WILLIAM PATERSON UNIVERSITY OF NEW JERSEY

The Effect of Mouth Protective Gear on VO_2 Intake

A Thesis

Submitted partial fulfillment of the requirements for the degree of

Master of Science

In Exercise Physiology

By:

Hunter Webber

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December 2025

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College/School: Science and Health

Department: Kinesiology

Thesis Supervisor:

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Chairperson:

David Hack, PhD.

ABSTRACT

Aerobic and Anerobic Capacity are central for athletic performance, with training methods, equipment and coaching styles being a central facet ensuring optimal competitive output. Oral protective gear(mouthpieces) is commonly used during training and competition with their primary goal is to protect against ortho-maxillary injuries. However, little evidence is present to show if mouthguards are useful in augmenting athletic performance during competition. Previous studies show mixed results with augmentation and attenuation both being present. **PURPOSE:** To determine if mouthpieces affect aerobic and/or anaerobic capacity in healthy, athletic populations. **METHODS:** Individuals are monitored via a metabolic cart and undergo a modified Bruce Protocol to examine aerobic and anaerobic performance. Individuals conduct a controlled performance test (no mouthpiece), usage of standard mouthpiece (maxillary mouthpiece) and finally a "pacifier" styled mouthpiece where a testing of 10 minutes, will be completed. Testing equipment such as ECG monitors, sphygmomanometer, VO2 mask will be used during the duration of the equipment. **RESULTS:** Participants relative VO2 measurements were higher when using the pacifier mouthpieces as opposed to the standard maxillary oral guards. Additionally, their Anaerobic Threshold (AT) was lower using the pacifier mouthpieces as opposed to the standard maxillary mouthpieces once more. Additionally, their absolute VO2 follows the same trends of performance enhancement and augmentation. **Conclusion:** Mouthpiece type can affect performance of athletes and their ability to perform competitively, with participants subjective surveys describing a similar change with qualitative data.

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CHAPTER 1 INTRODUCTION

Improving athletic performance is hallmark of varying populations, whether it be the most learned individuals consisting of professional athletes or people who have just been introduced into their respective sports. The ability to achieve optimal aerobic and anaerobic power and endurance is essential for the completion of physical activity. As maximizing power output and one's ability to improve upon one's own physicality is a hallmark for securing victory, quite often the deciding factor in sports that are reliant on the transiting of different energy systems quickly will be in play (ex. a football player running down the field or a boxer attempting for a late bout knockout blow). Due to the ever-increasing reliance of supplements and other forms of performance augmentation, inquiries about the best types and brands of equipment have been central to the on-going dialogue about improving an athlete's competitive skill. However, knowledge of protective oral equipment (ex. mouthguards) is not as readily available for review with regards to how such equipment aids in performance as merely protecting against physiological damage. (1). The goal of this paper is to determine the effect two differing mouthguards have on aerobic capacity, anerobic capacity, anerobic threshold, respiratory exchange ratio (RER) and heart rate on college-aged, healthy, athletic populations. Examining athletic performance will be paramount to the study while using the differing styles of oral protective equipment. Such an examination of the differing materials and their respective types of mouthpieces will provide additional insight into the possibilities of performance augmentation for specific activities pertaining to the athlete, even particular positions within a sport.

Evidence to show the differences in athletic performance (ex. maximal oxygen consumption [VO_2max] and rating of perceived exertion [RPE]) between using mouthguards and not has been inconclusive, as studies have not shown appropriate control variables and have yielded mixed results (2). Studies usually focus on the concepts of injuries to one's maxillary region, severity of concussion,

and other orthopedic injuries and incidents. Mouthpieces were first formulated as a form of protection of one's maxillary tissues and teeth, a common sight of injury within certain combat sports such as boxing, mixed martial arts (MMA) and Muay Thai. However, certain sports like powerlifting (who may use mouthpieces for their ability to compress under pressure allow for biting down on their materials for augmenting of a maximal lift) are commonly seen. This study examined the relationship between mouthpiece types and maximal oxygen consumption (VO_2), respiratory exchange ratio (RER) and anaerobic threshold (AT) to determine if mouthpieces had effects on the performance and metabolism of athletic populations when exercising. Despite the study's primary focus being that of aerobic capacity and the athletes' ability to utilize oxygen in the process of exercising, being able to examine how glucose is used during a metabolic test is essential to the process of high-intensity exercise. The supplemental information provided by the end of the study will aid in broadening the information that is readily available within sports exercise physiology and provide additional insight into how equipment can be readily used not only for protective purposes at the expense of performance, but to increase performance and further avenues for athletes to compete optimally.

