To the Graduate Council:

I am submitting herewith a dissertation written by Vernon Bond, Jr., entitled "Effects of Alcohol on Cardio-respiratory Function and Lactate Production." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education with a major in Physical Education.

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EFFECTS OF ALCOHOL ON CARDIORESPIRATORY FUNCTION AND LACTATE PRODUCTION

A Dissertation

Presented for the

Doctor of Education

Degree

The University of Tennessee, Knoxville

Vernon Bond, Jr.

August 1979

1398029

DEDICATION

To my wife, Johnetta.
Without her love, help, understanding,
and encouragement this would
not have been possible.
To my parents.
For giving so much of themselves to me.
They were always there when needed.

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ABSTRACT

The study was conducted to assess the effects of the ingestion of small and moderate dosages of alcohol on selected physiological responses during rest, exercise, and recovery. Twelve subjects, six abstainers and six moderate drinkers, performed a progressive work task on the Monark bicycle ergometer to exhaustion after ingestion of a placebo (.0 ml./kg.), small (.44 ml./kg.), and moderate dose (.88 ml./kg.) of 190 proof ethyl alcohol mixed in grapefruit juice. The work tasks consisted of three minutes each at 360, 720, and 1,080 kpm./minute. Thereafter, the resistance was increased by 180 kpm./minute every three minutes until the subject was unable to maintain a pedal rate of 60 rpm. Differences due to dosages and type of drinkers were evaluated by a two way (2 x 3) analysis of variance.

There were no significant differences ($p > .05$) in heart rate, oxygen uptake, endurance, rating of perceived exertion, and blood lactate due to the ingestion of a small and moderate dose of alcohol compared to the control condition.

Post hoc analysis revealed that the diastolic blood pressure of abstainers during exercise at 720 kpm./minute was significantly higher after ingestion of the small and moderate dosages than the control dose. The ventilation of moderate drinkers at rest 30 minutes after ingestion

of the moderate dose was significantly higher than after ingestion of the control and small dose.

There is little evidence from this study to support the conclusion that ingestion of small and moderate dosages of alcohol by abstainers and moderate drinkers affect cardiorespiratory function and lactate production.

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CHAPTER I

INTRODUCTION

During the past decade investigations have been conducted on the effects of ethyl alcohol on different aspects of physical performance. Most of the experiments made it evident that the ingestion of large amounts of alcohol produced a deterioration in physical performance when blood alcohol was higher than 1.5% (100 mg./100 ml.). However, the physical effects of small and moderate dosages of alcohol remain a controversial issue (19). Since numerous workers have concerned themselves with this problem, it may seem to many readers that nothing remains to be said. However, no solution seems to have been sufficiently substantiated to have gained general recognition. The results of the many experiments show numerous disagreements and there seems to be no way of harmonizing many of the contradictions. It is unsafe to totally discredit certain experiments that do not harmonize with others for each experiment must be regarded as a sincere attempt to answer scientific inquiry, and it must be remembered that the problem is by no means a simple one. There are many known variables which influence the results and there are, undoubtedly, as many unknown factors (35).

In previous alcohol experimentation, the inability to harmonize many of the investigators' results have been

attributed to the following factors:

1. Studies tended to differ in the type of research design used. Subjects may be used as their own control or there may be a separate control group. The former condition often leads to results which may be confounded by practice effects while the latter condition increases subject variability.
2. Important factors concerning the subject population are often not considered by the experimenter. Such factors include sex, weight, age, and type of drinker (abstinent, moderate, or heavy).
3. Experimenters differed on the method of alcohol administration. Ideally, dosage should depend on the body weight of each subject, but often it was administered as a fixed dose.
4. Studies tended to differ in terms of alcohol type: vodka, bourbon, beer, wine, etc. Each type has its own rate of absorption into the blood stream and thereby may influence performance differentially.
5. Studies varied in terms of the time allowed to consume the alcohol, the time of day alcohol was ingested, and the time allowed to pass from the beginning of drinking to the beginning of testing. These parameters were often uncontrolled and yet may markedly influence performance.

6. Studies were concerned with a wide variety of tasks with a wide range of dependent and independent variables. No consistent index of performance was used, making it very difficult to compare studies to one another.

Because of these inconsistencies in experimental procedures and approaches used by investigators, few dependable generalizations regarding the influence of alcohol on performance can be advanced (31). It would appear that generalizations will be derived only from studies in which several of the above factors are carefully controlled. The purpose of this study was to determine the effects of ethyl alcohol administered per unit body weight to abstainers and moderate drinkers on cardiorespiratory function during rest, exercise, and recovery.

I. HYPOTHESES

1. There will be an increase in cardiorespiratory and metabolic functions (heart rate, blood pressure, oxygen consumption, and ventilation) after ingestion of ethyl alcohol.
2. Endurance (time to exhaustion) will decrease after ingesting ethyl alcohol.
3. There will be a decrease in subjective rating of perceived exertion after ingestion of ethyl alcohol.
4. Lactic acid production will increase after ingestion of ethyl alcohol.

II. DEFINITIONS

Alcohol refers to ethanol (C_2H_5OH) in its nearest possible form of human experimental use. The alcohol used was 190 proof (95%) ethyl alcohol.

Small dose of alcohol refers to an ingested quantity of alcohol equal to .44 ml. of 190 proof (95%) alcohol per kilogram body weight.

Moderate dose of alcohol refers to an ingested quantity of alcohol equal to .88 ml. of 190 proof (95%) alcohol per kilogram body weight.

Abstainer refers to one who drinks less than once a year or not at all (42).

Moderate drinker refers to one who drinks at least once a month, typically several times, but usually with no more than three or four drinks per occasion (42).

Pre-ingestive period refers to that time before the ingestion of alcohol or placebo.

Post-absorptive period refers to that time from the completion of the ingestion of alcohol or placebo until the physical performance test begins.

CHAPTER II

REVIEW OF RELATED LITERATURE

The primary purpose of this study was to assess the effects of alcohol on cardiorespiratory function and lactate production. Measurements were also taken of time to exhaustion and subjective rating of perceived exertion. The information in this chapter has been grouped under the following five subheadings: (1) Studies Relating to the Effects of Alcohol on Cardiovascular Function, (2) Studies Relating to the Effects of Alcohol on Respiratory Function, (3) Studies Relating to the Effects of Alcohol on Lactate Production, (4) Studies Relating to the Effects of Alcohol on Work Capacity, and (5) Studies Relating to the Effects of Alcohol on Perceived Exertion.

I. STUDIES RELATING TO THE EFFECTS OF ALCOHOL ON CARDIOVASCULAR FUNCTION

Studies pertaining to the effects of alcohol on cardiovascular function have varied considerably in the amount of alcohol ingested, the type of alcoholic beverage used, the performance parameter measured, and the time allowed for absorption. Karvinen, Niettinen, and Ahlman (29) investigated various aspects of physical performance 12 hours after cessation of drinking ethanol and water added to cognac to make a 33% alcohol solution. The subjects,

30 men, performed on a bicycle ergometer (1,500 kgm./ minute) for five minutes. Significant increases in heart rate ($p < .05$) were noted during rest, the second minute of work, and three minutes after cessation of work.

The effect of consuming .0 ml., .44 ml., .88 ml., and 1.32 ml. per kilogram body weight of 190 proof (95%) ethyl alcohol on resting and exercise heart rate was studied by Bobo (6). Subjects, 19 college males, performed three minute treadmill runs on a grade beginning at 4% and increasing by 2% on each subsequent run. The run was preceded by consumption of the specified dose, a 30 minute absorption period and a five minute warm up was allowed. Heart rate values were taken prior to exercise and during the last 30 seconds of exercise. The author concluded that only resting heart rate was affected by the alcohol. There was a significant increase in resting heart rate after ingestion of the small (.44 ml.) dose.

In slight disagreement with Bobo, Williams (48) studied the effects of a small and moderate dose of alcohol on heart rate before, during, and after a progressive work-load. Nine conditioned male students and faculty members at Old Dominion University, all moderate drinkers, served voluntarily as subjects. All subjects underwent three separate trials of a nine minute work task consisting of three minutes each at 500, 1,000, and 1,500 kpm. Prior to each trial, the subjects consumed either .0 ml./kg.,

.44 ml./kg., or .88 ml./kg. body weight of 190 proof (95%) ethanol. The author's investigation permitted the following conclusion: a small or moderate dose of alcohol exerted no effect on heart rate during (a) rest, (b) all levels of a progressive workload on a bicycle ergometer, or (c) in recovery, one and five minutes after the workload.

Hebbelinck (19), using 21 male moderate drinkers as subjects, conducted a series of experiments in which he investigated the effects of the ingestion of .6 ml. of 94% alcohol per kilogram body weight on cardiovascular efficiency, as measured by various responses to a bicycle ergometer test. The subject performed for five minutes on the bicycle ergometer at 1,500 kgm./minute. The results of the tests indicated some measures of cardiovascular efficiency were affected (i.e., an increase of four beats/minute at rest 30 minutes after ingestion, and 23 beats/minute during work). Hebbelinck (21, 22) later published two additional studies pertaining to neuromuscular performance and cardiac output which supported the results of his first study.

Shortly after Hebbelinck's first study was published, Garlind, Goldberg, Graf, Perman, Strandell, and Ström (14) conducted a similar study with nine male subjects. Three types of work tests were used.

1. Increased stepwise workloads of 300 kpm./minute every six minutes until a heart rate of 170 beats/minute was reached.

2. Continuous work for 20 minutes at a load producing a rise in heart rate to 160-170 beats/minute.
3. Intermittent work for 60 minutes, with work periods and rest periods of two minutes, at a load producing a rise in heart rate to 160-170 beats/minute.

Ethanol, 96%, was diluted to about 25% in fruit juice before consumption and given in doses of .40 or .81 ml./kg. The authors concluded that the average heart rate response to all submaximal work tests was not significantly influenced by ethanol ingestion.

Blomqvist, Saltin, and Mitchell (5) studied the acute effects of various ethanol concentrations in the blood (in the range of 100 to 200 mg./100 ml.) on the response to submaximal and maximal exercise in normal subjects. The subjects were eight male moderate drinkers in good health. Ethanol was administered in the form of 2.0 ml./kg. of 43% whiskey, rum, or gin, during a 20 minute period starting 60 minutes before exercise was undertaken. Control experiments and studies after the ingestion of ethanol were conducted on separate days within an interval of one week. The subjects reported to the laboratory in the morning after a light breakfast and performed exercises on a bicycle ergometer at two submaximal workloads and one maximal workload. Submaximal workload levels were selected that required approximately 50 and 75% of each

subject's maximal oxygen uptake. The duration of work at both submaximal exercise levels was 12 minutes. Each workload was followed by a rest period of 10 to 15 minutes. The maximal workload was chosen so that the subject was able to perform for two and one-half to five minutes. The authors concluded that heart rates at rest and during the submaximal exercise were significantly higher after alcohol ingestion. Alcohol had no effect on stroke volume at rest or during exercise. Mean arterial pressure was slightly lower both at rest and during submaximal exercise during the ethanol treatments. Ethanol had no effect on mean arterial pressure or peripheral resistance during maximal work.

The effect of ethyl alcohol on cardiac output, stroke volume, and peripheral resistance in man was investigated by Juchems (26). Fourteen healthy male volunteers were given ethanol, 0.92-1.21 ml. per kilogram (mixed with 350 ml. of juice), which they drank within five minutes. The cardiac output, stroke volume, total peripheral resistance, and the blood alcohol levels were measured at regular intervals every 10 minutes, up to 140 minutes. The blood alcohol was determined enzymatically with alcohol dehydrogenase and DPN^{+}/DPNH as coenzyme. The cardiac output was measured with dye dilution methods. At blood alcohol levels of 39 mg. percent and of 120 mg. percent, cardiac output was significantly higher ($p < .05$). In

like manner, the heart rate showed a maximal rise of 13% at a blood alcohol level of 85 mg. percent ($p < .05$). The total peripheral resistance was lower at a blood ethanol concentration of 85 and 120 mg. percent compared to 39 mg. percent ($p < .025$). No significant changes were noted in the stroke volume. Juchems additionally measured the circulatory parameters of seven subjects who received 350 ml. of juice, and compared the results with those of seven subjects who drank the same amount of juice with alcohol. The heart rates after ethanol were statistically higher than after ingestion of juice ($p < 0.05$).

Changes in pulse rate, blood pressure, and cardiac output following the use of alcohol were studied by Grollman (16). The subjects were six normal young male adults, two moderate drinkers, two non-drinkers, and two occasional drinkers. The alcohol was ingested in the form of whiskey or rum, or in the form of a 40% aqueous solution. The determinations of cardiac output were made by the use of acetylene. The author concluded that administration of small doses (10 ml.) of alcohol to non-drinkers resulted in a psychic response characterized by a transient rise in pulse rate, blood pressure, and cardiac output. Where no psychic reaction was elicited (e.g., in moderate drinkers), such changes did not occur. Moderate quantities of alcohol (35 ml. or more) caused slight changes in the pulse rate with appreciable increases in the blood pressure and cardiac output.

Regan et al. (40) studied the effects of alcohol on the metabolic and hemodynamic responses of the left ventricle in dogs. The subjects, mongrel male dogs weighing 19 to 22 kg., were anesthetized 18 hours postprandially with morphine sulfate and pentobarbital, and studied without opening the chest. Ethanol was dissolved in water to make a 15% solution and administered through a femoral venous catheter for approximately two hours at a rate of 0.1 mg. per kg. per minute for 12 minutes. Ventricular and femoral aterial pressures were measured through 50-cm Goodall-Lubin 8F catheters connected directly to Stratham P 23 D strain-gauge transducers. The authors concluded that a diminished left ventricle function, manifested as a decline of stroke output and rise of end-diastolic pressure was observed as early as 15 minutes, was well established by 30 minutes at blood alcohol concentrations of 110$\pm$ 13 mg. per 100 ml., and persisted through five hours without significant heart rate or arterial pressure changes.

In 1962, E.S. Perman (38) studied the effect of a small ethanol dose on oxygen uptake in seven healthy young men, all with modest ethanol habits. In several of the subjects, Perman also investigated the heart rate response after alcohol ingestion. The experiments were carried out in the afternoon without previous fasting. One hundred and fifty ml. of chilled fruit juice, to which 30 ml. of a 71% (w/v) ethanol solution had been added, were given to the

test subject to drink within 10 minutes. Control experiments with fruit juice were carried out one day before or after the ethanol experiments. The author found heart rate to be unchanged, but the investigator did not control for fasting, which in turn could greatly affect experimental results.

Horwitz, Longcaker, and Montgomery (25) studied the effects of alcohol on blood pressure and pulse rate in six healthy adults of both sexes. The subjects reported for the study without having had food for 6 to 12 hours. They reclined, clad in an examining gown and a sheet, on a ballistocardiographic table in a thermoregulated room. In the experiments 60 to 150 ml. of whiskey, with an alcoholic content of 24 to 60 ml., were diluted and given to each of five subjects. In one other instance, a subject was given 600 ml. of 5% alcohol intravenously within 120 minutes, as fast as the subject could tolerate the pain in the vein receiving it. Horwitz and others noted that no significant change in pulse rate or blood pressure resulted after ingestion or infusion of alcohol.

Wendt, Ajluni, Bruce, Prasad, and Bing (44) investigated the acute effects of alcohol ingestion on the human myocardium to gain a more complete understanding of the pathogenesis of alcoholic cardiomyopathy. Eleven hospitalized patients with a history of chronic alcoholism, but without clinical evidence of heart or liver disease, were

studied. The patients ranged in age from 32 to 61 years; eight were male and three were female. All were in the post-absorptive state, and none was premedicated. Patients were given 6 ounces (178 ml.) of chilled vodka (containing 84% alcohol by weight) by mouth. The authors concluded that there was no significant change in heart rate or mean blood pressure 30 minutes after ingestion of alcohol.

A study on how ethyl alcohol (.05 ml./kg. of 200 proof) affect heart rate, skin resistance, finger blood volume, and respiration rate was conducted by Docter and Perkins (11). Twenty four male social drinkers served as the experimental group and were administered 0.5 ml. of ethyl alcohol per kg. of body weight mixed in orange juice. Fifteen subjects served as the control group and drank one-tenth the amount of alcohol given to the alcohol subjects. The authors reported that the resting heart rate was not significantly different in the control and experimental groups.

In a study to determine the effect of alcohol on physical performance, Adolph (1) investigated the effect of alcohol on heart rate, oxygen consumption, and ventilation. Six healthy active men who volunteered as subjects were tested by use of the Balke Treadmill Test under two alcohol conditions and one placebo condition. Under the first alcohol condition the subjects drank a 14.29% alcohol solution containing 1 ml./kg. body weight of 190 proof

(95%) ethyl alcohol mixed with grape juice. Eleven hours after ingestion the performance test began. The second alcohol condition used the same solution with the subjects performing the test three hours after ingestion. Under the control condition, water was used as a substitute for ethanol in the solution. In all cases, ingestion of the liquid began at least three hours after any food, liquor, or tobacco had been consumed. The physical performance test was terminated under all conditions when the heart rates of the subjects reached 180 beats per minute. The authors reported significant differences in the heart rate response at each minute during the first five minutes of exercise in the experimental condition three hours after ingestion of ethanol, when compared with the heart rate in the control condition and the experimental condition 11 hours after ingestion of ethanol.

In a study to determine the acute hemodynamic effects of ethanol, Riff, Jain, and Doyle (41) investigated 17 paid volunteers who ranged in age from 18 to 33 years. The subjects having abstained from eating and smoking for at least four hours and from alcohol for at least 12 hours, entered the laboratory with a control blood alcohol level of zero. Ten were test subjects and seven served as controls. A history of alcohol consumption was obtained on all subjects to exclude those with a history of more than moderate ethanol intake. A Cournand needle was inserted

into the brachial artery of one arm and a short flexible cannula into an antecubital vein of the other arm. The heart rate was monitored by a continuous electrocardiogram, and the arterial pressure was sensed by a Stratham P 23 Db strain gauge on a Gilson multichannel recorder. After control measurements were made, the subjects bicycled on an ergometer in the supine position for five minutes at 100 watts (approximately 600 kpm./minute). The cardiac output and arterial pressure were recorded during the fifth minute of exercise and five minutes after exercise. Following this, 10 subjects were given 6 ounces (178 ml.) of chilled 90 proof (45%) ethyl alcohol to drink in less than 10 minutes. The seven control subjects merely lay on the bed for 10 minutes. At 15, 30, 60, and 90 minutes after the ingestion of the alcohol, blood was drawn for estimation of the alcohol level, and the cardiac output, heart rate, and arterial pressure were measured. The subjects then exercised on the ergometer for five minutes at 100 watts. Exercise and five minute recovery records were taken as before. Peak blood alcohol levels were reached within 30 minutes in the majority of the subjects. The authors reported that the increase in heart rate was significantly greater in the alcohol group than in the control group ($p < .10$). The arterial pressure remained unchanged after alcohol ingestion.

II. STUDIES RELATING TO THE EFFECTS OF ALCOHOL ON RESPIRATORY FUNCTION

Grubbs and Hitchcock (17) investigated the effects of small amounts of ethyl alcohol on the respiratory exchanges during rest and work. Two series of experiments were carried out using five different subjects upon whom a total of more than 50 tests were run. The oxygen consumption, carbon dioxide production, and total respiratory volume were determined by means of the Tissot-Haldane technique. In the first series of experiments three subjects were used. With these subjects both control and alcohol tests were run while the subject was lying in a basal condition, while he was sitting at rest on the bicycle, and while he was pedalling the bicycle at a rate which was equal to 2,500 to 3,000 foot pounds of work per minute (345 to 414 kpm./minute). In the basal tests, the subjects reported to the laboratory in a post-absorptive condition and rested for a one-half hour period. The subject then ingested 200 ml. of approximately 10% alcohol in the alcohol tests. The quantity of alcohol given was from 0.25 to 0.30 gm./kg. of body weight. In the work tests the subject came to the laboratory in a post-absorptive condition and ingested the water or alcohol solution. The dosage of alcohol was the same as that used in basal tests. In the second series of experiments no basal tests were run. Approximately the same quantity of

alcohol was ingested but in this case it was diluted with 200 ml. of a 10% dextrose solution. The results of the tests indicated the following effects of alcohol upon the variables measured:

1. Alcohol produced no specific dynamic action during the first two hours following its ingestion.
2. There was no significant change in the ventilation equivalent or in carbon dioxide production following the ingestion of alcohol.
3. The rate of oxidation of alcohol in the body was higher in the sitting position than when reclining and still higher when working on the bicycle ergometer than when sitting at rest.

