MAY 27, 2021

RSAF – 1 Grant Final Report

Grant Code: GR-000080

Grant Title: An Examination in Cardiorespiratory Performance and Cardiovascular Function in Healthy College Students

Principle Investigator: Dr. Andrew S. Perrotta

Grant Duration: September 1, 2020 – August 31, 2021

Grant Amount: $ 3,000.00

DR. ANDREW S. PERROTTA
LANGARA COLLEGE
Department of Kinesiology

Please introduce yourself – include pertinent background information relating to the topic of your research project.

- Throughout my research, I have had the privilege of working with female athletes that allowed the data obtained to directly impact athletes within Canada's National Sporting Organizations. My research program concentrates on bridging the fields of cardiovascular and exercise physiology to better understand the body's response to exercise and stress, as well as how to enhance human performance. A major focus of my work involves examining the dose-response to exercise, heart rate variability, as well as alterations in cardiorespiratory performance in response to environmental stress. The purpose of my work is to conduct applied research that can relate to practitioners, to support evidence-based decisions to help their patients and athletes. As a postdoctoral fellow, I expanded upon my work in environmental physiology examining cardiorespiratory performance and cardiac function in both hot and cold environments. In particular, my research examining the utility of hot yoga to enhance blood volume and cardiorespiratory performance has gained international recognition for its innovation and focus on the female response to a novel form of heat stress.

Please discuss your educational background and your work experience that led you to taking on this research project. If possible, include a quote that helps define your interest in this project.

- I completed my (hon) B.A.Sc in Kinesiology from the University of Guelph that strongly focused on physiology and nutrition metabolism. My graduate journey began in Calgary where I completed my M.Kin (applied exercise physiology) at the University of Calgary. I moved to Vancouver to complete my Ph.D. at UBC in the Faculty of Medicine, that focuses on cardiovascular and exercise physiology. I completed further training as a postdoctoral fellow at SFU in the department of Biomedical Physiology and Kinesiology, the focuses on the effect of the environment on cardiorespiratory function.
- Throughout my tenure as PhD student, I was the Head Physiologist for the Canadian Women's National Field Hockey team. I was responsible for supervising graduate and undergraduate students at the University of British Columbia who were keen to learn about human performance and applied research. This position developed my passion for finding unique and sustainable avenues that allow kinesiology students to develop as young practitioners and researchers. I have continued to develop this model of integration as the Head of Sport Medicine and Sport Science for the Langara College women's soccer program through connecting with the Department of Kinesiology. This has allowed me to supervise and train undergraduate students in conducting exercise assessments and applied research that were funding by the RSAF-1 Grant. Establishing this form of relationship between departments is an integral component of my research program, and one that is designed to work in a collegial environment that maximizes the development of our students, while also supporting the success of our coaches and student athletes.

Please explain the concept for your project in terms that others not in your field would understand, like an executive summary.

- The purpose of this investigation is to establish a non-invasive technique that elicits suitable levels of agreement for estimating the volume of oxygen consumption in healthy young adults during rest and maximal exercise with the use of an automated blood pressure machine and a heart rate monitor.
- A comparison between the estimated volume of oxygen consumption and the direct measure of oxygen consumption will identify the strength of relationship and level of agreement between the two methods.
- Additionally, the data used for this primary project was analyzed from other perspectives that supported multiple poster presentations at scientific conferences. All data used was supported through the achievement of Ethical approval the LREB (Notice of Approval: 20210128-02).

Identify goals and objectives for the project, and how the results may be used, perhaps to solve a problem, or to inform further research in that field.

- The intention of this study is to provide practitioners and clinicians a valid and acceptable alternative to assessing their patient's fitness and health status without the use of invasive and costly equipment.

Briefly explain the steps taken to conduct the project research, and the results found.

- This investigation involved healthy young adults, male and female, that allows for the examination of cardiovascular function without the influence of disease and health complications. All participants where Langara Kinesiology students registered in KINS 2235 Exercise Physiology during the 2019 and 2020 school year.
- This investigation examined the level of agreement between actual VO2 and estimated VO2 during rest VO2EST-REST and maximal exercise VO2EST-MAX. Nine (n=9) healthy college students (4 males & 5 females) with an age of (mean ± SD) 21.3 ±1.2 yr, a weight of 63.4 ± 17.2 kg and a height of 162.4 ± 10.2 cm performed a graded maximal exercise test on a cycle ergometer, after being fitted with a mouth piece for the collection of expired gas concentrations and analysis using a calibrated metabolic cart. Initial fly-wheel resistance was set at 2W x bodyweight (kg) and involved 25 W increments every three minutes until volitional fatigue. Resting and maximum Q were calculated immediately before and upon completion of the exercise test while seated on the cycle ergometer. An automated BP monitor using an arm cuff positioned around the brachial artery and a HR monitor chest strap were utilized to calculate Q using the formula: [(SBP – DBP) / (SBP + DBP) x HR] x 0.29. VO2 was estimated using the formula: [(VO2EST) = [(Q) / (Q / body weight (lbs)) x1000]. A Pearson correlation coefficient (r) and a Bland Altman analysis examined the association and level of agreement between estimated and actual VO2. This study was approved by the Research Ethics Review Board at Langara College.

Who else was involved in this project? How did their involvement help? Ie: other faculty, students, community partners

- Two kinesiology students were involved in this project. Each student was responsible for creating components of the poster and providing a verbal 3-min presentation for each poster at each conference.

What were/are you hoping to get from conducting this research?

- Cardiovascular function, specifically cardiac output, has demonstrated to be the determining factor in oxygen utilization, whereby concomitantly regulating maximum aerobic power (VO2MAX). The utility for determining cardiac output using a non-invasive technique such as blood pressure and heart rate, coupled with its strong association to oxygen utilization, may allow for the estimation of VO2 during rest and exercise without the use of invasive and costly equipment.
- The purpose of this investigation was to examine the level of agreement for determining VO2 at rest and during maximal exercise using a non-invasive technique for estimating cardiac output using heart rate and blood pressure when compared to an automated metabolic cart

Can you share any personal stories that made this research experience memorable/valuable?

- It was an amazing experience watching my trainees present at conferences of the highest calibre in the field of exercise physiology. These experiences will no doubt support their applications when transferring to UBC and for graduate scholarships.

Do you have any tips/suggestions/ideas for applying this research in your field? Or for others in their fields? Or for conducting future research of this kind?

- Our abstracts have been published in the Journal of Applied Physiology, Nutrition and Metabolism as well as the Journal of Medicine & Science in Sports & Exercise. As such, researchers and practitioners will have access to our findings and guidelines for conducting replications studies or using our techniques.

Any final comments? What are the "next steps" for this project? And for you?

- This grant was able to support two kinesiology students in attending and presenting 5 poster at national and international scientific conferences. Each poster was accepted for publication as a conference abstract in prestigious scientific journals that have an impact factor >3.5. Please find attached all five posters for your review. I wish to sincerely thank you for supporting my work with the RSAF-1 Grant. This grant was used to develop our student's ability in conducting applied research. I will continue to apply for ARC grant moving forward for the same purpose.

