ABSTRACT

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Extrinsic motivation and its effect on exercise performance has been a subject of controversy in the literature. The purpose of this study was to determine whether verbal encouragement would affect the maximal physiological responses and/or exercise duration of sedentary college aged women. Sedentary college aged women (n = 15) performed 2 maxVO_2 tests. During one test the Ss were extrinsically motivated through verbal encouragement to exercise as long as possible. The other test was performed with little or no interaction during exercise between the Ss and the researchers. The test sequence (motivation/no motivation or no motivation/motivation) was randomly assigned. Ss performed each test at the same time of day with at least 24 hrs, but no more than 1 wk between tests. A dependent "t" test indicated that verbal encouragement resulted in sig ($p < .05$) higher maxVO_2 values (41.6 vs 39.3 $ml \cdot kg \cdot min^{-1}$), HR (193.5 vs 189.9 $beats \cdot min^{-1}$), VE (86.8 vs 78.2 $l \cdot min^{-1}$), and test duration (757.1 vs 699.3 seconds). Verbal encouragement, however, did not result in sig ($p > .05$) higher RER values (1.07 vs 1.04) or RPE values (19.1 vs 18.7). This indicates that a maximal effort was given in both tests. Furthermore, there were no sig ($p > .05$) diff when the variables during the first test, regardless of treatment, were compared with the second test. It appears that in sedentary college aged women verbal encouragement sig increases maxVO_2, HR, VE, and test duration. Therefore, when working with this population in exercise programs and classes, it is important to recognize the influence of extrinsic motivation in the form of verbal encouragement.

MOTIVATION DURING MAXVO$_2$ TESTING

OF SEDENTARY COLLEGE AGED WOMEN

A Thesis Presented

to

The Graduate Faculty

University of Wisconsin - LaCrosse

In Partial Fulfillment

of the Requirements for the

Master of Science Degree

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by

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of this candidate's requirements for the degree:

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CHAPTER I

INTRODUCTION

MaxVO_2 testing has been a method for determining exercise guidelines for years. Achievement of a true maximal effort by the subject is one of the greatest concerns when assessing an individual's maximal aerobic capacity. Testing protocols have been carefully developed to standardize progression of effort throughout each test. Equipment of extremely intricate design is now being used to insure the accuracy of data collected. With every effort being made to use appropriate protocol and to insure precise instrumentation, it is important that a truly maximal effort is given. This effort may be influenced by motivation factors.

Motivation is not a new topic in the field of physical education. According to Shepard (1985) motivation is the key to fitness compliance. Kircher (1984) indicated that motivation can be defined as a factor of perceived exertion in purposeful activity. It would seem that with motivation playing such a large part in sport and exercise that it would also gain attention in the area of maxVO_2 testing. Very little research, however, has been conducted in this area.

There are several extrinsic rewards which may motivate the individual to improve the quality or quantity of the task being performed. Among these extrinsic rewards is the interjection of verbal encouragement during activity. There is some controversy in the literature as to whether extrinsic motivation actually increases intrinsic motivation. Several researchers (Snyder, 1983; Kruglanski, Friedman & Zeevi, 1971; Weinberg & Jackson, 1979) all concluded that external rewards do not increase intrinsic motivation and may actually cause a decrease in task performance. This negative effect of external rewards has also been supported in the research of McCaughan and McKinlay (1981) and Kruglanski et al. (1971). In contrast, Wilmore (1968) found subjects to be significantly motivated through competitive situations. Deci (1971) determined that motivation in the form of monetary reward decreased intrinsic motivation while motivation in the form of verbal encouragement actually increased motivation in task performance. Similarly, Martin's et al. (1984) research suggested the importance of social support, feedback and praise during exercise. It remains to be determined whether this same type of condition would elicit a similar response during maxVO_2 testing.

Motivation plays an important role not only in sport, but in every day tasks. Very little research, however, has been done on the effect that motivation has on maximum oxygen consumption. MaxVO_2 testing is often utilized in sport, exercise, fitness and cardiopulminary rehabilitation facilities to evaluate fitness variables and cardiovascular performance. It should be of interest, therefore, to those in the field of physical education as to whether or not extrinsic motivation will affect maxVO_2 test results.

Purpose

The purpose of this study was to determine whether motivation in the form of verbal encouragement would significantly affect the maximum physiological responses and/or exercise duration of sedentary college aged females during a maxVO_2 test.

Hypothesis

The major hypothesis of this study was that motivation in the form of verbal encouragement would not affect physiological responses (i.e., oxygen consumption, heart rate, ventilation and RER) during maxVO_2 testing of sedentary college aged females.

In addition, it was also hypothesized that motivation in the form of verbal encouragement would not increase exercise duration during maxVO_2 testing of sedentary college aged females.

Assumptions

It was assumed that the subjects would consider verbal encouragement a positive motivation to exercise.

It was also assumed that the subjects would respond to verbal encouragement rather than some other unaccounted for extraneous variable.

Another assumption was to trust the subject not to injest food within two hours prior to testing.

It was assumed that no physical changes nor training occurred between tests.

Delimitations

The same researchers conducted testing throughout the study. No one but the researcher, an assistant and the subject were in the laboratory during any testing. Subjects were tested only when no further outside stimuli (e.g., other people entering the laboratory), other than those which the researcher conducting the test wished to impose, would interfere.

Testing and retesting were performed within a two week period using the same protocol for all subjects. Both tests were done at approximately the same time of day for each participant.

Fifteen sedentary, college aged (18-25 years) female volunteers were studied.

Prior to the initial test, the researcher determined whether to test the subject with or without motivation for the first test using a random replacement method.

Clocks were covered or removed from the laboratory (i.e., wall clocks were covered with a towel, clocks which could be moved were taken out of the laboratory during any test, etc.)

Limitations

A small sample size was studied. The sample consisted of volunteers who may have reacted differently to verbal encouragement than the average population (i.e., volunteers are generalized as a group of individuals who are eager to please). Individuals within the sample were selected from a relatively small, homogeneous college community.

Definition of Terms

Rating of Perceived Exertion (RPE) - subjective value selected by the subject which best represents the overall level of difficulty of the activity. Values were chosen from the Borg and Noble (1974) Scale of Perceived Exertion (see Appendix A).

Extrinsic Motivation - an external reward (verbal encouragement) given by the experimenters used to stimulate the individual toward increase in achievement.

Intrinsic Motivation - an innate or learned desire to perform a task or activity with no apparent rewards except the activity itself.