CHAPTER 2 REVIEW OF LITERATURE

Prior Evidence

Evidence to discuss the topic regarding mouth pieces has been sparce with great amounts of evidence pertaining to custom-made mouthpieces and boil-and-mold mouthpieces. While evidence shows that both can help in the protection of oral tissues (mandible and maxillary), there are inconclusive results regarding if there is a definite outcome to mouthpiece types and athletic performance. Information is quite often using retrospective, literary analysis of results from prior studies and their interpretation of experimentation. It has been examined, the relationship between mouthpieces and anaerobic power output, studies done through randomized, prospective cross over study that examined how anaerobic power output can be measured through the clamping down on a mouthpiece involving one's masseters muscles (3). There was no significant difference between individuals using a mouthpiece and individuals who were not, while the article was similar to this study, it did not provide additional evidence to the ponder question that was proposed, additionally the usage of kettlebells, single leg jumps and, countermovement jumps while using one's arms did not yield evidence to show there was a difference. However, the study focuses on basketball players and while studies can be transferred to other sports, the specific activities of the sport might be basketball's physical demands. Additional studies have shown similar results that mouthpieces did not significantly affect one's ability to use oxygen during an exercise test and did not affect one's aerobic and/or anaerobic capacity (4). While the prior studies address a facet of the question, the analysis of anaerobic threshold and RER were not obtained, furthermore the study's testing module consisted of using individuals while sprinting (4), as opposed to the methodology that will be conducted during the experimentation that will be used during this experimental study. While the current investigation focused on running on a treadmill, the study's result can be applied to running and other laboratory results that can be applicable to field tests presented within this experimental study . It must be stated sprinting uses differing energy systems to illicit physical activity; therefore it must be

made aware that the testing results could be different when comparing sprinting to walking and eventual running, the activities present completed in the current study.

However, it was concluded that the readings of VO_2 were not impeded by the presence of a mouthpiece, regardless of maximal or submaximal testing and performance conditions. It can be explained that the rationale for such was the breathing patterns (4). While not a central facet of the current study, in the study by Bourdin et al., it was shown that power and force output were not significantly altered by the presence of a mouthpiece. The study highlighted the non-observable effect of a mouthpiece and how such equipment should be used for orthopedic safety reasons and not a deciding factor in athletic performance augmentation. With regards to visual reaction time (another facet of the study) results show there were no effects on one's ability to identify and appropriately react to a stimulus through laboratory testing. The possible avenues or mechanisms for this result could be due to mouthpieces allowing for greater concentration or for a greater amount of tolerable pain/discomfort to be tolerated and therefore not impede performance or the ability to make decisions in the midst of competition or testing(4).

The use of a mouthpiece is essential for contact sports, with combat athletes being the most reliant and most dependent on the equipment to prevent the occurrence of maxillary, mandibular and/or orbito-facial injuries. When examining the effect of mouthpieces on the performance of taekwondo athletes and their reaction time, agility and handgrip strength there were shown to be a non-significant reaction upon athletic performance due to the presence of a protective mouthpiece (5). No data was shown regarding aerobic and/or anaerobic capacity during the duration of the experimentation, the focus on the investigative, randomized study was meant to determine the many facets of combative sports(taekwondo), not accounting for cardiopulmonary performance. The study highlights (like many) the importance of mouthpieces for protective uses and non-significant influences of isometric strength and stability, focus on aerobic and anerobic output, considering anaerobic threshold, lactate threshold and RER are not readily addressed at length for many of the forementioned studies. The release of cortisol was shown to be affected by the presence of a mouthpiece, as the protective guard can help lower cortisol

levels when bitten and held with one's mandible (5). Such results were shown ten through sixty minutes after the cessation of a high-intensity resistance training session with a mouthpiece as compared to the individuals who did not have such piece of equipment present.

When looking at neurotransmitters and peptide hormones and how they have an effect, it was shown that the biting on a mouthpiece amidst high intensity exercise can help in the process of lowering cortisol levels (6). While cortisol has been shown to aid in the production and allocation of glucose for muscular usage (6), the study did not address the many other varying facets of athletic performance (RER, AT, VO_2 etc.) thus not completely answering the central question to this research thesis. The reduction of stress, when optimally controlled, can help increase physiological fitness through the Fitness-Fatigue Model (where eustress upon the body illicit physiological adaptations). The theory which states that has individuals illicit a certain amount of physiological fatigue through exercise, there will be a period of fatigue followed with the adequate rest, increased fitness(7).The presence and overall physical stress that is elicited through intense physical exercise can be inferred to influence VO_2 and the other measurements explored in the testing; quantitative data must be shown and recorded to make an appropriate determination for information to be collected.