Perman (38) conducted a study in which he measured the oxygen uptake after a small ethanol dose in seven healthy young men with modest ethanol habits. The experiments were carried out in the afternoon without previous fasting, thus not under basal conditions. The subjects had to rest for 30 minutes before determination of the initial oxygen uptake level. Conventional Krogh technique was used for the oxygen uptake determinations. After determining the initial oxygen uptake, 150 ml. of chilled fruit juice, to which 30 ml. of 71% (w/v) ethanol solution had been added, was given to the test subject to drink within 10 minutes. Twenty to fifty minutes, and in a few experiments 70-100 minutes, after ethanol intake the oxygen uptake was

again determined and its percentage change from the initial value was computed. Control experiments with fruit juice were carried out one day before or after the ethanol experiments. Perman concluded in the ethanol experiments there was a small increase (average 6%) in oxygen uptake 20-50 minutes after intake which was not seen in the control experiments. The oxygen uptake was back to its pre-ethanol level 70-100 minutes after ethanol intake. In several experiments the respiratory rate was determined concomitantly with the oxygen uptake and were found to be unchanged.

In a former study, Perman (39) studied the effect of ethanol on oxygen uptake in six Albino rabbits. They were anesthetized with urethane. Ethanol solutions were made up from absolute ethanol (99.5% by volume). The highest ethanol concentration used in any of the experiments was .06 ml./kg. Pure saline or distilled water was used in control infusions. The intravenous infusions were made with a motor-driven infusion apparatus set at a constant rate of 1.0 ml./minute. The animals were artifically ventilated with a Starling pump connected to the closed-circuit system so as to permit recording of oxygen uptake. The author reported that a small dose of ethanol (.25 ml./kg.) caused a 12% increase in oxygen uptake.

Blomqvist et al. (5) studied the acute effects of various ethanol concentrations in the blood (in the range

of 100 to 200 mg./100 ml.) on the response to submaximal and maximal exercise in normal subjects. Subjects were eight male moderate drinkers in good health. Ethanol was administered in the form of 2.0 ml./kg. of 43% whiskey, rum, or gin during a 20 minute period starting 60 minutes before the onset of exercise. Maximal oxygen uptake was used as a measure of the functional capacity of the oxygen transport system.

All tests were conducted on separate days within an interval of one week. The subjects reported to the laboratory in the morning after a light breakfast and performed exercise on a bicycle ergometer at two submaximal workloads and one maximal workload. Submaximal workloads were selected that required approximately 50 and 75% of each subject's maximal oxygen uptake. The duration of work at both submaximal exercise levels was 12 minutes. Each workload was followed by a rest period of 10 to 15 minutes. The maximal workload was chosen so that the subject was able to perform for two and one-half to five minutes. The authors reported oxygen uptake at rest and during submaximal exercise at corresponding workloads was 0.05 to 0.15 l./minute higher after administration of alcohol than during the control study. Maximal oxygen uptake did not change significantly. Ethanol did not affect pulmonary ventilation at rest and during submaximal exercise but caused a significant reduction during maximal work.

Garlind et al. (14) conducted a study to determine the effect of alcohol on respiratory rate in nine male subjects. Three types of work tests were used.

1. Increased stepwise workloads of 300 kpm./minute every six minutes until a heart rate of 170 beats/minute was reached.
2. Continuous work for 20 minutes at a load producing a rise in heart rate to 160-170 beats/minute.
3. Intermittent work for 60 minutes, with work and rest periods of two minutes, at a load producing a rise in heart rate to 160-170 beats/minute.

Ethanol, 96%, was diluted about 25% in fruit juice before consumption and given in the doses of .40 or .81 ml./kg. The test began immediately after ingestion. In addition to respiratory rate, determinations were made of oxygen uptake, respiratory quotient, and ventilation equivalent. The following results were reported.

1. Respiratory frequency and ventilation equivalent were not significantly influenced by ethanol.
2. Oxygen uptake and respiratory quotient were similar during muscular work under control and alcohol conditions.

Bobo (6) studied the effects of consuming .0, .44, .88, and 1.32 ml. of 190 proof ethyl alcohol per kilogram body weight on maximum aerobic capacity, lung ventilation, and ventilation equivalent. The ethanol used was diluted with grape juice and administration of the alcohol dose was

randomized. Subjects, 19 college males, performed a three minute treadmill test on a grade beginning at 4% and increasing 2% each subsequent run. The run was preceded by consumption of the specified dose, a 30 minute absorption period, and a five minute warm-up. Expired air was collected until an oxygen uptake criterion of 150 milliliters was reached. The author reported that the statistical analysis failed to show that the parameters of oxygen uptake, lung ventilation, and ventilation equivalent were affected by the alcohol ingestion.

The influence of alcohol on oxygen consumption before, during, and after a progressive workload was studied by Williams (48). Nine conditioned male students and faculty members at Old Dominion University, all moderate drinkers, served voluntarily as subjects. All subjects underwent three separate trials of a nine minute work task consisting of three minutes each at 500, 1,000, and 1,500 kpm. Prior to each trial, the subject consumed either a placebo (.0 ml./kg.), small (.44 ml./kg.), or moderate (.88 ml./kg.) dose of 190 proof (95%) ethanol. The author reported the following conclusion: a small or moderate dose of alcohol exerted no effect on oxygen consumption during (a) rest, (b) all levels of a progressive workload on a bicycle ergometer, or (c) recovery one and five minutes after the workload.

Hebbelinck (2) studied the effects of alcohol on oxygen uptake in one healthy male occasional drinker. In the experiment 0.6 ml./kg. of 96% alcohol was diluted with

water to make a total volume of 225 ml. which was taken by the subject at 10:00 a.m. Twenty minutes later, the collection of gas samples for the determination of the resting respiratory gas exchange was started and continued for 10 minutes. Immediately afterwards, the subject began the exercise, which lasted for another 30-60 minutes. The muscular exercise was performed on a bicycle of the mechanical braking type. The rate of work varied from 620 to 640 kgm. per minute with an average of 630 kgm. per minute. The expired air was collected and metered into a large Tissot tank from which small samples were taken and analyzed for O_2 and CO_2 content using Scholander 12 cc. gas analyzer. The author reported a significant increase in oxygen consumption in the work experiments with alcohol in comparison to the experiments without alcohol.

In a study in which he investigated the effects of alcohol, caffeine, and tobacco on oxygen consumption, Grollman (16) studied six normal young adults (two moderate drinkers, two nondrinkers, and two occasional drinkers). The alcohol was ingested either in the form of whiskey, rum, or in the form of a 40% aqueous solution. Oxygen consumptions were determined with the Krogh spirometer. The author reported no difference in oxygen consumption after moderate quantities (35 ml.) of alcohol.

A study using 200 proof (100%) ethyl alcohol in a dose of 0.5 milliliter per kilogram on heart rate, skin

resistance, finger blood volume, and respiration rate was conducted by Docter and Perkins (11). Twenty-five male social drinkers served as the experimental group and were administered 0.5 ml. of ethyl alcohol per kg. of body weight mixed with orange juice. Fifteen subjects served as the control group and drank one-tenth the amount of alcohol given to the alcohol subjects. The authors concluded that the alcohol and control groups did not differ significantly with respect to respiration during the experiment.

In a study to determine the effect of alcohol on physical performance, Adolph (1) investigated the effect of alcohol on heart rate, oxygen consumption, and ventilation. Six healthy active men who volunteered as subjects were tested by use of the Balke Treadmill Test under two alcohol conditions and one placebo condition. Under the first alcohol condition the subjects drank a 14.29% alcohol solution containing 1 ml./kg. body weight of 190 proof (95%) ethyl alcohol mixed with grape juice. Eleven hours after ingestion the performance test began. The second alcohol condition used the same solution with the subjects performing the test three hours after ingestion. Under the control condition water was used as a substitute for ethanol in the solution. In all cases, ingestion of the liquid began at least three hours after any food, liquid, or tobacco had been consumed. The physical

performance test was terminated under all conditions when the heart rates of the subjects reached 180 beats per minute. The author concluded that oxygen consumption and ventilation showed no significant changes after ethanol ingestion.

The effect of the ingestion of ethanol upon metabolic rate was studied by Kalant, Hawkins, and Watkin (27) on eight male rats of the Wistar strain. The animals were placed in sealed Lucite chambers and their oxygen consumption was measured in a constant temperature bath at 27+ 1° C. The chambers were gassed with 100% oxygen and the carbon dioxide produced was absorbed with Baralyme granules. Control readings were started 30 minutes after immersion and were taken for 30 minutes before injection of the test substance, and continuously thereafter for at least 90 minutes. In the first series, ethanol was administered intraperitoneally in doses of 2 and 4 g./kg. (1.25 and 2.5 ml. per 100 g. body weight, respectively, of a 20% (v/v) solution in saline). In the second series, ethanol in dose of 0.4 g./kg. was administered intraperitoneally as 5 ml./kg. of 10% (v/v) solution in 0.0% saline. The authors reported that alcohol (0.4 g./kg.) caused a significant increase in oxygen uptake during the period 30-50 minutes post injection which persisted until a little over an hour after the alcohol administration.

III. STUDIES RELATING TO THE EFFECTS OF ALCOHOL ON LACTATE PRODUCTION

Himwich, Rakietan, DuBois, and Gildea (23) determined the influence of alcohol on the pH, carbon dioxide content, and carbon dioxide capacity of arterial blood in 30 dogs and 12 human subjects. The blood samples were also analyzed for lactic acid, dextrose, and alcohol. In the dogs, blood was drawn from the femoral artery, and in the human subjects, from the brachial artery. Both dogs and human beings were studied in the post-absorptive state and without narcotics other than the alcohol, which was always given as a 19% solution. As a result of these studies, it was found that alcohol produced an acidosis which was evident in changes of pH and carbon dioxide capacity and content as well as of the lactic acid and dextrose concentration of the blood. The effects on humans and dogs were similar. In 18 out of 21 experiments on dogs, and in all the human experiments, the blood sugar rose. A rise in blood lactic acid from 14 to 25 mg. per 100 ml. was found in the dog and from 15 to 30 mg./100 ml. in the human subject. This effect of alcohol may be explained as a result of insufficient oxidation in muscle, due perhaps to reduced blood flow and to an inhibitory effort on cellular respiration. It is well known that when oxidations are inadequate, lactic acid accumulates in the muscles and is poured into the blood stream. Ordinarily this sets into operation a series of adjustments

producing hyperventilation to eliminate the freed carbon dioxide. In one experiment there was a transitory rise in carbon dioxide content, and in three others it remained unchanged in the first observation after the ingestion of alcohol. Ten other experiments disclosed a progressive diminution of carbon dioxide content.

Blomqvist, Saltin, and Mitchell (5) studied the acute effects of various ethanol concentration (in the blood in the range of 100 to 200 mg./100 ml.) on the response to submaximal and maximal exercise in normal subjects. Subjects were eight male moderate drinkers in good health. Ethanol was administered in the form of 2.0 ml./kg. of 43% whiskey, rum, or gin during a 20 minute period starting 60 minutes before the onset of exercise. Lactic acid was determined from capillary blood by a micromodification of an enzymatic method. Control experiments and studies after the ingestion of ethanol were conducted on separate days within an interval of one week. The subjects reported to the laboratory in the morning after a light breakfast and performed exercise on a bicycle ergometer at two submaximal workloads and one maximal workload. Submaximal workloads levels were selected that required approximately 50 and 75% of each subject's maximal oxygen uptake. The duration of work at both submaximal exercise levels was 12 minutes. Each workload was followed by a rest period of 10 to 15 minutes. The maximal workload was chosen so that the subject was

able to perform for two and one-half to five minutes. The authors reported no significant difference in peak lactate concentration during maximal exercise after ingestion of alcohol.

Somewhat earlier, Wendt, Ajluni, Bruce, Prasad, and Bing (44) attempted to determine the acute effects of alcohol ingestion on the human myocardium to gain a more complete understanding of the pathogenesis of alcoholic cardiomyopathy. Eleven hospitalized patients with a history of chronic alcoholism, but without clinical evidence of heart or liver disease, were studied. The patients ranged in age from 32 to 61 years; eight were male and three were female. All were in the post-absorptive state, and none was premedicated. The coronary sinus was intubated, and simultaneously arterial and coronary venous samples were obtained for determination of oxygen, carbon dioxide, glucose, lactate, pyruvate, acetoacetate, betahydroxybutyrate, free fatty acids, triglycerides, phospholipids, zinc, copper, magnesium, and the enzymes alcohol dehydrogenase and isocitric dehydrogenase. Patients were then given 6 ounces (178 ml.) of chilled vodka (containing 84% alcohol by weight) by mouth. The authors reported that arterial lactate rose from 6.5 to 10.2 mg. percent ($p < 0.001$). In eight patients myocardial lactate extraction rose; however, in three patients lactate was significantly liberated by the myocardium. This

resulted in statistically significant overall decline in myocardial lactate extraction.

In a manner similar to Blomqvist et al., Garlind, Goldberg, Graf, Perman, Strandell, and Ström (14) conducted a study in an attempt to determine the effect of alcohol on heart rate, oxygen uptake, respiratory quotient, ventilating quotient, lactate concentration, and mechanical efficiency. Nine healthy male subjects were examined under standardized conditions by different types of work test. Three types of work test were used.

1. Increased stepwise workloads of 300 kpm./minute every six minutes until a heart rate of 170 beats/minute was reached.
2. Continuous work for 20 minutes at a load producing a rise in heart rate to 160-170 beats/minute.
3. Intermittent work for 60 minutes, with work and rest periods of two minutes, at a load producing a rise in heart rate to 160-170 beats/minute.

Ethanol, 96%, was diluted about 25% in fruit juice before consumption and given in doses of .40 or .81 ml./kg. The authors reported blood lactate concentrations during muscular work were similar with and without ethanol.

Regan et al. (40) studied the effects of alcohol on the metabolic and hemodynamic responses of the left ventricle in dogs. The subjects, mongrel male dogs weighing 19 to 22 kg., were anesthetized 18 hours post prandially

with morphine sulfate and pentobarbital, and studied without opening the chest. Ethanol was dissolved in water to make a 15% solution and administered through a femoral venous catheter for approximately two hours at a rate of 0.1 mg. per kg. per minute after an initial priming dose of 0.2 ml. per kg. per minute for 12 minutes. Blood samples from the arterial and coronary sinus were taken for determination of arteriovenous differences of substrates. Substrate determinations were done in duplicate and included glucose, lactate, pyruvate, free fatty acid, triglyceride, and phospholipid. The authors concluded that myocardial metabolic response to ethanol included an initial shift in the respiratory quotient characteristic of predominant carbohydrate oxidation. During this period, left ventricular lactate extractions were enhanced.

IV. STUDIES RELATING TO THE EFFECTS OF ALCOHOL ON WORK PERFORMANCE

In a review of the literature, investigators have reported ethyl alcohol causing a decrease in blood supply to the working muscles, which suggests a decrease in muscular efficiency during work. The effect of alcohol on performance of the following selected gross motor skills was studied by Nelson (37): (1) grip strength, (2) speed and reaction, (3) softball throw for accuracy, (4) vertical jump, (5) bicycle ergometer work, and (6) push-ups. The

physical performance tests were selected to test such basic components as strength, endurance, speed and reaction time, power, and a complex throwing skill. Subjects were 30 male students at Utah State University. The study was set up as a cross over design and included five men in each of six groups. Three different drinks (one each week) containing no alcohol, 2 ounces (59 ml.), and 3 ounces (89 ml.) of 200 proof (100%) ethyl alcohol were administered to each subject. The exact amount of 2 ounces or 3 ounces (59 or 89 ml.) was given if the subject weighed 160 pounds (72 kg.) with proportionately more or less, depending on how much more or less he varied from the base weight. The amount was 1/2 ounce (15 ml.) for each 50 pounds (23 kg.) over or under the base weight, and then in turn broken down according to the subject's weight. The tests were administered on three days each week: (a) the day before consuming alcohol, (b) at the peak of the blood concentrations, which was 30 minutes following the last of three drinks (drinking covered a 45 minute period), and (c) the day following the drinking. All tests were given at the same time during each day and on the corresponding day each week. Beverages were ingested during the noon hour on an empty stomach. The author reported that the ingestion of the 2 ounces and 3 ounces (59 and 89 ml.) of alcohol significantly affected the performance of five of the six skills as measured one-half hour after ingestion. The

performance of the subjects decreased in proficiency approximately twofold for four of the six skills when the alcohol ingestion was increased from 2 ounces (59 ml.) to 3 ounces (89 ml.) of alcohol.

Blomqvist, Saltin, and Mitchell (5) studied the acute effects of various ethanol concentrations (in the blood in the range of 100 to 200 mg./100 ml.) on the response to submaximal and maximal exercise in normal subjects. Subjects were eight male moderate drinkers in good health. Ethanol was administered in the form of 2.0 ml./kg. of 43% whiskey, rum, or gin during a 20 minute period starting 60 minutes before exercise at the initial workload. Control experiments and studies after the ingestion of ethanol were conducted on separate days within an interval of one week. The subjects reported to the laboratory in the morning after a light breakfast and performed exercise on a bicycle ergometer at two submaximal workloads and one maximal workload. Submaximal workload levels were selected that required approximately 50 and 75% of each subject's maximal oxygen uptake. The maximal workload was chosen so that the subject was able to perform for two and one-half to five minutes. The authors reported work time at the maximal level was slightly shorter for the ethanol treatment, but the difference was not significant.

Asmussen and Boje (3) studied the effect of alcohol on the ability to perform maximal muscular work in four

healthy athletes. The work was performed on a stationary, braked bicycle ergometer. Two grades of work were investigated, one consisting in turning the pedals of the bicycle 35 revolutions, making a total amount of work of 956 mkg., and one in 450 revolutions, making a total work of 9,860 mkg. The first kind of work could be performed in 12 to 15 seconds and simulates a 100 meter run. The ethyl alcohol was given as a solution of from 25 to 75 g. of pure alcohol in water 30 to 45 minutes prior to the work. Immediately before starting a blood sample was collected from a stab in the finger, and the blood alcohol analysis was afterwards determined by the methods of Wildmark (45). The results from the alcohol experiments indicated that the solution given in 25 g. had no effect on the performance, and the solution given in 75 g. had a slight deteriorating effect, especially in the long work.

An investigation to determine the effect of a small and moderate dose of alcohol on several aspects of muscular strength and endurance was conducted by Williams (47). The parameters studied included initial strength, maximal strength, steady state or final strength, total work, fatigable work, and the rate of fatigue of the forearm flexors. Thirty-five students, all male moderate social drinkers, served voluntarily as subjects. Each subject was randomly assigned to one of four groups, each group representing a time interval for testing following the

drinking phase. For the experimental stage, variable one consisted of three variations of the amount of alcohol (95% ethanol) ingested. The amounts were regulated according to a set proportion per kilogram of body weight; proportions used were .0 ml. (control dose), .44 ml. (small dose), and .88 ml. (moderate dose). Variable two consisted of four variations of the elapsed time from cessation of the absorption period to the fatigue testing. Fifteen minutes were allowed for drinking the allotted amount. An additional 30 minutes were allowed for complete absorption to take place. Elapsed time period from the end of the absorption period were 1, 15, 30, and 60 minutes. Each subject observed a three hour fast prior to the drinking bout. Following the 15 minute drinking period, the subject remained seated or rested until his time elapsed before testing. He then underwent a testing bout which consisted of maximum contraction of the forearm flexors at the rate of 30 flexions/minute for six minutes. The author reported that a small or moderate dose of alcohol does not affect initial strength, maximal strength, final strength, total work, and fatigable work. Since these parameters are indicative of strength, endurance, and physical working capacity, it was concluded that these overall characteristics were unaffected by the various doses of alcohol.