Sedentary - individuals who perform aerobic exercise less than two times per week for thirty minutes, who had not been involved in any type of organized exercise program which consisted of aerobic activity in the past two months prior to testing, and who had not participated in vigorous sporting events on a regular basis in the two previous months.

Maximum Oxygen Consumption (maxVO_2) - the greatest rate of oxygen uptake, expressed in both absolute and relative units, observed during exercise using treadmill running which continued to increase in intensity until the individual being tested felt she could no longer continue exercise at the given workload and had achieved an RER greater than 1.0.

Beckman Metabolic Measurement Cart (BMMC) - a programmable, automated, open circuit system which analyzes expired air with the OM-11 and LB-2 to determine oxygen and carbon dioxide concentrations. The calculations of oxygen consumption, respiratory exchange ratio, and minute ventilation are determined via the calculator which coordinates operation of the measurement system.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

Coaches and athletic trainers have recognized the importance of motivating their athletes for years. Controversy exists, however, as to whether motivation is always effective. It appears that certain types of motivation are perceived differently in different situations. The following is a review of literature and research in the areas of maximal oxygen consumption and motivation.

Maximal VO_2 Testing

Many tests have been designed to measure maximal oxygen consumption, which is defined by the American College of Sports Medicine (1986) as the greatest rate of oxygen uptake observed during exercise which is indicated by failure of oxygen consumption to increase with external work. The body's metabolic processes utilize oxygen and produce carbon dioxide continuously at rest and during activity. Energy output, therefore, is directly related to respiratory gases. The two methods used to measure these values are the closed or open circuit air procedures. The closed circuit method involves conducting expired air back to an oxygen chamber by way of a soda lime cannister where the CO_2 produced is absorbed (deVries, 1980). The changes in the volume of oxygen that remains in the chamber is a measurement of metabolism over a period of time. In the open-circuit method, the subject inspires directly from the atmospheric air, the expired air is collected and is then analyzed for its oxygen and carbon dioxide content. Differences between the expired sample and the atmospheric air gives a measure of oxygen consumption (deVries, 1980).

MaxVO_2 testing is an accurate and reliable method for measuring cardiorespiratory fitness levels. Research by Katch, Sady and Freedson (1982) showed that when re-testing the same individual's maxVO_2, only 10% of the variability in results was accounted for by technical error. Biological variability accounted for 90% of the difference between tests. This research indicates that if measures are taken to prevent technical error, any variation in results would be inherit to the individual rather than procedure.

The reliability of a maxVO_2 test also depends on whether certain protocol criteria are followed. Several sources suggest similar guidelines to follow when measuring maximal oxygen consumption. According to Astrand and Rodahl (1986) a maxVO_2 test should meet the following criteria: the exercise should involve large muscle groups; oxygen uptake should be initiated when the exercise has lasted a few minutes to permit the oxygen uptake to reach its maximum; and, the workload must be measureable and capable of being reproduced. Wilson, Fardy and Froelicher (1981) defined the guidelines for measuring maximal oxygen uptake as: (1) using a large portion of the muscle mass in familiar dynamic exercise; (2) precise gas measurement techniques must be used; (3) workloads must increase progressively to fatigue; and, (4) minimize testing time to lessen endurance effects. DeVries (1980) suggests using any method for measuring maximal oxygen consumption which involves working subjects at ever-increasing work loads. When an increased work load fails to elicit significant increases in oxygen consumption, he states that the highest value obtained represents maxVO_2. The American College of Sports Medicine (1986) and the American Heart Association (1972) both recommend that maxVO_2 testing should be graded and that the initial workload should not exceed 3 METs for poorly conditioned individuals. The workloads should increase gradually and not progress more than 2 METs per stage. Also, each stage of a continuous test should be at least one minute long. These criteria were used in the current research to ensure proper maxVO_2 testing.

Classifications of cardiorespiratory fitness levels have been developed and are used to analyze maxVO_2 results. The American Heart Association (1972) classifies cardiorespiratory fitness of women age 20-29 as follows: less than 24 $ml \cdot kg \cdot min^{-1}$ - low, 24-30 - fair, 31-37 - average, 38-48 - good, and greater than 49 - high.

In laboratory experiments, three general methods are used to produce maximal efforts: running on a treadmill, exercising on a cycle ergometer, or using a step test. The method or protocol used for determining maxVO_2 varies depending on the preference of the researcher and/or the purpose of the investigation. The most common method used for maxVO_2 testing is the treadmill according to Jopke (1981). Research conducted by Astrand and Rodahl (1986) suggests that cycling produces a lower oxygen uptake compared to maximal uphill treadmill testing. Reported values for treadmill testing were, on the average, 4 to 8 percent higher than for cycle ergometer testing. This could be due to the fact that walking and running are familiar activities to most individuals whereas other modes of activity are less familiar, especially in the sedentary individual. Methods of exercise testing such as cycling are often limited by localized muscle fatigue rather than cardiovascular fatigue.

Many protocols are used in treadmill maxVO_2 testing today. Pollock, Bohannon, Cooper, Avres, Ward, White and Linnerud (1976) analyzed four commonly used protocols to evaluate each protocol's ability to assess maximal cardiopulminary responses. They found that of the four tests studied, the Balke, Bruce, Ellestad, and Modified Astrand, the Modified Astrand elicited the highest maximal values for heart rate and VO_2. The Modified Astrand also involved the shortest test duration for the sedentary group which was tested. Therefore, a modification of this protocol, preceded by a warm-up of 3.5 miles per hour at 10 percent grade, was selected for use in the current investigation.

Motivation

The measurement of maximal oxygen consumption requires a willingness on the part of the subject to work to exhaustion. According to deVries (1980) this condition is difficult to achieve in sedentary adults. It is important, therefore, to determine what methods are most effective in achieving a maxVO_2 test. Controversy in research exists, however, as to whether external rewards elicit an increase in internal motivation.

The Negative Effect of Reward

In their 1971 study of motivation, Kruglanski et al. (1971) attempted to answer the question: does extrinsic motivation significantly increase creativity, enjoyment and quality of task performance? Extrinsic motivation is an external reward which is given to stimulate an individual toward increase in achievement. In Kruglanski's et al. study, teenagers of both sexes were tested under two experimental conditions on a variety of creativity and memory tasks to determine whether extrinsic motivation in the form of reward would increase test performance. A significant decrease was found in quality of task performance and motivation in the presence of extrinsic incentives. The reward in this study was a tour of the laboratory facility.