There is evidence to possibly support the notion of proper mandibular alignment that could assist in the improvement of aerobic and anerobic power (8). When looking at contact sports (ex. basketball), evidence can be seen regarding power output across varying sports. One study demonstrated that "CAP" (concurrent, activation, potential) could be presented when performing a vertical jump with a mouthpiece present, in the case for male basketball players (8). Overwhelming data supports there to be evidence (with the mechanism largely being ambiguous) that using a mouthpiece could in some degree aid in the augmenting of power during athlete performance, with agility being a factor that is not readily seen or influenced upon during such experimental trials. Such evidence does provide additional information for the improvement regarding anaerobic power, however the need for additional information is needed especially when examining aerobic performance and overall metabolic processes that occur

during other physical tests that are not as truncated as many of the tests described in prior testing (ex. vertical jumps, countermovement jumps and bench presses). All the forementioned tests provide reliable yet singular information about the possible varying effects a mouthpiece (custom made or "boil-and-bite") could have on an athlete's performance during a randomized study or during an actual competition. However, it is important to state that such a test was performed on basketball players and while the physical augmentations of the mouthpiece might be transferable from one sport to another, the possibility of limitations are important to state as such might not be present in other sports as such in prior studies mentioned within other parts of the paper's body.

When evaluating much of the prior studies, it is important to note the methods that such tests were conducted during the experimental phase. Neither of such tests were performed within a field study and conducted without a controlled environment. Testing was performed in a laboratory setting, allowing for controlled and randomized cohorts to be created and information to be subsequently collected throughout the duration of data collection. The occurrence of field tests allows for conditions to be more like that of what the athlete(s) would find during competition and allows for a greater amount of reliability between experimentation and real-life sport application. Conversely, laboratory experimentation permits the ability for control, randomization and, section of participants into differing cohorts, allowing for easier identification of the independent variables and dependent variables. While both provide adequate testing environments and depending on the athletes, testing performed and resources that are readily accessible, it is important to understand that both tests provide advantageous and disadvantageous when pursuing tests via both respective avenues.

Furthermore, additional studies have quite often examined athletes from singular sports as opposed to varying different athlete activities, season-phases and mixed biological sex groups. There is great importance in allowing for a diversity of athletes in wide array of sports, and metabolic demands, seasonal preparations phases and, sex, as such allows for a differing response involving substrate usage, cardiopulmonary responses to exercise, rating of perceived exertion (RPE), RER and, anaerobic

parameters that are essential in the collection of data with regards mouthpiece testing. Despite similar responses being possible amongst individuals regardless of their gender and sport activity, the importance of knowing how an array of diverse individuals react within the same testing parameters and experiment outlines can help in providing additional testing reliability and further increase the foundation of knowledge for exercise equipment-oriented testing.

Furthermore, the testing that has been implemented for many of the studies did not include measurements such as RER, AT, blood pressure or electrocardiogram (ECG) readings (5-7), or only a few of the forementioned variables. The lack of such a comprehensive set of factors to examine does not delegitimize the experimentation or the studies that were completed; however, it does provide a singular or narrow perspective of what is being examined during the duration of the study and does offer an extensive examination of what could be addressed during the length of the study and the subsequent fodder for a post-study analysis. The lack of additional quantitative data points could be heavily dependent on the equipment used as some experiments conducted testing through other modalities (ex. stationary bike) and did not use a metabolic cart, furthering the need to provide testing that uses equipment that provides appropriate testing information that can be used during the test. While the stationary bike is effective in providing evidence and data from exercise testing, stationary bikes are a different modality of testing avenue compared to treadmills and provide their own adaptative and maladaptive facets. It is imperative that such information can be used during analysis to provide an explanation for results, provide evidence for such claims and to find possible significant data differences/similarities between the groupings (ex. control and/or experimental). However, the results and conclusions of the research results can be interpreted and understood to provide additional evidence that can aid in deciding if mouthpieces should be used at all during competition and if the purchasing of a mouthpiece is a worthwhile investment in legal, augmentation of athletic performance.

CHAPTER 3 METHODS

This study was approved by the Institutional Review Board at William Paterson University. All testing procedures were completed in the Human Performance Lab at William Paterson University. A testing population of twelve male and female athletes were asked to participate in a treadmill-based graded exercise stress test to determine their ability to utilize oxygen and glucose effectively during the process of athletic and physical exertion. Athletes participated in three differing conditions for the testing procedures, once without any form of equipment, once with a standard-maxillary mouthguard (Everlast Ever-Shield Single Mouthguard, New York, NY) and, finally with a "Lip Guard" full-covering mouthguard (Shock DoctorMax Airflow, United Sports Brands, Fountain Valley, CA) traditionally meant for American Football and goalie usage in Ice Hockey and Lacrosse games.. Participants proceeded to run for ten minutes on a stationary treadmill, every three minutes the next stage/interval of the test would commence, with continuing increasing speed and intensity until completion. The conditions for which testing was performed remained the same for all testing cohorts, except for the mouthpieces. Observations for contradictions were conducted to ensure that participants would not be subjected to adverse cardiovascular and/or pulmonary events during the entirety of the testing schedule. The metabolic testing was conducted on a metabolic cart (Quinton, Bothell, Washington) via a modified Bruce Protocol where 10 minutes of running time will be conducted with the same speed and incline increases during the standardized three-minute intervals. Ten minutes was the allotted amount of time and as such would provide appropriate time constraints and data collection for all participants, unless participants could not continue due to contraindications. Blood pressure and RPE were collected during a three-minute interval to determine how the participants will be performing. ECG's and participants' physical conditions were observed throughout the entirety of the testing for safety purposes. Participant demographics are shown in Table 1.