Karvinen, Mettinen, and Ahlman (29) selected subjects between 24 and 54 years of age to determine the effects of

alcohol on heart rate, hand grip tension, back lift, and jump tests. The experimental beverage consisted of ethanol and water added to cognac to make a 33% alcohol solution. One-half of the group drank in diluted form between 1.2 and 3.0 ml. of alcohol per kg. of body weight within two to three hours. The remaining subjects formed a control group that spent the evening and night in the dormitory with those given alcohol. On the next occasion (two to four weeks later) the two groups were reversed. The hangover was presumed to exist on the morning following drinking. On the following morning all the subjects performed the test, consisting of a given workload on a bicycle ergometer (1,500 kgm./minute), continuing for five minutes. Both groups of men also performed hand grip tension, back lift, and jump tests both when sober and with a hangover. The authors reported that the ergometer work was completed by 15 of 27 test subjects in a sober condition and by 9 of the 27 during hangover. Twelve subjects performed more in the sober condition and two during hangover, the difference being significant ($p < .05$), while 13 subjects performed equally long during both conditions. In other tests (hand grip, back lifting, and jumping) there were no significant differences between the control and hangover groups.

V. STUDIES RELATING TO THE EFFECTS OF ALCOHOL ON RATING OF PERCEIVED EXERTION

It must be noted in general, the review of the literature was disappointing in respect to studies on the psychological effects of alcohol during stress testing. Only one study appeared in the literature dealing with this topic. Garlind, Goldberg, Graf, Strandell, and Ström (14) conducted a study in attempt to determine the effect of alcohol on circulatory, metabolic, and neurohormonal function during muscular work in men. Nine healthy male subjects were examined under standardized conditions by different types of work tests. Three types of work tests were used.

1. Increased stepwise workloads of 300 kpm./minute every six minutes until a heart rate of 170 beats/minute were reached.
2. Continuous work for 20 minutes at a load producing a rise in heart rate from 160-170 beats/minute.
3. Intermittent work for 60 minutes, with work and rest periods of two minutes, at a load producing a rise in heart rate to 160-170 beats/minute.

Ethanol, 96%, was diluted to about 25% in fruit juice before consumption and given in doses of .40 or .81 ml./kg. The authors reported the subjects felt the ethanol effect at about seven to nine minutes after the ingestion but were not severely affected during the course of work.

After the end of a work test the feeling of dizziness, etc., usually increased suddenly. Sweating during work was more profuse under ethanol, as judged by both subjects and experimenters. According to subjects' own evaluation, physical work capacity was not decreased under ethanol. The most exhausting work test (intermittent work), was even felt to be easier to do under ethanol.

VI. SUMMARY

In general, there are no conclusive reports concerning the acute effects of ethyl alcohol on cardiorespiratory function. The numerous variables of physical performance, such as heart rate, blood pressure, oxygen uptake, ventilation, endurance, and lactate production exhibit varying degrees of reaction to the ingestion of ethyl alcohol according to the literature cited. The existing controversy in the literature lends to the basic premise of conducting this study.

CHAPTER III

METHODS AND PROCEDURES

In order to determine the effects of the ingestion of ethyl alcohol on cardiorespiratory function and lactate production, the subjects performed the bicycle ergometer test following the ingestion of either a placebo or experimental liquid. Each subject performed the test under three conditions, two of which included the ingestion of alcohol with grapefruit juice, while the control had grapefruit juice substituted for the alcohol solution.

The physical factors controlled were the following: ingestion time of the liquid, post-absorption time, fasting time, liquid volume ingested, workload, and pedal rate. The physiological variables measured included: heart rate, blood pressure, oxygen uptake, ventilation, rating of perceived exertion, lactate production, and endurance.

In this study the amount of alcohol used was based upon the subject's body weight to assure as much uniformity in blood alcohol levels as possible among the subjects. Measurements under experimental and control conditions were taken 30 minutes after ingestion to ensure that any changes were due to the presence of alcohol within the body (2, 30). The amounts of alcohol used, .0 ml., .44 ml., and .88 ml. per kilogram of body weight, were chosen as the dosages of alcohol to be ingested because of

the apparent intoxicating effects of these amounts. For example, a subject weighing 73 kilograms, ingesting .88 ml. per kilogram body weight would ingest 64 ml. of 190 proof alcohol, which is equal to 2.15 ounces or approximately 4.3 ounces of 80 proof alcohol in common whiskey. This amount would produce a mean peak blood alcohol level of .10% (48), which is legally considered an intoxicating amount.

Another experimental consideration was the rate of consumption of the liquid. In the investigation, the total quantity of liquid was consumed during a 10 minute period, with one-fifth the total amount ingested every two minutes. In the example cited above, the subject would have ingested 64 ml. of ethyl alcohol with 256 ml. of grapefruit juice, resulting in a total solution of 320 ml. At a predetermined time the subject would begin ingestion of the liquid, consuming 64 ml. of the solution each two minutes.

In this study an attempt was made to disguise the type of liquid which was ingested. During the ingestion phase the subject wore a nose clip to help eliminate the taste of the solution.

I. METHODS

Subjects

Twelve physically active males, six abstainers and six moderate drinkers, served voluntarily as subjects during the Winter and Spring quarters of the 1978-79

academic year. Experimental protocol was explained to each subject and an informed consent form was signed by each subject prior to participation (see Appendix A). The abstainers ranged in age from 18 to 29 years, in weight from 63.6 to 97.7 kilograms, and in total skinfold measures from 30.5 to 71.5 millimeters (tricep, chest, subscapular, mid axillary, abdomen, and iliac crest). The moderate drinkers ranged in age from 20 to 29 years, in weight from 59.5 to 110.9 kilograms, and in total skinfold measures from 31.5 to 114.6 millimeters. The age, weight, and total skinfold measures of the subjects appear in Tables 1 and 2.

TABLE 1

AGE, WEIGHT, AND TOTAL SKINFOLD MEASURE OF ABSTAINERS

Subject	Years	Weight (kg)	Skinfold (mm)
1.	23	73.6	32.5
2.	22	97.7	55.0
3.	20	79.1	58.0
4.	29	63.6	30.5
5.	22	77.7	71.5
6.	18	70.9	35.5
Mean (N = 6)	22.33	77.1	47.16
S.D.	3.72	11.50	16.73

TABLE 2

AGE, WEIGHT, AND TOTAL SKINFOLD MEASURE OF MODERATE DRINKERS

Subject	Years	Weight (kg)	Skinfold (mm)
7.	24	110.9	114.6
8.	26	77.7	48.5
9.	28	59.5	31.5
10.	29	70.9	50.0
11.	20	78.2	33.0
12.	26	77.3	41.5
Mean (N = 6)	25.50	79.08	53.18
S.D.	3.20	17.13	31.04

Experimental Conditions

The three conditions of this study included the following, and were systematically assigned to help eliminate any order effect:

1. Control: Each subject consumed a designated quantity of grapefruit juice. Thirty minutes after termination of ingestion the physical performance test began.
2. Small dose: Each subject consumed a designated quantity of grapefruit juice with .44 ml./kg. body weight of ethyl alcohol. Thirty minutes

after termination of ingestion the physical performance test began.

3. Moderate dose: Each subject consumed a designated quantity of grapefruit juice with a .88 ml./kg. body weight of ethyl alcohol. Thirty minutes after termination of ingestion the physical performance test began.

Administration of Liquid

The total volume of liquid consumed by each subject was based upon the subject's body weight. Commercial whiskey (95% alcohol, 190 U.S. proof) was administered in dosages of .0 ml. (placebo), .44 ml. (small dose), and .88 ml. (moderate dose) per kilogram body weight. These dosages were chosen because of their apparent intoxicating effect and produced Blood Alcohol Levels (BALS) of .0, .05, and .10 (48). During the control phase grapefruit juice was substituted for alcohol and administered in the dose of .88 ml. per kilogram of body weight. The order of administration of the dosages were systematically assigned and diluted as a 20% mixture with unsweetened grapefruit juice. This solution was used for two reasons. First, solutions of alcohol between 10 and 30% provide for the most rapid absorption of alcohol in the bloodstream without irritating the mucosa (24). Secondly, this solution eliminated most of the unpleasant taste of the mixture. The subjects ingested the total quantity of liquid in five

equal parts over a 10 minute period, and were instructed not to indulge in the use of alcohol on the night prior to the experiment and refrain from the use of any food, liquid, or tobacco for four hours prior to the test.

Heart Rate

Heart rates were recorded during the pre-ingestion rest, post-absorptive rest, third minute of exercise at each work level, and at 1, 3, and 10 minutes immediately following the termination of exercise. Two electrode leads were placed on the subject's right and left lower rib cage anteriorly, and one lead was placed on the manubrium of the sternum. The leads were connected to a cardiac coupler Type 7176 (Narco Biosystem) and the heart rate readings were recorded.

Blood Pressure

Systolic and diastolic blood pressure were recorded during the pre-ingestion rest, post-absorption rest, third minute of exercise at each work level, and at 1, 3, and 10 minutes following termination of exercise. Both systolic and diastolic blood pressure were readily measured with the use of a sphygmomanometer. A hollow cuff was wrapped around the left arm and inflated with air pressure. A stethoscope was placed over the brachial artery just below the cuff. Systolic pressure was recorded as sound first appeared and diastolic pressure recorded as the sound disappeared.

Oxygen Consumption

The technique used for measurement of oxygen uptake was that of the open circuit method utilizing meteorological balloons and a Daniels' Valve. Expired gas was collected in the meteorological balloons and immediately analyzed electronically on the Beckman Oxygen Analyzer (Model E2) and Beckman Medical Gas Analyzer (Model LB1). These analyzers were calibrated with gas samples analyzed by the Scholander technique. To assure accurate electronic readings (Model E2 and Model LB1), two 50 ml. gas samples were taken periodically with glass syringes from the meteorological balloons and analyzed by the Scholander technique.

For this experiment the resting Vo_2 was based upon a two minute collection of expired gases. Thus, the result of the calculations for the resting Vo_2 was divided by two. Collections during exercise and recovery were one minute volumes.

Ventilation

Inspired gas volumes were measured for two minute (pre- and post-rest) and one minute (exercise and recovery) periods. Ventilation was measured with a Parkinson Cowan CD-4 dry gas meter and recorded with a Narco Biosystem DMP-4A recorder. The dry gas meter was calibrated against a 120 liter Tissot gasometer respirometer resulting in a correction factor of 0.997. Appropriate calculations were

made to convert these volumes to minutes-volumes of inspired gas at standard temperature and pressure, dry (STPD). Using this information, oxygen uptake was calculated according to standard procedures:

$$\dot{V}O_2 = \dot{V}_{I_{STPD}} \left[F_{I02} - \frac{F_{IN2}}{F_{EN2}} \cdot F_{E02} \right]$$

where $\dot{V}_{I_{STPD}}$ = Volume of air (liters) inhaled per minute.

F_{IN2} = Fraction of inspired nitrogen.

F_{EN2} = Fraction of expired nitrogen.

F_{E02} = Fraction of expired oxygen.

Endurance

Endurance was measured as length of time worked on the bicycle ergometer while a pedal rate of 60 revolutions per minute was maintained. Time was recorded by the Narco Biosystem with an event pen marker set at five seconds intervals on physiograph 4-Channel 1 mm. Grid paper. The subject was encouraged to work until exhaustion and time was recorded to the nearest second. During this experiment the subjects were not informed of the time worked during the test to help eliminate the competitive effect among oneself and other subjects.

Rating of Perceived Exertion

The technique used for measuring the effect of ethyl alcohol on perceived exertion during work was a simple

rating scale for use in physical work tests developed by Borg (9). The rating scale (see Appendix B) ranged from 6 (very, very, very light) to 20 (very, very, very hard). The scale was printed in large bold letters on 8-1/2 x 11 white construction paper and mounted on the wall in front of the subject. During the last 30 seconds at each workload the subject, who was unable to talk because of the mouth piece, responded with an upward and downward motion of his head when he felt the number being pointed to corresponded to the amount of physical exertion at that time. The subject's response was then recorded.

Blood Sampling

Before samples were taken the hand was warmed by a heating pad and then submerged into a beaker of hot water. The blood was collected and stirred in a spot plate containing the residue of 0.05 ml. of 4% sodium fluoride.

Blood Samples and Lactate Analysis

Resting fingertip blood samples were taken before and after ingestion of the experimental liquid and five minutes (± 20 seconds) after termination of the workload. Fifty microliters of the sample were pipetted in a tube containing 2.0 ml. of 7% perchloric acid. The blood and perchloric acid were thoroughly mixed and placed in an ice bath for later analysis. At the completion of the recovery period all blood samples were centrifuged at 4,000 rpm. for 10

minutes. The supernatant was decanted into another chilled tube and stored in a freezer until analyzed (43). Each blood sample was analyzed in duplicate for lactic acid by the method of Gutman and Wahlfeld (18) (see Appendix C for detailed description of the procedure).

Blood Samples and Blood Alcohol Analysis

Resting and recovery fingertip blood samples were collected 30 minutes after ingestion of the experimental liquid and five minutes after termination of the workload. A 30 minute absorption period was chosen because diffusion of ethanol is rapid, with 80-90% of the quantity ingested being absorbed in 30 minutes (2, 30). Fifty microliters of the sample were pipetted in a tube containing 2.0 ml. of 6.25% trichloroacetic acid. The blood and trichloroacetic acid were thoroughly mixed and placed in an ice bath for later analysis. At the completion of the recovery period all blood samples were centrifuged at 4,000 rpm. for 10 minutes. The supernatant was decanted into another chilled tube and stored in a refrigerator until analyzed. Each blood sample was analyzed in duplicate for blood alcohol level by the method of Bonnichsen and Theorall (8) (see Appendix D for detailed description of the procedures). For the safety precaution described in the informed consent form (see Appendix A), a model 900 Brethanalyzer was used to assure the investigator that the subject's blood alcohol level upon leaving the laboratory was .03% or lower.

Workload

In order to determine the acute effect of ethyl alcohol on submaximal and maximal performance, a progressive work task on a mechanically braked Monark bicycle ergometer was utilized as the standardized test. All subjects were pre-tested to acquaint the subjects with the experimental procedures, workloads and pedal rate, and to obtain the proper seat height. The workload consisted of three minutes each at 360, 720, and 1,080 kpm./minute. Thereafter the resistance was increased by 180 kpm./minute every three minutes until the subject was unable to maintain a pedal rate of 60 rpm. A Seth Thomas metronome and a mark on the speedometer of the ergometer was used to ensure proper pedaling cadence. Pedaling frequency was recorded by use of a micro-switch attached to the ergometer frame. Each revolution of the right pedal arm tripped the switch to result in a printed record on the physiograph (Physiograph Desk Model Type DMP-4A). The bicycle ergometer was calibrated each week prior to testing. Seat height was set on the first pre-test day by using the subject's full leg extension. The seat height for each subject was recorded and used for each testing session.

II. PROCEDURES

On the day prior to the initial experiment the subject was instructed not to indulge in any alcoholic beverage on the night prior to testing and to refrain from eating, smoking, and drinking for four hours prior to entering the laboratory. The subject was also instructed not to engage in any physical exertion for one hour prior to testing. The sessions were conducted at approximately the same time of day for each subject.

Pre-Exercise Protocol

One hour prior to the beginning of the performance test the subject entered the laboratory dressed in the following attire: (1) T shirt, (2) shorts, (3) athletic socks, (4) athletic supporter, and (5) athletic shoes. The subject was weighed wearing only shorts, athletic supporter, and socks using a Health O Meter scale. This weight was used to calculate the volume of liquid to be ingested. Using a Lange Skinfold Caliper, the subject's total skinfold measures were obtained using the following sites: (1) tricep, (2) chest, (3) subscapular, (4) mid axillary, (5) abdomen, and (6) iliac crest. The three electrodes from the cardiac coupler were then placed on the manubrium of the sternum and right and left lower rib cage. The subject then rested comfortably on the ergometer for 10 minutes with the heating pad wrapped around

his right hand. After a nose clip was secured on the nose, a rubber mouthpiece attached to a Daniels valve was then placed in the subject's mouth. The valve was connected to a Parkinson Cowan CD-4 gas meter by flexible tubing. The subject was instructed to breath normally. After five minutes, a two minute collection of expired gases was obtained in a meteorological balloon and analyzed for oxygen and carbon dioxide percentages.

Heart rate and blood pressure were recorded at the beginning of the final minute of gas collection. At the beginning of the ninth minute, the subject's finger was sterilized with an iodine sterile pad, and pricked with a Microlance B-D Sterile Disposable Blood Lancet for determining blood lactate.

The subject then removed the nose clip and mouthpiece and sat comfortably in a chair. From the subject's weight obtained earlier, the quantity of experimental solution was then mixed. The subject was informed that the solution he received may or may not contain any alcohol. The subject was then instructed to put on his nose clip and he had two minutes to consume each volume of solution given to him. The total time for consumption of the entire quantity of the solution was 10 minutes. After 10 minutes for consumption, the subject was informed to take off his nose clip and to remain quiet for 30 minutes for absorption to occur.

After 10 minutes of absorption, the subject was instructed to sit on the ergometer for the remainder of the absorption period. At 30 minutes after absorption, his finger was pricked to obtain 200 ul. of blood to determine blood alcohol level and blood lactate level. At this time the subject was instructed to put on his nose clip and mouthpiece and remain quiet and physically inactive for 10 minutes to obtain post rest absorption values on heart rate, ventilation, oxygen uptake, and blood pressure. All the measures for the pre-exercise, exercise, and recovery phases of the experiment were taken with a Model 168 Gra Lab Universal Timer.

Exercise Protocol

At the end of the post-absorption rest, the subject began the bicycle ergometer test. The workload consisted of three minutes each at 360, 720, and 1,080 Kpm./minute, thereafter the resistance was increased by 180 kpm./minute every three minutes until the subject was unable to maintain a pedal rate of 60 rpm. The subjects were encouraged to work as long as possible and only the last full minute values of work at 60 rpm. were recorded for maximal performance. Heart rate was continuously monitored and when a heart rate of 170/beats was obtained, or the subject indicated he was reaching exhaustion, the recording of all variables was changed to every minute, instead of every three minutes. Resistance and pedal rate were monitored

continuously to inform the subject if he was pedaling above or below the desired pedal rate. Heart rates and blood pressure were recorded during the third minute of exercise at each workload.

Expired gas collections and ventilation were recorded during the third minute at each exercise workload and lasted for a one minute period. The gas samples were immediately analyzed and two samples were drawn into glass syringes to be analyzed by the Scholander technique.

Rating of perceived exertion was indicated by the subject and recorded during the last 30 seconds at each workload.

Recovery Protocol

When the subject indicated he had reached maximal exhaustion, or could no longer maintain the 60 rpm. pedal rate, the test was stopped. The total time worked was recorded to the nearest second by a timer on the Narco Biosystem set at five second intervals. After termination of the workload, the subject was instructed to sit on the ergometer for 10 minutes without pedaling. Three heart rate readings, blood pressure readings, ventilation readings, and oxygen uptake measurements were taken at the following times after termination of exercise: (1) one minute, (2) three minutes, and (3) 10 minutes. Blood lactate and blood alcohol levels during the recovery phase were taken five minutes after termination of exercise.

Statistics

A two-way (2 x 3) ANOVA with repeated measures on the second independent variable was used to determine the differences between types of drinkers (abstainer or moderate), the different dosages of alcohol (.0, .44, or .88 ml./kg.), and the interaction between type of drinker and dosages of alcohol. A separate analysis was done on each dependent variable. The Newman-Keuls post hoc test was used on those variables significantly different on dosages of alcohol to determine where significant differences existed among the three dosages. Simple main effects were determined on variables which had a significant interaction to determine at which dosages the different type of drinkers were significantly different. The .05 level of significance was used to generalize beyond this study.

CHAPTER IV

RESULTS AND DISCUSSION

I. ANALYSIS OF DATA

It was the purpose of this study to determine the effects of ethyl alcohol, 30 minutes after ingestion, on cardiorespiratory function by measuring heart rate, blood pressure, oxygen uptake, and ventilation. Additional measurements were taken of blood lactate production, time to exhaustion, and perceived exertion. Twelve subjects, six abstainers and six moderate drinkers, performed the bicycle ergometer test under one control and two experimental conditions. The raw and mean data are contained in Appendix E, and summary of statistical analysis in Appendix F.

Statistical Procedure

Because each subject was tested under three conditions, it was possible that an order effect could influence the test data. In an effort to preclude that possibility, the order of the dosages was systematically assigned.

The hypothesis was established at the .05 level of significance to determine if any significant differences occurred among the variables measured under the three conditions. It was hypothesized that a significant increase would occur in heart rate, blood pressure, oxygen uptake, ventilation, and blood lactate, and a significant

decrease in endurance and perceived exertion. In order to test the hypotheses, a 2 x 3 ANOVA, with repeated measures on the second independent variable, was used to analyze the data. If any significant differences occurred among the dosages as indicated by the "F" test, the Newman-Keuls post hoc test was used to determine where the differences actually occurred. If significant interaction occurred among any of the variables, a one-way analysis of variance was conducted on the dosages for each group. The Newman-Keuls post hoc test was used to determine at which dosages the different type of drinkers were significantly different.

