINGS

Analytical Plan

A two phase (follicular, luteal) by three intensity (30, 50, 70%) ANOVA with repeated measures on both variables was used to assess the RPE values during the aerobic exercise. Paired samples t-tests were utilized to examine the difference between Phase 1 and Phase 2 for the following dependent variables: flexibility as assessed by the sit-and-reach test, calculated watts produced during the Margaria-Kalamen test, and the recorded anaerobic power, peak watts, mean watts, fatigue index, and total work from the Wingate test. A-priori significance was set at $\alpha \leq 0.05$ and all data were analyzed using the Statistical Package for the Social Sciences Version 20.

Results

A total of 10 participants were included on this study. Participant’s initial pre-testing physical characteristics are shown in Table 1. The speed variables determined using the ACSM metabolic jogging equation, $\text{VO}_2 = 3.5 + [0.1 \cdot \text{speed}] + [1.8 \cdot \text{speed} \cdot \text{grade}]$, to calculate 30%, 50%, and 70% of the $\text{VO}_2\text{peak}$ are included in Table 2. The dependent variables between the two phases are included in Table 3.

Table 1. Participant Physical Characteristics
<table>
<thead>
<tr>
<th>Variable</th>
<th>Females (N=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>20.7 ± 1.7</td>
</tr>
<tr>
<td>Height, centimeters</td>
<td>166.8 ± 5.8</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>22.2 ± 2.8</td>
</tr>
<tr>
<td>Weight, kilograms</td>
<td>63.7 ± 10.6</td>
</tr>
<tr>
<td>Aerobic Capacity (VO(<em>2)(</em>{\text{max}})), ml·kg(^{-1})·min(^{-1})</td>
<td>45.8 ± 4.6</td>
</tr>
</tbody>
</table>

Data are presented as the means ±SD.

**Table 2. Determined Fixed Aerobic Intensities**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30% VO(<em>2)(</em>{\text{peak}})</td>
<td>1.9 ± 0.3</td>
</tr>
<tr>
<td>50% VO(<em>2)(</em>{\text{peak}})</td>
<td>3.7 ± 0.4</td>
</tr>
<tr>
<td>70% VO(<em>2)(</em>{\text{peak}})</td>
<td>5.3 ± 0.6</td>
</tr>
</tbody>
</table>

Data are presented as the means ±SD.

**Table 3. Dependent Variables from the Two Phases**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Follicular Phase</th>
<th>Luteal Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, kilograms</td>
<td>63.6 ± 10.5</td>
<td>63.8 ± 10.8</td>
</tr>
<tr>
<td>RPE at 30% of VO(<em>2)(</em>{\text{peak}})</td>
<td>6.6 ± 0.7</td>
<td>6.6 ± 0.7</td>
</tr>
<tr>
<td>RPE at 50% of VO(<em>2)(</em>{\text{peak}})</td>
<td>9.5 ± 2.1</td>
<td>9.3 ± 2.3</td>
</tr>
<tr>
<td>RPE at 70% of VO(<em>2)(</em>{\text{peak}})</td>
<td>12.0 ± 2.6</td>
<td>11.8 ± 2.5</td>
</tr>
<tr>
<td></td>
<td>Follicular Phase</td>
<td>Luteal Phase</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Sit-and-reach, centimeters</td>
<td>36.2 ± 6.1</td>
<td>36.1 ± 5.7</td>
</tr>
<tr>
<td>Margaria-Kalamen test, seconds</td>
<td>0.7 ± 0.1</td>
<td>0.7 ± 0.1</td>
</tr>
<tr>
<td>Margaria-Kalamen test, watts</td>
<td>831.8 ± 291.7</td>
<td>1010.5 ± 215.0</td>
</tr>
<tr>
<td>Wingate anaerobic capacity, watts/kg</td>
<td>7.8 ± 1.2</td>
<td>8.3 ± 1.5</td>
</tr>
<tr>
<td>Wingate peak power, watts*</td>
<td>514.6 ± 120.4</td>
<td>560.4 ± 137.7</td>
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<tr>
<td>Wingate mean power, watts*</td>
<td>349.9 ± 63.8</td>
<td>364.4 ± 75.1</td>
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<tr>
<td>Wingate fatigue index, watts/second*</td>
<td>9.0 ± 3.1</td>
<td>10.1 ± 3.7</td>
</tr>
<tr>
<td>Wingate total work, Joules*</td>
<td>10498.4 ± 1915.0</td>
<td>10929.5 ± 2254.6</td>
</tr>
</tbody>
</table>