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The association between fatigue index and anthropometric and physiological performance measures from an anaerobic performance assessment in healthy college students

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Arif D. Khan, Camila J. Correa and Andrew S. Perrotta

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ABSTRACT

Background. Anaerobic performance, when examined using a 60-sec Wingate test, allows for the assessment of anaerobic capacity and the calculation of a fatigue index (FI), a derivative of the depletion in anaerobic metabolism. **Objective.** This study examined the association between the FI calculated from a 60-sec Wingate test and both anthropometric and physiological performance measures in healthy young adults. **Methods.** Ten (n=10) college students (7 males & 3 females) with an age of (mean ± SD) 21.9 ±2.3 yr, a body weight of 78.4 ±13.0 kg, a height of 174.2 ±8.4 cm, a BMI of 25.7 ±2.7 kg/m^2 , and a body surface area (BSA) of 1.89 ±0. 17 m^2 performed a 60-sec Wingate test with an initial fly-wheel resistance set at 0.075 x body weight (kg). A graded maximal exercise test was performed on a separate occasion using a cycle ergometer and involved an initial resistance of 2W x body weight (kg) and progressed using 25 W increments every three minutes until volitional fatigue. The collection of expired gas concentrations for analysis using a calibrated metabolic cart was used to record $VO2_{MAX}$ and maximum aerobic power (MAP). FI was calculated using the formula: FI = [(Peak 5-sec PWR – Lowest 5-sec PWR/Peak 5-sec PWR) x 100]. A Pearson correlation coefficient (*r*) was utilized to examine the strength of association between the FI and both anthropometric and physiological measures. This study was approved by the Research Ethics Review Board at Langara College. **Results**. The strength of association between the FI and anthropometric characteristics were as follows; BMI (r = 0.18, p = 0.621), height (r = 0.68, p = 0.031), weight (r = 0.47, p = 0.166) and BSA (r = 0.73, p = 0.017). The association between the FI and physiological measures were; $VO2_{MAX}$ (r = 0.17, p = 0.647), 5- sec peak PWR (r = 0 .54, p = 0.105), relative power (r = 0.45, p = 0.187) and MAP (r = 0.10, p = 0.785). **Conclusion.** The FI from a 60-sec Wingate test was positively associated to anthropometric characteristics, namely height and BSA, a possible result of altered biomechanics and physiological strain.

INTRODUCTION

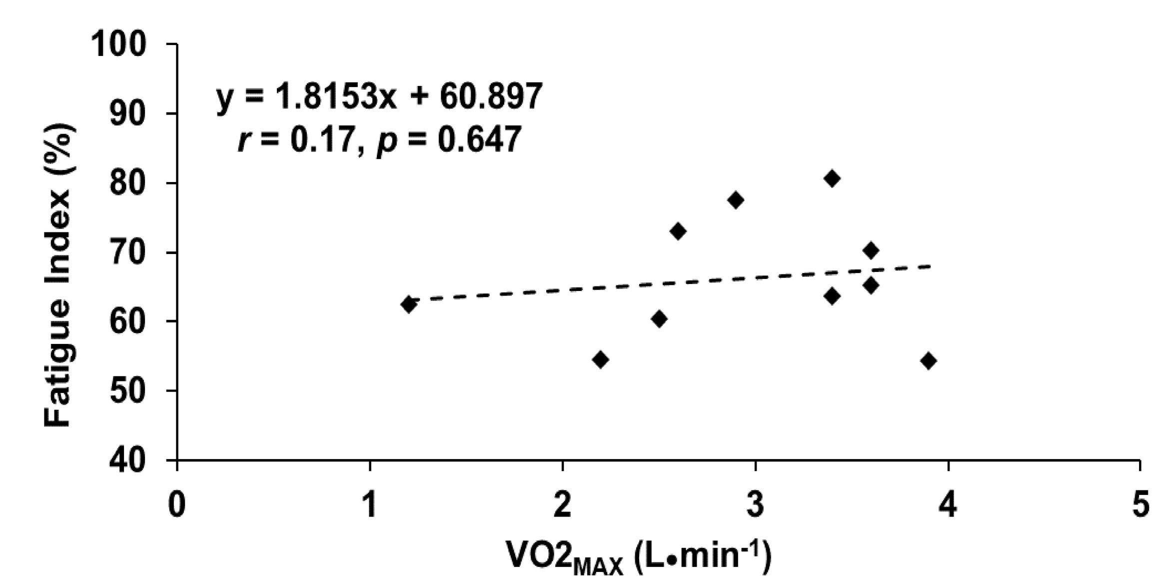
Anthropometric characteristics are often a critical focus point for integrative support staff when monitoring adaptation to exercise and its utility to reinforce exercise programs to maximize human performance. The significant association of somatotype on both anaerobic capacity[1,2] and aerobic power ($VO2_{MAX}$)[3,4] supports the need for further examination between the association of anthropometric characteristics and anaerobic performance measures. This study examined the association between the fatigue index (FI) calculated from a 60- sec Wingate test and both anthropometric and physiological performance measures in healthy young adults.