Because some of the subjects were not able to work at the 1,260 kpm./minute workload and above, all measurements were terminated for analysis purpose at the 1,080 kpm./minute workload. This was the last measurement interval in which all subjects performed during exercise.

Graphical Illustration

In the presentation of the graphs, the values collected during pre-ingestion rest have been included. It should be noted that the purpose of this collection was not for determining differences between pre and post conditions, but to determine if there were any initial differences between the groups at the beginning of the experiment. Analysis of the data indicated no initial differences between the groups. If initial differences had existed, analysis of covariance would have been

conducted to adjust for group differences.

Blood Ethanol Concentration

The concentration of alcohol in the blood 30 minutes after ingestion was determined on two duplicate blood samples drawn from the fingertip. For the different groups, the doses of ethanol produced almost identical results per kilogram body weight (± .005 mg./100 ml.). Data on blood alcohol levels for the groups 30 minutes after ingestion are listed in Tables 97 and 98 (see Appendix E). The mean blood alcohol level for both experimental groups after ingestion of the small and moderate dose of ethanol was .05 and .10% respectively. The result of this analysis supports the findings reported earlier by Williams (46, 1972).

Heart Rate

Data on heart rate during rest, exercise, and recovery after ingestion of three dosages of alcohol are listed in Tables 3-18 (see Appendix E). Graphical illustrations of the means for the groups' heart rates are shown in Figures 1 and 2. The average heart rate for the 1,080 kpm./minute work rate ranged from 155 to 160 beats/minute across groups and treatments. The results of the "F" test for mean heart rate revealed that no significant differences ($p > .05$) existed between the groups among the three conditions during rest, exercise, and recovery (Tables 99-106). The hypothesis related to heart rate was, therefore, not accepted.

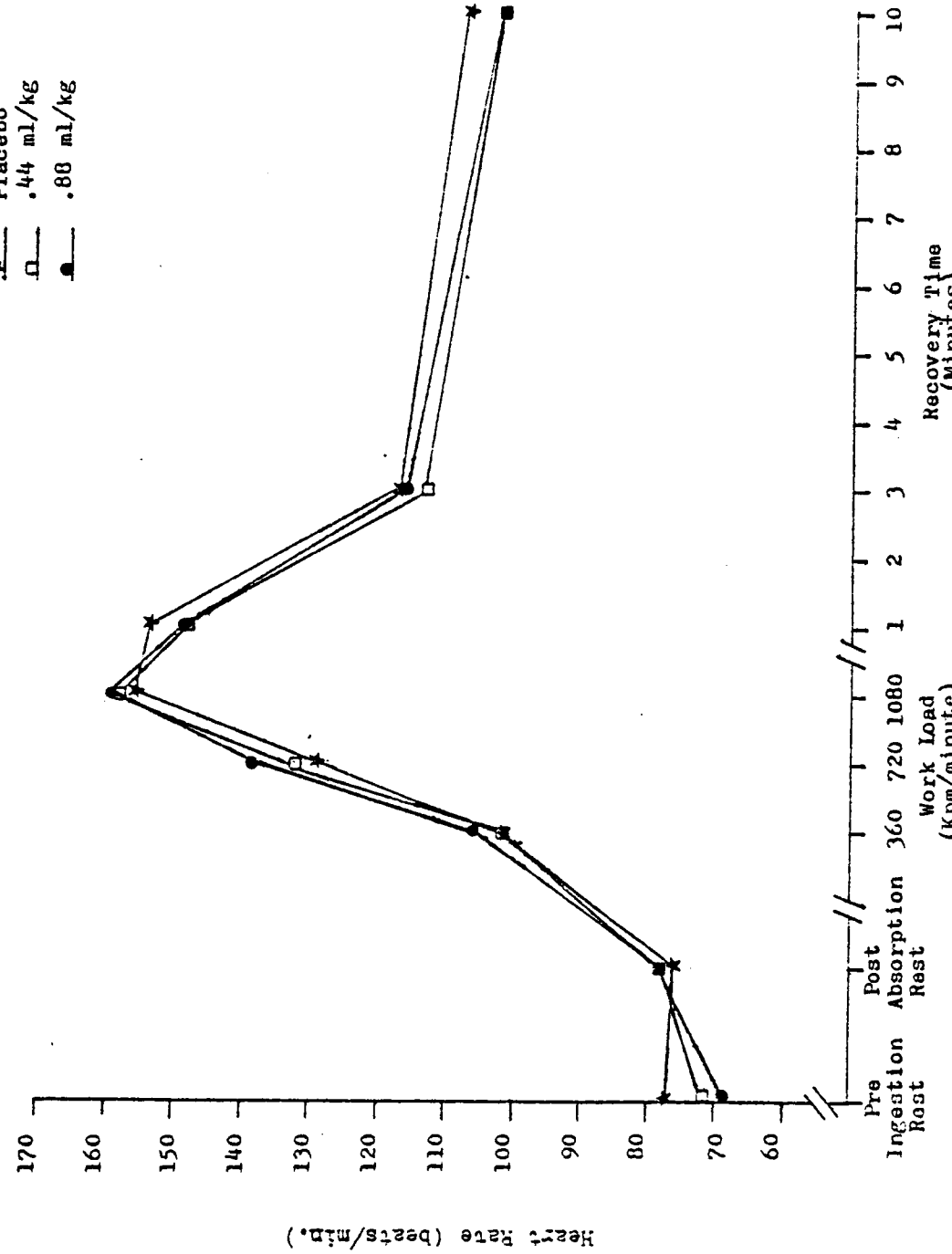

Figure 1. Mean heart rate response of abstainers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

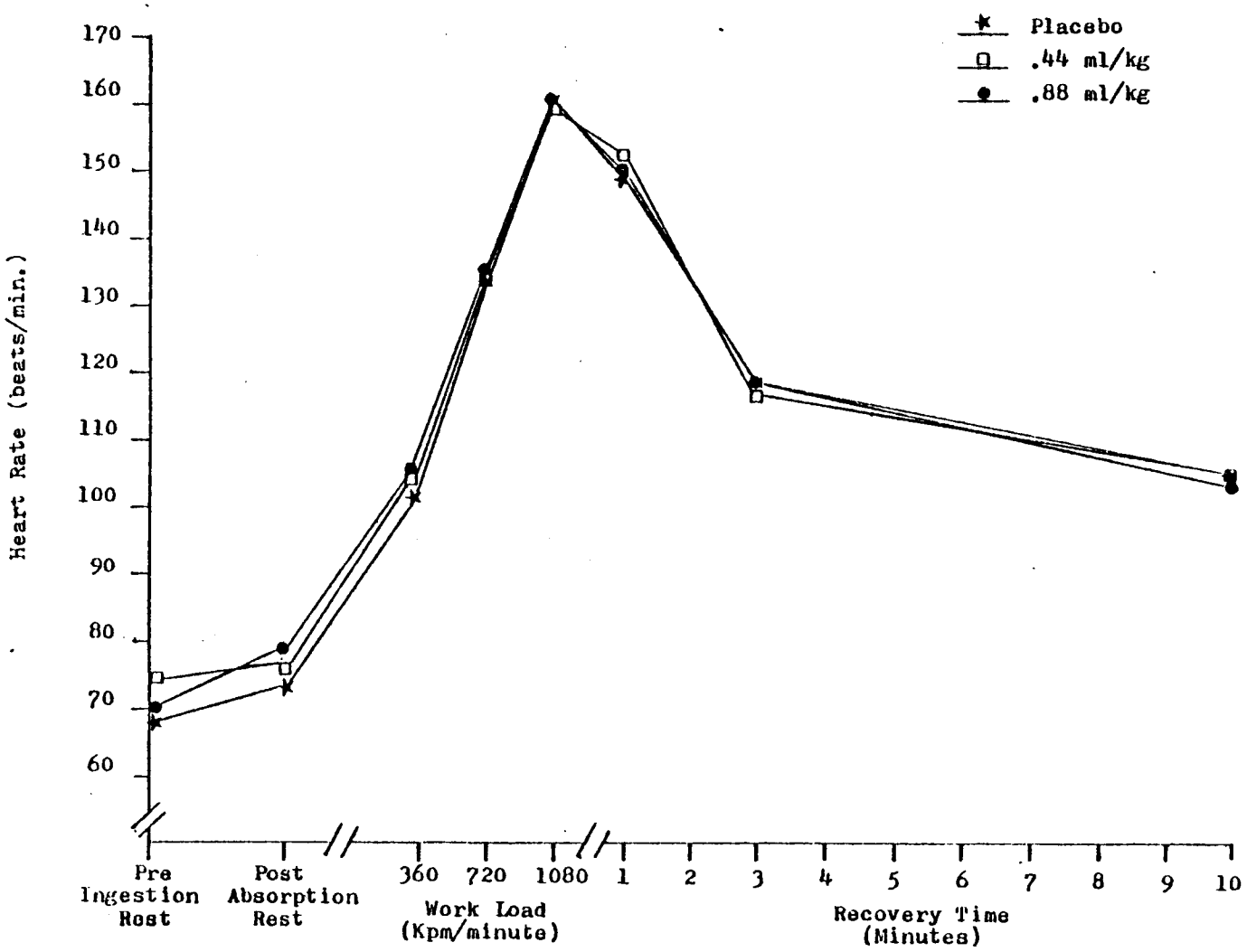

Figure 2. Mean heart rate response of moderate drinkers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

Systolic Blood Pressure

Data on systolic blood pressure during rest, exercise, and recovery after ingestion of three dosages of alcohol are listed in Tables 19-34 (see Appendix E). Graphical illustrations of the means for the groups' blood pressure during rest, exercise, and recovery are shown in Figures 3 and 4. The average systolic blood pressure for the 1,080 kpm./minute work rate ranged from 158 to 172 mm. Hg. across groups and treatments.

The analysis of variance revealed no significant differences ($p > .05$) among any of the measurements for the three conditions at the prescribed times of collection (Tables 107-114). The hypothesis related to systolic blood pressure was, therefore, not accepted.

Diastolic Blood Pressure

Data on diastolic blood pressure during rest, exercise, and recovery after ingestion of three dosages of alcohol are listed in Tables 35-50 (see Appendix E). Graphical illustrations of the means for the groups' diastolic blood pressure during rest, exercise, and recovery are shown in Figures 5 and 6. The average diastolic blood pressure for the 1,080 kpm./minute work rate ranged from 77 to 87 mm. Hg. across groups and treatments. The results of the "F" test for mean diastolic blood pressure revealed that no significant differences occurred between the groups during rest, exercise, and

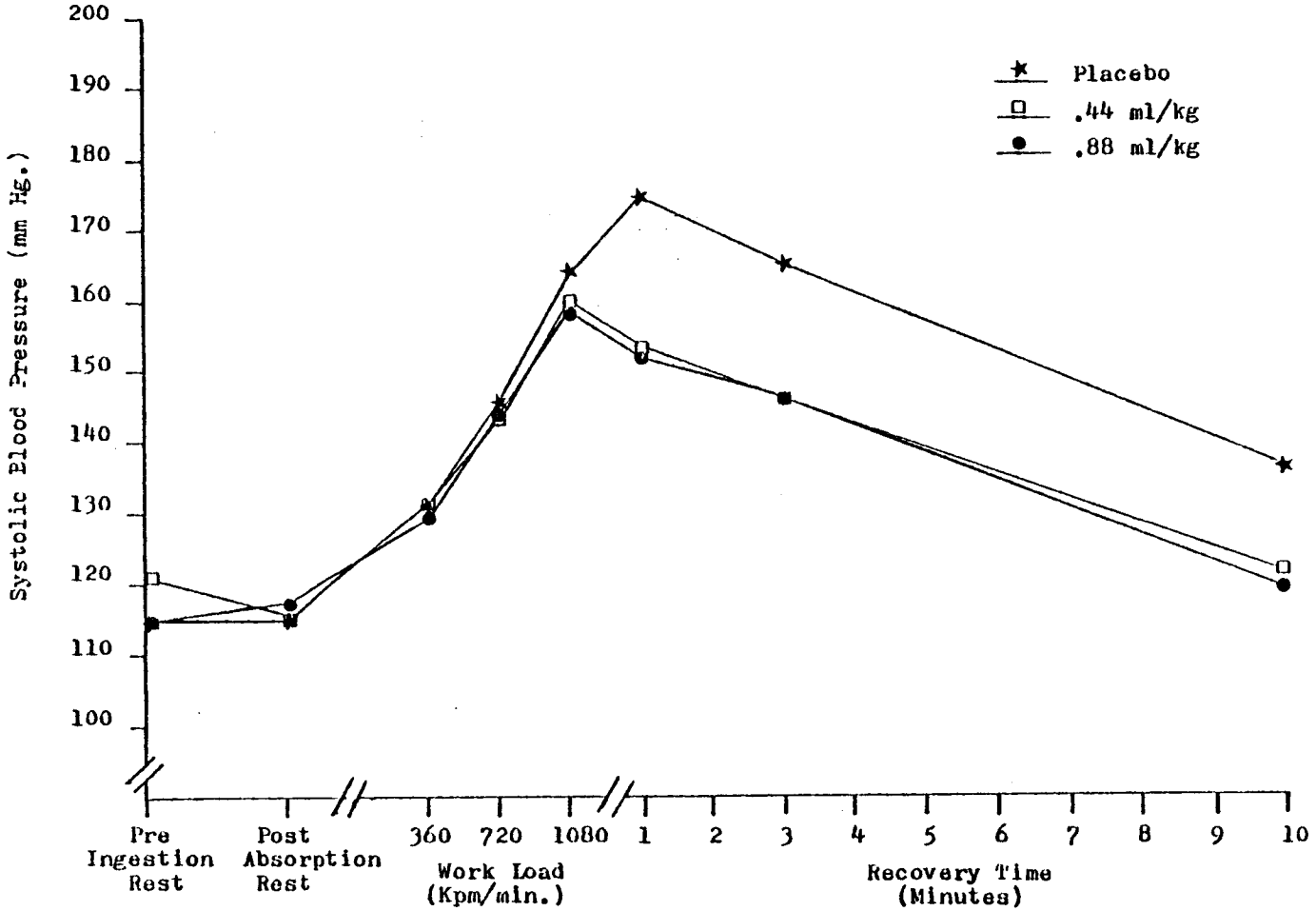

Figure 3. Mean systolic blood pressure of abstainers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

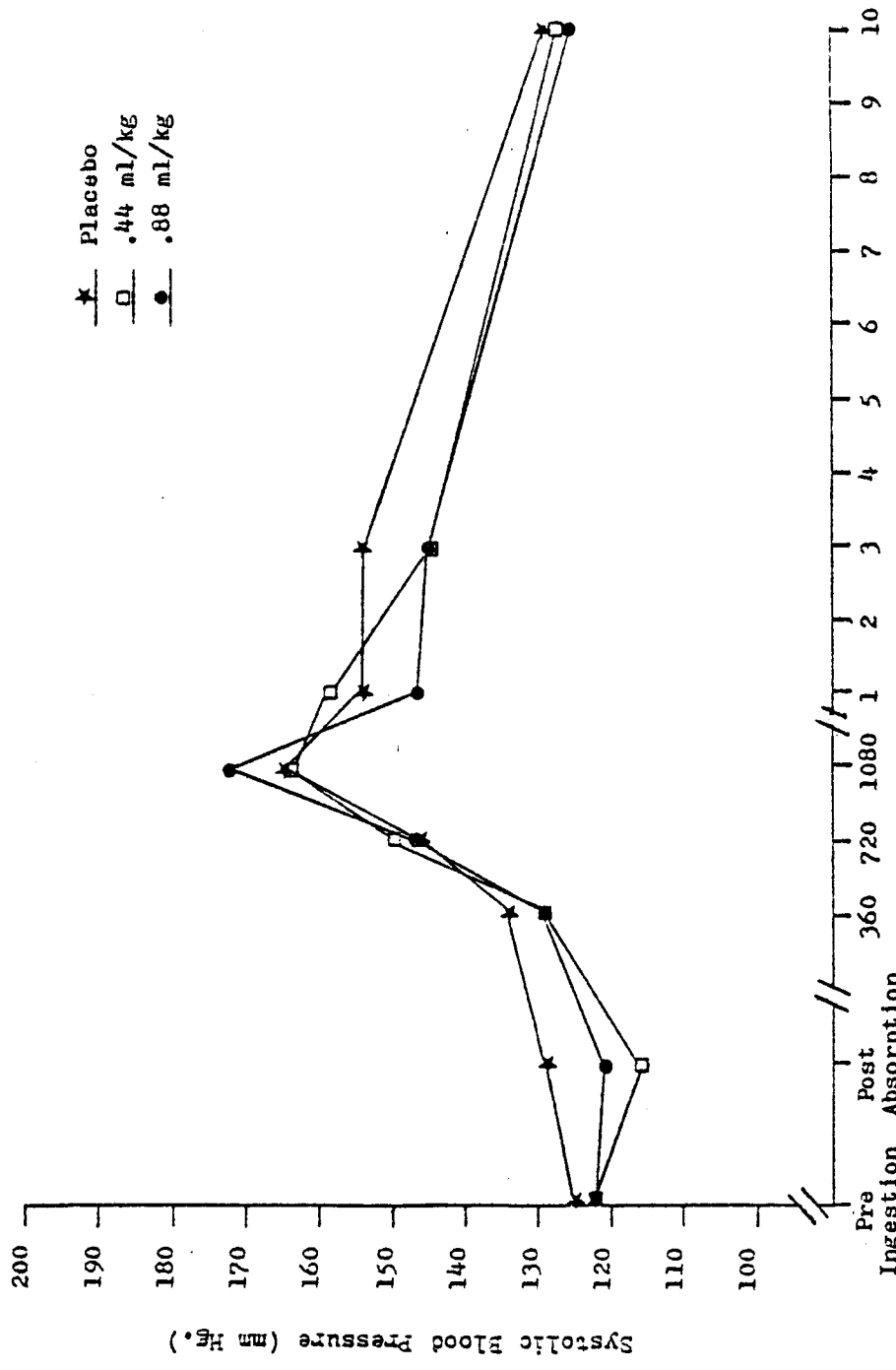

Figure 4. Mean systolic blood pressure of moderate drinkers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

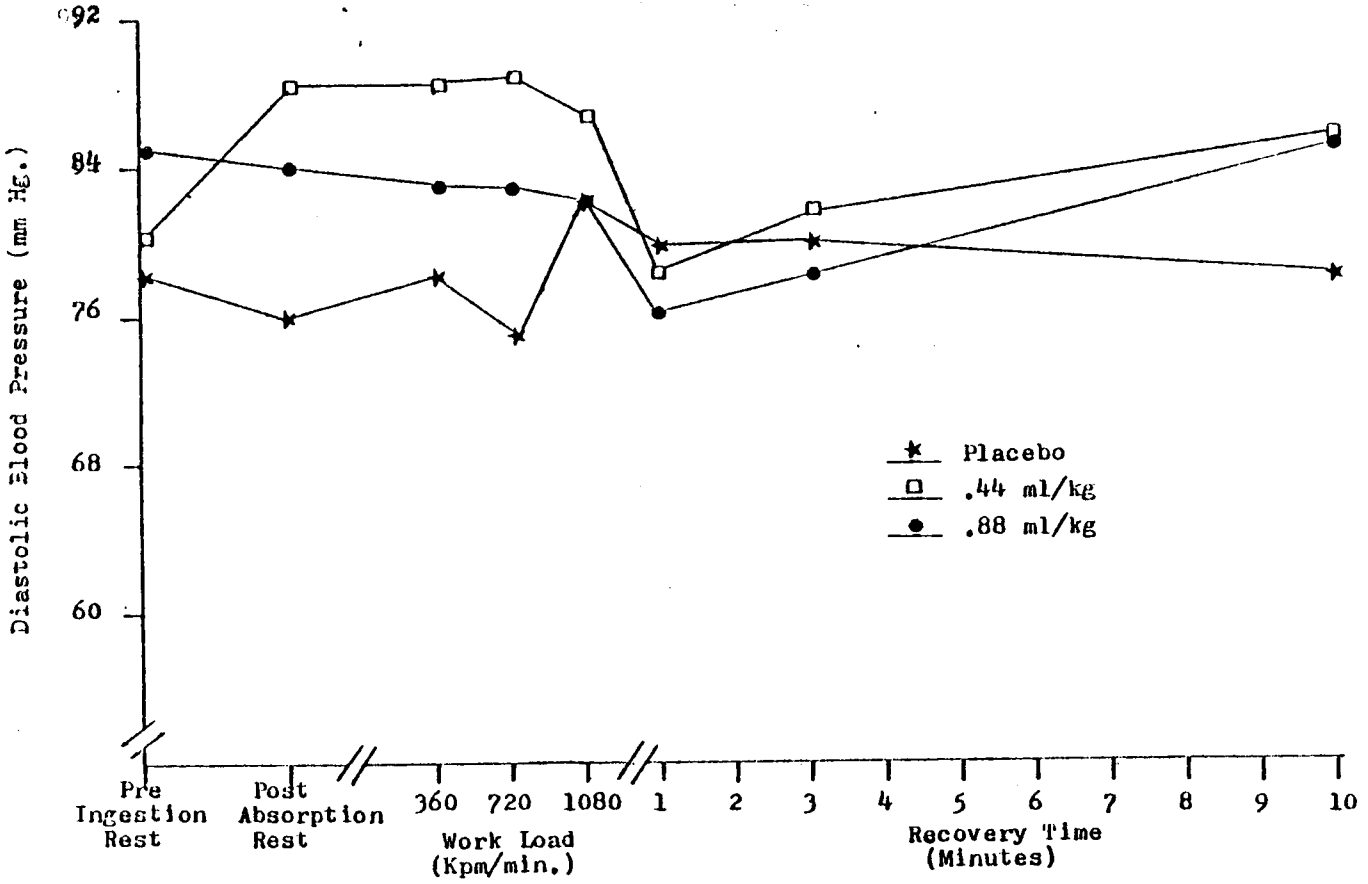

Figure 5. Mean diastolic blood pressure of abstainers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

