UNIVERSITY OF WISCONSIN-LA CROSSE

Graduate Studies

HEART RATE RESPONSES ASSOCIATED WITH WATERFOWL HUNTING IN MALES

A Manuscript Style Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of Master of Science

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College of Science and Health
Physical Education Teaching / Adventure and Outdoor Pursuits

August, 2009

HEART RATE RESPONSES ASSOCIATED WITH WATERFOWL HUNTING IN MALES

By Jason C. Lulloff

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Science in Physical Education Teaching / Adventure and Outdoor Pursuits

The candidate has completed the oral defense of the thesis.

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ABSTRACT

LULLOFF, J. C. Heart rates associated with waterfowl hunting in males. M.S. in Physical Education Teaching, August 2009, 57pp. (J. Steffen)

With growing populations of waterfowl, waterfowl hunting has become a popular outdoor activity. Previous studies have established that men can achieve excessive heart rate responses from hunting related activities. This study observed the heart rate (HR) during four phases of authentic waterfowl hunts: Phase I - Decoy Set-Up, Phase II - Waiting Time, Phase III - Retrieval, and Phase IV - Decoy Pick-Up. Oxygen consumption (VO_2) and energy expenditure were predicted from maximal exercise testing. Experienced male waterfowl hunters volunteered for this study. When comparing results, Phase III presented significantly higher ($P<.05$) caloric expenditure, HR, and VO_2 than Phases I and IV. Phase III yielded a mean HR of 136 ± 14.9 bpm, which was 46 ± 5.8% of the average respectively. HR responses of 117 ± 9.9 bpm and 118 ± 10.8 bpm were documented for Phases I and IV respectively. Similarly, Phase III yielded the highest mean VO_2 of 28.7 ± 8.64 ml/kg/min which was 54 ± 14.0% of the VO_2 max compared to responses of 19.7 ± 5.4 ml/kg/min and 20.0 ± 4.88 ml/kg/min for Phases I and IV. Phase III also demanded the highest energy output with 11.7 ± 3.47 Kcal/min. Phases I and II were similarly lower, yielding results of 8.1 ± 2.6 and 8.4 ± 2.96 respectively. The activities associated with waterfowl hunting constitute a legitimate basis for classifying related activities as physical activity.

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to everyone involved in the development and production of this thesis. The chairperson, Dr. Jeff Steffen, proved to be the backbone of support for this project. His dedication, time commitment, flexibility, and mentoring provided me with the knowledge, resources, and confidence to complete this manuscript. Dr. Steffen is a great man, a natural teacher, and an influential person in my life and the lives of many students at UW-L.

Special thanks also go out to Dr. John Porcari for his expertise and continued support in my project. Without Dr. Porcari's insight and advice, this thesis would not have been possible. Thanks also to Dr. Abdulaziz Elfessi for being on my committee and being flexible with me during this process. Chris Dodge deserves thanks for his continued expertise in the laboratory and with the technology used in this study. His dedication to this project was unexpected but greatly appreciated.

The subjects in this study were fabulous and put forth an exceptional effort. I would like to thank them for volunteering to be a part of this study. I would also like to thank my parents for their continued support and encouragement throughout this past year of my educational experience. I especially want to thank my mother for her efforts in being my second set of eyes in proofreading and helping me revise my project.

Lastly, the partial funding received for this work from UW-L resources is gratefully acknowledged and appreciated.

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INTRODUCTION

The State of Wisconsin is part of one of the longest migratory bird flyways in North America -- The Mississippi Flyway. Waterfowl commonly travel through the state of Wisconsin during fall and early winter, making Wisconsin a major waterfowl highway during migration season. With about 26% of Wisconsin's total land mass being wetlands (Wisconsin Department of Natural Resources [DNR], 2008), waterfowl are easily coaxed down from flight to rest and feed. It is not surprising in the six-year span from 1999 to 2005 that Wisconsin averaged 85,000 waterfowl hunters per year (Wisconsin DNR, 2008). With the growing numbers in both duck and geese populations (Wisconsin DNR, 2008), waterfowl hunting can be an attractive Wisconsin pastime.

It has been established by observation and simulated studies that men can achieve excessive heart rate (HR) responses from other hunting related activities (Haapaniemi et al., 2007; Kerhoff & Kolars, 1962; Peterson et al., 1999). In a simulated study of hiking and dragging a deer carcass, HRs at or above the aerobic training zone (70 to 85% of max HR) were observed (Peterson et al., 1999). An observational study even displayed abrupt increases in HRs while shooting and hitting a deer at rest (Haapaniemi et al., 2007). Haapaniemi et al. (2007) observed 88% of their subjects sustaining HRs above 85% of their maximal heart rate (MHR) during at least one of the activities of sighting, shooting, dragging, and tree climbing.

Although waterfowl hunting has different types of movements than deer hunting, there are still cardiovascular events that occur during preparation, hunting, and retrieval. Much like a deer hunter walks through wooded areas or a field, a waterfowl hunter must walk through water or marsh grass to put out decoys, retrieve decoys, and retrieve their game. Studies show that there is no significant difference between HR response obtained while walking in water and that obtained while walking on land (Masumoto et al., 2007; Masumoto, Takasugi, Hotta, Fujishima, & Iwamoto, 2004). There might be a difference, however, in waterfowl hunting due to the composition of the river or lake bottom. Often in a river system, the top layer of the bottom is loose sediment that is soft and gives way to the weight of a human being. It is not uncommon when waterfowl hunting to bury the entire foot and ankle in the loose mucky settlings. Maintaining balance and creating force to take the next step can increase cardiovascular demands.

As mentioned earlier, abrupt increases in HR were displayed in the study by Haapaniemi et al. (2007) during shooting. According to a study comparing different hunting activities for specialization, waterfowl hunters finished second in specialization, partially because waterfowl hunting requires identification (Miller & Graefe, 2000). In order to identify a duck, the bird must be in close proximity. Because of this, hunters are often forced to hold a shot longer than they care to ensure their target is identified. This anticipation of shooting might cause an increase in HR much like the data in the Haapaniemi et al. (2007) study that showed HRs as high as 114% of maximal when subjects saw a deer.

Studies have shown that exercise intensities may place some individuals at an increased risk for acute cardiovascular events (Foster & Porcari, 2001). Studies also suggest that unaccustomed heavy exertion, particularly in sedentary individuals with a reasonable likelihood of having atherosclerotic disease, is frequently the trigger of acute myocardial infarction (Mittleman et al., 1993; Willich et al., 1993). The risk of complications during exercise is normally predictable and, at least in sedentary adults, is related to exercise intensity (Foster & Porcari, 2001).

Before any complications or risks can be identified, it is necessary to determine if waterfowl hunting causes abrupt increases in HR and if it is indeed a strenuous activity. This study is intended to document the HR of a hunter during a real waterfowl hunt and compare the results to data obtained during maximal treadmill (TM) exercise.

METHODS AND PROCEDURES

Subjects

The subjects for this study were 11 male volunteers between the ages of 22 and 36. Subjects differed in physical fitness abilities, weight, and height, but each subject apparently was healthy and without major risk factors for cardiovascular disease. All subjects were experienced in waterfowl hunting and were Harvest Information Program (HIP) registered. The protocol for this study was approved by the University of Wisconsin - La Crosse Institutional Review Board for the Protection of Human Subjects and subjects were required to fill out and sign an informed consent form (Appendix A) prior to any testing.

Testing Protocol

The subjects took part in two separate data collection tests. The first test included a maximal exercise test on a motorized treadmill using a modified Balke protocol to determine maximal oxygen consumption (VO_2) and HR. The second test recorded HRs during a natural observation of waterfowl hunting. During both tests, Polar heart rate monitors (HRMs) were worn using a memory mode to collect data in five-second intervals.

Treadmill Testing

Each subject underwent a maximal exercise test via treadmill (TM). Polar technology was used to monitor HRs during TM testing. Each subject underwent a three-minute warm-up period where the grade was set at 2.5% with a speed of 3.0 mph. After the warm-up, the speed was set to 6 mph and the grade began at 0%, increasing by 2.5% every 2 minutes until exhaustion. VO_2 peak was defined as the highest one-minute uptake value achieved during TM exercise. The VO_2 and respiratory exchange ratio were computed, averaged, and printed by an online computer system every minute. Metabolic gases were continuously collected using the AEI Moxus system (AEI Technologies Inc.) metabolic measurement system.

Hunting Observation Testing

All subjects wore a Polar HRM with a memory mode. The recording of HRs began upon reaching the hunting site. The lap button on the HRM was used to depict the start and end of different phases of the data. Four different phases were monitored:

Phase I - Decoy Set-Up, Phase II - Waiting, Phase III - Waterfowl Retrieval, and Phase IV - Decoy Pick-Up. One to two subjects were observed per hunt. To create the most natural hunting environment, duration of the hunts varied depending on a variety of variables such as weather, time of day, bird flight patterns, and success of the hunt.

Phase I - Decoy Set-Up

After starting the HRMs, the subjects put out 30 decoys. The decoys were spread out in groups around the boat no further than 35 yards away. Each subject was equipped with neoprene waders and was asked to set the decoys to their respective spots so they formed one of two formations. One formation used was the “J” or hook pattern (Appendix B) and the other formation used was the “C” or “U” pattern (Appendix B). Once decoys were deployed, the hunters took their position in the blind and hit the lap button on their HRMs. The data collected from starting the HRM until the lap button was hit again constituted the decoy set-up phase.

Phase II - Waiting

After setting up decoys and hitting the lap button, the waiting phase began. The hunters sat in the boat waiting for waterfowl to enter proximity of 40 yards or closer. This waiting phase lasted until a waterfowl was harvested. Upon harvesting the waterfowl, subjects hit the lap button to end the waiting phase.

Phase III - Retrieval

The retrieval phase of this test consisted of the time the subjects spent wading out into the water or marsh grass to hand retrieve the bird(s). When multiple subjects were being tested, both subjects went to retrieve each bird. Once the subject returned to the boat with the game, they hit the lap button to end the retrieval phase and begin a new waiting phase.

Phase IV - Decoy Pick-Up

Upon completion of the hunt, the subject hit the lap button on the HRM and collected and packed the decoys back into the decoy bag. This phase lasted until the boat was ready to depart back to the landing. At this point, subjects ended the collection of HR data.

Statistical Analysis

All statistical analysis was conducted using SPSS Statistical Package Version 16.0. Standard descriptive statistics were used to evaluate the characteristics of the subjects. The HRs obtained from the field hunts were separated into the four phases. After isolating HRs into respective phases, descriptive statistics such as mean, range, and standard deviation were calculated for each phase. Individual regression equations were developed by plotting HR and VO_2 data obtained during TM. VO_2 for each individual was calculated using the regression equations and HR obtained during the field hunt. Kcal was calculated from oxygen consumption data. Group statistics such as mean HR and VO_2 were then calculated and compared to percentage of maximal results obtained during TM. Finally, Kcal was calculated using the calculated VO_2 data. Comparisons between phases were made using a one-way ANOVA with repeated measures. Alpha was set at .05 to achieve statistical significance.

RESULTS

Eleven subjects completed the study protocol. The physical characteristics of the subjects are presented in Table 1.