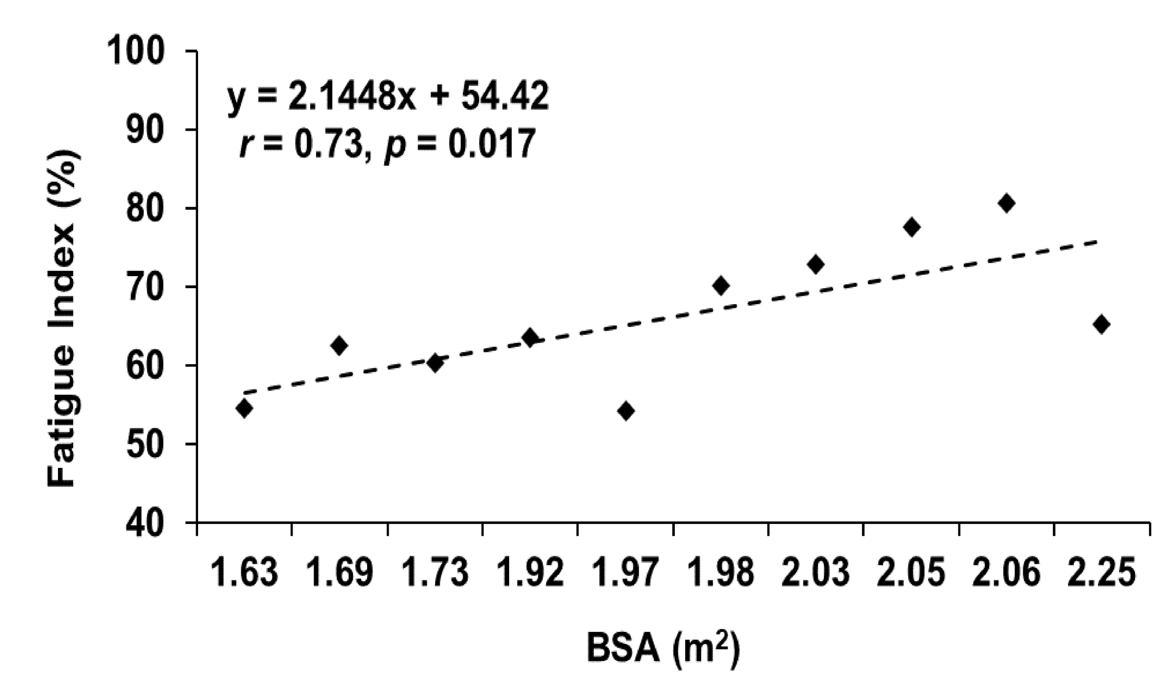
METHODOLOGY

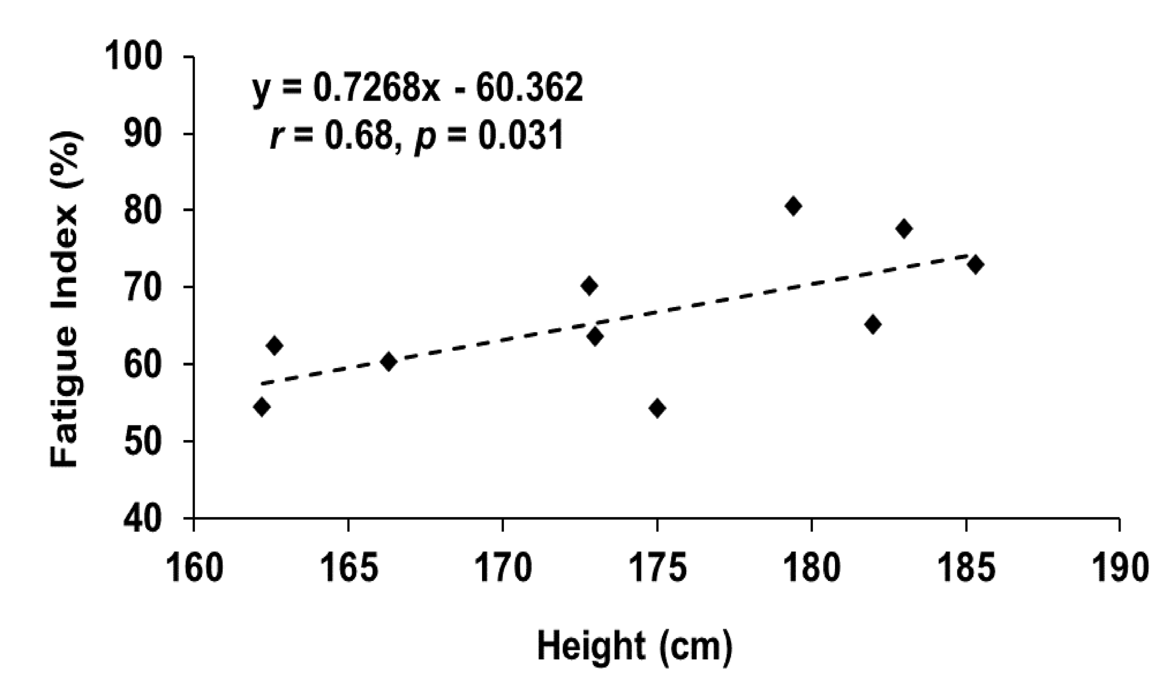
7 males & 3 females with an age of (mean ± SD) 21.9 ±2.3 yr, a body weight of 78.4 ±13.0 kg, a height of 174.2 ±8.4 cm, a BMI of 25.7 ±2.7 kg/m^2 , and a body surface area (BSA) of 1.89 ±0. 17 m^2 performed a 60-sec Wingate test with a fly-wheel resistance set at 0.075 x body weight (kg). A graded maximal exercise test performed on a cycle ergometer was used to record $VO2_{MAX}$ and maximum aerobic power (MAP). FI was calculated using the formula: FI = [(Peak 5-sec PWR – Lowest 5-sec PWR/Peak 5-sec PWR) x 100]. A Pearson correlation coefficient (*r*) was utilized to examine the strength of association between the FI and both anthropometric and physiological measures.

RESULTS

Significant associations were observed between the FI and both BSA (m^2) (r = 0.73, p = 0.017) and height (cm) (r = 0.68, p = 0.031). Remaining anthropometric measures displayed an insignificant association with the FI; BMI (kg/m^2) (r = 0.18, p = 0.621), weight (kg) (r = 0.47, p = 0.166). The association between physiological performance measures and FI were as follows; $VO2_{MAX}$ (L•min^{-1}) (r = 0.17, p = 0.647), 5-sec peak PWR (W) (r = 0 .54, p = 0.105), relative power (W/kg) (r = 0.45, p = 0.187) and MAP (r = 0.10, p = 0.785).







CONCLUSION

Anthropometric measures, specifically BSA and height, were positively associated with the FI from a 60-sec Wingate test. Previous evidence has shown a significant correlation between height and anaerobic power within sub-elite athletes[5], supporting the current study's results as the calculation for FI relies on Peak 5-sec PWR to calculate anaerobic capacity. Furthermore, previous inquiries that have categorized subjects by BSA, while testing for anaerobic and aerobic performance, have observed positive correlations between BSA and maximal anaerobic power[6]. These findings encourage support staff to monitor anthropometric adaptations from participating in sport or exercise to help maximize human performance.

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A comparison in $VO2_{MAX}$ when using different sampling intervals of metabolic data in healthy college students

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ABSTRACT

Background. Maximal aerobic power ($VO2_{MAX}$) is a classic and valid assessment for examining cardiorespiratory performance and overall health. The utility of metabolic carts for assessing $VO2_{MAX}$ in post-secondary programs allow students the opportunity to conduct assessments and familiarize themselves with data collection and its analysis. The influence of sampling intervals for determining $VO2_{MAX}$ is an important aspect one should consider when learning to implement standardized testing procedures. This investigation compared the difference in $VO2_{MAX}$ when using 10-sec and 30-sec sampling intervals in healthy college students. **Methods.** Twenty (n=20) healthy college students (13 males & 7 females) with an age of (mean ± SD) 21.7 ±2.9 yr, a weight of 70.6 ±16.4 kg, and a height of 167.7 ±9.5 cm performed a graded maximal exercise test on a computer controlled cycle ergometer, after being fitted with a mouth piece consisting of a one-way breathing valve for the collection of expired gas concentrations and analysis using a calibrated metabolic cart. Initial fly-wheel resistance was set at 2W x kg bodyweight and involved 25 W increments every three minutes until volitional fatigue. Participants were verbally encouraged throughout each test. Absolute ($L\bullet min^{-1}$) and relative ($mL\bullet kg^{-1}\bullet min^{-1}$) $VO2_{MAX}$ was examined using 10-sec and 30-sec sampling intervals. A one-way ANOVA and standardized mean differences to reveal the effect size (ES), with accompanied 95% CI, were utilized to examine the variance between each sampling interval. Significance was declared as ($p<0.05$). This study was approved by the Research Ethics Review board at Langara College. **Results.** Differences (mean ± SD) between 10-sec 'vs' 30-sec sampling in relative VO2 [(40.5 ± 8.0 'vs' 38.5 ± 7.6 $mL\bullet kg^{-1}\bullet min^{-1}$), ES = 0.25 ± 0.65, p = 0.43] and absolute VO2 [(2.9 ± 0.89 'vs' 2.7 ± 0.85 $L\bullet min^{-1}$), ES = 0.16 ± 0.65, p = 0.61] were observed. **Conclusion.** This study revealed larger $VO2_{MAX}$ values using 10-sec sampling that were not significant when compared to 30-sec sampling intervals. However, students should consider the reliability of each sampling interval for identifying $VO2_{MAX}$ when implementing repeated testing.