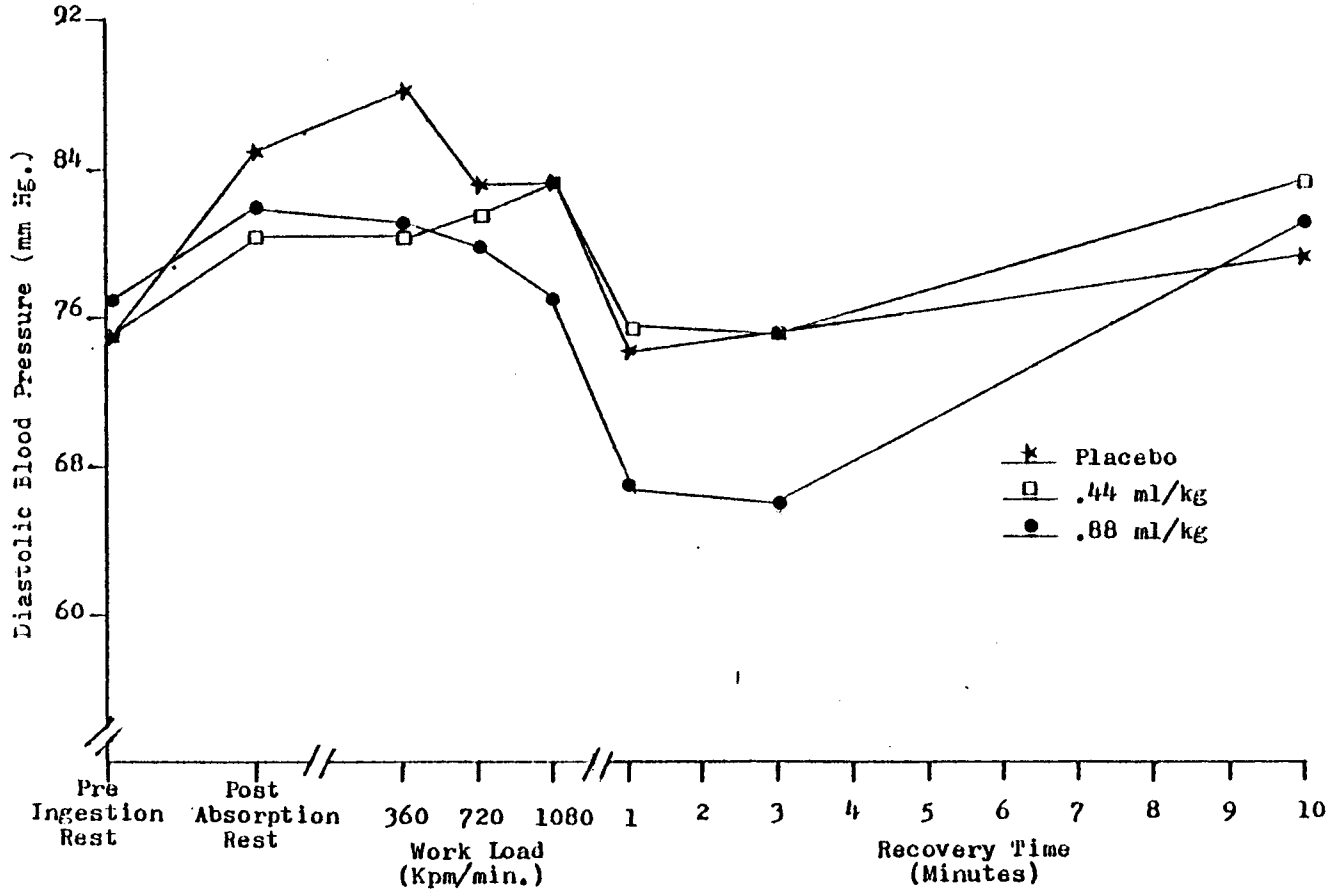

Figure 6. Mean diastolic blood pressure of moderate drinkers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

recovery (Tables 115-122). The analysis revealed that significant interaction ($p < .05$) occurred during post-absorption rest, exercise at 360 and 720 kpm./minute (Tables 116-118). The "F" test also revealed that significant differences occurred among the three dosages during the third minute recovery collection (Table 121). In order to determine at which dosages the different type of drinkers were significantly different, a one-way analysis of variance was conducted on dosages for each group. The Newman-Keuls post hoc test was then conducted to determine at which alcohol dosage the type of drinkers were significantly different. Although the "F" test of the variance analysis revealed a significant interaction during post-absorption rest and exercise at 360 kpm./minute workload, variance analysis of the type of drinkers and alcohol dosages were all judged to be statistically non-significant at the .05 level using the one-way analysis of variance (see Appendix G).

A visual examination of the graphs of mean difference between type of drinkers and alcohol dosages during post-absorption rest and exercise at 360 kpm./minute workload (Figures 7 and 8) indicated the greatest difference between the type of drinkers and alcohol dosages occurred after ingestion of the control dose (.0 ml./kg.).

The one-way analysis of variance and Newman-Keuls post hoc test revealed significant differences ($p < .05$)

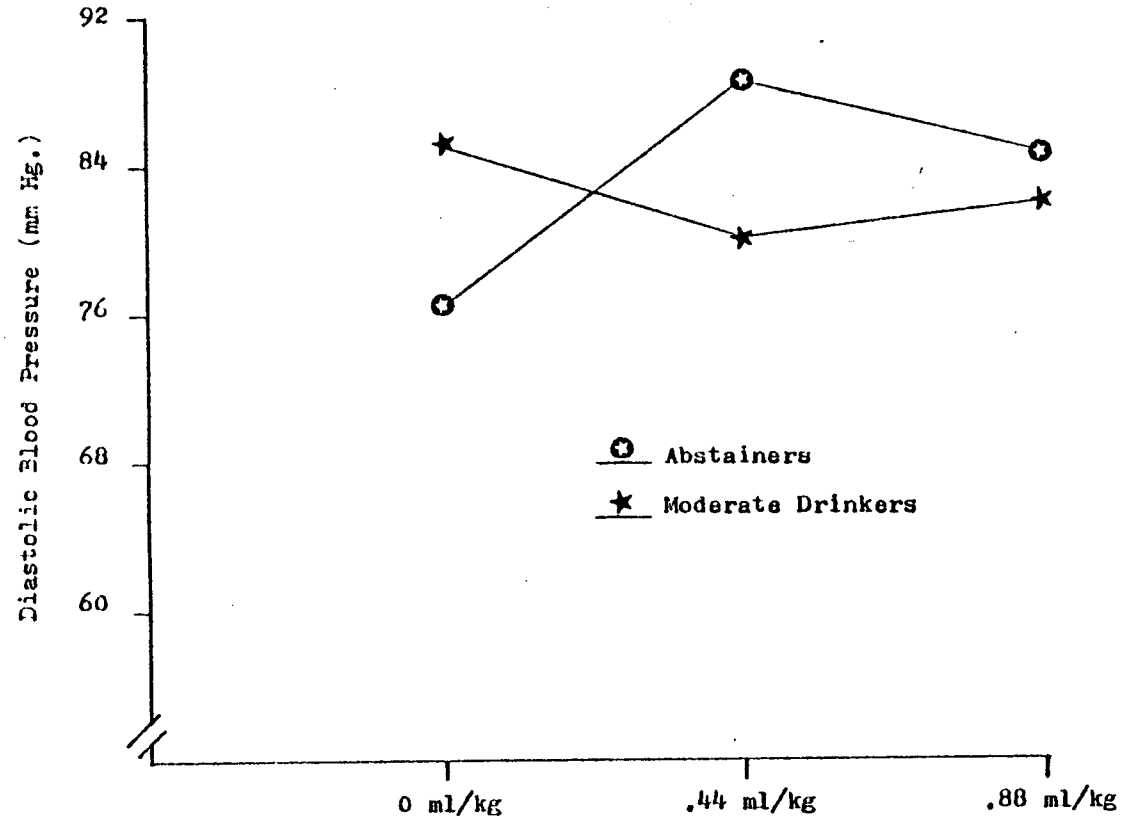

Figure 7. Diastolic blood pressure of different dosages of alcohol and types of drinkers during post-absorption rest.

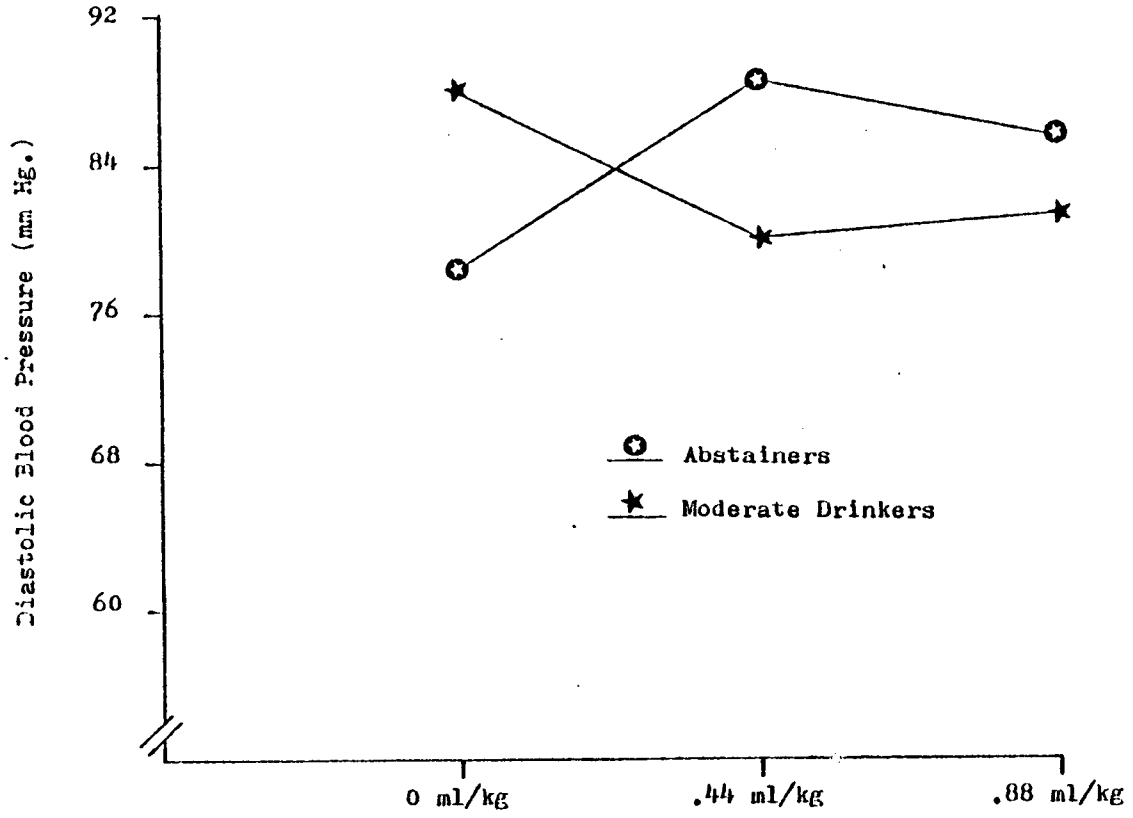

Figure 8. Diastolic blood pressure of different dosages of alcohol and types of drinkers during exercise at 360 kpm./minute.

among the three dosages for the abstainers during the 720 kpm./minute workload (Figure 9). Diastolic blood pressure of the abstainers were significantly higher after ingestion of the small and moderate dosages than the control dose (see Appendix G). In order to determine where significant differences prevailed among the three dosages during the three minute recovery collection, Newman-Keuls post hoc test was conducted. Although the "F" test of the variance analysis revealed a significant difference between the dosages during the three minute recovery, comparisons of the dosages were all judged to be statistically non-significant at the .05 level using the Newman-Keuls post hoc test (see Appendix G). A visual examination of the graph of difference between dosages (Figure 10) indicated the greatest difference occurred between the small (.44 ml./kg.) and moderate dose (.88 ml./kg.). The hypothesis related to diastolic blood pressure was, therefore, partially accepted. The diastolic blood pressure of the abstainers was significantly higher after ingestion of the small and moderate dosages than control dose at 720 kpm./minute.

Oxygen Uptake

Data on oxygen uptake during rest, exercise, and recovery after ingestion of three dosages of alcohol are listed in Tables 51-66 (see Appendix E). Graphical illustrations of the means for the groups' oxygen uptake during

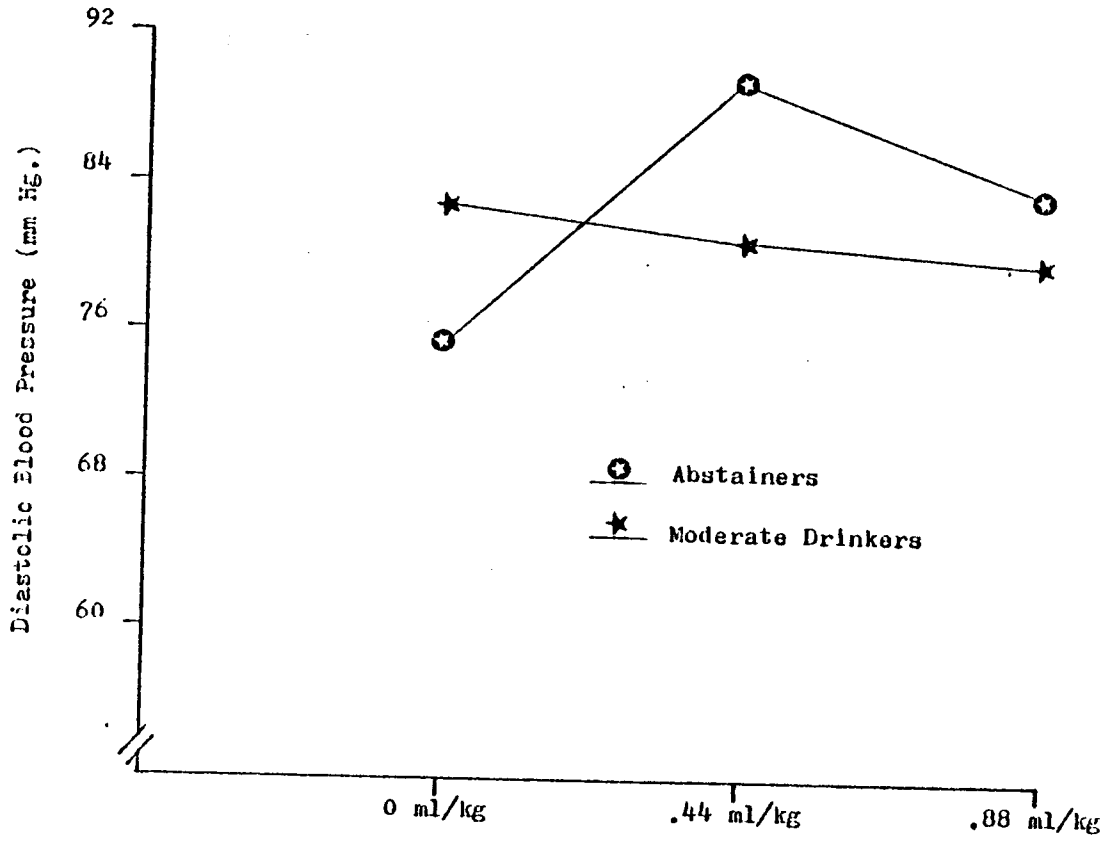

Figure 9. Diastolic blood pressure of different dosages of alcohol and types of drinkers during exercise at 720 kpm./minute.

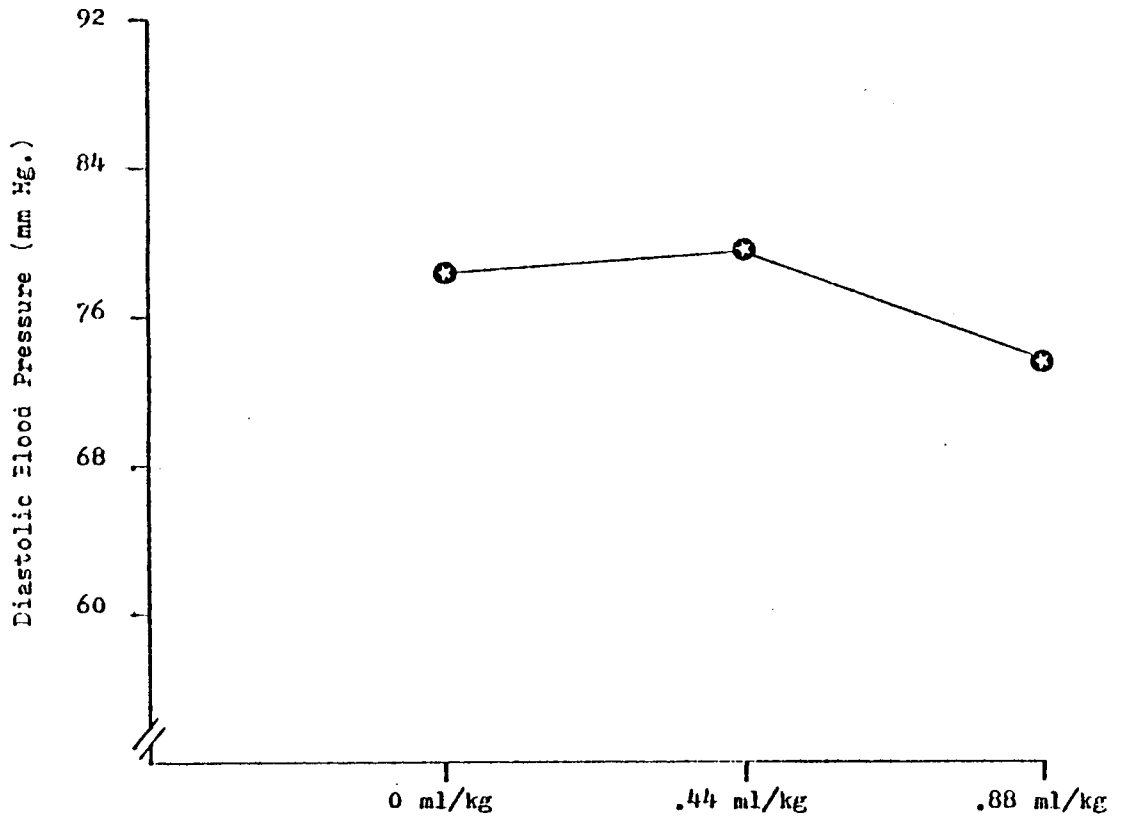

Figure 10. Mean difference between the alcohol dosages during three minute recovery, measuring diastolic blood pressure.

rest, exercise, and recovery are shown in Figures 11 and 12. The average oxygen uptake for the 1,080 kpm./minute work rate ranged from 34.68 to 36.45 ml./kg./minute across groups and treatments.