Table 1. Subject Descriptive Characteristics Including Heart Rate and VO_2 Max

	Male Waterfowl Hunting Subjects (n=11)	
Variable	**Mean ± SD**	**Range**
Age (years)	24.5 ± 3.98	22 - 36
Height (inches)	71.2 ± 3.60	66 - 78
Weight (pounds)	182.1 ± 32.20	138 -251
Heart Rate Max (bpm)	186 ± 7.9	168 - 196
VO_2 Max (ml/kg/min)	53.2 ± 6.89	42 - 60

The group HR comparisons for MHR and the group mean of each phase can be found in Figure 1. The mean for the group MHR was 186 bpm. Phase III had the highest mean HR of all phases with 136 ± 14.9 bpm, which constitutes 46 ± 5.8% of the average group HR. Phases I and IV had comparable mean HRs with 117 ± 9.9 bpm and 118 ± 10.8 bpm respectively. The lowest mean HR was 86 bpm during Phase II.

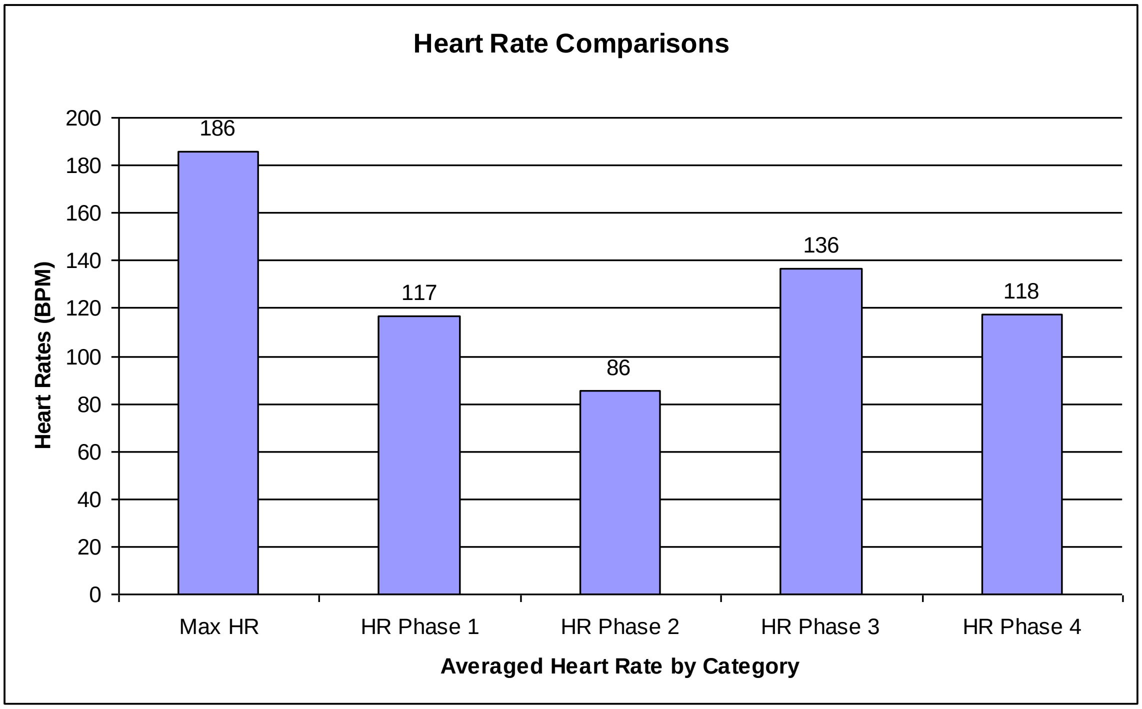

Figure 1. Heart Rate Comparisons of Averaged Results by Phase

Using the data obtained from TM, regression equations for each individual were calculated (Appendix C). These regression equations were used as a predictor for aerobic functioning (VO_2) during the field hunting test. The ability of these regression equations to predict a trend is very high with a mean R^2 value of .941 ± .052 (see Table 2).

The VO_2 comparisons for maximum VO_2 and the predicted group mean VO_2 of each phase can be found in Figure 2. Phase III yielded the highest mean VO_2 of 28.7 ± 8.64 ml/kg/min, constituting 54 ± 14.0% of the mean max VO_2. Phases I and IV yielded similar mean VO_2 values of 19.7 ± 5.4 ml/kg/min and 20.0 ± 4.88 ml/kg/min respectively.

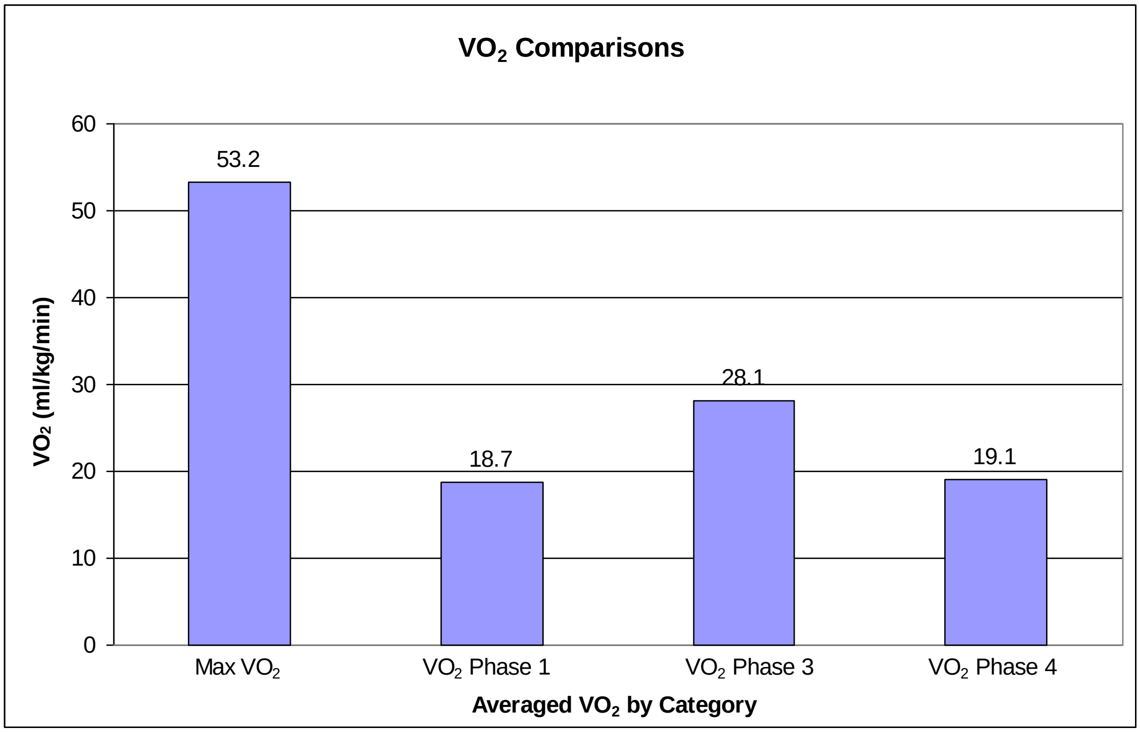

Figure 2. VO_2 Comparisons of Averaged Results by Phase

Table 2. Predictive Power of VO_2 Max Based on Maximal Exercise Testing

Subject	**R^2**
Subject 1	0.987
Subject 2	0.915
Subject 3	0.832
Subject 4	0.978
Subject 5	0.891
Subject 6	0.971
Subject 7	0.995
Subject 8	0.885
Subject 9	0.960
Subject 10	0.966
Subject 11	0.970
Mean	0.941
SD	0.052

Table 3. Physiological Responses and % of Maximal TM Exercise During Phases

	Mean ± SD	**Range**
Phase I		
Heart Rate	117 ± 9.9	94 - 131
% Max Heart Rate	63 ± 6.0	50 - 70
VO_2	19.7 ± 5.4	13.7 - 29.5
% Max VO_2	37 ± 10.3	23 - 54
Kcal / min	8.1 ± 2.6	5.4 – 13.2
Phase II		
Heart Rate	86 ± 10.6	62 - 104
% Max Heart Rate	46 ± 5.8	33 - 56
VO_2	Not Reported	Not Reported
% Max VO_2	Not Reported	Not Reported
Kcal / min	Not Reported	Not Reported
Phase III		
Heart Rate	136 ± 14.9	103 - 160
% Max Heart Rate	74 ± 8.9	54 - 88
VO_2	28.7 ± 8.64	18.5 - 45.07
% Max VO_2	54 ± 14.0	32 – 75
Kcal / min	11.7 ± 3.47	8.2 – 17.3
Phase IV		
Heart Rate	118 ± 10.8	103 ± 142
% Max Heart Rate	64 ± 7.7	53 - 79
VO_2	20.0 ± 4.88	13.0 – 27.0
% Max VO_2	38 ± 11.4	26 - 65
Kcal / min	8.4 ± 2.96	5.0 – 15.4

Looking at the caloric expenditure by phase, Phase III demanded the highest energy output with 11.7 ± 3.47 Kcal/min. Phases I and II were very similar, yielding results of 8.1 ± 2.6 and 8.4 ± 2.96 respectively.

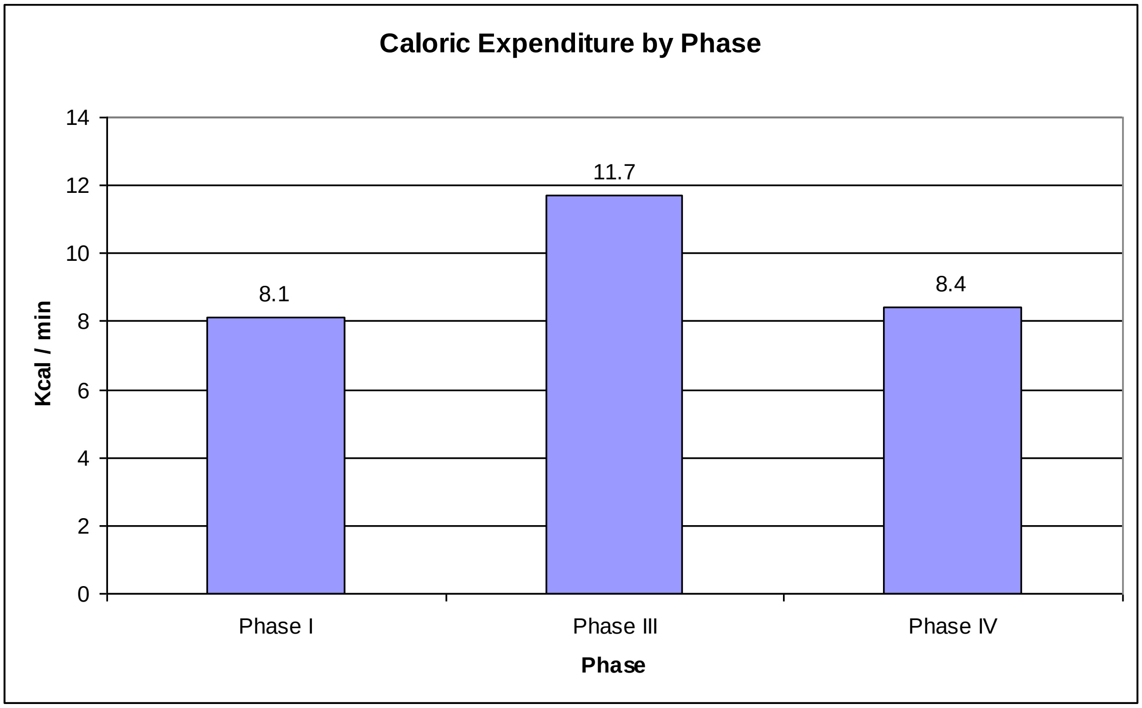

Figure 3. Predicted Caloric Expenditure by Phase

DISCUSSION

The purpose of this study was to examine the physiological demands of waterfowl hunting activities in male hunters. More specifically, this study examined HR responses and oxygen consumption during four phases of waterfowl hunting (decoy set-up, waiting, retrieval, and decoy pick-up). The secondary goal was to compare waterfowl hunting with similar demanding physical activities.