Snyder (1983), in his research of commitment to sport, concluded that motivational rewards such as money, awards and favors often cause less emphasis on intrinsic motivation. He believes that individuals are naturally motivated to participate in sport activities as a form of arousal-seeking. He feels that humans are propelled by curiosity, challenge, exploration, investigation and wonder. When an individual is intrinsically motivated, the introduction of an external reward will often cause a shift from the intrinsic to the extrinsic side. He cited big time collegiate and professional sports as an example of this phenomenon. Another case of this is evident in the shift from the playful and fair play of children's informal games to an emphasis on competition and winning (extrinsic) in the more formal sports of older youths.

Weinberg (1981) suggested that young athletes may begin to perceive sports involvement as being controlled by the pursuit of trophies or other similar extrinsic rewards. Specifically, if a young athlete perceives the reward to be controlling his or her participation, then this will lead to a shift in locus of cause from internal to external, thus decreasing intrinsic motivation. McCaughan and McKinlay (1981) found that teenaged girls produced higher levels of intrinsic motivation after success without a reward than following failure with a reward.

Positive Effect of Reward

Deci (1971, 1972) conducted several studies involving the effect of external rewards on intrinsic motivation. His results suggest that the effect which an external reward has on intrinsic motivation depends largely on the form of external motivation. In a study conducted in 1971, he found that when money was used as an external reward for an activity, intrinsic motivation was decreased. In contrast, when motivation in the form of verbal reinforcement and positive feedback were used, the opposite occurred. Deci concluded that when external rewards such as money were given for an intrinsically motivated activity, the money may have worked to "buy off" the subject's intrinsic motivation for the activity. On the other hand, rewards such as verbal encouragement may have increased motivation due to the fact that the subject was less likely to think of verbal approval as a control mechanism.

Weinberg and Jackson (1979) studied the effect that monetary reward had on intrinsic motivation. In their research they tested college-aged males and females on simple task performance in the form of balancing on a stabilometer. Half of the students were offered monetary rewards for completion of the task above the seventieth percentile rank and the other half of the group was given no external motivation to perform well. They found that monetary reward had a negative effect on intrinsic motivation. Conversely, they found that telling their subjects that they were "successful" at the task being performed resulted in a significant increase in intrinsic motivation. Intrinsic motivation was determined by questionnaire. These results indicate that positive feedback is a more effective extrinsic motivator than monetary reward.

In his study of the influence of motivation on physical work capacity and performance, Wilmore (1968) found subjects to be significantly motivated through a competitive situation. Subjects who competed against a partner or against their own previous test time on a bicycle ergometer had a statistically higher mean work output and riding time than those in a control group who had no competition. He found that physiological variables such as maxVO_2 and heart rate were essentially fixed or absolute for any individual who was tested and then re-tested on the same apparatus (i.e., bicycle ergometer). He concluded, however, that test endurance may be inhibited by psychological barriers. It was suggested that either one or both of the afore mentioned competitive situations broke down psychological inhibitions and resulted in an incresed or "supramaximal" test performance.

Kircher (1984) determined that when a participant perceived an activity as being purposeful, he or she would be motivated to perform the task. In her study, half of the subjects exercised via jumping a rope, defined as a purposeful activity. The other half jumped in place without a rope, defined as nonpurposeful activity. Kircher found that those subjects jumping with a rope had a longer exercise duration and a decreased fatigue perception on the Borg scale. She concluded that task purposefulness acted as an external motivator. It appears, therefore, that task motivation is largely influenced by the type of reward involved.

According to Pennebaker and Lightner (1980), people who are exercising at high intensities are less likely to process internal sensations if the external sensation is demanding or interesting than if it is undemanding and redundant. To research this hypothesis, they performed two sets of experiments. In the first experiment, physical performance (i.e., speed) was held constant during exercise on a treadmill. The subjects were then given a tape of street sounds, instructed to listen to their own breathing or nothing at all. Results indicated that subjects hearing the distracting street sounds reported less fatigue and fewer symptoms than subjects hearing an amplification of their own breathing. In the second experiment, subjects ran on either a cross country or circular lap course. They found that subjects on the cross country course traveled faster than the lap runners. The researchers felt that processing external information reduced the capacity of the person to process internal cues to the same degree. The conclusion of these studies, therefore, indicated that non-elite runners who focus on external cues will have enhanced performance during exercise.

In a similar study, Weinberg, Smith and Jackson (1984) found that dissociation and positive self-talk treatments produced a significant increase in task persistence in exercise activities which were unfamiliar to the subject. In contrast, these treatments had no effect in activities with which the subjects were familiar. In their study, subjects either ran for thirty minutes or performed a leg-lift task. Subjects were asked to use association, dissociation or positive self-talk cognitive strategies throughout both activities. These subjects were runners and, therefore, it was hypothesized that they had established strategies to enhance running endurance. The researchers felt that these established strategies conflicted or competed with the strategies they were told to employ for the experiment. Therefore, dissociation and positive self-talk had no effect on this familiar activity. Conversely, during the leg-lift task, an unfamiliar activity, results revealed that the dissociation and positive self-talk treatments produced significantly greater persistence.

The Effect of Motivation on Attendance

Wankel, Yardley and Graham (1985) hold the belief that behavior can be explained in terms of environmental factors, particularly external stimuli and the resultant reinforcement, without concern for the psychological characteristics of the individuals involved. In their study of exercise program attendance, they found structured social support to have a significant positive effect on exercise participation.

Similarly, Martin's et al. (1984) research results suggested the importance of social support, feedback and praise during exercise. They found that individualized feedback and praise provided by an instructor during exercise resulted in better attendance than did group-based feedback and praise given following exercise. The individualized praise/feedback group also exercised more on their own and continued to exercise more after the end of the program than did the control group. These studies suggest then that external motivation in the form of social support, verbal encouragement and praise will have a positive effect on intrinsic motivation. This is in contrast to external reward in the form of money, awards, or trophies which appear to have a negative effect on intrinsic motivation as was mentioned earlier. This appears to be especially true when the participant is unfamiliar with the activity according to Weinberg et al. (1984).

The Effect of Motivation on Strength

Rube and Secher (1981) found that subjects attempting to perform maximum voluntary contractions experienced more pronounced fatigue when verbally encouraged than during the non-encouraged contractions. Subjects in this study performed one and two legged maximum voluntary contractions. Less work was done when the exercise was verbally encouraged. Regardless of the type of exercise performed, fatigue was more pronounced during the encouraged than during the non-encouraged contractions.