Table 1. Participant demographics

	Female (n=9)	Male (n=3)
Age	20.3 ± 2	22.7 ± 0.94
Height(m)	1.67 ± 0.078	70.3 ±2.35
Weight(kg)	61.7 ±7.93	181.3 ±14.1

(a)

(b)

Figure 1. Types of Mouthpieces: (a) maxillary vs. (b)"lip-guard"

CHAPTER 4 RESULTS

Results showed that there were non-significant differences between the mouthpiece types and the control. The control (no mouthpiece) yielded the highest results for VO_2 max readings for the conditions of for the control (19.0 ± 1.19), maxillary (17.2 ± 1.26) and lip-guard (16.7 ± 0.97), respectively. While the maxillary mouthpiece was close to follow and finally by the lip-guard mouthpiece was last, with regards to relative VO_2, as shown in Figure 2.

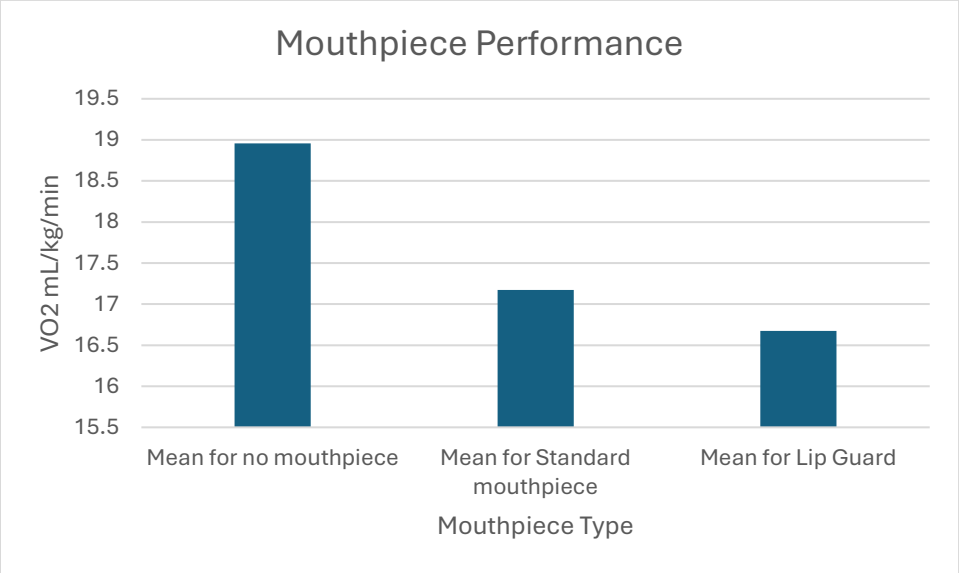

Figure 2. Mouthpiece Performance

As shown in Figure 3, repeated measures ANOVA yielded a non-significant *p*-value (F (2,12) =3.8, =0.74) Among all conditions individuals used mostly carbohydrates for their substrate fuel as opposed to lipids/fats to complete the running (18.9 ± 1.19) vs maxillary (17.1± 1.26) vs lip guard (16.7 ± 0.97). Participants reported an increase in comfort when using the lip-guard mouthpiece as opposed to the maxillary boxing mouthpiece also used during the experiment.