Previous research states that gains in mobility and fitness levels can occur from participation in outdoor activities, which then contributes to the participant's overall well being (Kimbrough, 2007; Taylor, Gilbert, Kaufman, & Morgan, 2004). The data from this study agrees with the idea that participation in outdoor activities can enhance fitness levels. The American College of Sports Medicine (ACSM) recommends an intensity of exercise corresponding to 40 -85% of VO_2 or 64 - 94% of MHR (Whaley, Brubaker, Otto, & Armstrong, 2005). Table 4 compares current test findings to ACSM recommendations for exercise intensity.

Table 4. Comparison of Hunting Intensities to ACSM Exercise Recommendations

	Current Test Finding	**ACSM Recommendation**
Phase I		
% of VO_2 Max	37%	40 - 85%
% Max Heart Rate	63%	64 - 94%
Phase III		
% of VO_2 Max	54%	40 - 85%
% Max Heart Rate	74%	64 - 94%
Phase IV		
% of VO_2 Max	38%	40 - 85%
% Max Heart Rate	64%	64 - 94%

The current study shows that Phases I and IV are on the brink of the minimal threshold of an exercise training zone. While retrieving waterfowl (Phase III), hunters are participating in an activity that enhances aerobic functioning. The findings from this study suggest that fitness enhancement is possible from participation in waterfowl hunting activities.

In a study performed by Ekelund et al. (2001), results indicated that the percentage of MHR gives relevant and easy indication of exercise intensity. The results from the current study coincide with Ekelund's findings that percentage of MHR and percentage of VO_2 Max both represent relatively the same exercise intensities when comparing test findings with ACSM recommendations for exercise intensities (Table 4). Using both percentage of MHR and percentage of VO_2 Max as a predictor for exercise intensity, Phases I and IV both narrowly fall short of being in the training zone and Phase III falls in the middle of the training zone

HR monitoring has become an accepted practice as a solid direct measure of physical activity when using chest electrodes (Ekelund et al., 2001; Esposito et al., 2004; Laukkanen & Virtanen, 1998). The current study adds confidence to studies that examined HRMs and their ability to reproduce results. Phases I and IV (decoy set-up and decoy pick-up) required the exact same amount of movement. Phase I required the hunter to walk out and put the decoys in the water, and Phase IV required that same hunter to go pick up the same decoys. The HRs for these two phases were almost identical with Phase I recording an average HR of 117 ± 9.9, and Phase IV an average HR of 118 ± 10.8. The findings from this study support the reliability of using chest electrode HRMs.

In a study conducted by Strath et al. (2000), the validity of using HR data to predict energy expenditure was examined. The data collected from the Strath study indicates that HR is a moderate physiological indicator of VO_2 during a variety of lifestyle activities and is a strong indicator of energy expenditure. In the current study, HR was used to predict energy expenditure in three of the four phases. Phase III had significantly higher caloric expenditure, HR, and oxygen consumption than Phases I and IV. The results obtained from Phases I and IV can be compared to playing badminton, dancing, playing frisbee, skiing in soft snow, playing recreational tennis, or walking on a treadmill at 3.5 mph. The results obtained from Phase III can be compared to backpacking with a 22 lb. load, competing in a basketball practice, sparring in boxing, jumping rope at 110 rotations per minute, running on a flat surface at about a 10-minute mile pace, competing in tennis, or playing recreational water polo (McArdle, Katch, F., & Katch, V., 1996).

Studies have shown that triggering an acute myocardial infarction while exercising is positively related to heavy exertion (Chowdhury et al., 2003; Franklin, Bonzheim, Gordon, & Timmis, 1996; Willich et al., 1993; Willich, Maclure, Mittleman, Arntz, & Muller, 1993). Snow shoveling is classified as a heavy exertion activity. In a study conducted by Franklin et al. (1996), HR responses exceeding 85% of the MHR after only two minutes. In addition, during shoveling, HRs sustained very high levels with the average HR being 175 bpm. In the current study, the highest average heart response for a particular phase was 136 bpm which constituted only 74% of the MHR. The current study suggests that even though significant increases in physical activity were shown through various phases, the level of intensity does not compare to shoveling snow and, therefore, probably would not be associated with the triggering of acute myocardial infarction.

It has been documented through observation that deer hunting activities elicit increased HR due to anticipation. In a study conducted by Haapaniemi et al. (2007), HRs as high as 114% of Maximal TM exercise was documented when the subjects saw deer while hunting. The results from Phase II in the current study indicate that waterfowl hunting does not elicit large arousal of anticipation like deer hunting, most likely due to the brief interludes of the bird being in proximity of the hunters. Although arousal was not apparent while sighting game, Phase I and IV could have been affected by anticipation. When hunters set out decoys often they are excited about the hunt and eager to get set-up as quickly as possible which could affect Phase I. Similarly, Phase IV could have been affected by urgency to pick-up decoys and get going before darkness sets in. Although the results from this study do not definitively indicate these happenings, it can be assumed that any arousal playing on set-up and pick-up of decoys is fairly equivalent being the results from this study was nearly identical in those areas.

It has been established by observation and simulated studies that men can achieve excessive HR responses from hunting related activities (Haapaniemi et al., 2007; Kerkhof & Kolars, 1962; Peterson et al., 1999). In a study conducted by Peterson et al. (1999), average HRs during hiking were found to be 74 ± 7.0% of percentage of maximal exercise HR. This is very comparable to the results found in Phase III of the current study where HR averages were found to be 74 ± 8.9%. Peterson also found HR responses while dragging a deer carcass to be 89.1 ± 4.5%. No phase from the current study compares to this finding due to Phases I and IV having lower HR responses than Phase III. By comparing the results of deer hunting studies and this current waterfowl study, the peak HR responses from water fowling can be compared, but all other data for waterfowl hunting appears to be less demanding.

Conclusion

Contrary to common belief that waterfowl hunting consists of long hours of sedentary activities, the activities associated with waterfowl hunting constitute a legitimate basis for classifying waterfowl related activities as physical activity.

Study Limitations

Although findings demonstrate legitimate argument for activities associated with waterfowl hunting to be considered physical activity, the research presents technical limitations. The subjects for this study were all young, apparently healthy men who were high in aerobic functioning (VO_2 max average 53.2 ±6.89 ml/kg/min). With this considered, the response in older populations may be under estimated.

Another limitation to the study was the fact that nothing was controlled. Retrievals were all different distances as the location that the waterfowl drops can easily make the retrieval more difficult or easier depending on distance away, depth of water, falling in the open water versus marsh grass, or urgency of retrieval (e.g. high waterfowl action tends to increase speeds of retrieval so there are no people in the decoys). The low sample number might not be a true representation of waterfowl hunting, as some of these variables may or may not have been present in the study.

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APPENDIX A

INFORMED CONSENT

Heart Rate Responses Associated With Waterfowl Hunting in Males

Informed Consent

Primary Researcher: Jason Lulloff · 730 Oakland St. #60 La Crosse, WI · (920) 286-1406

I, ________________, give my informed consent to participate in this study of heart rate responses associated with waterfowl hunting in males. The purpose of this study is to determine the demands of waterfowl hunting activities. The tests involved in this study include a maximal exercise test and field hunting observation. The maximal exercise test will be done on a treadmill where the grade and speed will be adjusted to make the task increasingly harder until it becomes too demanding. A chest harnessed heart rate monitor will be used, along with a snorkel-like device to monitor oxygen consumption. The field hunting observation will take place in a natural setting where heart rates will be monitored every 15 seconds using a chest harnessed heart rate monitor. I have been informed of and agree to the presentation and publication or other dissemination of the results with the understanding that all information is anonymous and that no identification can be made.

I have been informed the following will be associated with the study:

- The time requirement for the maximal exercise test is approximately 20-30 minutes.
- The time requirement for the field hunting observation is approximately 2-5 hours.
- The field test hunting observation will take place on the Mississippi River within a 20 mile radius of La Crosse, WI.
- I may experience muscle soreness and fatigue.
- Individuals trained in CPR and first aid will be in the laboratory during the exercise test, and the test will be terminated if complications occur.
- The risk of serious complications for healthy individuals is near zero.
- I will be in a hunting environment with loaded guns. All people with me will be experienced waterfowl hunters who have completed a hunter's safety course.
- I will be boating while wearing a life preserver to reach the hunting location.

I have been informed that participation is strictly voluntary and I am free to withdraw from the study, without penalty, at any time. I state that to the best of my knowledge, I am healthy and no conditions exist that should preclude my participation in the study.

Questions regarding study procedures may be directed to the principal investigator, or the study advisor Dr. Jeff Steffen, Department of Exercise and Sport Science, UW-L (608-785-6535). Questions regarding the protection of human subjects may be addressed to the UW-La Crosse Institutional Review Board for the Protection of Human Subjects (608-785-8124 or irb@uwlax.edu).