The analysis of variance revealed no significant differences among any of the three conditions of measurements at the prescribed times of collection (Tables 123-130). The hypothesis related to oxygen uptake was, therefore, not accepted.

Ventilation

Data on ventilation during rest, exercise, and recovery after ingestion of three dosages of alcohol are listed in Tables 67-82 (see Appendix E). Graphical illustrations of the $V_{I_{STPD}}$ are shown in Figures 13 and 14. The average ventilation for the 1,080 kpm./minute work rate ranged from 59.10 to 69.52 liters/minute across groups and treatments. The analysis of variance revealed no significant differences among the groups or dosages during the three experimental conditions (Tables 131-138). The variance analysis revealed that significant interaction ($p < .01$) occurred during post-absorption rest (Table 132). In order to determine at which dosages the different types of drinkers were significantly different, the one-way analysis of variance and Newman-Keuls post hoc test were conducted (see Appendix G). This analysis revealed that the resting ventilation 30 minutes after ingestion of the moderate

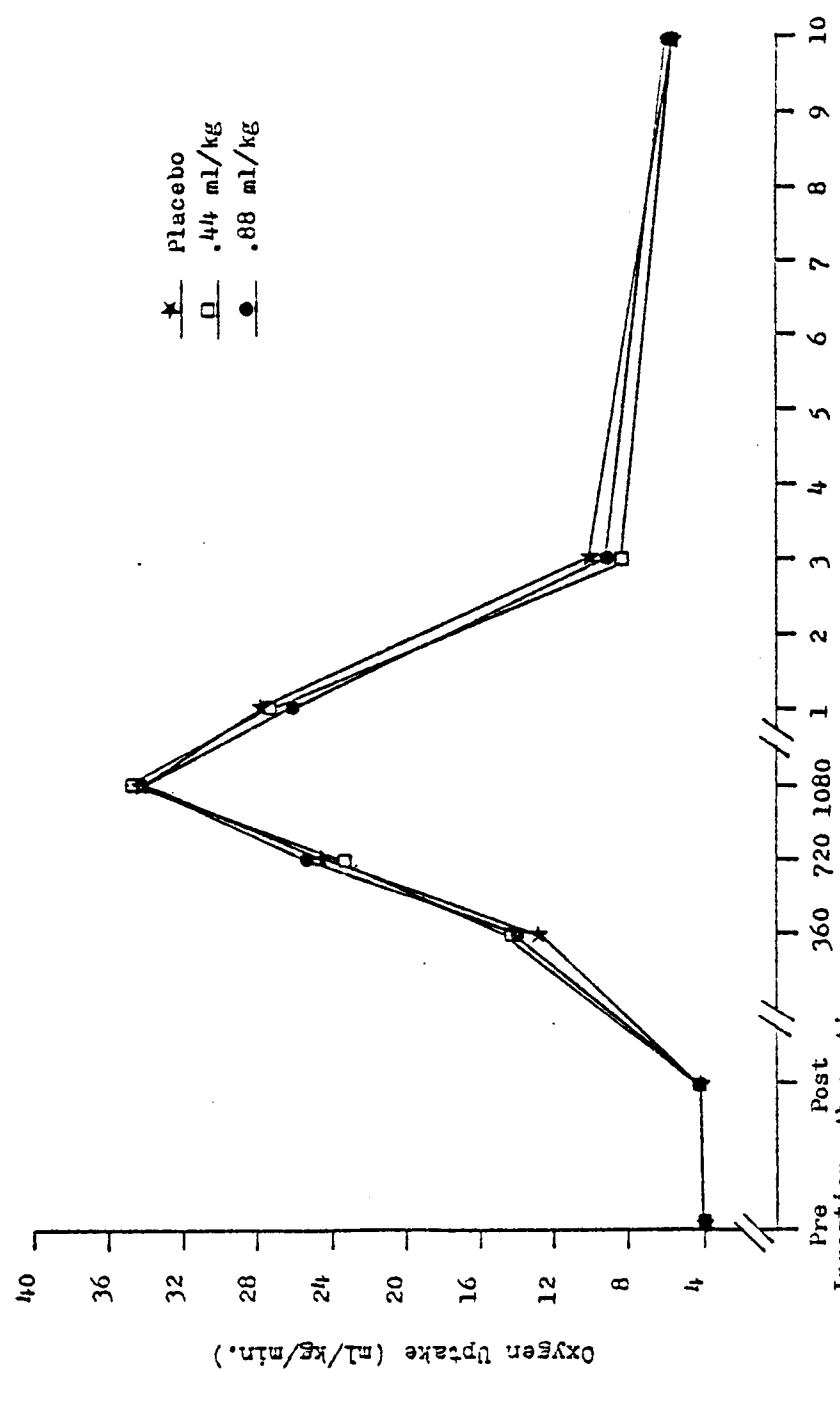

Figure 11. Mean oxygen uptake of abstainers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

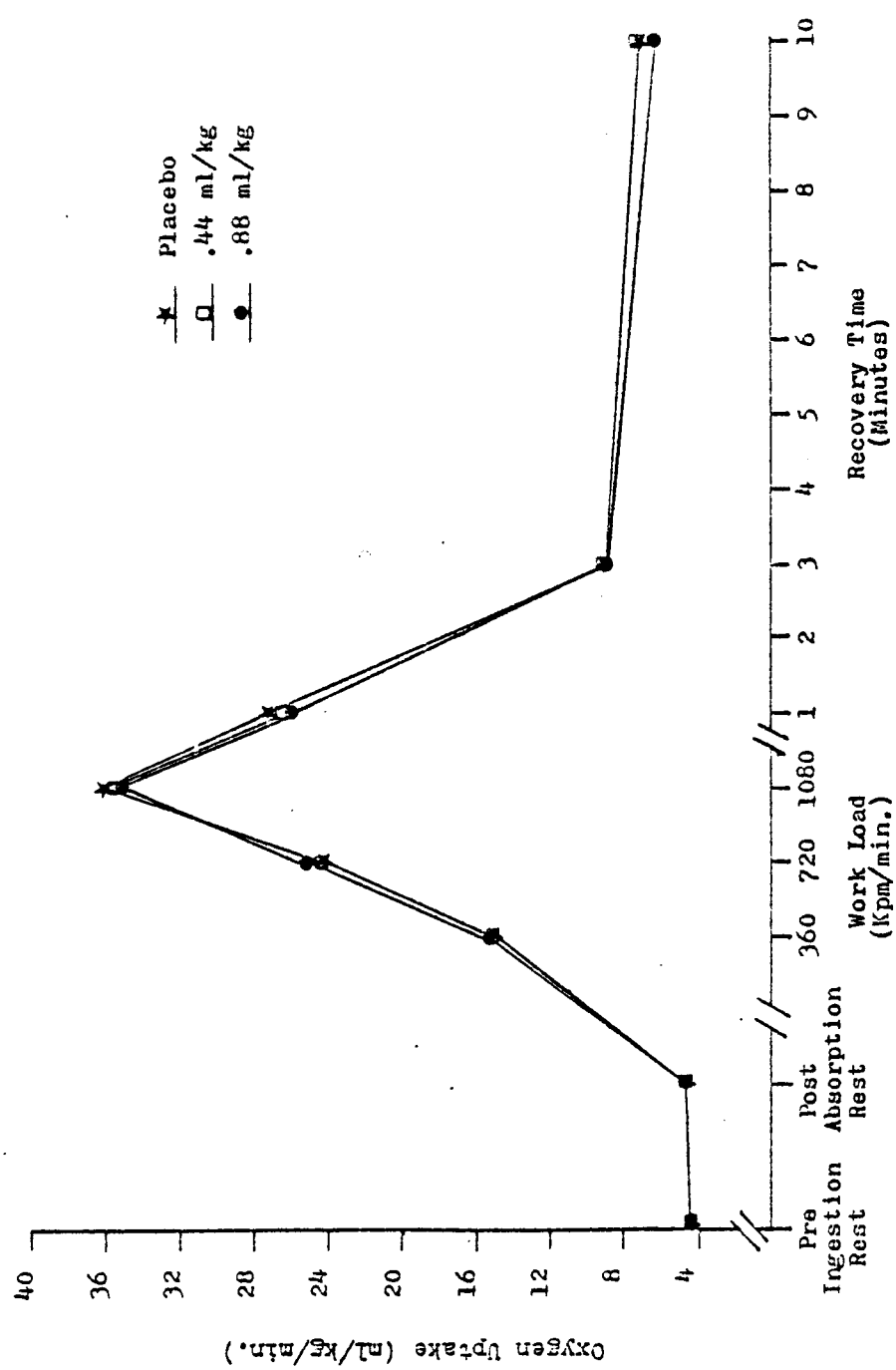

Figure 12. Mean oxygen uptake of moderate drinkers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

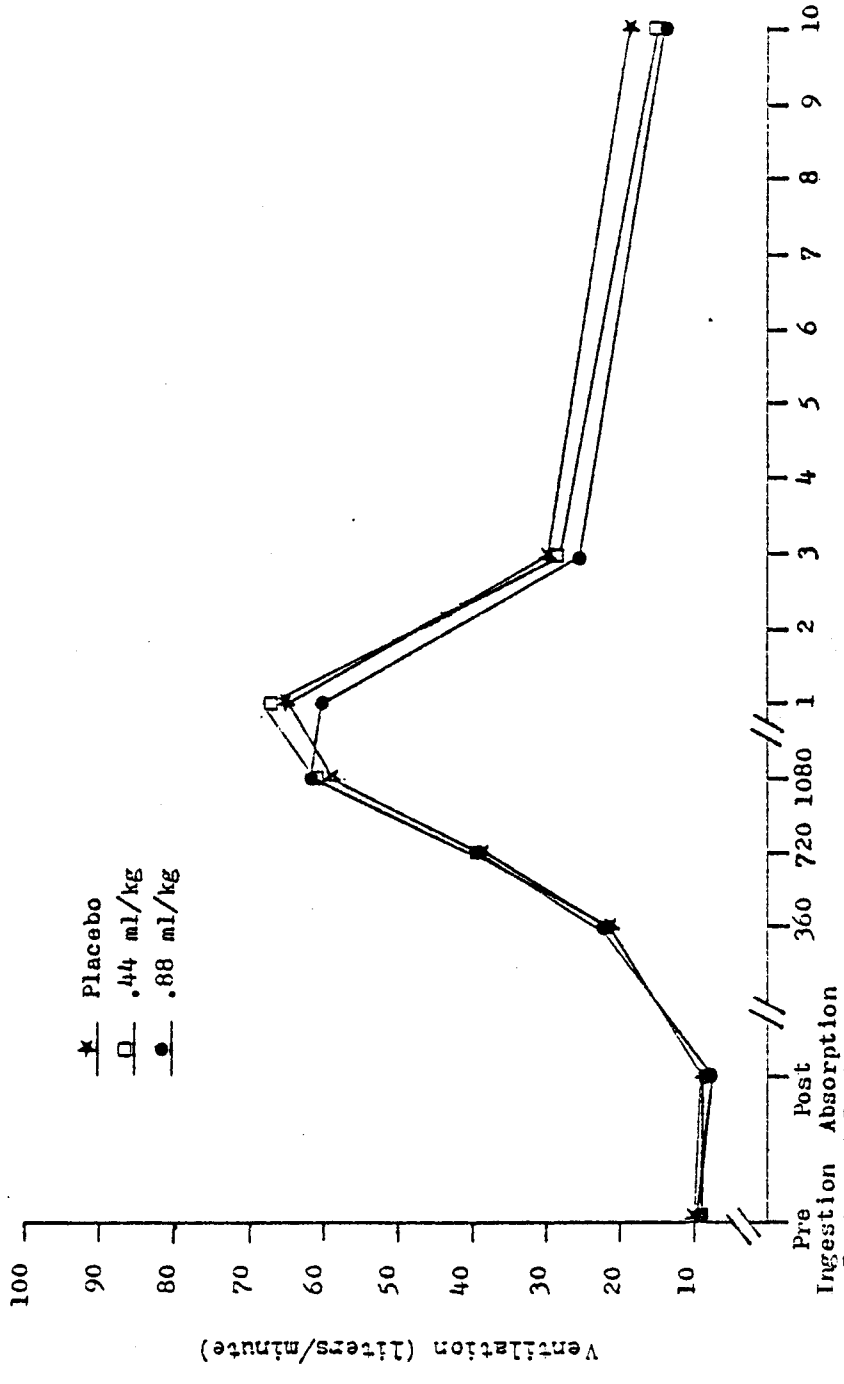

Figure 13. Mean ventilation response of abstainers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

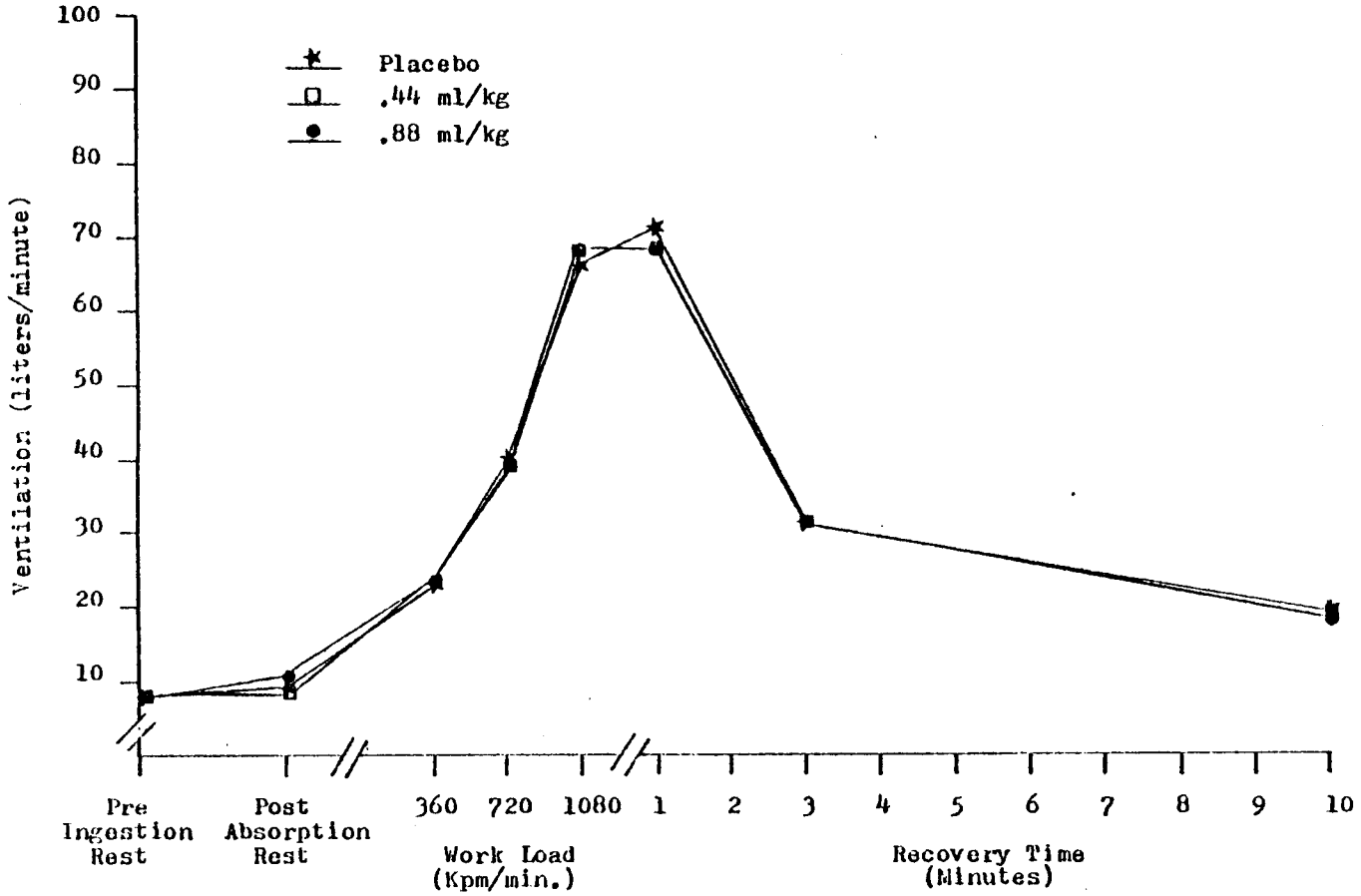

Figure 14. Mean ventilation response of moderate drinkers during rest, exercise, and recovery after ingestion of three dosages of alcohol.

dose (.88 ml./kg.) for the moderate drinkers was significantly higher than the control and small dose (Figure 15). The hypothesis related to ventilation was, therefore, partially accepted.

Blood Lactate

Data on blood lactate during rest after ingestion of three dosages of alcohol are listed in Tables 83-86 (see Appendix E). Blood lactate levels for both groups after ingestion of alcohol (Figure 16) shows a slight, but non-significant, increase in the small and moderate dosages. The variance analysis of resting blood lactate after ingestion of alcohol (Table 140) revealed that no significant differences occurred among any of the resting lactate measures for all conditions. The hypothesis was not accepted that ingestion of small and moderate dosages of alcohol increase resting blood lactate in abstainers and moderate drinkers.

Data on blood lactate during the five minute recovery after ingestion of three dosages of alcohol are listed in Tables 85-88 (see Appendix E). Blood lactate values for both groups indicated an increase with increasing alcohol dosage (Figure 17). The average blood lactate for the five minute recovery ranged from 6.36 to 10.36 mm./liter across groups and treatments. The analysis of variance revealed significant differences ($p < .01$) among the three dosages during five minute recovery collection (Table 141).

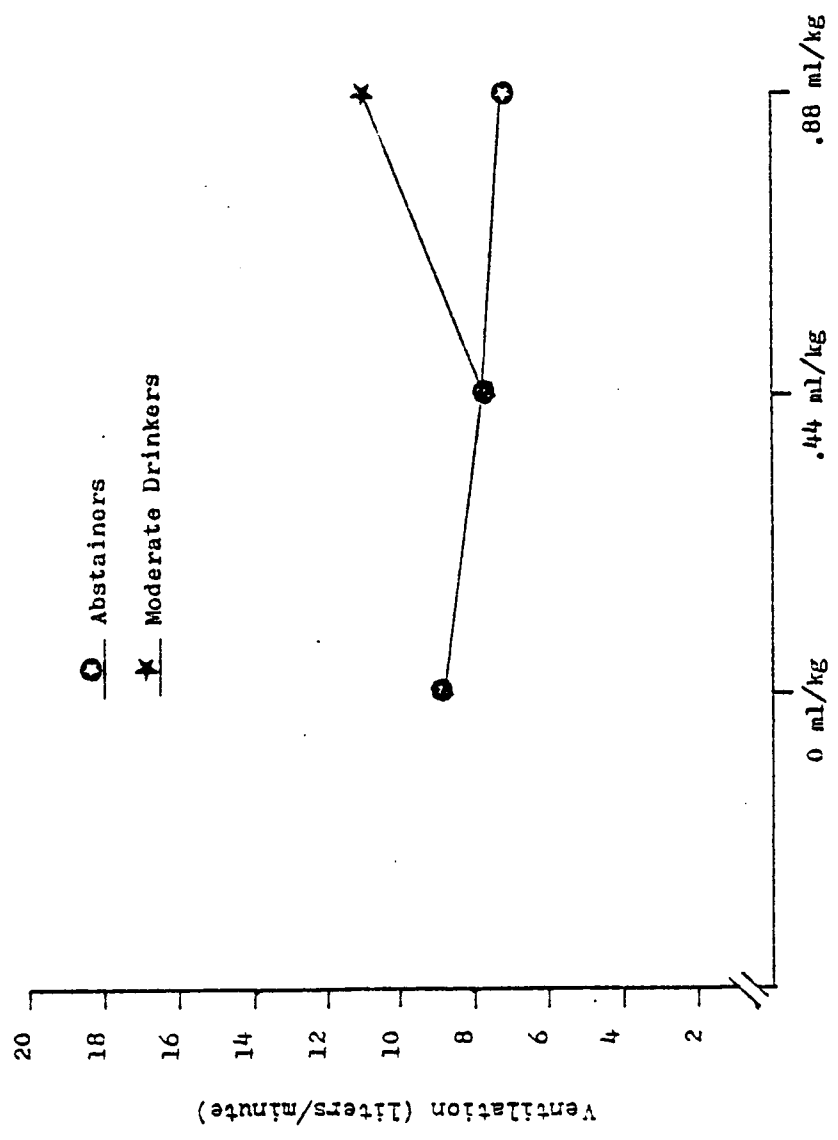

Figure 15. Ventilation response of different dosages of alcohol and types of drinkers during post-absorption rest.