INTRODUCTION

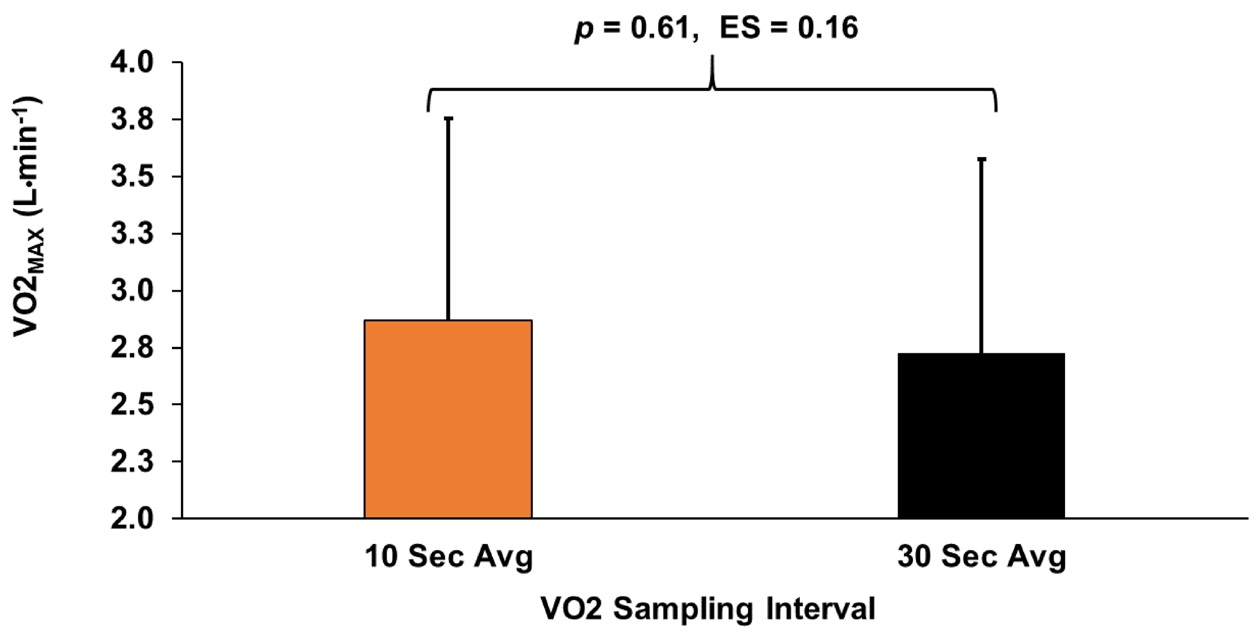
When performing a $VO2_{MAX}$ test the sampling interval at which expired gas is analyzed has demonstrated to significantly influence both peak VO2 and the presence of a plateau in oxygen consumption[1]. Short sampling intervals have shown to elicit larger $VO2_{MAX}$ values[1], an outcome that has demonstrated to be independent of the testing protocol utilized[2]. However, there remains a paucity of research examining the effect of different sampling intervals when analyzing $VO2_{MAX}$ in healthy college students whose activity levels are widely varied.

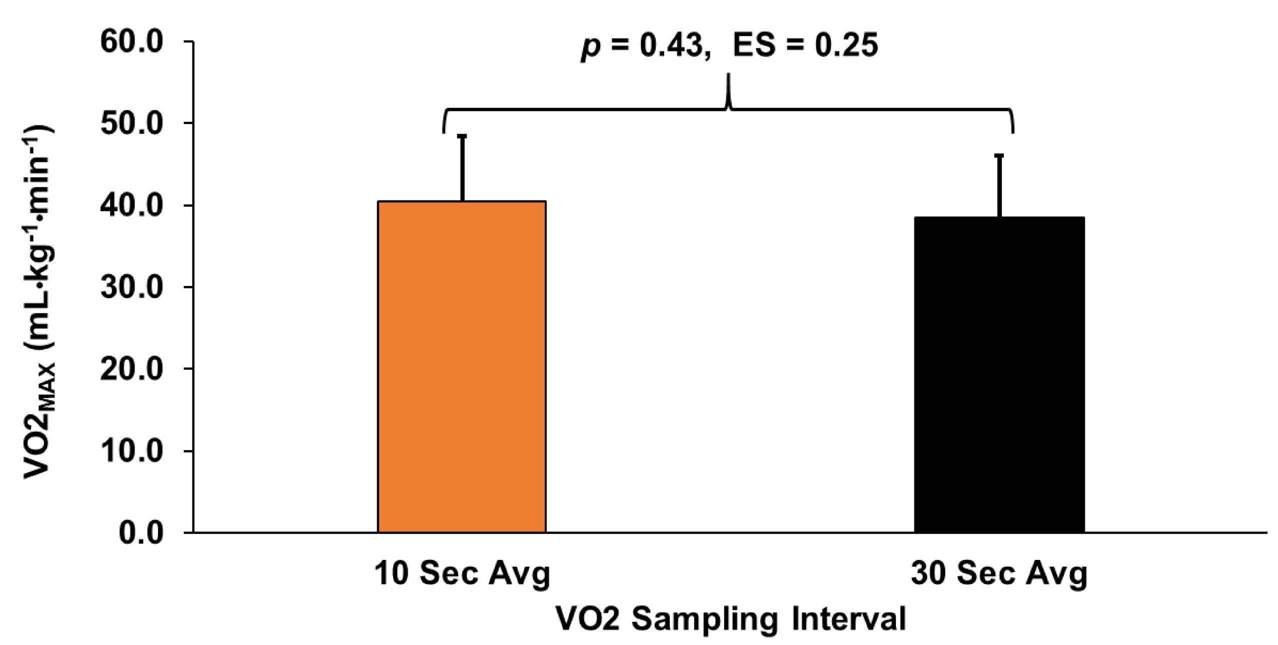
METHODOLOGY

Twenty (n=20) healthy college students (13 males & 7 females) with an age of (mean ± SD) 21.7 ±2.9 yr, a weight of 70.6 ±16.4 kg, and a height of 167.7 ±9.5 cm performed a graded maximal exercise test on a computer-controlled cycle ergometer. Initial resistance was set at 2W x kg bodyweight and incrementally added 25 W every three minutes until volitional fatigue. Absolute and relative $VO2_{MAX}$ was examined using 10-sec and 30-sec sampling intervals. A one-way ANOVA and standardized mean differences to reveal effect size (ES), with accompanied 95% CI, were used to examine variance between each sampling interval. Significance was declared as ($p<0.05$).

RESULTS

The differences (mean ± SD) between 10-sec 'vs' 30-sec sampling in relative $VO2_{MAX}$ [(40.5 ± 8.0 'vs' 38.5 ± 7.6 $mL\bullet kg^{-1}\bullet min^{-1}$), ES = 0.25 ± 0.65, p = 0.43] and absolute $VO2_{MAX}$ [(2.9 ± 0.89 'vs' 2.7 ± 0.85 $L\bullet min^{-1}$), ES = 0.16 ± 0.65, p = 0.61] were observed.