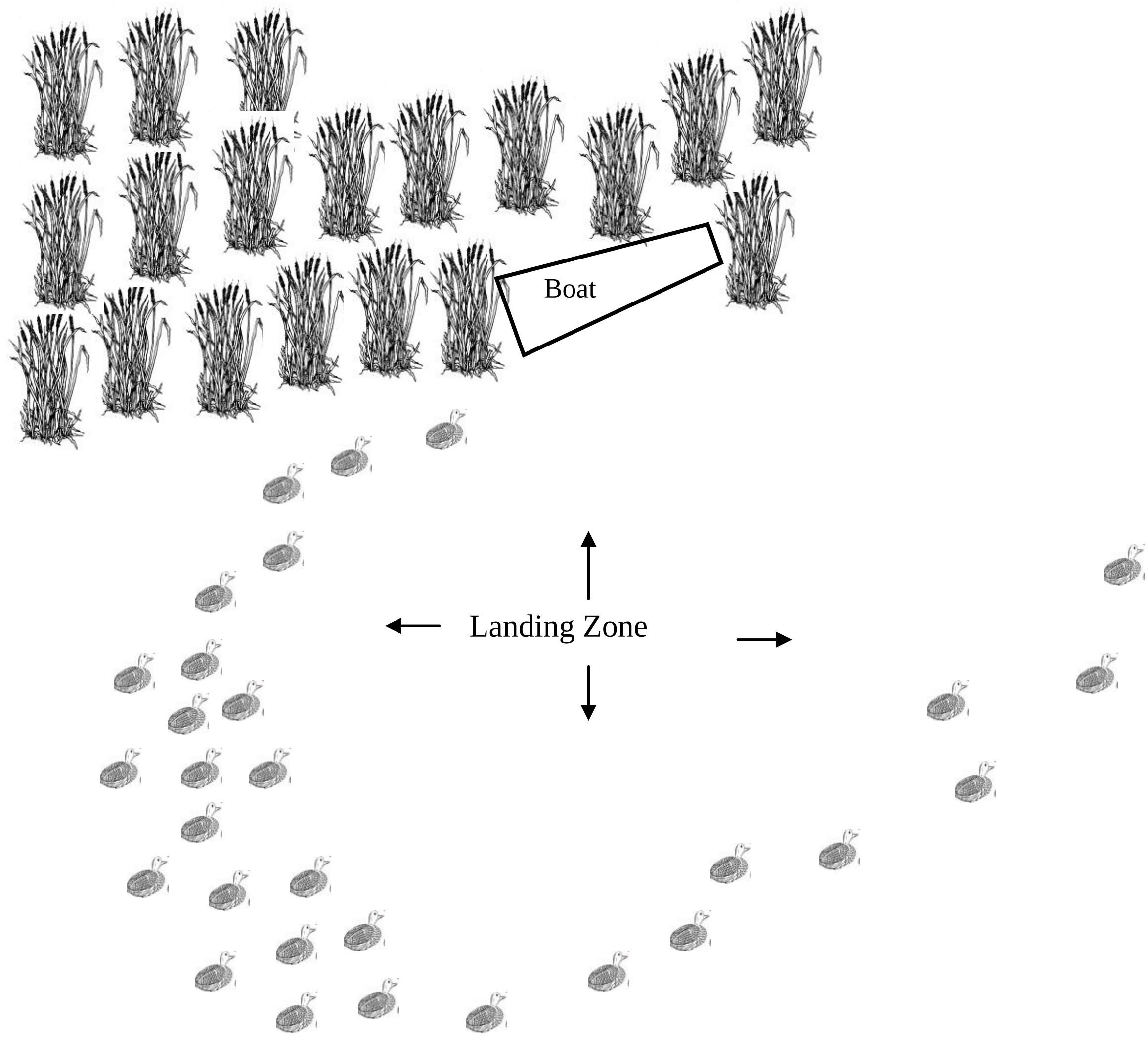
Participant: ____________________________________ Date: ________________