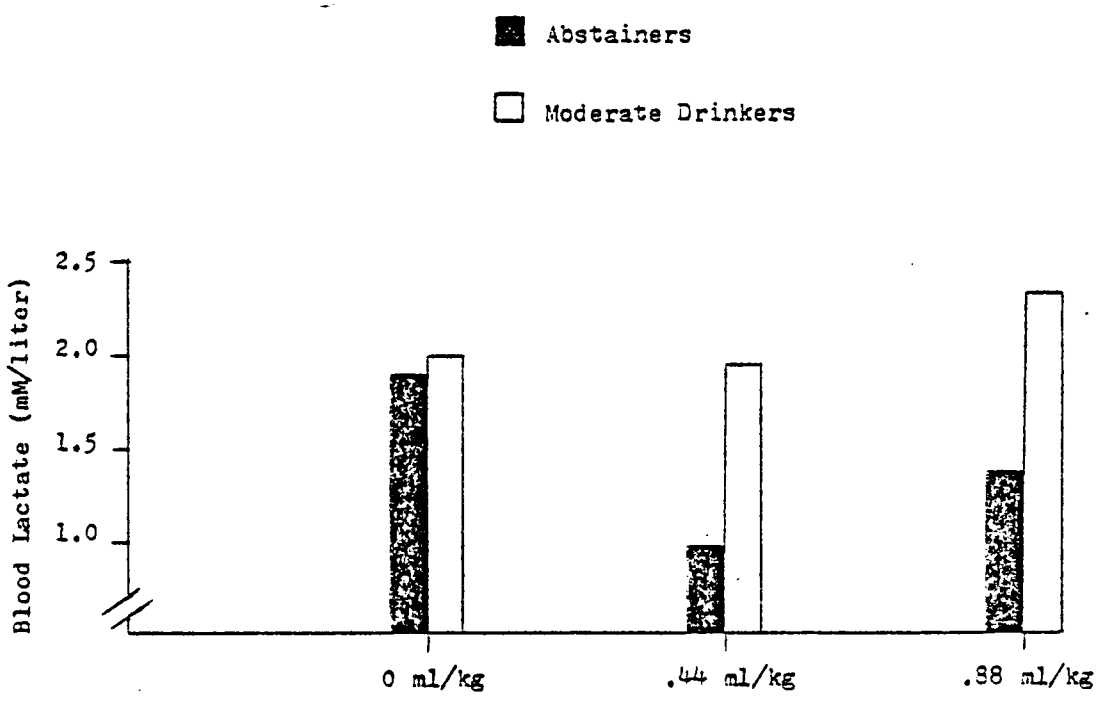

Figure 16. Mean blood lactate values of abstainers and moderate drinkers at rest after ingestion of three dosages of alcohol.

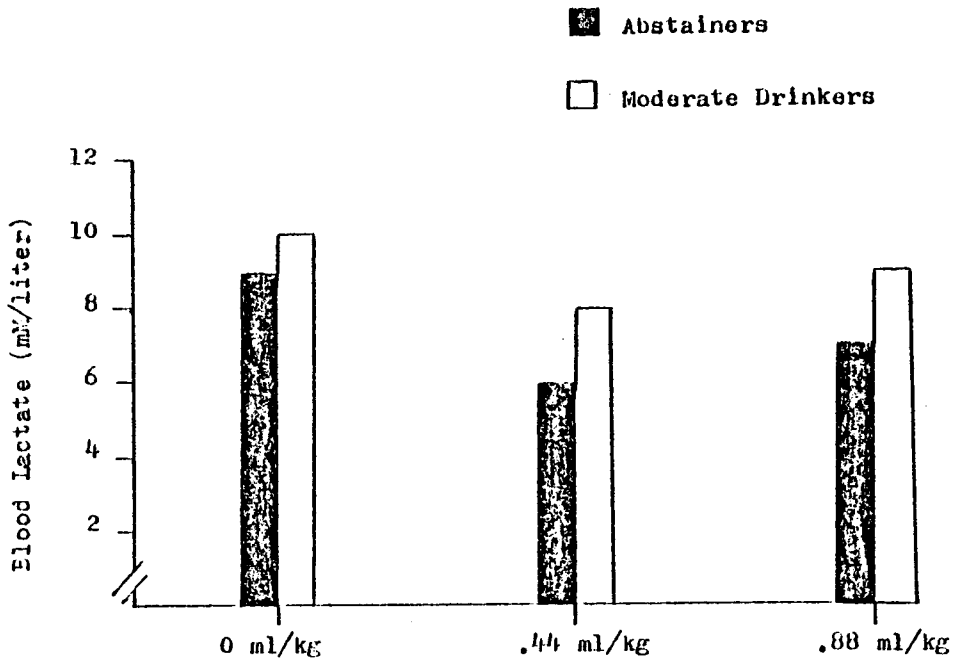

Figure 17. Mean blood lactate values of abstainers and moderate drinkers during five minute recovery after ingestion of three dosages of alcohol.

In order to determine where significant differences prevailed among the three dosages during five minute recovery, Newman-Keuls post hoc test was conducted. This analysis revealed that blood lactate was significantly higher after ingestion of the control dose than the small (.44 ml./kg.) and moderate dose (.88 ml./kg.) five minutes after exercise (see Appendix G). The hypothesis related to recovery blood lactate was rejected.

Endurance

Data on time worked at 60 rpm. after ingestion of three dosages of alcohol are listed in Tables 89-90 respectively (see Appendix E). Time worked for both groups indicated a slight, but non-significant, decrease after ingestion of small and moderate dosages of alcohol (Figure 18). The average time worked at 60 rpm. ranged from 819 to 866 seconds across groups and treatments.

The variance analysis of time worked after ingestion of three dosages of alcohol (Table 142) revealed that no significant differences occurred among any of the conditions measured. The hypothesis related to time worked was, therefore, not accepted.

Rating of Perceived Exertion

Data on rating of perceived exertion during work after ingestion of three dosages of alcohol are listed in Tables 91-96 (see Appendix E). A visual examination of the

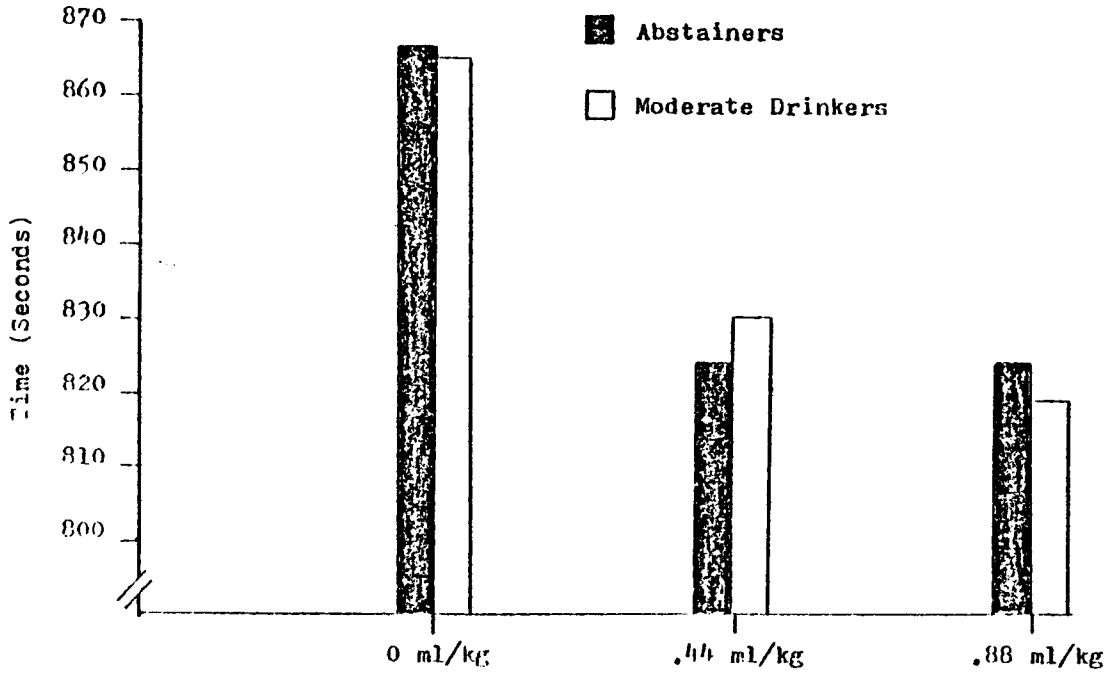

Figure 18. Mean time abstainers and moderate drinkers worked to exhaustion after ingestion of three dosages of alcohol.

graphs for both groups on rating of perceived exertion (Figures 19 and 20) indicated both groups felt that the workload of 1,080 kpm./minute required greater exertion after ingestion of alcohol. The average rating of perceived exertion for the 1,080 kpm./minute work rate ranged from 13 to 15 across groups and treatments. The variance analysis of perceived exertion revealed that no significant differences occurred among any of the measures for all conditions (Tables 143-145). The hypothesis related to rating of perceived exertion was, therefore, not accepted.

II. DISCUSSION

Heart Rate

This study demonstrates that ingestion of a small and moderate dose of alcohol does not affect the resting heart rate of abstainers and moderate drinkers 30 minutes after ingestion. Variance analysis for group, dosages, and group X dosages were non-significant. Previous research regarding the effect of alcohol on the resting heart rate has produced controversial results. Data from this investigation, analyzed for both within and between treatment effects, support the concept that ingestion of small and moderate dosages of alcohol exerts no significant effect on the resting heart rate in abstainers and moderate drinkers.

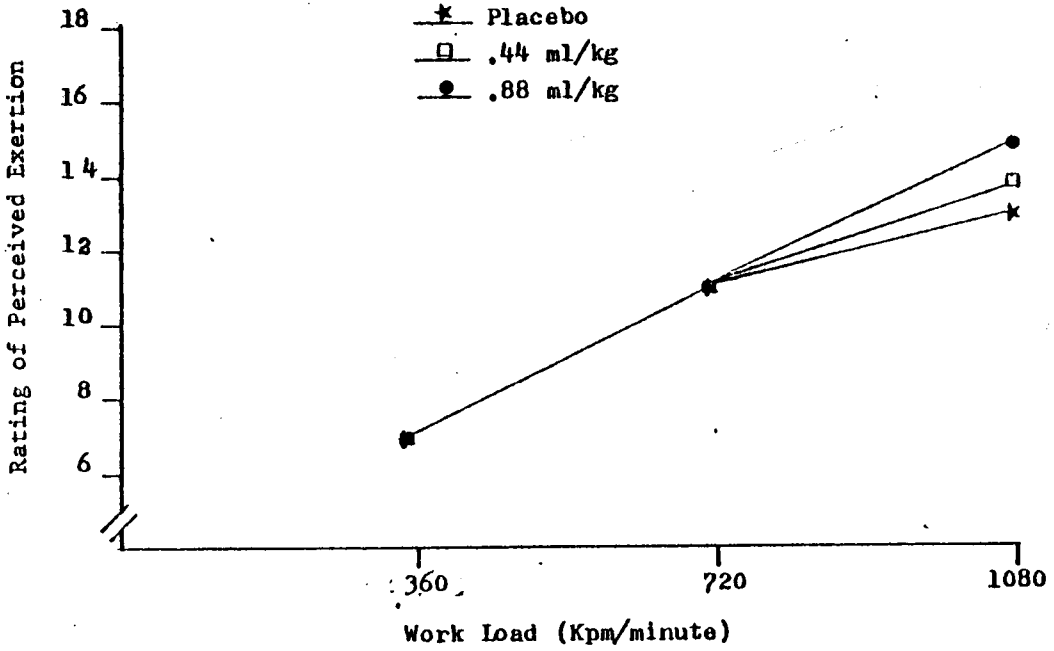

Figure 19. Abstainers response to rating of perceived exertion during exercise after ingestion of three dosages of alcohol.

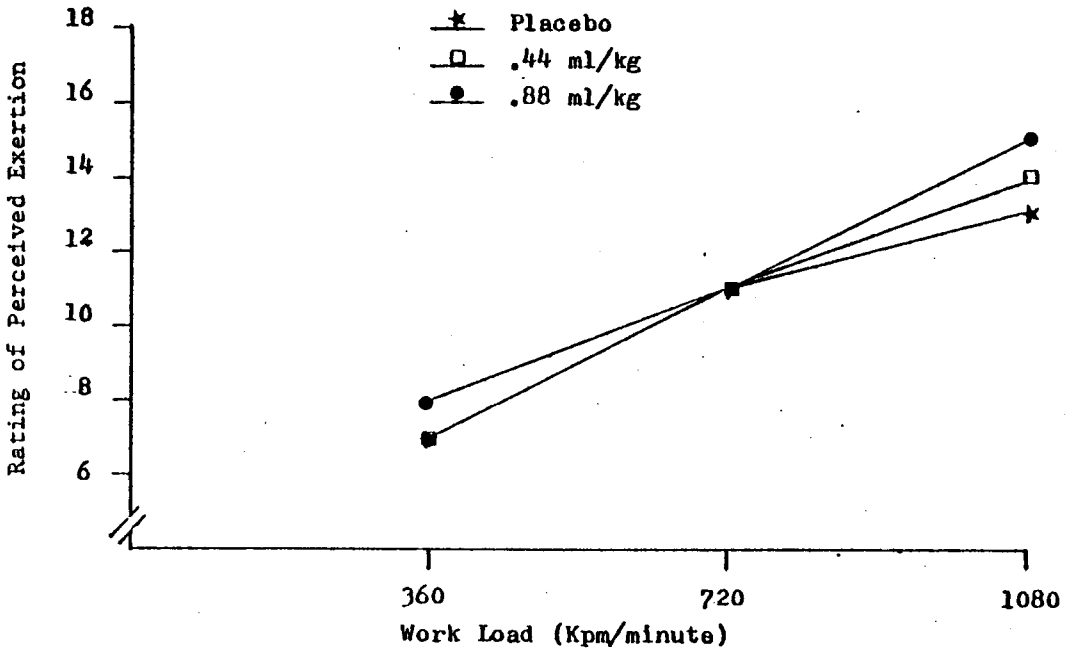

Figure 20. Moderate drinkers response to rating of perceived exertion during exercise after ingestion of three dosages of alcohol.

Heart rate was monitored continuously during the exercise phase. Although the heart rates during exercise for both groups were continuously higher after ingestion of the moderate dose, the statistical analysis indicated that alcohol exerted no significant effect on exercise heart rate at either submaximal or near-maximal work rates. While this study has shown the effect of alcohol on submaximal or near-maximal heart rate to be negligible, Adolph (1), Blomqvist et al. (5), and Hebbelinck (19) have noted a significant increase in submaximal exercise heart rates. Adolph and Blomqvist also reported a rise in the resting heart rate following the alcohol ingestion. According to Williams (46), the moderate relationship between resting heart rate and the early stages of a submaximal work task indicated that 27% of the variance of the submaximal heart rate was accounted for by the immediately preceding resting heart rate, and thus may partially explain the reported significant increase in heart rate during the early stages of the exercise. This does not explain the findings reported by Hebbelinck who found a significant increase in heart rate during work after ingestion of alcohol, while resting heart rate increased only four beats per minute after alcohol ingestion.

Although heart rate during the first phase of recovery appeared higher for the moderate drinkers after ingestion of the small dose as contrasted with the control

and moderate dose, the statistical analysis revealed no significant differences. Also no differences were noted during the recovery periods 3 and 10 minutes after exercise. This result supported the finding of Williams (48) who has reported no significant difference in heart rate after ingestion of .44 and .88 ml./kg. body weight of 95% alcohol.

Blood Pressure

An analysis of the data regarding systolic and diastolic blood pressure revealed no significant differences among groups or dosages during rest and exercise after ingestion of small and moderate dosages of alcohol. Although a significant F ratio was obtained between the type of drinkers and alcohol dosages for diastolic blood pressure during post-absorption rest, exercise at 360 and 720 kpm./minute workload, the overall analysis by one-way ANOVA for group and dosages supported the conclusion that neither a small nor moderate dose of alcohol significantly affected the diastolic blood pressure of abstainers or moderate drinkers during rest or exercise at 360 kpm./minute workload (see Appendix G). A significant F ratio was indicated by the one-way ANOVA for the abstainers during the 720 kpm./minute workload after ingestion of the three dosages of alcohol. Analysis by Newman-Keuls post hoc test revealed that diastolic blood pressure of abstainers during 720 kpm./minute workload was significantly higher ($p < .05$) after ingestion of the small and moderate

dosages of alcohol (see Appendix G). Although a significant F ratio was revealed among the three dosages during three minute recovery collection, the overall analysis by Newman-Keuls post hoc test supported the conclusion that neither a small nor moderate dose of alcohol significantly affected diastolic blood pressure during three minute recovery (see Appendix G).

Although analysis of the diastolic blood pressure data indicated that significant differences occurred only for the abstainers after ingestion of the small and moderate dosages of alcohol during the 720 kpm./minute workload, a consistent pattern was noted between the groups after ingestion of alcohol. This pattern showed the diastolic blood pressure of the abstainers to be higher after ingestion of the small and moderate dose, than the control dose, during the post-absorption rest, and exercise at 360 and 720 kpm./minute workload. The moderate drinkers had a response opposite that of the abstainers, in that the diastolic blood pressure of the moderate drinkers was lower after ingestion of the small and moderate dose than the control dose. This finding suggests that the diastolic blood pressure of abstainers is higher than moderate drinkers after ingestion of small and moderate dosages of alcohol. This finding may persist because of differences in alcohol tolerance between abstainers and moderate drinkers. These results partially supported the

findings reported by Grollman (16) concerning the rise in blood pressure of abstainers after ingestion of a small dose (10 ml.) of alcohol. Grollman also found a transient rise in the heart rate of the abstainers, which was not found in this study.

Oxygen Uptake

In the present investigation, resting oxygen uptake was not found to be affected by ingestion of a small or moderate dose of alcohol. Variance analysis for group, dosage, and group X dosage were non-significant.

Oxygen uptake measured during submaximal and near-maximal workloads indicated no significant differences for group, dosage, and group X dosage. Although the differences were not significant, oxygen uptakes for both groups at 360 and 720 kpm./minute were slightly higher after ingestion of alcohol. This result supported the findings of Adolph (1) and Blomqvist et al. (5) who have reported a slight increase in oxygen uptake during work after ingestion of alcohol. There were no differences among treatment levels during recovery. With the measure of oxygen uptake representing an index of work efficiency, the latter fact suggests no deteriorative effect of alcohol on mechanical efficiency.

Ventilation

The statistical analysis of data on ventilation during rest 30 minutes after ingestion of alcohol revealed no

significant differences among the groups or dosages. However, the analysis revealed a significant interaction among the type of drinkers and alcohol dosages during post-absorption rest. The one-way ANOVA revealed a significant F ratio for the moderate drinkers after ingestion of the three dosages of alcohol. Analysis of the Newman-Keuls post hoc test revealed that the resting ventilation for moderate drinkers was significantly higher after ingestion of the moderate dose of alcohol than the control and small dose of alcohol (see Appendix G). This difference between the groups after ingestion of the moderate dose of ethanol may be explained by the group's resting blood lactate values after ingestion of the moderate dose. Thirty minutes after ingestion of the moderate dose of alcohol the moderate drinkers' blood lactate level was 1.0 mm. higher than the abstainers. Two effects of alcohol ingestion are a diminution in pH and an accumulation of lactic acid in the blood. The presence of lactic acid is a stimulant to respiration and oxidation. Therefore, there is secondarily an increased respiratory ventilation.

Ventilation was monitored continuously during the exercise phase. Although ventilation at submaximal and near-maximal exercise at corresponding workloads was .08 to 2.98 l./minute higher after administration of the moderate dose than the control dose, statistical analysis revealed no significant differences. This result supported

the findings of Blomqvist et al. (5) who has reported no difference in ventilation during submaximal exercise after ingestion of 150 ml. of 43% alcohol.

Ventilation during all recovery periods was not found to be affected after ingestion by a small or moderate dose of alcohol. Variance analysis for group, dosage, and group X dosage were non-significant.