CONCLUSION

This investigation revealed no significant differences between sampling intervals of 10-sec 'vs' 30-sec when examining both relative and absolute $VO2_{MAX}$ in healthy college students. Previous literature has demonstrated the significant influence of test duration on $VO2_{MAX}$ values, with shorter duration tests eliciting larger VO2 consumption[3]. It is recommended future investigations focus on the influence of sampling intervals when using multiple test durations when examining $VO2_{MAX}$.

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A comparison in power output between maximal aerobic power (MAP) and 60-second Wingate end power

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ABSTRACT

Background. Power output (W) at $VO2_{MAX}$ can be defined as maximal aerobic power (MAP) and represents the transition where work completed above this point is primarily derived through anaerobic metabolism. Exhaustion in anaerobic metabolism from a constant load test, such as a 60-sec Wingate, may produce similar end power outputs as MAP. This investigation examined the similarity between MAP derived from a graded maximal exercise test and the power output upon completion of a 60-sec Wingate test. **Methods.** Ten (n=10) healthy college students (7 males & 3 females) with an age of (mean ± SD) 21.9 ±2.3 yr, a weight of 78.4 ±13.0 kg and a height of 174.2 ±8.4 cm performed a graded maximal exercise test on a cycle ergometer after being fitted with a mouth piece for the collection of expired gas concentrations and analysis using a calibrated metabolic cart. Initial fly-wheel resistance was set at 2W x body weight (kg) and involved 25 W increments every three minutes until volitional fatigue. A 60-sec Wingate test was completed one month after and involved a resistance of 0.075 x body weight (kg). A one-way ANOVA and standardized mean differences to reveal the effect size (ES), along with a Pearson correlation coefficient (*r*) were utilized to examine the variance and magnitude of association between final power outputs. This study was approved by the Research Ethics Review Board at Langara College. **Results.** Difference in power output (mean±SD) at MAP (219.1 ± 42.5 W) and 60-sec Wingate end power (217.1 ± 67.8 W) was not significant (p = 0.87, ES = -0.04). A significant association between 60-sec Wingate end power and MAP was observed (r = 0.78, p = 0.008). **Conclusion.** These findings suggest a 60-sec Wingate test may sufficiently diminish anaerobic capacity to elicit similar end power outputs compared to MAP in healthy college students.

INTRODUCTION

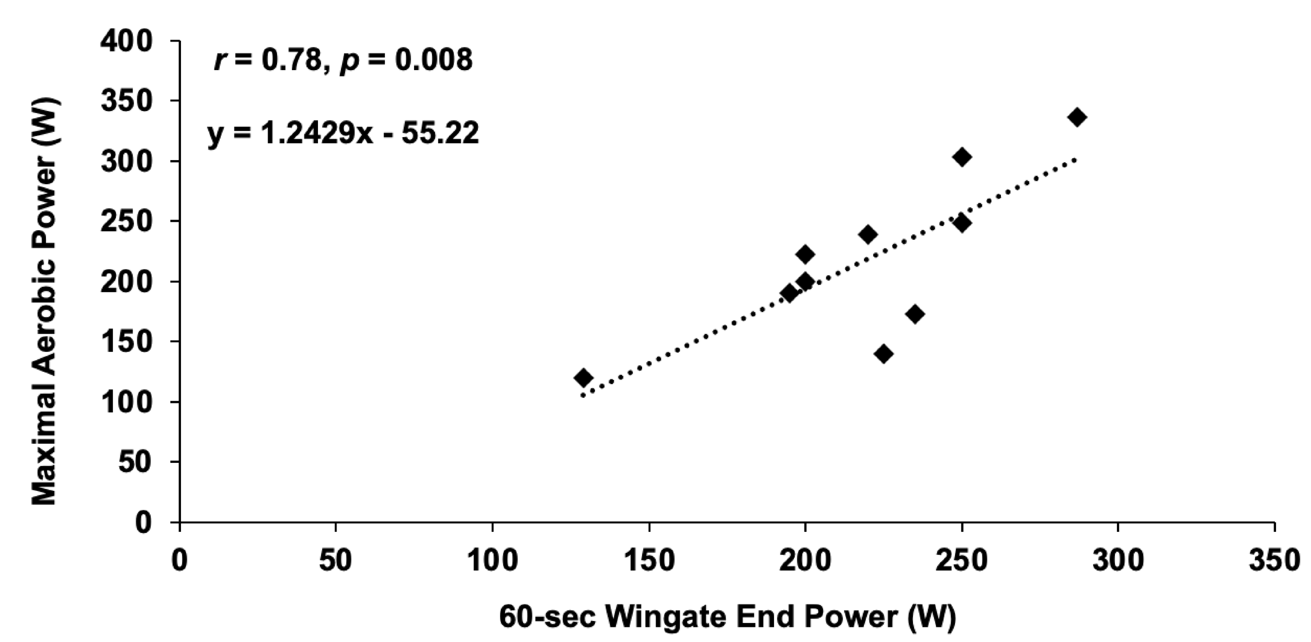
Given that brief high-intensity exercise relies predominantly on anaerobic metabolism[1], practitioners typically utilize maximal tests of short duration to evaluate anaerobic power and capacity. However, Serresse et al.[1] demonstrated that $VO2_{MAX}$ can be achieved after approximately 60-sec in a 90-sec maximal ergometer test. As such, a constant load test, such as a 60-second Wingate, may sufficiently deplete both the ATP-PC and glycolytic system to produce similar end power outputs as maximal aerobic power (MAP). The purpose of this investigation was to examine the similarity between MAP derived from a graded maximal exercise test and the power output upon completion of a 60-sec Wingate test.