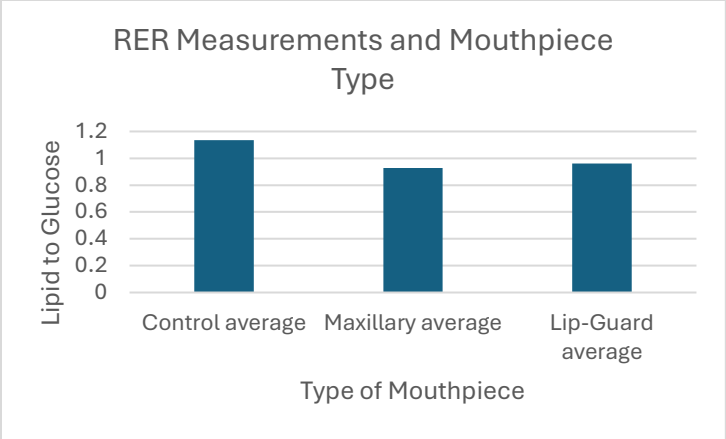

Figure 3. RER Measurement and Mouthpiece type

One individual had to have the test stop during the experiment due to contradictions that occurred during the experiment. The participants stopped on their own accord and later completed all conditions of the study to complete their three trial sessions. None of the participants were stopped due to contradictions or complications that were considered unsafe or detrimental to their health (ex. ST elevation of 2mm) as the participants were of a healthy populus and did not suffer from cardiovascular, pulmonary or musculoskeletal conditions. RER was slightly higher in maxillary mouthpieces as opposed to the lip-guard; difference was non-significant (maxillary mean ± SD vs lip mean ± SD). Blood pressure was similar amongst all conditions for the athletes, regardless of the mouthpiece they were using during the experimentation phase. Anaerobic threshold was shown to have a non-significant difference between the varying conditions via repeated measures ANOVA (mean:3.48, 4.4 and,2.98 for the control, maxillary and lip guard, respectively), (SD: 0.586 *P*-value = 0.39 and F=1.13). Providing additional evidence that such mouthguard usage is dependent on sport and not influenced by proposed athletic augmentation (Figure 4).

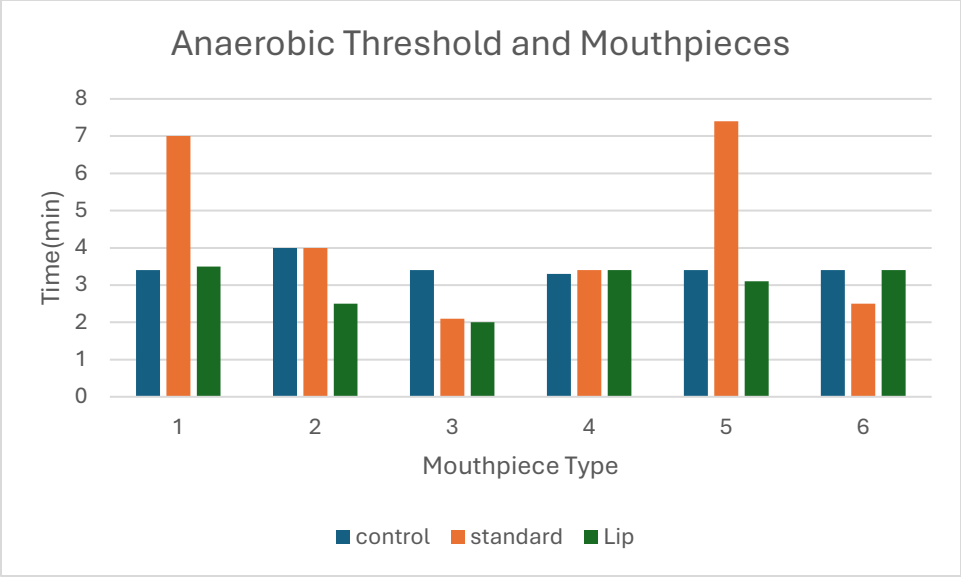

Figure 4. Anaerobic Threshold and Mouthpieces

Participants discussed increased comfort with the lip-guard mouthpiece as opposed to the maxillary mouthpiece, additionally it was stated through the participants that individuals who had prior experience with mouthpieces before the beginning of experimentation, the lip-guard was much more heavily favored as the maxillary mouthpiece was foreign to them and once settled for testing was resulted in discomfort and annoyance on a subjective, qualitative basis. Participants described the need to use additional muscles and torso-related movements to complete a cycle of inhalation and exhalation during the test, as both mouthpieces, specifically the maxillary mouthpiece, resulted in inability to breathe. The usage of secondary and tertiary respiratory muscles was not examined during the experimentation as such was not a forementioned variable to observe until a subsequent number of athletes were already present and their data was recorded for analysis and discussion. However, despite the subjective comfort there was a dichotomy in results yielded by individuals who either performed better with the maxillary mouthpiece or the lip-guard. Male and Female sex differences were observed, as males how higher blood pressures than their female counterparts. This could be due to the influence of testosterone on the male's cardiovascular system (9), as higher or lower androgen levels are correlated with higher systolic and

diastolic blood pressures. However, a more plausible explanation for such could be due to the lack of males within the study as compared to the over-representation of women in the study, women who are mostly in-season soccer or volleyball players that are currently competing at intercollegiate Division III level. The same principle could apply to RER measurements as the testing pool was heavily dependent on the presence of female collegiate athletes during their competitive seasons.