Motivation and maxVO_2

The question of whether verbal encouragement will increase maxVO_2 remains unanswered. DeMeersman, Schaefer and Miller (1984) conducted a study to determine whether females exhibiting type A or type B behavior patterns would exert greater effort and work to higher levels of fatigue when verbally encouraged by an experimenter versus being self-motivated. Twenty female subjects, half of them classified as Type A and half as Type B, were administered a graded exercise test to determine their maxVO_2 value. On the first test no encouragement was given by the experimenter to the subjects. During a second test, each subject was continuously encouraged by the experimenter to maintain exercising until incapable of further work.

No significant differences between Type A and Type B subjects in either self-motivated or experimenter motivated exercise tests were found. However, when verbally encouraged by the experimenter, both groups of women pushed themselves significantly longer. It was concluded that this was in response to perceived social evaluation.

Butts, Jensen and Lui (1982) in their study of motivation during maxVO_2 testing of intercollegiate female cross country runners found no significant difference in maxVO_2 when the runners were verbally motivated by the experimenter versus no verbal encouragement. They did, however, find a significant increase in heart rate and test duration with verbal encouragement. It was concluded that in highly trained female competitive runners, extrinsic motivation in the form of verbal encouragement may enhance treadmill running time. It appears, however, that verbal encouragement does not significantly increase maxVO_2 values in the college aged woman athlete.

The psychological aspects of exercise and how to enhance performance through alteration of various factors has been of interest to many researchers in the field of physical education (Butts et al., 1982; Deci, 1971, 1972; DeMeersman et al., 1984; Kircher, 1984; Kruglanski et al., 1971; Martin et al., 1984; McCaughan & McKinlay, 1981; Pennebaker & Lightner, 1980; Rube & Secher, 1981; Snyder, 1983; Wankel et al., 1985; Weinberg, 1981; Weinberg & Jackson, 1979 and; Wilmore, 1968). The specific question of whether verbal encouragement will increase maxVO_2 in the sedentary individual remains to be answered.

Summary

$MaxVO_2$, defined as the greatest rate of oxygen uptake observed during exercise, is measured either through closed or open circuit air procedures. Most commonly used for testing of apparently healthy individuals is the open circuit method. Criterion for $maxVO_2$ testing include: exercise should involve large muscle groups; the workload should be measureable and reproduceable; subjects should exercise at ever-increasing workloads; precise gas measurement techniques should be used; and, testing time should be minimized to lessen endurance effects. In laboratory experiments, three general methods are used to produce maximal efforts: running on a treadmill, exercising on a cycle ergometer, or using a step test. Studies have shown treadmill testing to be most effective in producing a maximal cardiovascular effort.

The measurement of $maxVO_2$ requires willingness on the part of the subject to work to exhaustion. This is often difficult to achieve in sedentary adults. Controversy in research exists as to whether external rewards actually elict an encrease in internal motivation. Several studies have concluded that motivational rewards such as money, awards and favors actually cause a decrease in intrinsic motivation. It appears that motivation of this type leads to a shift in a locus of cause from internal to external, thus decreasing intrinsic motivation. In other words, the individual perceives the reward to be controlling his or her participation and, therefore, does not enjoy the game itself.

Other studies have suggested that the effect of an external reward on intrinsic motivation depends largely on what the external motivator consists of. While money, awards and trophies appear to decrease intrinsic motivation, external motivation in the form of social support, praise and verbal encouragement seem to have a positive effect on motivation for task performance. This has been found to be especially true in cases where the individual was unfamiliar with the activity being performed.

Research in the area of verbal encouragement during maxVO_2 testing suggests that individuals who are verbally encouraged throughout exercise will continue to exercise significantly longer than those who are not. The purpose of this study was to determine whether verbal motivation during maxVO_2 testing of sedentary college age women would not only increase test duration, but also maximal oxygen consumption.

CHAPTER III

METHODS

Introduction

This study was designed to evaluate whether motivation in the form of verbal encouragement would affect $maxVO_2$ and/or duration of activity in a maximal running effort.

The research methods employed for this study are presented in this chapter and consist of sample selection, motivation selection, test mode selection, test procedure, data collection and statistical treatment.

Sample Selection

Fifteen college aged, sedentary female volunteers were recruited from the University of Wisconsin-LaCrosse. Subjects were excluded from the study if: a) physical disabilities would not allow them to exercise (e.g., inability to walk on a treadmill without support); b) the individual was a smoker; or, c) they failed to complete two $maxVO_2$ tests.

Prior to any testing, the subject and the researcher reviewed a letter of informed consent (see Appendix B). Subjects were informed of potential risks involved in the study and understood that they could withdraw from the study at any time. Both subject and researcher then signed and dated the form. Physical characteristics (i.e., height, weight, age, etc.) of subjects were recorded on data sheets.

Motivation Selection

Verbal encouragement was the extrinsic motivation used in this study. Subjects were encouraged with positive feedback and verbal reinforcement (e.g., "good job", "you're doing better than most people have done", "can you go 30 more seconds?", etc.) during one of their two maxVO_2 tests. Deci (1971) found that verbal encouragement as an extrinsic motivator increased intrinsic motivation in purposeful tasks.

Test Mode Selection

For this research, the treadmill was the selected mode of activity. Walking and/or running are activities with which most individuals are familiar and comfortable. According to Jopke (1981), the treadmill is used in 71% of all maxVO_2 testing. Subjects were tested using the protocol shown in Appendix C. All subjects were monitored for heart rate and abnormal responses with an electrocardiogram throughout the test. Testing methods and procedures were similar to those used by Butts et al. (1982).

A Rating of Perceived Exertion Scale was utilized in the study (see Appendix A). This scale, developed by Borg in 1970, was used to obtain further information on exercise intensity.

Test Procedures

Each subject had a practice session on the treadmill prior to the actual exercise test. Walking on the treadmill was demonstrated by the researcher. Subjects were shown how to straddle the treadmill, how to walk properly while on the belt of the treadmill, how to dismount from the treadmill upon completion of the test and how to use the Borg Scale of Perceived Exertion.

The Beckman Metabolic Measurement Cart (MMC), which consists of a carbon dioxide analyzer (LB-2) and an oxygen analyzer (OM-11), was calibrated prior to each test. Calibration of the MMC was performed with a known gas sample previously determined by the Scholander technique. Temperature and pressure were adjusted to agree with external calibration references, water pressure was set at 50 inches on the vacuum gauge and the volume flowmeter was adjusted to stop drift.