Researcher: ____________________________________ Date: ________________

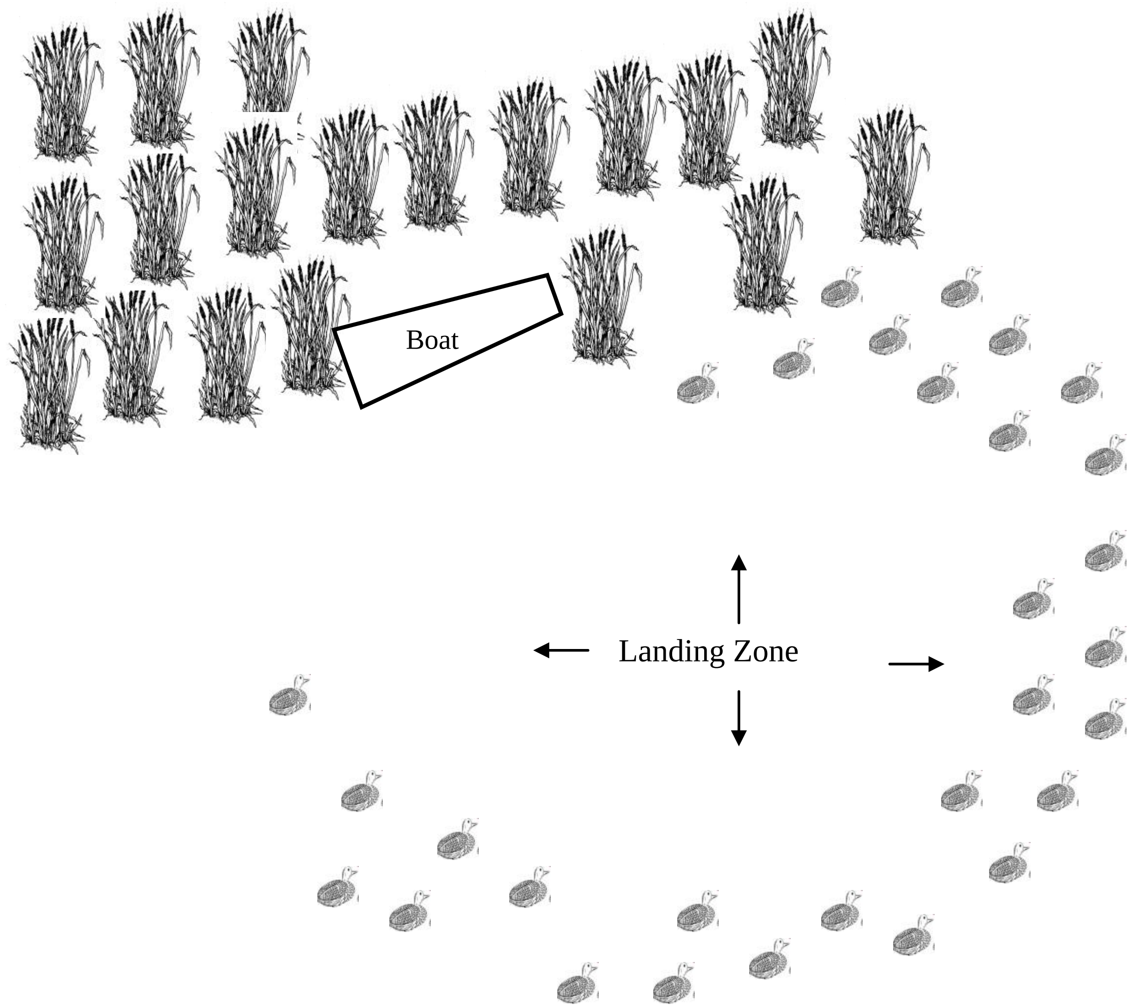
APPENDIX B

DECOY PATTERNS

“J” Hook Decoy Pattern



“C” or “U” Decoy Pattern



APPENDIX C

REGRESSIONS FOR PREDICTING VO_2 BASED ON TM EXERCISE TESTING

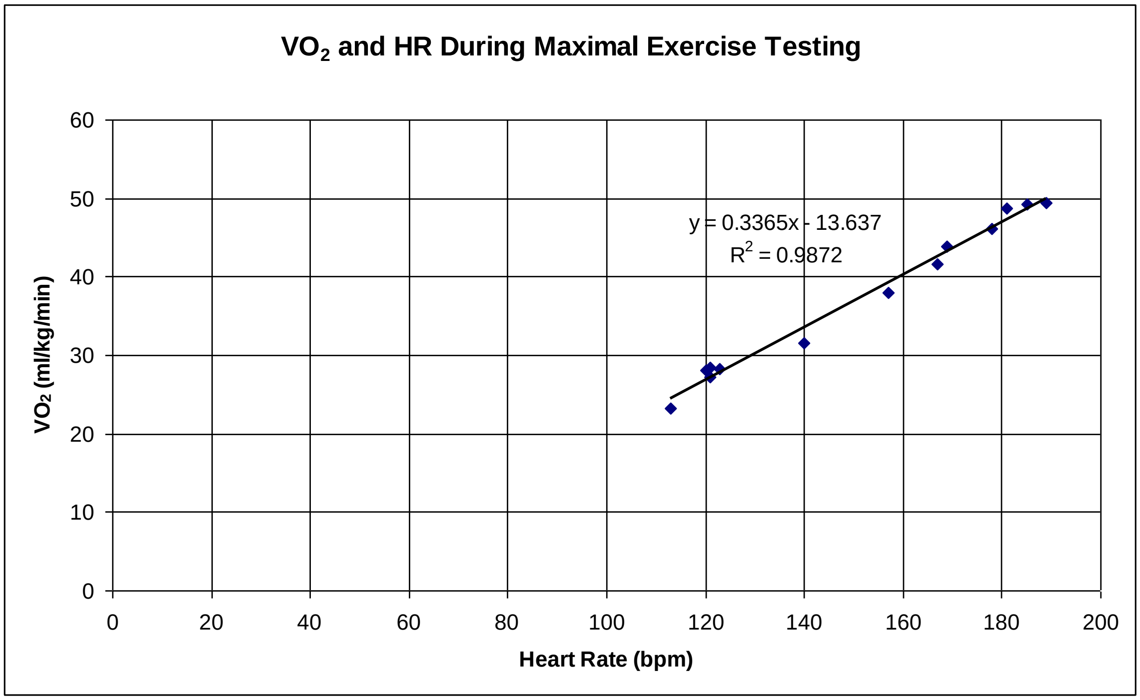


Figure 4. Subject 1 - Regression for Predicting VO_2 Based on TM Exercise

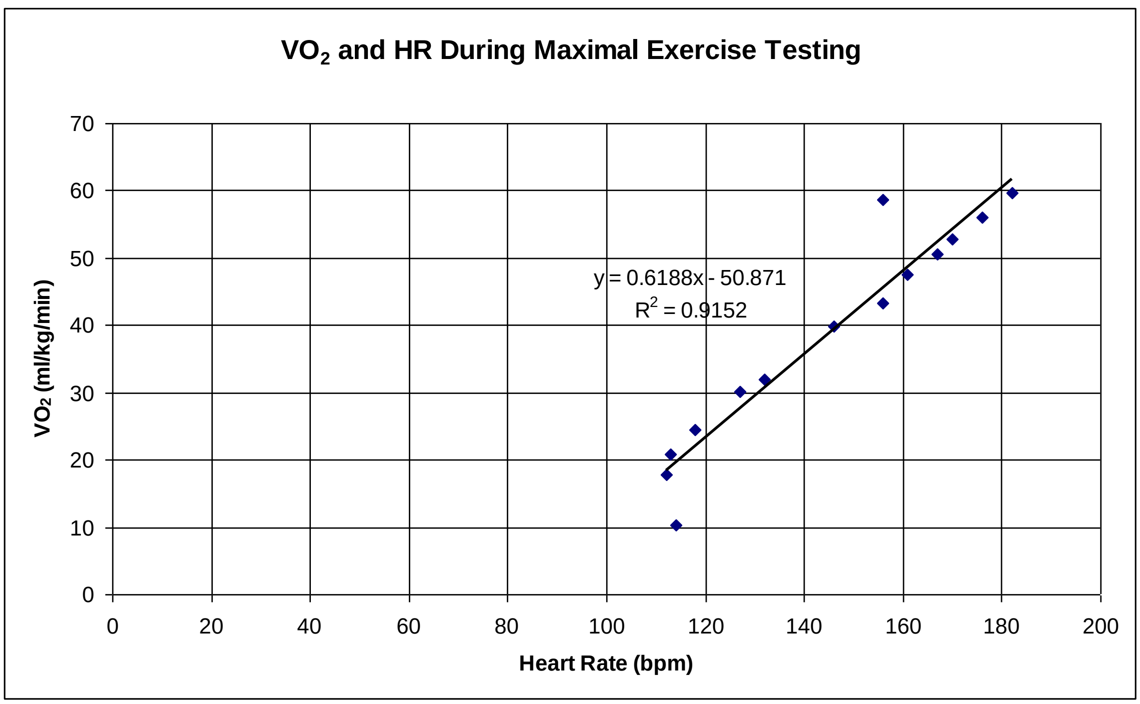


Figure 5. Subject 2 - Regression for Predicting VO_2 Based on TM Exercise

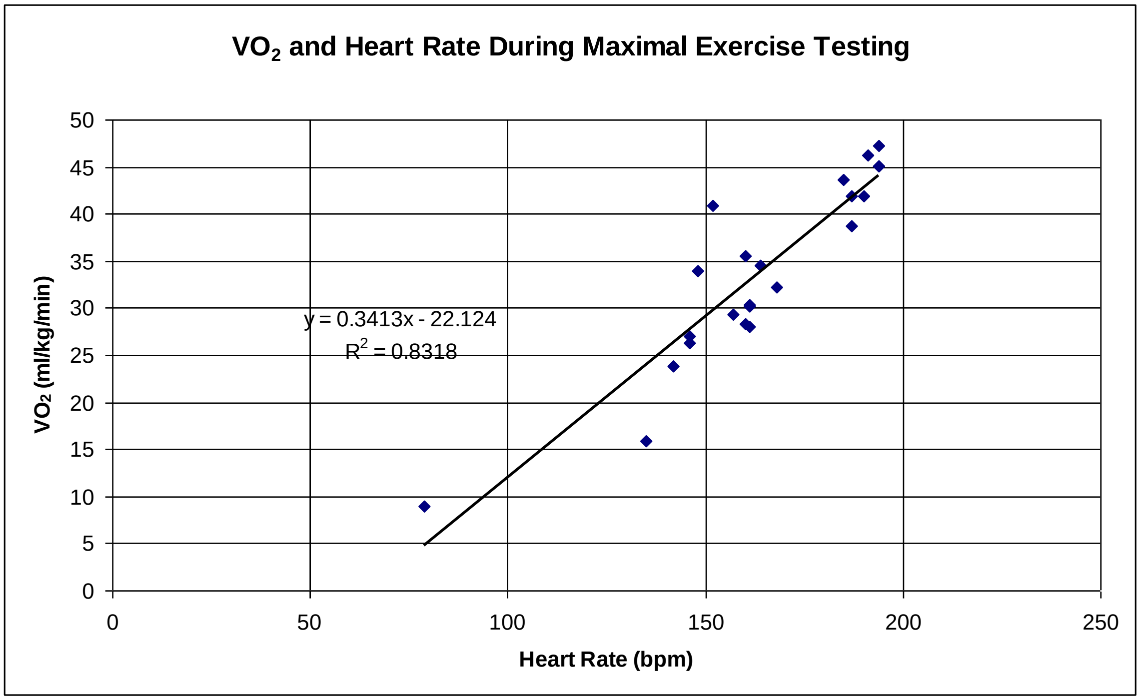


Figure 6. Subject 3 - Regression for Predicting VO_2 Based on TM Exercise

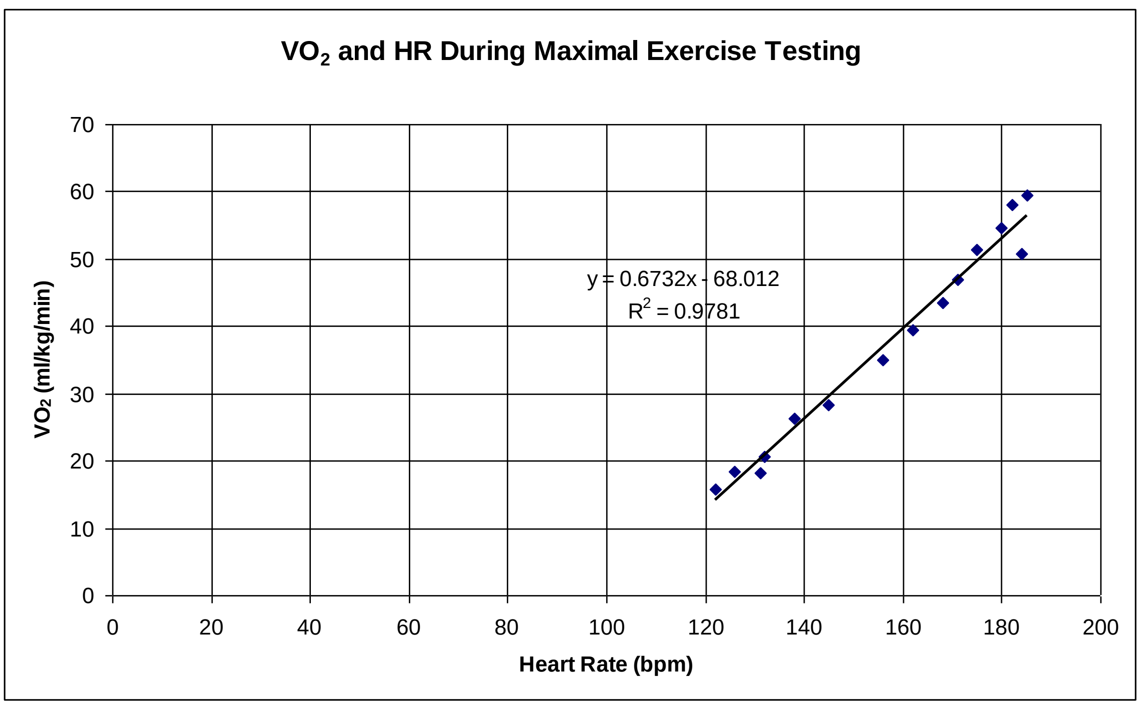


Figure 7. Subject 4 - Regression for Predicting VO_2 Based on TM Exercise

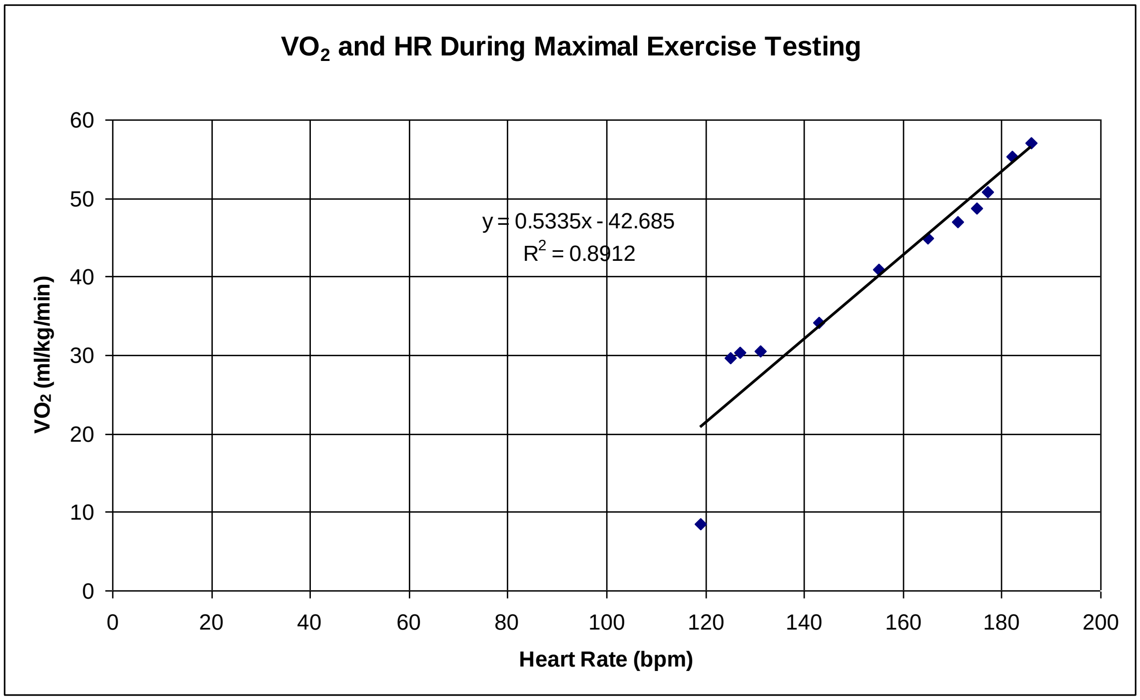


Figure 8. Subject 5 - Regression for Predicting VO_2 Based on TM Exercise

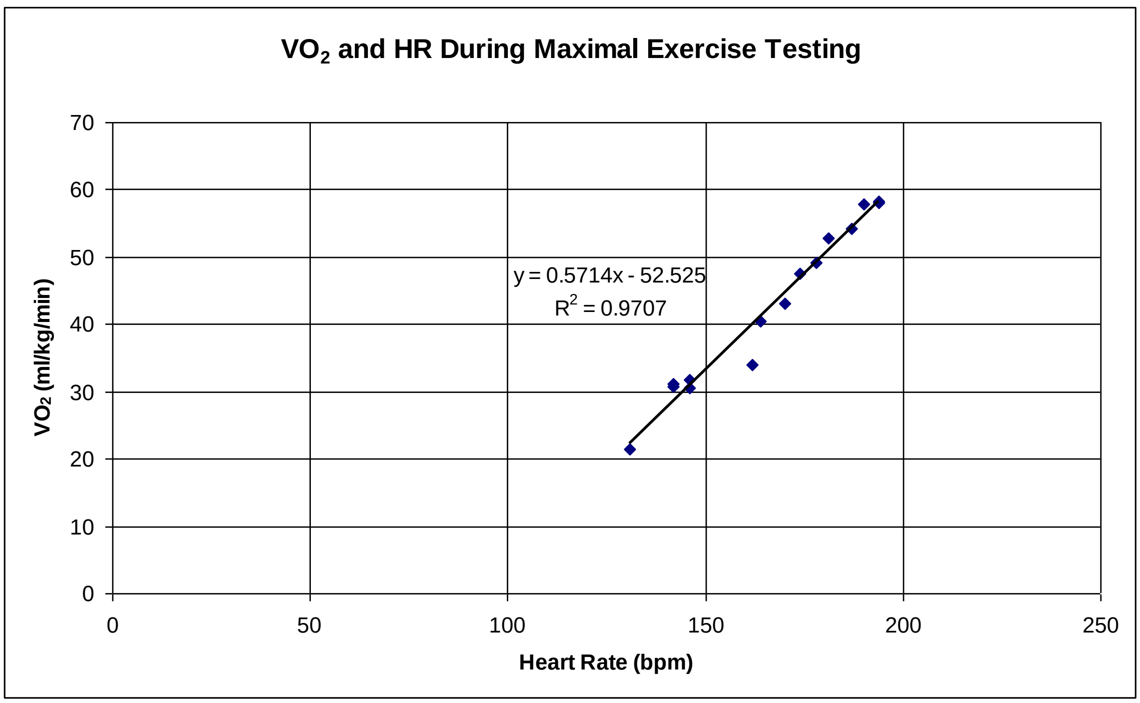


Figure 9. Subject 6 - Regression for Predicting VO_2 Based on TM Exercise

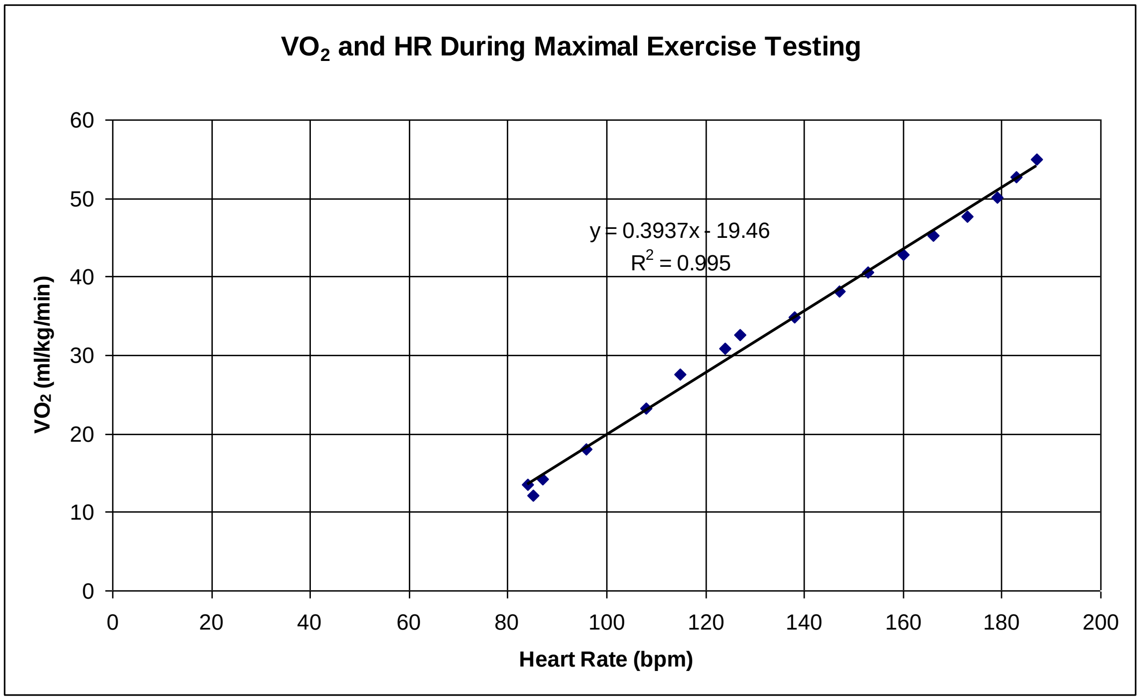


Figure 10. Subject 7 - Regression for Predicting VO_2 Based on TM Exercise

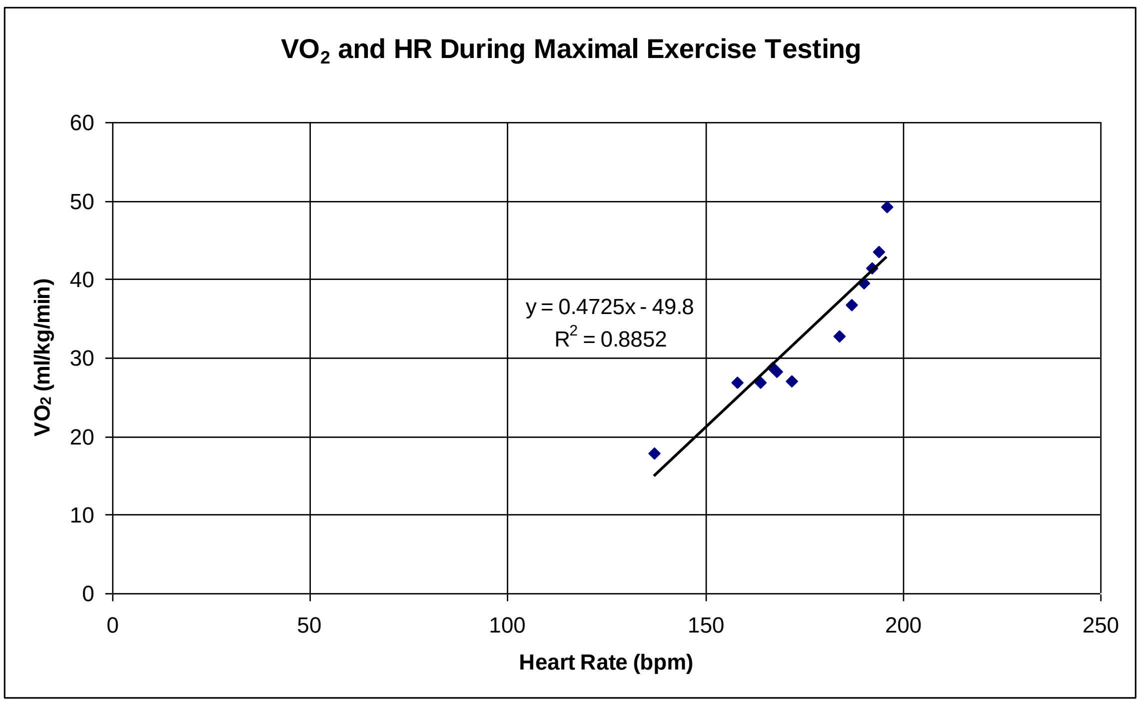


Figure 11. Subject 8 - Regression for Predicting VO_2 Based on TM Exercise

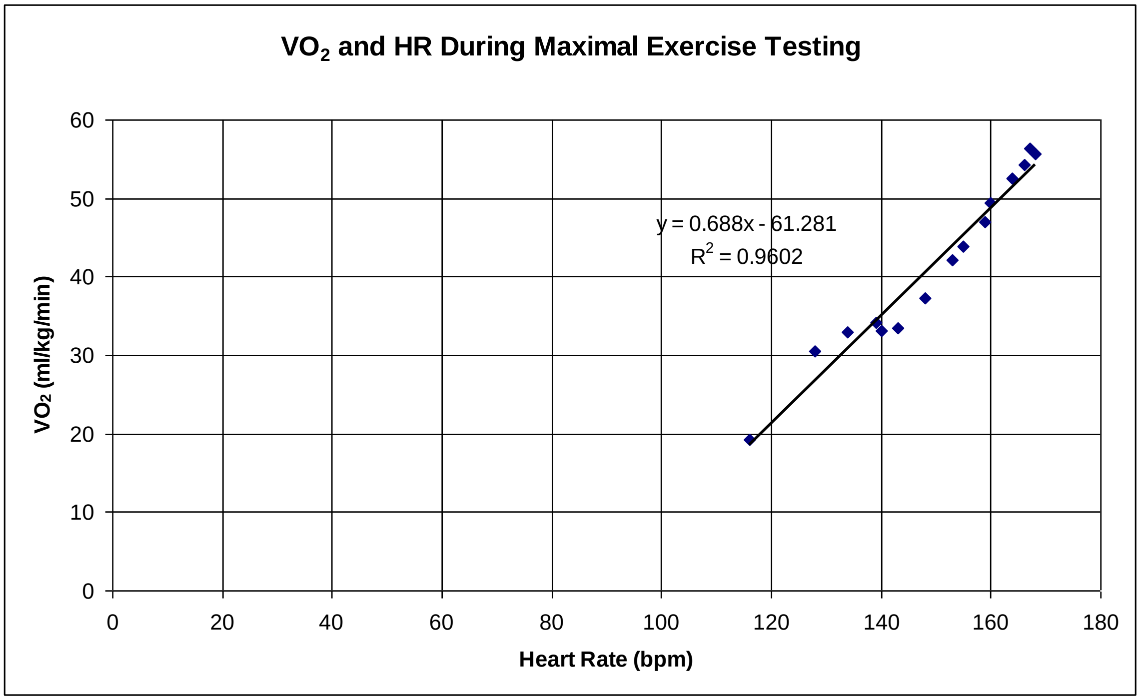


Figure 12. Subject 9 - Regression for Predicting VO_2 Based on TM Exercise

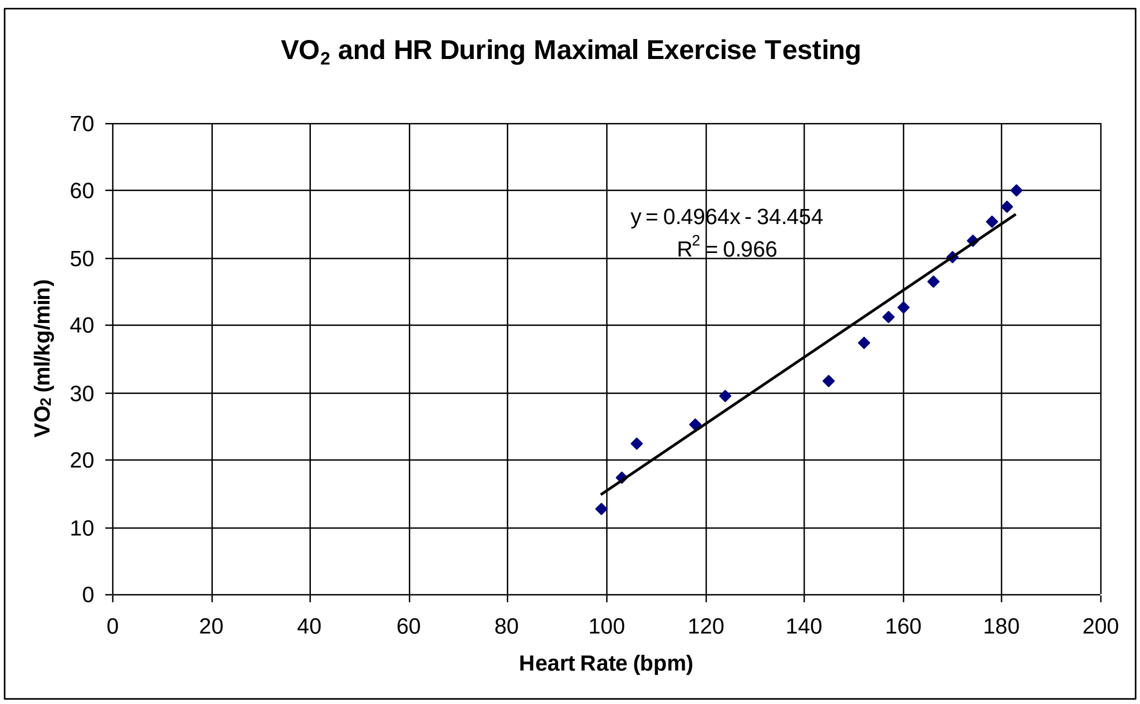


Figure 13. Subject 10 - Regression for Predicting VO_2 Based on TM Exercise

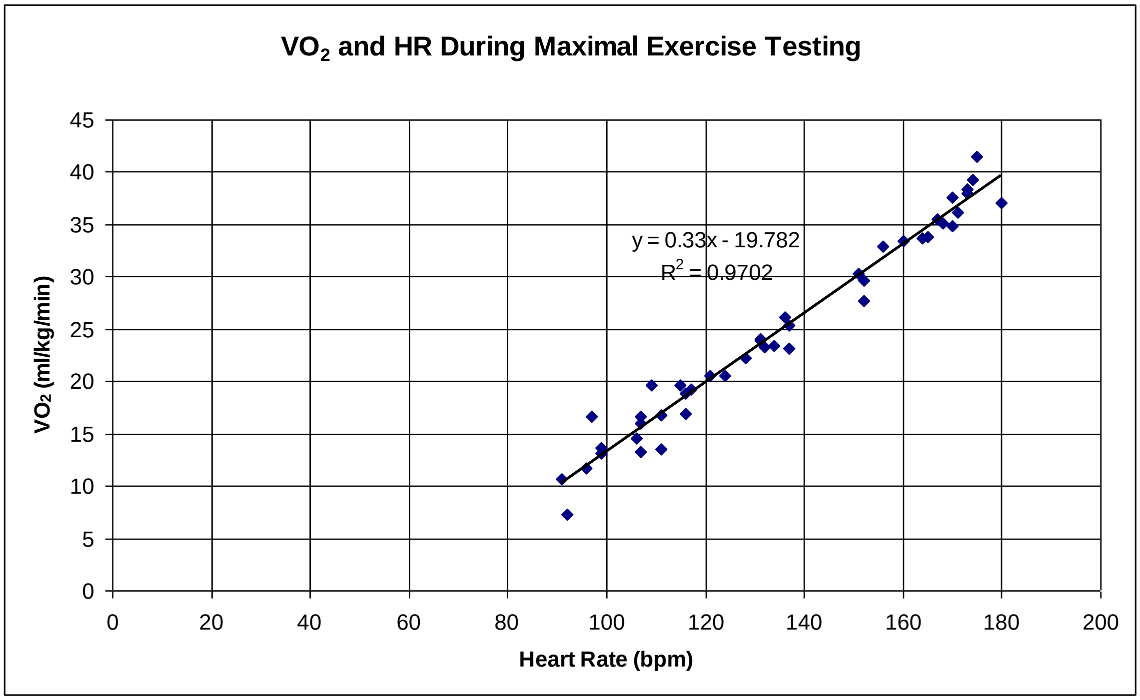


Figure 14. Subject 11 - Regression for Predicting VO_2 Based on TM Exercise

APPENDIX D

REVIEW OF RELATED LITERATURE

REVIEW OF RELATED LITERATURE

Introduction

There is a considerable amount of research that has been conducted in relation to complications associated with strenuous exercise. More specifically, some research has been conducted on hunting activities as it relates to cardiac and ventilatory demands in determining how strenuous hunting activities actually are. These research findings suggest that strenuous hunting activities might be associated with the onset of cardiovascular events (Peterson et al., 1999). No research has been conducted to determine the cardiac intensity of waterfowl hunting and its possible link to the onset of cardiovascular events.

The purpose of this literature review is to recognize the benefits and effects of outdoor pursuits and outdoor recreation on people, establish means for using heart rate (HR) as an indicator of intensity, using a heart rate monitor (HRM) as a valid measurement tool, to acknowledge the risk of strenuous activities, and to establish hunting activities as possible contributors to the onset of cardiovascular events.

The Benefits and Effects of Outdoor Pursuits and Outdoor Recreation on People

In recent years, the United States has seen a new interest for pursuing outdoor activities. In most states, the educational standards for physical education require that secondary students graduate with practical knowledge of outdoor pursuits (Kimbrough, 2007). Natural environment experiences have long been noted for their renewal, developmental, and educational benefits (Hendee et al., 1987). The idea that being in the outdoors is good for people is what powers programs such as Boy and Girl Scouts, as well as the drive for creating more national parks and wilderness areas. The benefits of outdoor experiences have also been supporting reasons for conservation corps programs aimed at the rehabilitation, growth, renewal, and development of young people through outdoor work in the natural environment (Hendee et al., 1987).

According to a monograph edited by Hendee (1987), there have been studies conducted on wilderness experience programs to determine their effect on participants (Hendee et al., 1987). Hendee and Brown developed a theory explaining how wilderness experiences facilitate growth. Their model states that participants must be receptive and ready, experience optimum stress, have cultural change that gives chance for attunement with themselves and the natural environment, and experience wilderness metaphors (Hendee et al., 1987). When these things are assumed to be true, Hendee and Brown recognized four additional ideas or hypotheses about how wilderness experiences can lead to personal growth.

The process includes first having an increased personal awareness of basic patterns of feelings, behaviors, values, and beliefs (Hendee et al., 1987). This is the first step toward personal growth. After increased awareness, there is the opportunity to evaluate the patterns and affirm or change them. This is followed by an increased social awareness (also to be evaluated for possible change) and the primal influences of nature that can result in a sense of humility in relation to the natural world (Hendee et al., 1987).