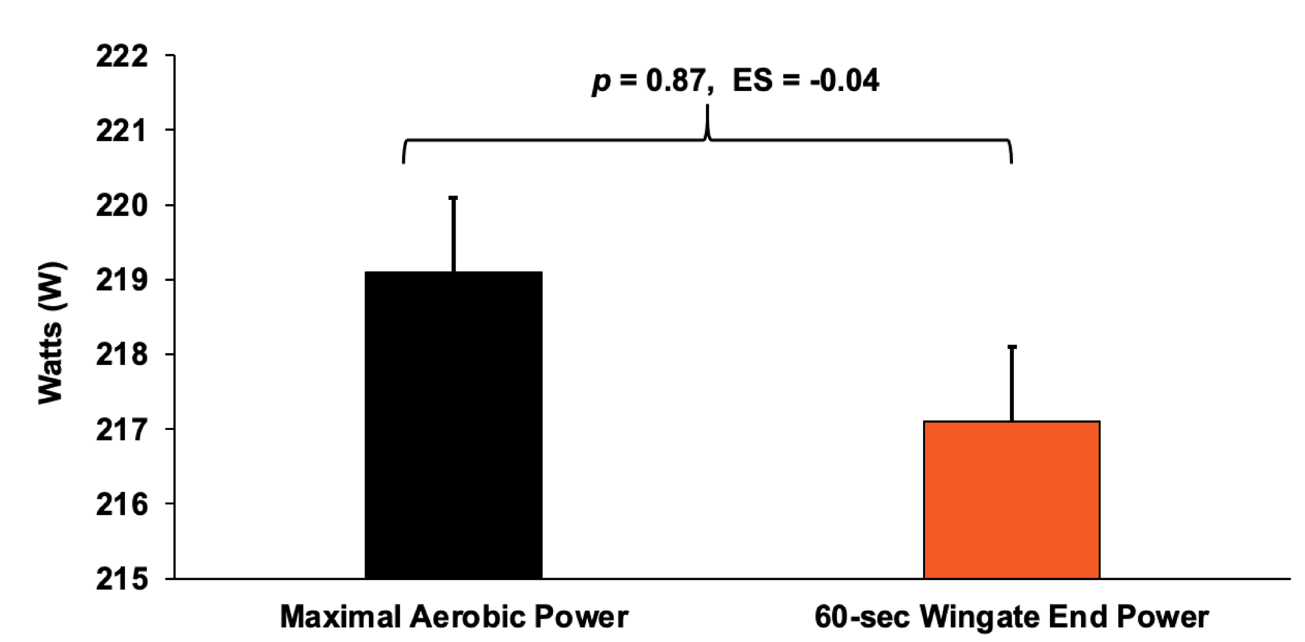
METHODOLOGY

Ten healthy college students (7 males & 3 females) with an age of (mean ± SD) 21.9 ±2.3 yr, a weight of 78.4 ±13.0 kg and a height of 174.2 ±8.4 cm performed a graded maximal exercise test on a cycle ergometer. Initial flywheel resistance was set at 2W x bodyweight (kg) and involved 25 W increments every three minutes until volitional fatigue. A month later, participants performed a 60-sec Wingate test that involved a resistance of 0.075 x body weight (kg). A one-way ANOVA and standardized mean differences to reveal the effect size (ES), along with a Pearson correlation coefficient (r) were utilized to examine the variance and magnitude of association between final power outputs

RESULTS

As presented in figure 1, the correlation between MAP and 60-sec Wingate end power demonstrated a very large association (r = 0.78, p = 0.008). Figure 2 illustrates an insignificant difference in power output (mean±SD) between MAP (219.1 ± 42.5 W) and 60-sec Wingate end power (217.1 ± 67.8 W).





CONCLUSION

The results presented in this investigation displayed a very large association between MAP obtained from a graded maximal exercise test and the power output upon completion of a 60-sec Wingate test. This suggests that a 60-second Wingate test may provide enough time to adequately diminish anaerobic capacity to elicit similar end power outputs compared to MAP in healthy college students. These findings may be useful for practitioners as they can utilize shorter test protocols to evaluate MAP, thus saving time and the need for expensive laboratory equipment.

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Estimated Cardiac Output for Determining Resting and Maximal VO2 in Healthy Individuals: A non-invasive Technique

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ABSTRACT

Background. Non-invasive techniques for estimating cardiac output (Q) using heart rate (HR) and systolic (SBP) and diastolic (DBP) blood pressure allow for advanced examination in cardiovascular function. Oxygen (O2) utilization during rest and maximal exercise are largely dependent upon Q and the concomitant delivery of O2 to the body. Consequently, the relationship between Q and VO2 supports the concept for estimating VO2 using a non-invasive assessment. **Methods.** This investigation examined the level of agreement between actual VO2 and estimated VO2 during rest $VO2_{EST-REST}$ and maximal exercise $VO2_{EST-MAX}$. Nine (n=9) healthy college students (4 males & 5 females) with an age of (mean ± SD) 21.3 ±1.2 yr, a weight of 63.4 ± 17.2 kg and a height of 162.4 ± 10.2 cm performed a graded maximal exercise test on a cycle ergometer, after being fitted with a mouth piece for the collection of expired gas concentrations and analysis using a calibrated metabolic cart. Initial fly-wheel resistance was set at 2W x bodyweight (kg) and involved 25 W increments every three minutes until volitional fatigue. Resting and maximum Q were calculated immediately before and upon completion of the exercise test while seated on the cycle ergometer. An automated BP monitor using an arm cuff positioned around the brachial artery and a HR monitor chest strap were utilized to calculate Q using the formula: [(SBP – DBP) / (SBP + DBP) x HR] x 0.29. VO2 was estimated using the formula: $[(VO2_{EST}) = [(Q) / (Q / \text{body weight (lbs)}) \times 1000]$. A Pearson correlation coefficient (*r*) and a Bland Altman analysis examined the association and level of agreement between estimated and actual VO2. This study was approved by the Research Ethics Review Board at Langara College. **Results.** $VO2_{EST-REST}$ values fell within the levels of agreement (-512 : 397 mL) but displayed an insignificant association with actual VO2 ($r = 0.32$, $p = 0.41$). Eight $VO2_{EST-MAX}$ values resided within the levels of agreement (- 799 : 732 mL) and displayed a significant association with actual VO2 ($r = 0.88$, $p = 0.005$). **Conclusion.** These results suggest improved accuracy in estimating VO2 during maximal exercise that may be the result of greater association between cardiovascular function and oxygen utilization.

INTRODUCTION

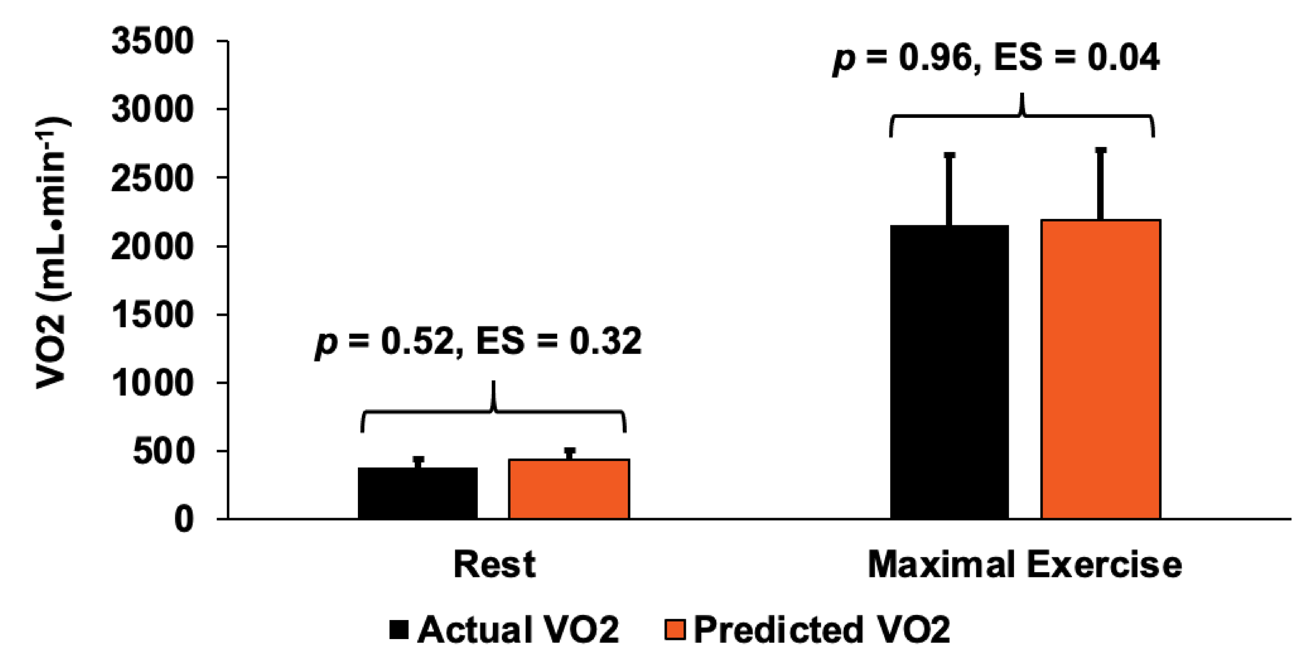
Cardiovascular function, specifically cardiac output (Q), has demonstrated to be the determining factor in oxygen utilization, whereby concomitantly regulating maximum aerobic power ($VO2_{MAX}$)[1]. The utility for determining Q using a non-invasive technique such as blood pressure and heart rate[2], coupled with its strong association to oxygen utilization, may allow for the estimation of VO2 during rest and exercise without the use of invasive and costly equipment. The purpose of this investigation was to examine the level of agreement for determining VO2 at rest and during maximal exercise using a non-invasive technique for estimating Q using heart rate (HR) and blood pressure when compared to a metabolic cart.