Subjects returned a questionnaire (see Appendix D) regarding their level of physical activity prior to the initial test date. Individuals were eliminated from the study if they performed aerobic exercise more than two times per week for thirty minutes, if they had been involved in any type of organized exercise program which consisted of aerobic activity or if they had participated in vigorous sporting events on a regular basis within the previous two months.

An informed consent form (see Appendix B) was explained and signed by each subject before practice session of the initial exercise test.

Subject Preparation

Subjects were instructed not to eat for two hours prior to arriving at the Human Performance Laboratory. Participants were also asked to arrive in comfortable clothing and proper shoes for exercising. Upon arrival, subjects were weighed with their shoes on to the nearest half pound and their height was measured to the nearest half inch. Their weight, height and age were then recorded on a data sheet.

Each subject was prepared for electrocardiogram monitoring with a three lead CM5 arrangement. The skin was cleansed with alcohol and then abraded prior to electrode placement. Leadwires were attached and the subject was then connected to a Burdick single lead electrocardiogram. The ECG strips were taken during the last 15 seconds of each minute. Heart rates off each fifteen second strip were then counted, multiplied by four, and recorded on the data sheet (see Appendix E).

When electrocardiogram preparation was completed and subject characteristics were recorded on data sheets, the subject was prepared for metabolic measurements by fitting a head piece and nose clip.

Experimental Procedures

The researcher selected, with a flip of a coin, the order in which the tests were to be given. Testing was done at a time when no external stimuli, other than those imposed by the researcher, would interfere with test results. Clocks were covered or removed from the laboratory.

Prior to beginning the first test, subjects practiced walking and then running on the treadmill at 3.5 and 5.0 miles per hour. A five minute warm-up period was conducted before each maximal test at a speed of 3.5 miles per hour and 10 per cent elevation. Immediately following the warm-up period, subjects began exercising on the treadmill at 5 miles per hour with no elevation. The intensity of exercise was increased every two minutes by increasing the elevation 2.5 percent (see Appendix C). Heart rate, ventilations, $mlO_2 \cdot min^{-1}$, $mlO_2 \cdot kg \cdot min^{-1}$, VCO_2, RER, $FeCO_2$, FeO_2 and perceived exertion were recorded at the end of each stage (see Appendix E). A maximal effort was determined as being the point at which the subject could no longer continue exercise at the given workload and an RER of at least 1.00 had been reached.

The second $maxVO_2$ test was completed no less than 48 hours, but no more than two weeks following the initial test. Whenever possible, second tests were performed at the same time of day as the first test. Tests were all performed on week nights by the same researcher and assistant each time. Doors were locked, windows were covered, clocks were covered, and no one but the experimenters and subject were in the laboratory throughout testing. All conditions were identical during both tests with the exception of the verbal encouragement variable which was randomly assigned to be given during either the first or second test. Subjects who inquired as to the purpose of the test were told that maxVO_2 test/retest reliability was being studied.

Data Collection

Data collection sheets were designed to record pertinent information throughout the test (see Appendix E). These factors included: heart rate, ventilations, $mlO_2 \cdot min^{-1}$, $mlO_2 \cdot kg \cdot min^{-1}$, VCO_2, RER, $FeCo_2$, FeO_2, perceived exertion and test duration. Data were collected throughout the maxVO_2 test at the end of each two minute stage. If the subject was not at least thirty seconds into the stage, the data from the end of the previous stage were used.

Statistical Treatment

Upon completion of testing, the results were analyzed to determine whether or not significant differences existed between maxVO2 testing with verbal encouragement and testing without verbal encouragement. In addition to means and standard deviations, a dependent "t" test was calculated on all performance variables for the two tests. A dependent "t" test was also used to analyse the first and second test to determine if there was any learning effect. The level of significance was represented by a probability (p) value of .05 or less to test the hypotheses for this study. Statistical analyses were performed using the Epistat computer program.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

This chapter presents the results obtained from the study of extrinsic motivation in the form of verbal encouragement and its effect on the physiological parameters of maxVO_2 testing.

Fifteen sedentary college aged women performed two maximal exercise tests on the treadmill. The subjects' metabolic measurements were recorded throughout each test. A dependent "t"-test was used to analyze the differences found between tests performed with verbal encouragement and those without.

The physiological parameters measured in this study included the maximal values for heart rate, VO_2 (ml·kg·min^{-1}), volume of expired ventilation (VE), rate of perceived exertion (RPE), and respiratory exchange ratio (RER). Test duration was also measured and compared. This chapter discusses the subject selection, physical characteristics, testing parameters and analyses of the test variables.

Subjects

The subjects were fifteen sedentary college aged women from the LaCrosse campus and community who volunteered to complete two maxVO_2 tests. Each participant filled out a questionnaire (see Appendix D) to determine whether they were sedentary according to the study definition.

Table 1. Mean and Standard Deviation of Subjects' Physical Characteristics (n = 15)

Variable	Mean	Standard Deviation
Age (yrs)	20.3	1.9
Weight (kgs)	62.4	7.6
Height (cms)	165.2	5.9

According to Behnke and Wilmore's (1974) reference woman, the subjects in this study were slightly taller and heavier than average for their age (see Table 1).

Testing Parameters

Two maxVO_2 tests were performed on each subject (n=15). The first test was randomly assigned by the flip of a coin to be either with or without extrinsic motivation in the form of verbal encouragement. The second test was then performed using the opposite condition with no less than forty-eight hours and no more than one week after the first test. Tests were done at the same time of day under identical conditions except one test was performed with verbal encouragement and the other was performed with little or no interaction during exercise between the subject and researcher.

Throughout each test, metabolic measurements were continuously monitored and recorded at the end of each minute. Statistical analyses of the maximal data collected and a discussion of the results are included in this chapter.

Physiological Characteristics

Physiological responses to maxVO_2 tests on the treadmill with and without extrinsic motivation are shown in Table 2. Variables included maximum VO_2 (ml˙kg˙min^{-1}), VO_2 (l˙min^{-1}), heart rate (beats˙min^{-1}), VE (l˙min^{-1}), RER, RPE, and test duration.

In order to determine whether any variable was influenced by the test re-test protocol each variable from the initial test, regardless of treatment, was compared to the results of the second test. Mean values from the first and second test were compared using a dependent-"t" test and no significant ($p > .05$) differences were found. This indicated that the differences found between physiological variables were due to the treatment (verbal encouragement) and not a learning effect.

Table 2. Physiological responses of sedentary college aged women to maxVO_2 tests with and without verbal encouragement.