A similar model was proposed by Walsh and Golins (Sibthorp, 2003). Their model of the adventure learning process included a motivated learner or program participant being placed into a prescribed social and physical environment where he or she masters specific problem-solving tasks (Sibthorp, 2003). The course instructor acts as a guide to ensure that the tasks are both authentic and manageable and provides the necessary feedback to aid mastery which, in turn, leads to participant development (Sibthorp, 2003). To help validate the key factors of personal development from outdoor experiences, Sibthorp did a study that examined if antecedent factors and participant perceptions are related to the participant's changes in self-efficacy. Through extensive research of examining underwater diving programs, Sibthorp found no direct relationship between the antecedent variables and changes in self-efficacy (Sibthorp, 2003).

Since Sidthorp, researchers have been examining more closely the relationship between outdoor recreational experiences and changes in self-efficacy. In a research update written by Kimbrough (2007), self-efficacy was noted as a benefit of outdoor recreation. The update states that gains in mobility and fitness levels can occur from participation in outdoor activities, which then contributes to the participant's overall well-being (Kimbrough, 2007). Kimbrough's research update also points out that outdoor educational experiences have gained a reputation for developing desirable personality characteristics in participants. Experiences like rock climbing, canoeing, orienteering, and camping have been suggested to foster initiative, perseverance, determination, self-restraint, cooperation, and resourcefulness (Kimbrough, 2007).

Often people think that outdoor education makes people tougher by helping them develop a greater ability to deal with real world challenges. According to Kimbrough's research update, outdoor-based education programs have been shown to achieve positive remedial effects on low academic performers. In addition, similar programs for delinquent students appear to contribute to reducing the likelihood of reoffending (Kimbrough, 2007).

In the past decade or so, the growth of outdoor pursuits and adventure programming has been increasing on college campuses. In Taylor's study (Taylor, Gilbert, Kaufman, & Morgan, 2004), 76 students from 8 universities were surveyed on their perceptions of benefits and rankings of the value of outdoor recreation facilities. Over 90% of the people surveyed claimed benefit in each of the following areas: sense of accomplishment, stress reduction, sense of adventure, feeling of well being, outdoor skill, developing friendships, self-confidence, fitness, communication skills, and group cooperative skills (Taylor et al., 2004).

With so many perceived benefits of outdoor activities, it is not a surprise that the use of outdoor pursuits and activities have become increasingly popular in teaching team building. Martin conducted a study that tested the assumption that outdoor pursuits can improve group and individual mental well-being (Martin & Davids, 1995). Twenty-two British professional soccer players attended a five-day development training course conducted by the British Army. The course included both athletic and non-athletic events. A time-series, quasi-experimental design was used in which data concerning self-reported indices of group cohesion and mental well-being were obtained from questionnaires (Martin & Davids, 1995). Surveys were given twice before (the first two months before and another immediately before) and once immediately after the training course was implemented.

The results showed that there was a significant difference between the second set of surveys and the last. There was no difference between the first surveys and the second, so maturation cannot be attributed to the effects (Martin & Davids, 1995). Self-esteem improved significantly, and general stress was reduced significantly from pre/post comparisons using the Newman-Keuls procedure (Martin & Davids, 1995). This data indicates that developmental training courses can improve group cohesion and individual mental well-being (Martin & Davids, 1995).

Using Heart Rate as an Indicator of Intensity