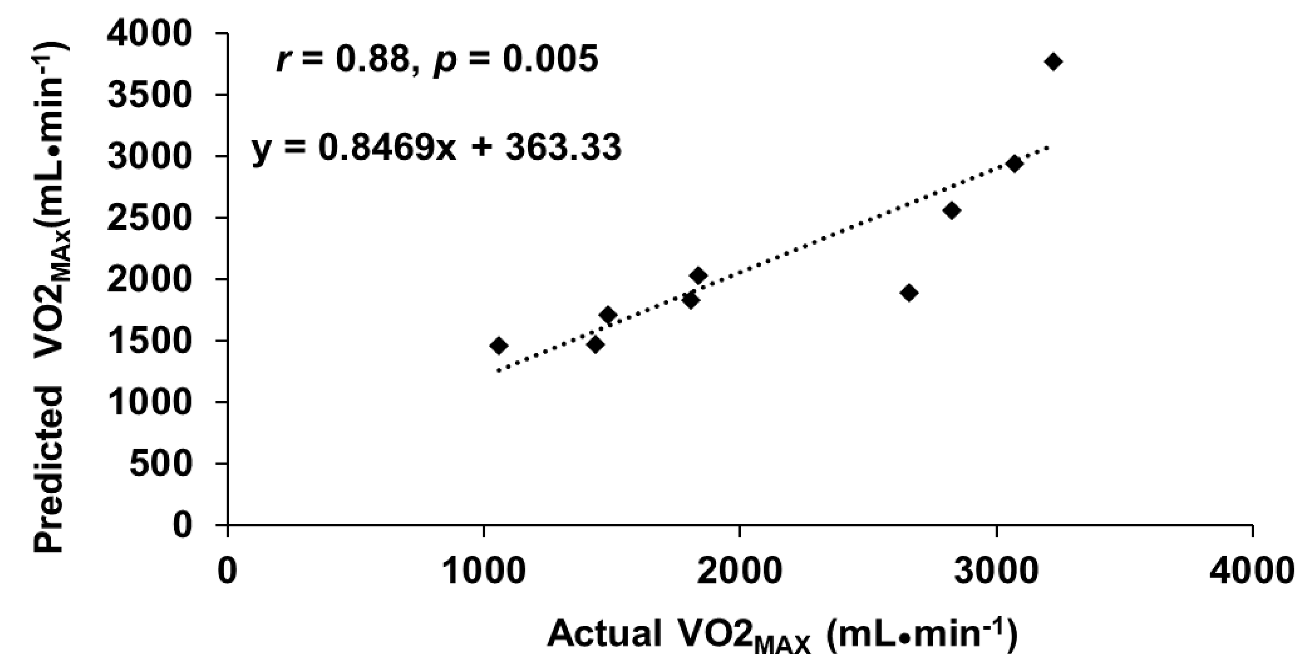
METHODOLOGY

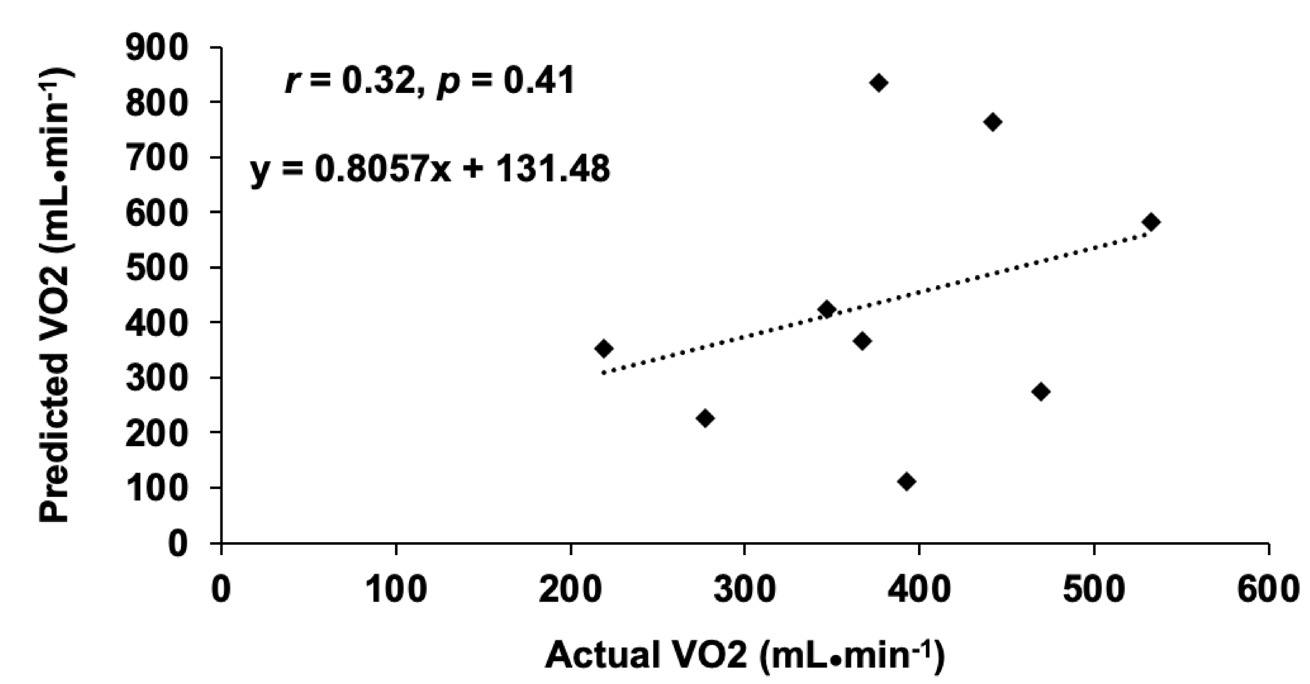
Nine healthy college students (4 males & 5 females) with an age of (mean ± SD) 21.3 ±1.2 yr, a weight of 63.4 ± 17.2 kg and a height of 162.4 ± 10.2 cm performed a graded maximal exercise test on a cycle ergometer. Initial flywheel resistance was set at 2W x bodyweight (kg) and involved 25 W increments every three minutes until volitional fatigue. Expired gas concentrations were analyzed using a calibrated metabolic cart. Prior to and upon completion of the exercise test, Q was calculated while seated on the cycle ergometer using an automated BP monitor and a HR monitor chest strap. Q was calculated using the formula: [(SBP – DBP) / (SBP + DBP) x HR] x 0.29. VO2 was estimated using the formula: $[(VO2_{EST}) = [(Q) / ([Q / \text{body weight (lbs)}) \times 1000]$.