Variable	With Extrinsic Motivation	Without Extrinsic Motivation
VO_2 (ml˙kg˙min^{-1})	41.6 4.8	39.3** 4.9
VO_2 (l˙min^{-1})	2.59 .44	2.45* .44
Heart Rate (beats˙min^{-1})	193.5 7.0	189.9** 7.2
VE (l˙min^{-1})	86.8 15.2	78.2** 14.2
RER	1.07 0.05	1.04 0.04
RPE	19.13 .52	18.67 1.11
Test Duration (seconds)	757.1 151.8	699.3* 116.6

* = $p < .05$ ** = $p < .01$

Maximal Oxygen Consumption

With the extrinsic motivation of verbal encouragement, the subjects had a mean relative $maxVO_2$ which was 2.3 $ml \cdot kg \cdot min^{-1}$ or 6% higher than without verbal encouragement (see Table 2). The results of this study showed that sedentary college aged women obtained significantly ($p < .05$) higher relative VO_2($ml \cdot kg \cdot min^{-1}$) values when verbally encouraged than without such encouragement.

Absolute VO_2 ($l \cdot min^{-1}$) is directly related to relative VO_2 ($ml \cdot kg \cdot min^{-1}$). With verbal encouragement not only did relative $maxVO_2$ significantly increase, but absolute $maxVO_2$ also significantly increased (see Table 2). Absolute VO_2 is the amount of oxygen consumed regardless of body weight. With verbal encouragement the subjects attained a mean absolute $maxVO_2$ which was .14 $l \cdot min^{-1}$ higher than without verbal encouragement.

The subjects were sedentary and had good cardiorespiratory fitness levels. According to the American Heart Association (1972), a woman in this age group with a $maxVO_2$ between 38-48 $ml \cdot kg \cdot min^{-1}$ is classified as being in good cardiorespiratory health. When verbally encouraged, the highest $maxVO_2$ obtained was 48.6 $ml \cdot kg \cdot min^{-1}$ and the lowest $maxVO_2$ obtained was 34.6 $ml \cdot kg \cdot min^{-1}$. Without verbal encouragement, the highest $maxVO_2$ obtained was 47.3 $ml \cdot kg \cdot min^{-1}$, with the lowest being 32.3 $ml \cdot kg \cdot min^{-1}$. Although the mean values were lower without verbal encouragement, the range of $maxVO_2$ values was greater. With extrinsic motivation, the subjects had a $maxVO_2$ range of 14 $ml \cdot kg \cdot min^{-1}$. Without extrinsic motivation, their values ranged within 15 $ml \cdot kg \cdot min^{-1}$. This may have been due to the fact that some subjects were more intrinsically motivated than others.

These results support conclusions by Deci (1971). He found that when extrinsic motivation in the form of verbal reinforcement and positive feedback were used, intrinsic motivation to perform activities (i.e., completing a puzzle) increased. In contrast, he found that money as an extrinsic motivator caused a decrease in intrinsic motivation. The significant increase in maxVO_2 which occurred in the present study was also attributed to extrinsic reward in the form of verbal encouragement.

Similarly, Pennebaker and Lightner (1980) also concluded that non-elite runners who focused on external cues such as verbal encouragement would have enhanced performance during exercise. They found that distracting noise and change of scenery caused these individuals to run faster. They also reported that these individuals reported less fatigue and fewer symptoms.

Butts et al. (1982), in their study of intercollegiate women, found that verbal encouragement did not cause a significant increase in maxVO_2 values for these competitive runners. In contrast, the present study suggested that verbal encouragement resulted in significantly higher maxVO_2 values for sedentary college aged women. The difference in the results of these two studies may be explained in research by Weinberg et al. (1984). They found that dissociation and positive self-talk treatments produced a significant increase in task persistence in exercise activities which were unfamiliar to the subject. In contrast, these treatments had no effect in activities with which the subjects were familiar. In Butts' et al. (1982) study and in the present research, subjects were required to run. However in Butts' et al. (1982) research, athletes who were familiar with running were studied. In the present study, sedentary women who were not regular runners were studied. These differences in familiarity with the activity may account for the differences found in the results.

Maximal Heart Rate

When the subjects were verbally encouraged they had a mean maximal heart rate which was 3.6 beats per minute higher than when they received no verbal encouragement. The mean maximal heart rate of the individuals when extrinsically motivated by verbal encouragement was significantly ($p <.05$) higher than when they were not (see Table 2).

As mentioned previously, several studies (Deci, 1971; Pennebaker & Lightner, 1980; Weinberg et al., 1984) concluded that certain types of extrinsic motivation such as verbal encouragement and positive feedback would have a positive effect on performance. In addition to those studies cited above, Martin et al. (1984) found that individualized feedback and praise had a positive affect on exercise performance and compliance. It appears that verbal encouragement and praise provided in this study during $maxVO_2$ testing had a positive affect on sedentary college aged women. The results in the present study indicated that these individuals could exercise to significantly higher heart rates when this form of extrinsic motivation was introduced.

Maximal Ventilation

When the subjects were verbally encouraged they had a mean maximal volume of expired ventilation (VE) which was $8.6\ l\cdot min^{-1}$ greater than when they were not verbally encouraged. The mean maximal VE value was significantly ($p < .05$) higher for these individuals when they were verbally encouraged than when they did not receive extrinsic motivation (see Table 2).

According to Astrand and Rodahl (1986) increases in VE are secondary to increases in oxygen consumption. Ventilation during exercise can be stimulated by increases in oxygen consumption as well as increases in lactate levels and/or increases in CO_2 production. These subjects achieved a higher $maxVO_2$ with verbal encouragement and corresponding they had significantly higher maximal VE values.

Lung volumes and capacities are directly related to body size. The subjects in this study were slightly taller than average according to Behnke and Wilmore (1974). Therefore, one would expect their maximal VE to be slightly higher than average. However, compared with values cited by Astrand and Rohdahl (1986), these individuals had maximal VE values which were slightly lower than average for women of their age. This may be due to the fact that the subjects in the present study were sedentary.

Maximum Respiratory Exchange Ratio

When verbally encouraged, subjects achieved a mean respiratory exchange ratio (RER) value which was .03 greater than during tests in which no verbal encouragement was used (see Table 2). However, this difference in RER values was not significant ($p > .05$).