It is well known and accepted that exercise or physical activity increases HRs. It is not surprising then that HR monitoring is often associated with determining the intensity of a particular activity. HR monitoring is one of the most frequently used methods for assessing physical activity in children and adolescents (Ekelund et al., 2001). Although it is not a direct measure of physical activity, it has been proven to be reliable and valid when using chest electrodes.

In the Esposito study (Esposito et al., 2004), the validity of HR as an indicator for aerobic demand was evaluated during soccer activities. Seven male amateur soccer players were tested in both the field and laboratory. The field test consisted of a modified circuit to test soccer players and reproduce important soccer activities. Each subject underwent three trials of this circuit at three different intensities -- moderate, high, and maximal. HR and VO_2 values on the field were evaluated (Esposito et al., 2004).

In the laboratory, each subject participated in an incremental exercise test that resembled three stages of intensities similar to the field test. Again HR and VO_2 values were evaluated. Data analysis and calculations were made to make the data comparable and quantifiable. Results showed that maximal values reached during the exercise test were similar with those found on the field. In addition, the average VO_2 values measured on the field during the different intensities were not statistically different from the intensities estimated from the HR -VO_2 relationship obtained in the laboratory (Esposito et al., 2004). This helps confirm the validity of HR monitoring in determining metabolic demands during soccer activities. The findings in this study might be relevant to other sports or activities where intermittent phases of the exercise are interspersed with continuous aerobic performances (Esposito et al., 2004).

In a study that was intended to demonstrate the use of HRMs in fitness research, Strand and Reeder investigated HR intensity levels of middle school students while they participated in physical education activities. Fifty-five middle school students between the ages of 12 and 13 wore POLAR Vantage XL wireless HRMs during physical education class. Strand and Reeder collected data every 15 seconds during the units of soccer, football, speedball, indoor football, dodgeball, basketball, swimming, volleyball, and wrestling using a chest strap wireless electrode HRM.

In this study by Strand and Reeder (1993), individual training zones of 60% - 90% of HR reserve was determined by obtaining resting HR levels using the Karvonen formula. The data was then analyzed in a number of ways that provided insight into cardiovascular fitness development. Results were reported in terms of means, standard deviations, percentiles, and minutes.

After analyzing and reporting the results for this study, Strand and Reeder (1993) addressed some concerns when using HRMs in research settings. They thought extreme caution must be taken to ensure that the study is not biased by the Hawthorne effect due to the fact that the use of HRMs is a novelty to most individuals (Strand & Reeder, 1993). Secondly, there is the possibility that subjects might start or stop their watches before or after they should (Strand & Reeder, 1993). Strand and Reeder suggest to have a plan in place in case this were to happen. Lastly, the researchers showed some concern for study bias when using the wrist band that beeps as an indication for being in certain zones (Strand & Reeder, 1993).

In the Strath et al. (2000) study, the relationship between HR and VO_2 was examined in laboratory and field settings. A second intent of this study was to examine the validity of using HR data to predict energy expenditure after adjusting for age and fitness. Eighty-one participants performed 1 to 7 activities for 15 minutes, either inside or outside, that were deemed as lifestyle activities. Each participant wore a chest electrode HRM, as well as a portable indirect calorimetry system. Statistical analysis was done to the data using SPSS to demonstrate the relationship between energy expenditure and HR.

The data collected from this study indicates that HR is a moderate physiological indicator of VO_2 during a variety of lifestyle activities (Strath et al., 2000). When adjusting age and fitness levels, HR proved to be a strong indicator of energy expenditure having a correlation of 0.87. This finding could have great practical significance in large-scale studies (Strath et al., 2000).