RESULTS

$VO2_{EST-REST}$ values fell within the levels of agreement (-512 : 397 mL) but displayed a moderate association with actual VO2 ($r = 0.32$, $p = 0.41$). Eight of nine $VO2_{EST-MAX}$ values resided within the levels of agreement (- 799 : 732 mL) and displayed a significant association with actual VO2 ($r = 0.88$, $p = 0.005$)







CONCLUSION

This investigation displayed a stronger level of agreement between the direct measurement and our predicted calculation of VO2 during maximal exercise when compared to rest. $VO2_{MAX}$ has demonstrated to be largely dependent on cardiovascular function[3] whereby alterations in Q can influence O2 transportation and subsequent skeletal muscle O2 utilization[1]. The concomitant relationship between cardiovascular function and oxygen utilization may be responsible for the superior accuracy in estimating VO2 during exercise[1]. These findings demonstrate the utility of a non-invasive technique for estimating $VO2_{MAX}$ using blood pressure and heart rate in healthy college age students.

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Association between Anthropometry and Indices of Cardiovascular Function at Maximal Exercise in Healthy College Students

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ABSTRACT

The delivery of oxygen to the working muscle has shown to be a limiting factor to maximal aerobic exercise (VO2 Peak). Both cardiac and vascular function play a pivotal role in the transportation of oxygen, however, the association between anthropometric characteristics and indices of cardiac and vascular function have yet to be explored at VO2 peak. **PURPOSE:** To examine the association between indices of cardiovascular function and anthropometric characteristics at VO2 peak in healthy college students. **METHODS**: Ten healthy college students (4 males & 5 females) with an age of (mean ± SD) 21.4 ± 1.2 yr, a weight of 64.3 ± 16.8 kg and a height of 163.0 ± 10.5 cm performed a graded maximal exercise test on a cycle ergometer. Each participant was fitted with a mouthpiece for the collection of expired gas concentrations and was analyzed using a calibrated metabolic cart. Initial flywheel resistance was set at 2W x bodyweight (kg) and involved 25 W increments every three minutes until volitional fatigue. An automated blood pressure monitor using an arm cuff positioned around the left brachial artery and a heart rate monitor chest strap were utilized to record data immediately upon completion of the test while seated on the cycle ergometer to analyze indices of cardiac and vascular function. Data was analyzed using a Pearson correlation coefficient to examine the association (r) between anthropometric characteristics and indices of cardiovascular function. This study was approved by and followed the recommendation of the Research Ethics Review board at Langara College. **RESULTS**: A significant and inverse association between heart rate and both body weight (r = -0.69, p < 0.05) and body surface area (r = -0.65, p < 0.05) were observed. A positive and significant association were observed between; 1) stroke volume and both height (r = 0.82, p < 0.05) and body surface area (r = 0.72, p < 0.05), 2) height and cardiac output (r = 0.77, p < 0.05) and 3) body mass index and both mean arterial pressure (r = 0.64) and systolic blood pressure (r = 0.64, p < 0.05). **CONCLUSION:** Indices of both cardiac and vascular function are associated with anthropometric characteristics at VO2 peak in healthy college students.

RESULTS

Correlation Matrix: Association between Anthropometry and Cardiac Function at VO2 Peak

		1	2	3	4	5	6	7
1	Height (cm)	-						
2	Weight (kg)	0.80	-					
3	Body Surface Area (m^2)	0.92	0.97	-				
4	BMI (kg/m^2)	0.48	0.90	0.79	-			
5	Heart Rate (bpm)	-0.52	-0.69*	-0.65*	-0.61	-		
6	Cardiac Ouput ($L \cdot min^{-1}$)	0.77*	0.47	0.62	0.18	-0.19	-	
7	Stroke Volume (mL)	0.82*	0.59	0.72*	0.31	-0.41	0.97	-

Pearson correlation coefficients. * $p < 0.05$ (n = 10)

Correlation Matrix: Association between Anthropometry and Vascular Function at VO2 Peak

		1	2	3	4	5	6	7	8
1	Height (cm)	-							
2	Weight (kg)	0.80	-						
3	Body Surface Area (m^2)	0.92	0.97	-					
4	BMI (kg/m^2)	0.48	0.90	0.79	-				
5	Systolic Blood Pressure (mmHg)	0.33	0.60	0.50	0.64*	-			
6	Diastolic Blood Pressure (mmHg)	-0.45	-0.11	-0.23	0.11	0.07	-		
7	Mean Arterial Blood Pressure (mmHg)	0.23	0.57	0.45	0.64*	0.98	0.25	-	
8	Total Peripheral Resistance (mmHg.sec/mL)	-0.62	-0.21	-0.41	0.08	0.30	0.60	0.40	-

Pearson correlation coefficients. * $p < 0.05$ (n = 10)

INTRODUCTION

When evaluating cardiovascular function, practitioners often focus on blood pressure and cardiac output to determine the performance of the cardiovascular system (Chantler et al., 2005). Adjustments in cardiovascular function are required during exercise to assure the metabolic demands of the body are achieved. Such adjustments provide practitioners a comprehensive measure of the malleability of the cardiovascular system and its relationship to anthropometry (Vella et al., 2012, Chantler et al., 2005). Establishing which anthropometric measurements are associated with cardiovascular function, is important when exploring differences found between subjects in data sets (Chantler et al., 2005). The purpose of this investigation was to examine the association between indices of cardiovascular function and anthropometric characteristics at VO2 peak in healthy college students.

METHODOLOGY

Ten healthy college students (4 males & 5 females) with an age of (mean ± SD) 21.4 ±1.2 yr, a weight of 64.3 ±16.8 kg and a height of 163.0 ±10.5 cm performed a graded maximal exercise test on a cycle ergometer. The initial flywheel resistance was set at 2W x bodyweight (kg) and involved 25 W increments every three minutes until volitional fatigue. An automated blood pressure monitor using an arm cuff positioned around the left brachial artery and a heart rate monitor chest strap were utilized to record data immediately upon completion of the test while seated on the cycle ergometer to analyze indices of cardiac and vascular function. Data was analyzed using a Pearson correlation coefficient to examine the association (r) between anthropometric characteristics and indices of cardiovascular function.

CONCLUSION

The results presented in this investigation displayed significant associations between anthropometric characteristics and indices of both cardiac and vascular function at VO2 peak. This evidence is suggestive that body size (height, weight, body surface area, and body mass index), may influence cardiovascular function at maximal aerobic exercise. The current investigation expands on our previous work displaying the association between anthropometry and maximal anerobic performance (Khan et at., 2021). These findings may be useful for practitioners when reviewing heterogenous data sets or for developing future studies examining cardiovascular function in diverse populations, as anthropometry may account for confounding outcomes.

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