Data are presented as the means ±SD. There are statistical differences (*) between the follicular and luteal phases for Wingate peak power (p=0.004), Wingate mean power (p=0.051), Wingate fatigue index (p= 0.032), and Wingate total work (p=0.055).

The two-way ANOVA revealed a significant main effect of intensity (p≤.01) for RPE. This is expected as RPE is known to increase with exercise workload (25). However, there were no significant (p≥0.80) main or interaction effects for phase. During the luteal phase versus the follicular phase, the females achieved a greater peak in power during the Wingate test (p=0.004) and a greater average power within the thirty seconds as well (p=0.051). Although the participants performed a greater amount of total work in the luteal phase (p=0.055), they also fatigued at a quicker rate versus the follicular phase (p= 0.032). There were no other differences between phases for the remaining dependent variables.
CHAPTER V
DISCUSSION

The purpose of this study was to fill in some of the gaps relating to how the ovarian cycle affects women’s perceived exertion during a fixed bout of aerobic exercise, overall anaerobic power, and hamstring flexibility. It was hypothesized that women would report greater RPE values while exercising for 15 minutes at a fixed intensity during the follicular phase (first day of menses) and that flexibility and overall anaerobic power output would be greater during ovulation (luteal phase) versus menses. However, there were no statistical differences between how the women perceived the aerobic exercise between the two phases nor was there a statistical difference between hamstring flexibility. Yet, women did achieve a greater peak power, average power, total work, and larger fatigue index in the luteal phase verses follicular.

One of the biggest differences between this research and others relating to this topic was that the phases chosen were based off of the ovarian cycle, not the menstrual (uterine) cycle. This study did not base the change in phase on varying female sex hormonal concentrations, but rather the accepted average 28-day female calendar month, which may be considered a limitation. Since previous studies centered on the menstrual cycle have shown significance where this study did not, this gives suggestion that future tightly-controlled female studies should consider focusing on the menstrual cycle and not the ovarian calendar.
However, from a practical approach, every woman with a regular menstrual cycle can use the ovarian cycle method without materials other than a calendar. This gives reason to suggest that the methods behind this study may be more applicable to female athletes and women in general who want to use this information to their advantage.

For example, this study analyzed hamstring flexibility using a sit-and-reach box. Though this equipment is practical, it is limited in its testing performance. When Bell and colleagues attempted to observe hamstring stiffness and extensibility across the menstrual cycle, they utilized electromyography (EMG) and a Biodex System 3 dynamometer chair. This more advanced technology provided incite beyond sit-and-reach box capabilities. They concluded that hamstring extensibility ($P = 0.003$) increased at the ovulation testing session, but hamstring muscle stiffness ($P = 0.66$) remained unchanged (17). This particular finding coincides with the non-changing hamstring muscles stiffness analyzed by the sit-and-reach box.