CHAPTER 5 DISCUSSION

For the duration of the experiment, it was shown there was no significant difference between the two mouthpiece types, with neither allotting augmented/attenuated aerobic performance during experimentation. While there was a difference in RER for the control, the usage of mouthpieces yielded similar, non-significant results, thus athletic performance would not be positively or negatively affected by the application of either form of oral protective equipment. Such non-significant differences could have been due to secondary and tertiary respiratory muscles being used during the testing (ex. trapezius) and therefore allowing for a smaller difference in performance despite the two mouthpieces differing designs. Additionally, the possibility of a retesting bias could have been present as participants had an idea of how the testing would be completed after their first trial without a mouthpiece present (controlled variable).

Subjective measurements and ratings of the mouthpieces were provided as participants said the maxillary mouthpieces were the most "uncomfortable" with individuals stating the accumulation of saliva was a contributing factor to its discomfort. Conversely, the lip-guard was considered the most comfortable of the two mouthpieces due to its medial port design that allowed for easier breathing and an ability to expel the excess saliva that accumulates during the process of testing. Regarding the sport, mouthpiece types would be important for specific sporting activities, maxillary mouthpieces are best for combat sports (boxing, wrestling and mixed martial arts) as the mouthpiece do not allow for the transfer of kinetic energy from a strike on the mandible to the brain (2). Lip-guards are best for the American football and sports of a similar nature due to the lessened need to withstand direct strikes to the head during competition of a combative sense. While mouthpiece usage has been shown to be instrumental in the preservation of teeth and other oral-structural components, with additional information being provided that allows individuals the capacity to monitor the vectors of force that results in a concussion (10), there is little data on aerobic capacity and mouthpiece usage. Biological influences could have made an influence upon the results due to sexual dimorphism that exists between biological males and females that become more prevalent during the onset and completion of puberty and the maturation of secondary

sexual characteristics. Furthermore, the prior experience with mouthpieces could have had an influence on athletes' abilities to perform as many of the athletes wear mouthguards of varying types to ensure their own oral protection during contact sports. The importance of having differing participants is highlighted by the reviewing of participants and the need to have additional individuals' participants outside of the athletic realm, yet still physically rigorous and fortified (ex. competitive dancers) would have greatly assisted in providing additional individuals whom could have provided supplemental information regarding physiological responses to exercise, and their assumptive lack of mouthguard exposure would have eliminated a possible bias that could be described as a confounding variable during the testing and data analysis.

LIMITATIONS

Due to the small sample size of the study, result findings were mostly dependent on that of female colleague soccer athletes who were currently in season. Due to the nature of their sport, mouthguards are commonly used and could have resulted in the studies possible inflation of data as said athletes could have been accustomed to running, training and, performing with mouthguards present of varying types. Two of the athletes were biological males and were of a baseball and powerlifting/Brazilian Jiu Jitsu background, activities that do not require the usage of a mouthpiece. While it can be inferred that such activities could have aided in the diversifying of data and participant dependent performance recordings, there must be additional participants to be included which were unfortunately not present during the participant pooling necessary for the study. Additionally, the over-representation of biological females present during the study's experimentation could have resulted in a homogenizing of data as women have a greater capacity to use fatty acid oxidation as opposed to men who use glucose as their main substrate for exercise (11). While evidence shows that athletic men and women show a non-significant difference in substrate usage (11), the biological differences of the sexes could have contributed to the study's results based upon the lack of participating biological males that were present during experimentation.

DELIMITATIONS

Factors within the study that augmented the experimentation were the presence of a smaller chronic age grouping (18-25 years old) for the testing, as the increase in age can result in the occurrence of age-related diseases and mitochondria dysfunction that occurs with aging (12). Furthermore, the usage of an athletic population allows for a narrowing of metabolic responses and ensures the study's validity pertains to the specific populus they would most likely benefit from the experiment's goals and parameters. The application of different measuring tools (objective and subjective) presents a multi-faceted evaluation of the mouthpiece's individual effects on the aerobic and anerobic capacity of the participants during the three trials. Additionally, many of the athletes were in their season of sport while participating in the study's progress. This would allow for a heightened chance of completion during the trials as the participants were most likely immersed in their In-Season exercise routines and playing competitive games as well during their three-exercise trial.