A value of 1.00 is considered to be the point at which the subject is producing more carbon dioxide than he/she is consuming oxygen during an activity. This is also an indicator of maximal effort. During both testing conditions, the subjects achieved mean RER values of greater than 1.00 at maximal exercise. It appears, therefore, that the subjects produced a maximal effort regardless of whether they were verbally encouraged to exercise to their maximum level. However, because the other physiological variables measured in this study (e.g., $maxVO_2$, heart rate and VE) significantly increased with extrinsic motivation, it seems that with verbal encouragement sedentary college aged women can be motivated to exercise beyond the "normally" accepted criteria for maximal effort.

Test Duration

When the subjects were extrinsically motivated by verbal encouragement during $maxVO_2$ testing their mean test duration was 57.8 seconds longer than when they were not extrinsically motivated (see Table 2). The results of this study suggest that sedentary college aged women will exercise significantly ($p < .05$) longer when verbally encouraged.

As previously mentioned, Butts et al. (1982) did a similar study on college aged women cross country runners. They also found that extrinsic motivation in the form of verbal encouragement caused a significant increase in test duration even in the absence of significant differences in various physiological variables. It appears, therefore, that regardless of fitness level and athletic ability, verbal encouragement is important in significantly increasing exercise duration. This increase in test duration seemed to occur regardless of significant changes in other physiological parameters.

Rate of Perceived Exertion

No significant difference ($p > .05$) was found in the mean maximal value given for perceived exertion between tests in which verbal encouragement was used and those in which no extrinsic motivation was given (see Table 2).

According to Smutok, Skrinar, and Pandolf (1980) oxygen uptake is highly correlated with rate of perceived exertion (RPE). It is important, therefore, when performing a maxVO_2 test that the highest RPE value selected represents a maximal effort. The mean maximal RPE value for both types of tests in this study were between 18-20. It appears that regardless of whether verbal encouragement was given, the subjects perceived they performed a maximal test.

Summary

According to Astrand and Rodahl (1986) an RER which is above or equal to 1.00 indicates a maximal effort. The mean RER values of the subjects in this study were high enough to assure maximal exertion during both tests. The RER values were not significantly higher when the subjects were verbally encouraged. Also there was no significant difference in mean maximal RPE values. Both of these factors support the idea that the subjects did perform maximally with and without motivation. The mean RPE values for both tests were between 18-20 which indicates that maximal efforts were given during tests in which verbal encouragement was given and those in which it was not given.

Analyses of the data in this study revealed that significant increases in maxVO_2 (ml·kg·min^{-1}), VO_2 (l·min^{-1}), heart rate (beats·min^{-1}), VE (l·min^{-1}) and test duration (seconds) occurred when sedentary college aged women were extrinsically motivated through verbal encouragement during maxVO_2 testing.

The results of this study support research by Deci, (1971); Pennebaker and Lightner, (1980); and Martin et al, (1984) who concluded that reward such as verbal encouragement would increase intrinsic motivation. It appears that this is true when performing maxVO_2 tests on sedentary college aged women.

Butts et al. (1982) found that verbal encouragement did not significantly increase maxVO_2 ($ml \cdot kg \cdot min^{-1}$) values for intercollegiate women cross country runners. They did find, however, that this form of extrinsic motivation caused a significant increase in maximum heart rate and test duration. It appears that verbal encouragement is important in motivating both active and sedentary populations to exercise for longer periods of time. To attain a significantly higher maxVO_2 ($ml \cdot kg \cdot min^{-1}$) value, however, college women athletes appear to be intrinsically motivated to acheive a maximal effort without extrinsic reward. Although they will exercise for a significantly longer period, the college aged woman athlete seems to be capable of reaching maximal physiological parameters without verbal encouragement. In contrast, sedentary college aged women will exercise to significantly higher metabolic levels when verbally encouraged. It appears that the sedentary college aged woman will exercise to levels which she perceives to be maximum and then discontinue the activity. When verbally encouraged by a spectator, however, this population is capable of exercising not only for longer periods of time, but also to significantly higher physiological parameters.

Extensive research has been conducted in the area of intrinsic and extrinsic motivation. Most of the studies have focused on task performance and enjoyment. Very little research, however, has been done on the effect that extrinsic motivation has on endurance, performance and rehabilitation. Studies such as Butts et al. (1982) and the present study attempt to resolve some of the unanswered questions in these areas.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study was designed to evaluate the effect of extrinsic motivation in the form of verbal encouragement on maximal oxygen consumption. The subjects that completed this study were fifteen college aged women (age = 20.3 yrs). Although these subjects had maxVO_2 values which classified them as good, they basically were sedentary and participated in little or no aerobic exercise.

Each subject performed two maxVO_2 exercise tests. The conditions for each test were identical. However, during one test the subjects were verbally encouraged to make a maximal effort while this motivation was not provided during the other test. The order in which the tests were given was randomly assigned and the subjects were retested within one week of the first test.

Tests were performed on a treadmill while metabolic measurements were continuously monitored. The parameters that were recorded and compared were the maximal heart rates, ventilations, VO_2 ($ml \cdot kg \cdot min^{-1}$), VO_2 ($ml \cdot min^{-1}$), VCO_2, RER, $FeCO_2$, FeO_2, and perceived exertion. In addition, exercise duration values were compared for significance.

Statistical analyses of the data were performed using a dependent "t" test. The level of significance was represented by a probability (p) value of 0.05 or less to test the hypotheses for this study.

The results of the first and second tests, regardless of condition, were compared for significant differences to determine if there was a learning effect. No significance was found between the first and second tests indicating that any differences between conditions were not due to learning. Significant increases were found in maxVO_2 (ml˙kg˙min^{-1}), VO_2 (l˙min^{-1}), heart rate, ventilation, and exercise duration with verbal encouragement compared to no encouragement. No significance was found for maximal RER nor RPE.

Conclusion

In this research the effect of extrinsic motivation in the form of verbal encouragement on the physiological variables of maxVO_2 testing of sedentary college aged women was studied. Butts et al. (1982), in a similar study, measured the same paremeters in college aged women athletes. With active subjects, although there was a significant increase in test duration with verbal encouragement, no significant increases in physiological responses were observed.

Based on the statistical interpretation detailed in the preceeding chapter and the limitations of this study, the following conclusions are offered.

The results of this study suggest that extrinsic motivation cause sedentary college aged women to exercise to a significantly higher maximal oxygen consumption and ventilation rates than when they are simply intrinsically motivated.

This study also indicates that sedentary college aged women could exercise to significantly higher heart rates with extrinsic motivation than without motivation.

There was no significant difference found in RER or RPE values. It appears, therefore, that RER and RPE are not affected by extrinsic motivation.