Additionally, this study based perceived exertion on submaximal aerobic exercise rather than maximal or near maximal bouts. Previous research has suggested that women will perceive exercise as more difficult during menses (8), but exercised their participants not only at a sustained elevated intensity between 60%-75%, but collected data for longer durations of at least 20 minutes (7, 8). This study had the females exercising at 30%, 50%, and 70% of their VO$_2$peak for 5 minute stages each. Examining the RPE data from this study, the ratings given between the follicular phase and the luteal phase were nearly identical for the 5 minute bouts of exercise at the intensities of 30% and 50% of VO$_2$peak.
However, when the exercise bout at 70% is examined, the ratings begin to differ from one phase to the other (follicular phase RPE= 12.0 ± 2.6, luteal phase RPE = 11.8 ± 2.5).

It is possible, based on these findings that females are more likely to perceive aerobic exercise at a fixed intensity differently between the follicular and ovarian phases the closer to maximal aerobic capacity in which they are exercising, but that suggestion is not proven with this data. Relating back to practicality of this research though, it is safe to suggest that the majority of females who exercise regularly do so at submaximal levels and may not have to drastically alter their exercise regimens between phases, especially if their bouts are of shorter time increments and or performed at lower intensities.

To reiterate the significant findings of this study, females produced a greater amount of power, average power, total work, and fatigue index in the luteal phase versus the follicular phase using the Wingate test. Since the loss of blood and iron during menses are frequently accompanied by fatigue, it is possible that this becomes a limiting factor during maximal, but not submaximal exercise. This could be due to the complete or near complete depletion of ATP stores induced by maximal exercise induces. This depletion fatigues the body to a state where significant differences between the phases are observed. The submaximal exercise did not produce this effect. However, as stated above; we did not assess RPE at maximal intensity. It is possible that maximal exertion during menses is more difficult thus reducing the ability or willingness of the participants to generate as much power on the Wingate test during menses as they were later in their ovarian cycle.
Conclusion

This was the first study that we are aware of to simultaneously assess RPE, flexibility, and anaerobic power of women during two separate phases of the ovarian cycle. Presently, females did not perceive submaximal aerobic exercise at a fixed intensity differently between the follicular versus luteal phases nor was hamstring flexibility significantly different. However, females produced more overall power during the luteal phase opposed to the follicular phase. Therefore, anaerobic athletes (sprinters, power lifters, etc.) may benefit by timing their maximal effort training days to avoid the follicular phase. Additionally, researchers may consider including women in their exercise-based studies when observing variables other than maximal power.
APPENDICES
APPENDIX A

LETTER OF CONSENT
APPENDIX A

LETTER OF CONSENT

INFORMED CONSENT FORM
Exercise Tolerance, Flexibility, and Power Output in Women throughout the Ovarian Cycle

INVITATION TO PARTICIPATE
You are cordially invited to participate in this study to explore the effects of the menstrual cycle on female performance.

BASIS FOR SUBJECT SELECTION
You must be an apparently female between the ages of 18-30 years with a regular menstrual cycle. If you have begun a new topical, oral, or implanted form of birth control within the past 6 months, you are ineligible to participate.

PURPOSE OF THIS STUDY
This research will explore the effects of the menstrual cycle on female performance. Upon conclusion of the study, I hope to answer three questions. One, do women tolerate aerobic exercise similarly at a fixed intensity between the follicular and ovulatory phases? Secondly, do women produce the same anaerobic power output between those phases? Thirdly, is flexibility affected by varying hormonal concentrations throughout the menstrual cycle?

PROCEDURES
Before you start your period, you will complete a VO\textsubscript{2}max test which is a test of maximal aerobic capacity. Then on the first day of your cycle you will contact the principal investigator, Kelsey O’Driscoll, to schedule testing within 24 hours. At the time of the appointment, you will come to the Clay Exercise Science Lab (MAAC 1300) to have your height, and weight recorded. Then you will complete the following:
1. 3 minutes of walking on the treadmill at 3.5 miles an hour to warm up
2. Jog at 30\% of your VO\textsubscript{2}max for 5 minutes
3. Jog at 50\% of your VO\textsubscript{2}max for 5 minutes
4. Jog at 70\% of VO\textsubscript{2}max for 5 minutes
   After each stage you will indicate how hard you feel you’re working (RPE) giving a value between 6-20.
5. 5 minute cool down walking slowly
6. 5 minutes of total rest in a chair
   Water hydration is acceptable at this point, but no food may be consumed.
7. YMCA flexibility test a total of 3 attempts*
8. Margaria Kalaman test a total of 5 attempts**
9. Wingate anaerobic test***

You will be required to repeat all of these tests exactly two weeks from when we first met.