FUTURE RECOMMENDATIONS

Future recommendations would include having a larger and more biological diverse testing sample (more biological men) and more participants as whole included during the study's duration. Furthermore, a greater number of individuals from varying sports should be included in the study's parameters, as most of the participants were soccer players and while a healthy population did not provide varying sport specific adaptations that could be applicable to the study's overall goal. However, it is recommended to continue to have the test completed on a metabolic cart as such piece of equipment allowed for the appropriate measuring of data in a controlled environment and allotted me the opportunity to record data in a safe manner that would not result in possible contradictions be dismissed and/or unrecognized during the completing of the test's parameters. Additionally, it would be ideal to have individuals from a healthy, athletic population in varying phases of their athletic season as the variable of preparation and competition could affect how such athlete performs during the testing. Due to changes in athletic phases during the off/on seasons it could be a plausible possibility that changes in body composition could affect the aerobic output of participates during the testing (as most of the athletes were in-season female athletes) (13). The diversifying of biological sex, sports and season phases could very much influence how the individuals' aerobic and anerobic measurements develop. Also, controlling athlete's diets would be appropriate to ensure that athletes are not under/overfeed before the testing and therefore are in a state of possible fasting or digestion, as the occurrence of a meal can affect the availability of glucose and/or lipids as a substrate for usage. Lastly, controlling the athlete's sleep would be an enhancement, while sleep is not a significant influence on one's RPE the variable could be controlled to reduce possible confounding variables (14).

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APPENDIX A: William Paterson University IRB Form

THE WILLIAM PATERSON UNIVERSITY OF NEW JERSEY
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973-720-2852 (Phone)
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Chair: Michelle Gonzalez (GonzalezM77@wpunj.edu)
College of Education
Contact: Kate Boschert (BoschertK1@wpunj.edu)
Office of Sponsored Programs

June 4, 2025

To: Hunter Webber

From: Michelle Gonzalez

RE: IRB Expedited Approval Notice

Study: Protocol #2025-048: *The Effect of Mouth Protective Gear on VO2 intake*

The IRB has APPROVED the above study involving humans as research subjects. This study was approved Expedited Category 4 and 7; special class of subjects: None.

General Conditions and Requirements:

1. The Institutional Review Board expects that your research will be carried out in accordance with your protocol request.
2. Modifications to the research plan, subject pool, informed consent, survey instruments, or other critical components of your project, must be submitted to the IRB for approval before those changes are implemented. Revisions/Modifications are to be submitted through the InfoReady System.
3. You are required to immediately report any problems that you encounter while using human subjects to your faculty sponsor who will help you report these problems to the Institutional Review Board using the Adverse Effects Form.
4. All research subjects must use the approved Informed Consent Form. If approved for using signed consent forms, you are responsible for maintaining them for a period of at least three years after study completion.
5. You are required to keep detailed records concerning this research project for a period of not less than three (3) years. The IRB reserves the right to inspect all records, research tools and databases that are associated with this research.
6. This approval of your research is effective for one year from the date of this approval. If your research extends more than one year you must submit a Continuing Review request through Cayuse to provide an update regarding the progress on your research and to obtain a new approval notice.

Good luck with your research, please contact IRBAdministrator@wpunj.edu if you have any questions.

C: Dr. Racine Emmons

APPENDIX B: William Paterson University Consent Form

William Paterson University Institutional Review Board

Informed Consent to Participate in a Research Study

The Effect of Mouth Protective Gear on VO_2 Intake

Principal Researcher: Hunter Webber
Other Researchers: N/A
Faculty Advisor Name and Department: Dr. Racine Emmons
Faculty Advisor Email and Phone Number: emmonshindelongr@wpunj.edu
Protocol Approval Date: May 8th, 2025
Protocol Number:

Key Information

You are being invited to participate in a research study. This document includes important information you should know about the study. Before agreeing to participate, please read this entire document and ask any questions you have.

Do I have to participate?
You do not have to be in this study. If you decide to take part in the study, it should be because you want to volunteer.

You will not lose any rights you would normally have if you choose not to participate. You can stop at any time during the study and still keep the rights you had before volunteering.

If you decide to participate, you will be one of about 20 people in the study.

What is the purpose of the study?
The purpose of the study is to examine the difference, if any, between aerobic capacity and the usage of a protective mouth-piece guard. A piece of equipment that is commonly used during athletic events and competitions.

The purpose of the study is to By doing this study, we hope to learn how using protective oral equipment such as a mouthguard can augment or attenuate one's ability to perform athletic feats of an aerobic nature.
Where is the study going to take place and how long will it last?
The research procedures will be conducted at Grant Hall at William Paterson University. The study will take about three days, with participants working about ten minutes per session.

What will I be asked to do?

1. Arrive to testing area with exercise clothing and prepare for testing.
2. Individuals will be equipped with monitoring equipment such as: EKG, and RER monitor to determine the intensity of their work.
3. Individuals will be subjected to performing an aerobic based running test. Their measurements (RER, EKG readings and, Heart rate) will be detailed during their session. Participants will be forced to run for 10 minutes at "moderate intensity".
4. Participants will return on two more occasions where two differing mouth pieces (Single Guard and Lip Guard) will be used during the duration of the study. Participants will be subjected to another aerobic capacity run once again.

Are there reasons why I should not take part in this study?