The results of this study inferred that with verbal encouragement, sedentary college aged women will exercise for a significantly longer period of time than when they receive no external stimulus to exercise.

This study suggests that sedentary college aged women will exercise significantly longer and have significantly higher physiological responses when extrinsically motivated. Specifically, the sedentary college aged woman appears to be motivated by verbal encouragement while exercising. Butts' et al. (1982) research suggested that active college aged women respond differently to this form of extrinsic motivation.

It appears that the active college aged woman will not achieve significantly higher physiological parameters with extrinsic motivtion. These individuals seem to be capable of pushing themselves to a physiological maximum on their own, but will exercise for a significantly longer period of time with verbal encouragement. In contrast, the sedentary college aged woman will exercise beyond what she perceives to be a maximal effort to significantly higher physiological parameters and for longer periods of time when verbally encouraged.

These results have practical implications in the field of exercise physiology. While the college aged female athlete appears to be intrinsically motivated to give a maximal effort during activities involving exercise, this may not be the case with the sedentary college aged woman. These individuals will exercise to significantly higher levels when verbally encouraged. Therefore, when working with this population in exercise programs and classes, it is important to recognize the influence of extrinsic motivation in the form of verbal encouragement. Verbal encouragement may be important in pushing the college aged female athlete at the end of a race to exercise for a longer period of time. For the sedentary college aged woman, however, verbal encouragement may be the key to exercise compliance and physiological benefit.

Recommendations

As a result of the conclusions presented and based on previous research, the following recommendations were offered:

A similar study could be done involving sedentary college aged men with the same parameters measured. Future research could compare the effect that verbal encouragement has on males versus females.

A less homogeneous group could have been used. It is possible that volunteers from a college community may be more affected by verbal encouragement than other populations.

A recommended study could involve a training program in which one group received verbal encouragement and the control group did not. The effect of this form of extrinsic motivation on compliance could then be measured.

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APPENDIX A

RATE OF PERCEIVED EXERTION

6	
7	VERY, VERY LIGHT
8	
9	VERY LIGHT
10	
11	FAIRLY LIGHT
12	
13	SOMEWHAT HARD
14	
15	HARD
16	
17	VERY HARD
18	
19	VERY, VERY HARD
20	

(BORG, 1974)

APPENDIX B

INFORMED CONSENT

Max VO_2 of Sedentary College Aged Females

I, ____________________________, am willing to participate in the maximal VO_2 study conducted by Darci Clark at the University of Wisconsin - LaCrosse. I understand that participating in this study involves completing two maximal VO2 exercise tests. I understand that the test consists of running to voluntary exhaustion on a motor-driven treadmill. After an initial warm-up of 3.5 mph at 10% grade, the speed of the treadmill will be 5 mph with a starting elevation of 0%; the grade will then be increased 2.5% every two minutes until exhaustion. During the test, heart rates will be monitored continuously through an electrocardiogram (ECG). This will involve the placement of 3 electrodes on the skin surface. Oxygen consumption will also be monitored through the use of a Beckman Metabolic Cart. This will involve breathing through a mouth-piece so that expired air can be collected and measured. The increase in workload will continue until a maximal oxygen consumption is reached or until I feel I cannot continue any longer. I am free to stop the test or withdraw from the study at any time.

As with exercise, there exists the possibility of adverse changes occurring, (i.e., dizziness, staggering, difficulty in breathing, etc.) during the test. In addition, I will feel tired at the end of the exercise. If any abnormal observations are noted, the test will be immediately terminated. The actual tests will be conducted by Darci Clark under the direction of Nancy K. Butts, PhD.

In signing this consent form, I acknowledge that I have read the foregoing and I understand it; any questions which may have occurred to me have been fully explained to my satisfaction. The potential risks have been fully explained to me and I understand their implications. I hereby acknowledge that no representations, warranties, guarantees or assurances of any kind pertaining to the procedures have been made to me by the University of Wisconsin - LaCrosse, the officers, administrators, employees, or by anyone acting on behalf of any of them. To my knowledge, I am not infected with any disease or have any limiting physical condition or disavility, especially with respect to my heart, that would prevent me from participating in such strenuous exercise.

Signed: ____________________________ Date: _______________

Signed: ____________________________ Date: _______________

APPENDIX C

PROTOCOL

STAGE TIME (MINUTES)	SPEED (MPH)	GRADE (%)
5	3.5	10.0
2	5.0	0.0
2	5.0	2.5
2	5.0	5.0
2	5.0	7.5
2	5.0	10.0
2	6.0	10.0
2	6.5	10.0
2	7.0	10.0

APPENDIX D

Name:______________________________ Date:_______________

QUESTIONNAIRE

Please answer the folowing questions as accurately and as honestly as possible.

1. Within the last two months, have you regularly been involved in any of the following activities two or more days per week for twenty continuous minutes per day ?

   walking _____
   running/jogging _____
   aerobic dance _____
   cross country skiing _____
   biking _____
   swimming _____
   other _____

   explain:

2. Have you been involved in any type of sports activity over two times per week during the past two months? Explain.

3. How far do you live from campus or work? How do you get there and back each day (e.g., walk, bike, etc.)?
   In what amount of time?
   On a regular basis?

4. Explain, in detail, what type of physical activity you have been involved in during a typical week in the past two months.

THANK YOU!!

APPENDIX E

NAME: ______ DATE: ______ TIME: ______ TEMP ______ Pbar ______

______ lbs ______ kg ______ %fat ______ LBW ______ Height ______ age ______ birthdate ______ miles/wk

	WORKLOAD	$\dot{V}_E$	ml O_2	ml·kg	$\dot{V}_{CO_2}$	RER	$FeCO_2$	FeO_2	H R	RPE	ml·LBW
(1)	3.5mph 10%										
(2)	3.5mph 10%										
(3)	3.5mph 10%										
(4)	3.5mph 10%										
(5)	3.5mph 10%										
(6)	5 mph 0%										
(7)	5 mph 0%										
(8)	5 mph 2.5%										
(8)	5 mph 2.5%										
(10)	5 mph 5%										
(11)	5 mph 5%										
(12)	5 mph 7.5%										
(13)	5 mph 7.5%										
(14)	5 mph 10%										
(15)	5 mph 10										
(16)	6 mph 10										
(17)	6 mph 10										
(18)	6.5 mph 10										
(19)	6.5 mph 10										
(20)	7mph 10										

O_2 ______ ______

CO_2 ______ ______