For the *YMCA flexibility test, you will sit with legs together stretched out in front of you, heels pointed to the ceiling, and reach with your fingers as forward as possible bending at the torso without your legs rising. A YMCA Sit-and-Reach Box will be used to assess these measurements. **The Margaria-Kalaman test is proctored on a flight of at least 12 stairs where two time sensor pads are placed on the 3rd and 9th steps. According to published protocol standards, the subject may have a 6 meter running start and run up the staircase in any manner the choose either skipping or not skipping stairs in between. The time from which they step on the first pad to the second is used to calculate their power. You may complete this test up to 5 times and the best score will be used for data collection. ***The Wingate procedure includes the subject peddling against zero resistance for two minutes on a designated stationary bike. After this warm up, you will be given a 20 second countdown followed by “3-2-1-GO!” verbal instructions. Finally, you must pedal as quickly as possible for 30 seconds against 7.5% of your body weight. Verbal positive encouragement will be given at this time. The data from these maximal anaerobic tests will be used to calculate overall power output.

POTENTIAL RISKS
No risks are associated with the testing procedure other than the potential for muscle soreness. This soreness will dissipate on its own after a few days.

POTENTIAL BENEFITS and COMPENSATION
You will receive information regarding their physical performance in comparison to national normative data and potentially qualify for future follow up research. Additionally, a grant has been submitted to the School of Health Science (SHS) Small Grant through Kent State University. If the grant is received, there will be financial compensation for your participation in this study. More information will be made known when determined.

ALTERNATIVES TO PARTICIPATION
N/A

GUARANTEE OF CONFIDENTIALITY
Subjects will be guaranteed full confidentiality in accordance with HIPPA laws. The only people who will have access to the subject's information will be the researchers. Documents will be kept in a locked filing cabinet when not in use. No names will be used throughout the study in order to ensure confidentiality standards.

IF YOU HAVE QUESTIONS
If you have any questions about the procedures in which you will participate, please do not hesitate to ask. If you have questions later, please feel free to contact the investigators listed below. All questions about the procedures or the study in general will be answered. However, the investigators may choose to wait to answer your questions until after you have completed the procedure, to ensure that your responses will not be affected by your knowledge of the research. If you have additional questions concerning the rights of research subjects, you may contact the University of Mount Union Human Subjects Committee at humansubjects@mountunion.edu.

You are voluntarily making a decision whether or not to participate. Your signature certifies that you have decided to participate, having read and understood the information presented. Your signature also certifies that you have had an adequate opportunity to discuss this study with the investigator and that you have had all your questions answered to your satisfaction. You will be given a copy of this consent form to keep.

_______________________________________  _______________________
Signature of participant                        Date

_____________________________________
Printed name of participant

_______________________________________  _______________________
Investigator Signature                        Date

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APPENDIX B

BORG RATING OF PERCEIVED EXERTION SCALE
APPENDIX B

BORG RATING OF PERCEIVED EXERTION SCALE

6 ................................................................. No exertion at all
7 ................................................................. Extremely light
8 ...........................................................................
9 ................................................................. Very light
10 ...........................................................................
11 ................................................................. Light
12 ...........................................................................
13 ................................................................. Somewhat hard
14 ...........................................................................
15 ................................................................. Hard (heavy)
16 ...........................................................................
17 ................................................................. Very hard
18 ...........................................................................
19 ................................................................. Extremely hard
20 ................................................................. Maximal exertion
REFERENCES