Being below the age of 18 and/or being of a special population (ex. Parkinson's Disease, suffer from severe cardiac abnormalities).

What are the possible risks and discomforts?

Exhaustion, Fatigue, Cardio-vascular EKG abnormalities.
To the best of knowledge, the activities you will be subjected to will not embed in your daily life or activities.

It is highly unlikely any emotional and/or mental harm will be done during the duration of the test.

Data regarding the participants' age, interest and name will be collected during all email-dependent communications.

What are the benefits of taking part in this study?

You may benefit from this study by having a better understanding of one's aerobic capacity, anaerobic threshold and other cardiovascular based information regarding their own individualized physiology. Others may benefit from this study by being instrumental in the betterment of athletic training and equipment interventions, furthering the intellectual foundation within the field of Exercise Physiology.

If I do not take part in this study, are there other choices?

If you do not participate in the study, there are no other choices except to not take part in the study.

If you do not participate in this study, there are other choices, including N/A

Other Important Details

Who is doing the study?

The person in charge of this study is Hunter Hawthorne Webber at William Paterson University. They are being guided by Dr. Racine Emmons. A professor at William Paterson University.

What will it cost for me to participate?

There are no costs associated with taking part in this study.

Will I receive any payment or reward for taking part in the study?
You will not receive any payment or reward for taking part in this study.

Who will see the information I disclose?
Your information will be combined with information from other people taking part in the study. When we write up the study to share it with other researchers, we will write about this combined information. You will not be identified in these written materials.

This study is anonymous. That means that no one, not even members of the research team, will know that the information you give came from you.

We will make every effort to protect your privacy. Data that could identify you will be kept separate from the data we report in a secure place. All paper materials will be stored in a locked, secure place. Computer data will be stored in a password-protected database). Informed Consent Forms will be stored in a locked, secure place.

Although the researchers will take every precaution to maintain confidentiality of the data, the nature of focus groups prevents the researchers from guaranteeing confidentiality. The researchers would like to remind participants to respect the privacy of fellow participants and not repeat what is said in the focus group to others.

Identifiers may be removed from the identifiable private information you provide as part of the study. After such removal, the information could be used for future research studies or distributed to another investigator for future research studies without additional informed consent.

What if I no longer want to participate in the study?
If you decide to take part in the study, you will still have the right to decide at any time that you no longer want to participate. You will not be treated differently if you decide to stop taking part in the study.

What happens if I get hurt or sick during the study?
Then immediate medical attention will be delivered, and medical personnel will be called for the safety of the participant and others.

What if I have questions?
If you have questions about the study, you can contact Hunter Hawthorne Webber, xxx-xxx-xxxx, @gmail.com and/or Dr. Racine Emmons, 973-720-3270, Emmonshindelongr@wpunj.edu

If you have any questions about your rights as a research volunteer, you can contact the IRB Administrator at William Paterson University at 973-720-2852 or IRBAdministrator@wpunj.edu.

One copy of this consent form is for you to keep.

Permission

If you would like to participate in this study, please read the statement below, write your name and sign.

I have thoroughly read this document, understand its contents, have been given an opportunity to have my questions answered, and agree to voluntarily participate.

If the investigator is in the process of photographing the participants, it is okay to include the current subject to be included.

Please initial: _____ Yes _____ No

Print Name	Signature	Date

APPENDIX C: Recruitment Flyer

Graduate Research Study Investigating Mouthpiece Use and Aerobic Capacity

Get Involved

Participate in an exciting research opportunity focusing on aerobic capacity and mouth-guard effectiveness. William Paterson University Master's program research project. Must be 18 years or older. Will examine how exercise equipment can effect athletic performance.

Be Athletic

Calling past and present athletes! Your involvement helps us create a better understanding within the field of exercise physiology. Participants will have an opportunity to examine their aerobic and anaerobic threshold to help identify how athletic equipment effects exercise capacity.

Contacts

For more details or wanting to participate, email us at webberh@student.wpunj.edu or emmonshindelongr@wpunj.edu.

Phone

Hunter Webber: 201-874-1795

Dr. Racine Emmons: 973-720-3270

Location

Grant Hall, Exercise Laboratory

APPENDIX D: Subject Questionnaire

Survey Questions

Mouth-Piece VO2 Testing

1. Did the mouthpiece make exercise harder for you during exercise? Yes or No

2. Was there an adequate amount of explanation in procedure? Describe

3. Were mouthpieces sufficiently applied and comfortably fitted? Describe

4. On a scale of 1(being least) to 5(being most), did the different mouthpieces make a difference in performance?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

5. On a scale of 1 to 5(one being the least and 5 being the most). Did the mouthpiece change the way you breathed during the test?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

6. Did you find yourself chewing and/or biting on the mouthpiece during the test?