Ekelund et al. (2001) did a study that examined various definitions of moderate and vigorous intensities of physical activity in adolescents. More specifically, the purpose of this study was to 1) identify the absolute HR and percentages of MHR as they correspond to percentages of peak oxygen uptake, and 2) identify the absolute oxygen uptake VO_2 and percentages of peak VO_2 as they correspond to various HR (Ekelund et al., 2001). Subjects in this study had their HR and VO_2 measured while walking and running on a motorized treadmill after heights and body masses were collected. Subjects were encouraged to exercise on the treadmill until the point of exhaustion. Data analysis was done to the results of the testing to determine peak VO_2, and relationships between results were calculated. Findings indicated that when used as an indicator of specific exercise intensity, absolute HR is influenced by the fitness level of the subject. The data from this study indicates the percentage of MHR is a better approach to defining exercise intensity than absolute HR (Ekelund et al., 2001).

The percentage of MHR appears to give a relevant and easy indication of exercise intensity as long as the method for measuring HR is accurate. Accuracy of HR monitoring has been extensively researched.

Heart Rate Monitors as an Accurate Measurement Tool

HR monitoring began by placing an ear on a patient's chest. In the 1980's, the first wireless HRM was invented. The invention of this piece of technology led to increased monitoring of HRs during exercise. Now HRMs are equipped with incredible memory for recording that can be downloaded into a computer for easy analysis (Achten & Jeukendrup, 2003). Due to the ease of use, this tool has become a favorite in determining exercise intensity. Many different research studies have been conducted on the accuracy of HRMs.

In a study conducted by Terbizan, Dolezal, and Albano (2002), seven commercially available HRMs were assessed for validity. Fourteen apparently healthy men were monitored using a one-channel electrocardiogram (ECG) machine. At the same time, seven different HRMs were attached to the subject. Four chest straps were applied with one chest strap being used for two different Polar monitors, one monitor was attached to the ear lobe, and a hand held unit was given to the subject to be held in both hands. HRs were monitored over four different sessions (rest and three progressively more intense speeds on a treadmill). The HR acquired from each HRM was the average HR determined on the face of the monitor during the same ten-second interval of the ECG recording (Terbizan et al., 2002).

When comparing the results of the HRMs to the ECG data, only four of the HRMs were found to be valid during rest and at the first two speeds of testing. None of the HRMs were valid when testing at speeds of 160.8m per min^{-1} (Terbizan et al., 2002). Two of the four HRMs that proved valid in this test were made by Polar, and they were the only two Polar made HRMs tested (Terbizan et al., 2002). Laukkanen and Virtanen (1998) reviewed the development of Polar HRMs and their measurement accuracy compared to Holter ECG devices.

In this review of literature concerning HRMs, it was noted that Thivierge and Leger did multiple studies reviewing various HRMs (Laukkanen & Virtanen, 1998). In two different studies, Thivierge and Leger (1989) found that HRMs with conventional electrodes are more accurate than monitors using non-conventional electrodes or photo electric sensors placed on either the finger or ear. According to Laukkanen and Virtanen

(1998), Polar HRMs have been known as the most accurate tools for HR monitoring and recording in the field.

A review of HR monitoring was conducted by Achten and Jeukendrup (2003). More specifically, applications and limitations were reviewed based on a collection of studies dealing with HRMs. Along with Laukkanen's review, this review too states that chest electrodes are valid while electrodes placed on fingers, earlobes, or hands are less reliable (Achten & Jeukendrup, 2003). HMRs were also validated in Achten and Jeukendrup's review during mental stress. Therefore, HRMs that utilize chest electrodes are considered to be both reliable and valid during mental and physical stress (Achten & Jeukendrup, 2003).

Treiber et al. (1989) did a three-part study to assess the accuracy of the Sport Tester PE 3000 (Polar Electrode) brand HRM in a variety of exercise settings with young children of a wide age range. The first study took ten 10-year-olds and put them through three continuous exercise loads on an exercise ergometer while monitoring their HR with ECG and the HRM. The coefficients for this study showed validity for the Sport Tester when using the ECG as a criterion during baseline in all three exercise loads. The correlation was between 0.97 and 0.99 respectively (Treiber et al., 1989).

The second study evaluated the Sport Tester with younger children using 23 children between the ages of 4 and 6. An exercise treadmill was the method used for collecting HR data using the ECG and HRMs. A mental imagery challenge was used with the children to increase the likelihood of maximum performance. Following a five-minute rest period, the children were asked to run on the treadmill until exhaustion with a 2% grade increase every minute starting with a 0% grade. Again the ECG and Sport

Tester readings were correlated from 0.93 to 0.99 for all comparisons (Treiber et al., 1989).

The third study used 14 males ages 7 to 9. During this study, children engaged in each of the following six structured playground activities for three-minute durations: a baseline standing period, walking, jogging, throwing a tennis ball for maximum distance every ten seconds, batting a tennis ball pitched every ten seconds, and playing on a jungle gym. Like the previous two studies, HR data was collected using an HRM and ECG. Significant correlations between the Sport Tester and ECG readings were obtained during all six activities. All correlations were greater than or equal to 0.98, and the standard errors of estimate were low during all periods ranging from 1.1 to 2.9 beats per minute (Treiber et al., 1989).

The accuracy and ease of use of HRMs has opened the doors for HR monitoring in field work. The measurement of exercise intensity using HRMs has shed light on the possibility of cardiac risk during exercise.

Acknowledgement of the Risk of Strenuous Activities

The risk of complications during exercise is usually predictable and related to exercise intensity -- at least in active adults (Foster & Porcari, 2001). Studies show that triggering an acute myocardial infarction while exercising is positively related to heavy exertion (Foster & Porcari, 2001; Willich et al., 1993; Willich, Maclure, Mittleman, Arntz, & Muller, 1993). In a study by Franklin, Bonzheim, Gordon, and Timmis (1996), cardiorespiratory activity in ten sedentary men was recorded. Each subject shoveled a mat of four inches of snow off a given amount of paved concrete while collecting HR and

VO_2 data. The results were compared with the same measurements from maximal exercise testing on a treadmill (Franklin et al., 1996).

Results showed that after only two minutes of shoveling, relative HR responses exceeded 85% of the maximal HR. Only one subject remained below 85% of their maximal HR, which is the upper limit of what is commonly prescribed for exercise training. During shoveling, HRs sustained very high levels with the average HR being 175 beats/minute (Franklin et al., 1996).

A different study conducted by Chowdhury et al. (2003), further examined the incidence of sudden cardiac death (SCD) after a snowstorm. The idea for this study came from a research estimation that estimated more than 1,200 people succumb annually to coronary artery disease (CAD) during major snowstorms (Chowdhury et al., 2003; Franklin et al., 1996). This estimation was made before snowplows and other automatic snow removal devices were popular. Chowdhury et al.'s study examined SCD before and after two major snowstorms in the Detroit, Michigan area. The total population of the area being studied was 4.1 million people. Only subjects who experienced SCD secondary to atherosclerotic cardiovascular disease as determined by autopsy evaluation were included in the analysis. These 271 subjects were analyzed by a review of their medical records in additional to performing statistical analysis.

Results for this study showed that 93% of exertion-related SCDs occurred in men compared to 63% of male SCDs that were not related to exertion (Chowdhury et al., 2003). Of the 43 total number of exertion-related deaths, 36 were involved in snow removal with only 3 of those 36 being women (Chowdhury et al., 2003). This study proves that SCD as a result of exertion is very realistic, especially in the male population.

Regular physical activity is known and accepted to reduce coronary heart disease events, but vigorous activity can also acutely increase the risk of SCD and acute myocardial infarction in susceptible populations (Thompson et al., 2007). Recent studies have indicated that HR may be considered as a true risk factor for atherosclerosis (Hall & Palmer, 2008). Understanding the risk of increased HR due to strenuous activity leaves question for strenuous hunting-related activities and how they might be related to SCD.

Hunting Activities as Possible Contributors to the Onset of Cardiovascular Events

It has been established by observation and simulated studies that men can achieve excessive HR responses from other hunting-related activities (Haapaniemi et al., 2007; Kerkhof & Kolars, 1962; Peterson et al., 1999). In a simulated study of hiking and dragging a deer carcass, HRs at or above the aerobic training zone (70 to 85% of the MHR) were observed (Peterson et al., 1999). Peterson et al. (1999) studied 16 subjects in a field and laboratory setting. The field observation consisted of a simulated hike and drag test where walking in heavy clothing while carrying a gun and dragging a deer carcass took place. The laboratory testing studied each subject's HR and VO_2 during maximal exercise testing. Metabolic results from the field and laboratory were analyzed and compared.

Results from this study showed average HR during hiking to be 74% ± 7.0% and peak HR of 83.2% ± 6.0% in terms of percentage of maximal exercise HR. The average HR during dragging was found to be 89.1% ± 4.5% and peak HR of 94.9% ± 4.2% in terms of percentage of maximal exercise HR (Peterson et al., 1999). The data from this study agrees with the study of Haapaniemi et al. (2007) that activities related with deer hunting can place a large demand on the cardiorespiratory system and elicit large hemodynamic responses (Haapaniemi et al., 2007; Peterson et al., 1999).

The study by Haapaniemi et al. (2007) looked at 25 men, 17 of which had CAD, including 13 with previous myocardial infarction. During normal gun deer hunting, the subjects were monitored using ECG. Subjects also underwent testing for a peak or symptom-limited treadmill exercise test (GTX). Mean peak HRs for seven deer hunting activities (walking, sighting, shooting and missing, shooting and hitting, gutting, dragging, and tree climbing) were expressed as percentages of the highest HR attained during GXT (Haapaniemi et al., 2007).

The results from this study displayed dragging HR responses averaging 97% of the MHR, with the highest value observed reaching 116% of the MHR (Haapaniemi et al., 2007). Overall, 22 of 25 subjects demonstrated sustained HR responses over the accepted upper limit commonly prescribed for aerobic training (85% of MHR). Ten subjects exceeded the maximal HR achieved during GXT for one to five minutes (Haapaniemi et al., 2007). This study even displayed abrupt increases in HRs while shooting and hitting a deer at rest.

As mentioned earlier, abrupt increases in HR were displayed in the study done by Haapaniemi et al. (2007) during shooting. According to a study comparing different hunting activities for specialization, waterfowl hunters finished second in specialization, partially because waterfowl hunting requires identification (Miller & Graefe, 2000). In order to identify a duck, the bird must be in close proximity. Because of this, hunters are often forced to hold a shot longer than they care to ensure their target is identified. This anticipation of shooting might cause an increase in HR, much like the data in the

Haapaniemi et al. (2007) study that showed HRs as high as 114% of maximal when the subjects saw a deer.

The results from these studies, especially the Haapaniemi et al. study (2007), suggest that abrupt or extreme responses could lead to symptomatic or silent myocardial ischemia. This threatens ventricular arrhythmias, and the potential for acute myocardial infarction or SCD rises (Haapaniemi et al., 2007).

Summary

In conclusion, HRs have been a great indicator of exercise intensity. HRMs of the chest electrode type have been proven to be a valid instrument in assessing HR and describing exercise intensities. Increasing studies using HRs have proven that there is a correlation and possible causation between unfamiliar and strenuous activities with SCD. With findings regarding strenuous activities and their role in SCD, various hunting-related activities have been looked at in relation to cardiovascular intensities and the risk of the onset of cardiovascular events. No studies have been conducted on the degree of cardiovascular demands during waterfowl hunting, so research regarding HR responses during waterfowl hunting needs to be examined to determine the possible risk of the onset of cardiovascular events.

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