Blood Lactate

This experiment presents no evidence that blood lactate significantly increases 30 minutes after ingestion of a small or moderate dose of alcohol. Only in the moderate drinkers was the blood lactate slightly, but non-significantly, higher after ingestion of the moderate dose. Although the blood lactate of the abstainers appeared to increase as the alcohol dosage increased, the results were confounded with a higher lactate value during the placebo treatment. A possible explanation of why the abstainers blood lactate was higher during the control phase than after ingestion of alcohol is that the degree of activity performed on the control day before entering the laboratory was greater than experimental days. Although the subjects were inactive for one hour before entering the laboratory, the degree and intensity of activity performed before the one hour observation may have influenced the resting lactate value. Therefore, in an effort to eliminate this problem, a period of inactivity greater than one hour

should be observed.

Blood lactate samples were collected five minutes after exercise to obtain maximal blood lactate values. The only significant difference, revealed by the analysis of data, was among the doses. A Newman-Keuls post hoc analysis revealed the blood lactate during the placebo treatment was significantly greater than after ingestion of the small and moderate dose of alcohol (see Appendix G). The findings suggest blood lactate is higher after ingestion of grapefruit juice. There was also a non-significant increase from the small to moderate dose. A possible explanation for the higher blood lactate value after ingestion of the control dose is that both groups worked for a longer period of time before reaching exhaustion during the control condition than the alcohol conditions.

This result supported the findings of Blomqvist et al. (5) who has reported no significant difference in peak lactate concentration during maximal exercise after ingestion of 150 ml. of 93% alcohol.

Endurance

The statistical analysis of time worked to exhaustion indicated ingestion of small and moderate dosages of alcohol do not influence the ability to perform maximal muscular work. Although the maximal performance time of both groups decreased after ingestion of alcohol, the statistical analysis revealed no significant differences.

This result partially supported the findings of Nelson (37) and Karvinen et al. (29). Nelson reported a significant decrease in performance on the bicycle ergometer after ingestion of 59 and 89 ml. of 100% alcohol. Karvinen et al. reported that work completed on the ergometer decreased significantly after ingestion of a 33% alcohol solution.

Measures of maximal heart rate, blood pressure, oxygen uptake, ventilation, and rating of perceived exertion were also observed for the groups under the three treatment conditions. The statistical analysis of maximal heart rate, blood pressure, oxygen uptake, ventilation, and rating of perceived exertion indicated no significant differences in these measures during maximal performance after ingestion of a small or moderate dose of alcohol (see Appendix H).

Rating of Perceived Exertion

Although both groups felt that exercise at near-maximal levels required greater exertion after alcohol conditions as compared to control condition, statistical analysis indicated no significant differences in rating of perceived exertion after ingestion of a small or moderate dose of alcohol. This finding suggests that the effect of alcohol on near-maximal performance exerts an inhibiting psychological restraint to physiological performance. This result does not support the findings of Williams (48)

who reported that the subjects remarked that the workloads seemed easier to perform when under the influence of alcohol.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The purpose of this study was to determine the effects of small and moderate dosages of ethyl alcohol on cardiorespiratory function and lactate production. Additional measurements were taken of time to exhaustion and rating of perceived exertion.

Twelve subjects, six abstainers and six moderate drinkers who volunteered as subjects, were tested by use of the Monark bicycle ergometer under two alcohol conditions and one placebo condition. The order of the conditions were systematically assigned to help eliminate any order effect of the dosages. Under the control condition, grapefruit juice was used as a substitute for ethanol in the solution, and the subjects began the test 30 minutes after ingestion. Under the experimental conditions, the subjects consumed .44 ml./kg. and .88 ml./kg. body weight of 190 proof ethyl alcohol mixed with grapefruit juice. In all cases, ingestion of the liquid began at least four hours after any food, liquid, or tobacco had been consumed. Thirty minutes after ingestion the performance test began. The physical performance test was terminated under all conditions when a pedal rate of 60 rpm. could no longer be maintained. All measurements, with the exception of blood

alcohol level and rating of perceived exertion, were taken during pre-ingestion rest, post-absorption rest, exercise, and recovery conditions.

Heart rate determination was made by use of a cardiac coupler Type 7176. Measurements of heart rate and blood pressure were taken during pre-ingestion rest, post-absorption rest, every third minute of exercise, and during the last minute of exercise, and at three prescribed intervals during the 10 minutes immediately following exercise.

Ventilation was measured with a Parkinson Cowan CD-4 dry gas meter. Oxygen uptake was determined from expired gas volumes collected in the meteorological balloons. Expired gas samples were withdrawn from meteorological balloons and analyzed for oxygen and carbon dioxide percentages by use of the Beckman Medical Gas Analyzer and Scholander respectively. Ventilation and oxygen uptake were taken during pre-ingestion rest, post-absorption rest, every third minute of exercise, and during the last minute of exercise, and at three prescribed intervals during the 10 minutes immediately following exercise. One minute calculations were then made for both variables.

Rating of perceived exertion was determined by use of a simple rating scale for use in physical work tests developed by Borg (9). Rating of perceived exertion was recorded every third minute of exercise and during the last

minute of exercise. Measure of endurance was recorded as time worked on the bicycle ergometer maintaining a pedal rate of 60 revolutions per minute.

Blood lactate was determined by the enzymatic method of Gutman and Wahlfeld (28). Measurements of blood lactate were taken during pre-ingestion rest, post-absorption rest, and five minutes after termination of exercise.

A two-way ANOVA (2 x 3) with repeated measures on the second independent variable was used to determine the differences between types of drinkers, the different dosages of alcohol, and the interaction between type of drinker and dosages of alcohol. A separate analysis was conducted on each dependent variable. The Newman-Keuls post hoc test was used on those variables significantly different on dosages of alcohol to determine where significant differences existed among the three dosages. Simple main effects were determined on variables which had a significant interaction to determine at which dosages the different type of drinkers were significantly different. The .05 level of significance was used to generalize beyond this study.

II. CONCLUSIONS

There is no evidence from this study that the ingestion of small and moderate dosages of alcohol affect heart rate, oxygen uptake, endurance, rating of perceived

exertion, and lactate production in abstainers and moderate drinkers. It is the general conclusion of this study that the ingestion of small and moderate dosages of alcohol has only a slight effect on cardiorespiratory function and lactate production.

There is slight evidence from this study that small and moderate dosages of alcohol cause an increased diastolic blood pressure of abstainers in response to moderate work.

There is also evidence that moderate dosages of alcohol cause increased resting ventilation in moderate drinkers.

III. RECOMMENDATIONS

Further investigation into the effects of alcohol on cardiorespiratory function and lactate production is advised. The recommendations which follow are based upon the conclusions drawn from the findings of this study.

1. A similar study should be conducted to determine if heart rate and oxygen uptake in heavy drinkers during rest, exercise, and recovery replicate the findings of this study.
2. Further study is needed concerning the increased diastolic blood pressure in abstainers and decreased diastolic blood pressure of moderate drinkers after ingestion of alcohol. For example, do heavy drinkers respond similar to moderate

drinkers? If so, this may indicate an alcohol tolerance.

3. Because the data did indicate a possible relationship between alcohol dosages and blood lactate during rest and recovery, a similar study is needed to determine the blood lactate response to different workloads after ingestion of alcohol.
4. Because the data in this sample indicated a decrease in endurance and an increase in perceived exertion of abstainers and moderate drinkers after ingestion of alcohol, further study is indicated to determine the relationship between endurance and psychological restraints of abstainers, moderate drinkers, and heavy drinkers after ingesting alcohol.

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APPENDIXES

APPENDIX A

INFORMED CONSENT FORM

INFORMED CONSENT FORM

Informed consent for participating in a study to measure the effect of alcohol on cardiorespiratory function and lactate production.

I, _____, hereby volunteer to participate in a research study to determine the effect of alcohol on heart rate, blood pressure, oxygen uptake, ventilation, rate of perceived exertion, endurance, and lactate production during exercise. The test which I will undergo will consist of three different sessions. I will be required to consume .0 cc., 2 cc., and 4 cc. of alcohol per pound of body weight with varying concentrations during each session. Three dosages are expected to produce blood alcohol levels of .0, .5, and .10% respectively. The behavior implicated by these blood alcohol levels are .0%--absence overall effect, .05%--lowered alertness--good feeling, and .10%--slowed reaction time--decreased inhibitions. I will ride the bicycle ergometer at varying workloads at three minutes each, maintaining a pedal rate of 60 revolutions per minute until maximum exhaustion has been reached. Five minutes after termination of the workload, 200 ul. of capillary blood will be extracted from the distal portion of the third finger to determine lactate production. After the test is completed, I will blow into a Breathalyzer (Model 900) to ensure, upon leaving the laboratory, my blood alcohol level is not above .03%.

I have read the foregoing and I understand it. Any questions that arose or occurred to me have been answered to my satisfaction.

Date_____ Participant_____

Witness_____

APPENDIX B

BORG RATING SCALE OF PERCEIVED EXERTION

BORG RATING SCALE 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

Source: Borg, G. "A Simple Rating Scale for Use in Physical Work Test." Kung Fys Sällsh Förh Lund, 1962, pp. 7-15.

APPENDIX C

ENZYMATIC LACTIC ACID ANALYSIS

LACTIC ACID PROCEDURE FOR TURNER 450 FLUOROMETER

$$\text{(L+) Lactic acid} + \text{NAD} \underset{\longleftarrow}{\overset{\text{LDH}}{\longrightarrow}} \text{Pyruvic acid} + \text{NADH}$$

In the presence of LDH, lactic acid and NAD are converted to pyruvic acid and NADH respectively. As this reaction will not go to completion unless the pyruvic acid is removed from the mixture, a hydrazine-glycine buffer is added in order that the hydrazine will complex with the pyruvic acid.

Reagents:

1. 70% Perchloric Acid ($HClO_4$)
2. Hydrazine-Glycine Buffer

   Hydrazine Sulfate--Sigma No. H-3376

   Glycine --Sigma No. G-7126
3. Lactic Dehydrogenase (LDH)--Sigma No. L-2625
4. Nicotinamide Adenine Dinucleotide, Reduced Form--Sigma No. N-7004
5. Lithium Lactate Standard Stock

   Dry 535-540 mg. of Lithium Lactate at 80° C. overnight.

   Add 532.5 mg. of the Lithium Lactate to 400 ml. of water.

   Add 0.25 ml. of concentrated H_2SO_4. Make up to 500 ml. in a volumetric flask. 1.0 ml. = 1,000 ug. LA.
6. 4% NaF

Daily Working Solutions

1. Deproteinizing Agent--7% Perchloric Acid (1.00 ml./assay). Add 6.0 ml. of 70% $HClO_4$ to a flask and add water up to 100 ml. (Refrigerate)

ml. 7% $HClO_4$	100	200	300	400	500	1,000
$HClO_4$	6	12	18	24	30	60
H_2O	94	188	282	376	470	940

2. Hydrazine Glycine Buffer (2 ml./assay)

   a. 0.4 Molar Hydrazine and 0.5 Molar Glycine. Add 3.76 gm. Glycine and 5.20 gm. Hydrazine Sulfate to about 80 ml. of water.

b. Adjust pH to 9.0 with concentrated NaOH and bring up to 100 ml. with water.

Assays	27	37	50	75	100	250	500
ml. Buffer	50	75	100	150	200	500	1,000
gm. Hydrazine Sulfate	2.60	3.90	5.20	7.80	10.40	26.00	52.00
gm. Glycine	1.88	2.82	3.76	5.64	7.52	18.80	37.60
ml. H_2O	35.00	60.00	80.00	120.00	170.00	400.00	800.00
Final Volume	50.00	75.00	100.00	150.00	200.00	500.00	1,000.00

3. Lactic Dehydrogenase

To a given volume of buffer add enough LDH so that the final concentration is 10 U LDH/ml. buffer.

Assays	25	37	50	75	100
ml. Buffer	50	75	100	150	200
ml. LDH	0.085	0.127	0.169	0.254	0.339

(5,900 U/ml. LDH)

4. B-Nicotinamide Adenine Dinucleotide, Reduced Form

Add enough NAD to given volume of buffer so that the final concentration is 1 mg. NAD/ml. buffer.

Assays	25	37	50	71	100
ml. Buffer	50	75	100	150	200
mg. NAD	50.0	75.0	100.0	150.0	200.0

5. Working Standards

Add water--H_2SO_4 solution to all volumes of stock to make up correct standards (0.25 ml. concentrated H_2SO_4 made up to 500 ml.)

a. Add 2.5 ml. of stock and make up to 100 ml. = 25 ug./ml.

b. Add 5.0 ml. of stock and make up to 100 ml. = 50 ug./ml.

c. Add 10.0 ml. of stock and make up to 100 ml. = 100 ug./ml.

d. Add 15.0 ml. of stock and make up to 100 ml. = 150 ug./ml.

e. Add 20.0 ml. of stock and make up to 100 ml. = 200 ug./ml.

Sample Collection:

1. 0.05 ml. of 4% NaF is added to spot plate and dried at 80^0 C overnight.
2. Put blood sample on spot plate containing the 4% NaF. Mix.
3. Using 50 ul. micropipettes, transfer 50 ul. of the sample to a cold test tube containing 1.0 ml. of 7% $HClO_4$. Mix and either put on ice or refrigerate.
4. Centrifuge at 4,000 rmp. for five minutes at 0-5° C.
5. Decant supernatant into another chilled tube.
6. Refrigerate or put on ice until analysis.

Analytical Procedure:

Standards and unknowns should be analyzed in duplicate. Add 0.1 ml. of Blank, Standards, and Samples to fluorometer tubes:

a. Blank 0.1 ml. of 70% $HClO_4$

b. Standard 1 0.1 ml. of Standard 1

c. Standard 2 0.1 ml. of Standard 2

d. Standard 3 0.1 ml. of Standard 3

e. Standard 4 0.1 ml. of Standard 4

f. Sample 0.1 ml. of Sample

Treat all of the above tubes as follows:

a. Add 2.0 ml. of buffer enzyme solution to each tube.

b. Mix thoroughly.

c. Incubate in water at 30^0 C for 30 minutes and cool to room temperature.

Fluorescence Determination:

Read fluorescence at 360/460 with 15 nm. slits.

Use the blank to correct for all readings.

Calculations:

Due to quenching by the fluorometer, the standard curve is curvilinear, not linear. In order to correctly calculate concentrations, a graph of the standard curve must be used.

Source: Gutmann, I. and A.W. Wahlefeld. "L - (+) - Lactate. Determination with lactate dehydrogenase and NAD." In Methods of Enzymatic Analysis, pp. 1464-1468. Edited by H.U. Bergmeyer. 2nd English edition. New York: Academic Press, Inc., 1974.

APPENDIX D

ENZYMATIC BLOOD ALCOHOL ANALYSIS

BLOOD ALCOHOL PROCEDURE FOR TURNER 450 FLUOROMETER

The enzyme, alcohol dehydrogenase (ADH), catalyzes the conversion of ethanol to acetaldehyde as follows:

$$\underset{\text{ethanol}}{C_2H_3OH} + NAD \xrightarrow{ADH} \underset{\text{acetaldehyde}}{CH_3CHO} + NADH$$

The formation of acetaldehyde is favored when the reaction takes place at an akaline pH (i.e., 9.2). Furthermore, the presence of semicarbazide in the buffer traps the aceteldehyde and allows the reaction to proceed nearly to completion.

The increase in fluorescence produced by the stoichiometric conversion of NAD to NADH allows a quantitative assessment of ethanol concentration. The fluorometric procedure allows the use of one-tenth the volume of blood and reagents which are necessary for the spectrophotometric procedure.

Reagents:

1. Trichloroacetic Acid (CCl_3COOH) Fisher No. A-322 (79685)
2. Pyrophosphate Buffer
   - Tetrasodium Phosphate--Sigma No. T-6379
   - Semicarbazide --Sigma No. S-4123
   - Glycine --Sigma No. G-7126
3. Alcohol Dehydrogenase (ADH)--Sigma No. A-7011
4. Nicotinamide Adenine Dinucleotide, OX. Form--Sigma No. N-7004
5. Ethanol Solution .08%--Sigma No. 330-20
6. 4% NaF

Daily Working Solutions:

1. Deproteinizing Agent--6.25% Trichloroacetic Acid. Add 6.25 gm. of Cl_3CCOOH to a flask and bring up to a volume of 100 ml. with water. (Refrigerate)

ml. 6.25% Cl_3COOH	100	200	300	400	500	750	1,000
gm. Cl_3COOH	6.25	12.50	18.75	25.00	31.25	46.87	62.50

2. Pyrophosphate Buffer

   a. Add 33.46 gm. of Tetrasodium Pyrophosphate, 8.36 gm. of semicarbazide Hydrochloride and 1.65 gm. of Glycine to 850 ml. of water.

   b. Adjust pH to 9.2 with saturated NaOH and bring up to 1,000 ml. with water.

Assays	48	248	498
ml. Buffer	100	500	1,000
gm. Tetrasodium	3.34	16.73	33.46
gm. Semicarbazide	.836	4.18	8.36
gm. Glycine	.165	.825	1.65
ml. H_2O	80.00	400.00	850.00
Final Volume	100.00	500.00	1,000.00

3. Alcohol Dehydrogenase

   To a given volume of buffer add enough ADH so that the final concentration is 1.5 U ADH/ml. buffer.

Assays	9	17	24	37	49	99
ml. Buffer	20	35	50	75	100	200
ul. ADH Stock	10	17.5	25	37.5	50	100

(3120 U/ml. ADH)

4. Beta Nicotinamide Adenine Dinucleotide, Oxidized Form

   Add enough NAD to a given volume of buffer so that the final concentration is .25 mg. NAD/ml. buffer.

Assays	9	17	24	37	49	99
ml. Buffer	20	35	50	75	100	200
mg. NAD	5	8.75	12.5	18.75	25	50

5. Ethanol Standards

   1. 50 ul. of the .08% ethanol standard should be added to various volumes of TCA to give a reasonable range of physiological values.
   2. Since 50 ul. aliquots of blood are added to 2 ml. of TCA, a sample which has 50 ul. of .08% solution in 2 ml. of TCA, will be .08%.
   3. Standards: Use .08% ethanol, 50 ul. in TCA.

      a. Blank — TCA
      b. .02% — 50 ul. in 8 ml. TCA
      c. .04% — 50 ul. in 4 ml. TCA
      d. .08% — 50 ul. in 2 ml. TCA
      e. .16% — 50 ul. in 1 ml. TCA
      f. Sample — 50 ul. in 2 ml. TCA

Sample Collection:

1. 0.05% ml. of 4% NaF is added to spot plate and dried at 80° C overnight.
2. Put blood sample on spot plate containing the 4% NaF. Mix. Do not use alcohol swab to sterilize skin.
3. Using 50 ul. disposable micropipettes, transfer 50 ul. of sample to a cold test tube containing 2.0 ml. of 6.25% TCA. Mix and either put on ice or refrigerate.
4. Centrifuge at 4,000 rpm. for 5 minutes.
5. Decant supernatant into another chilled tube.
6. Refrigerate or put on ice until analysis.
7. Keep tubes covered at all times.

Analytical Procedure:

1. Standards and unknows should be analyzed in duplicate. Add 0.1 ml. of working standards and samples, as defined under procedure for Ethanol Standards.
2. Treat all of the above tubes as follows:
   a. Add 2.0 ml. of Buffer--Enzyme solution to each tube.
   b. Recap and mix gently by conversion.
   c. Incubate in water both at 30° C for 30 minutes or at room temperature for 45 minutes.

Fluorescence Determination:

1. Read fluorescence at 360/460 with 15 mm. excitation slit and 60 mm. emission slit.
2. Set high standard to read 280.
3. Use the flank to correct for all readings.

Calculations:

Due to quenching by the fluorometer, the standard curve is curvilinear, not linear. In order to correctly calculate concentrations, a graph of the standards curve must be used.

Source: Bonnichsen, R.K. and H. Theorell. "An Enzymatic Method for the Microdetermination of Ethanol." Scandinavica Journal of Clinical Investigation 3:58, 1951.

APPENDIX E

INDIVIDUAL DATA ON PHYSIOLOGICAL RESPONSES DURING REST, EXERCISE, AND RECOVERY CONDITIONS

TABLE 3

INDIVIDUAL HEART RATE SCORES OF ABSTAINERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	66	54	54
2.	72	78	72
3.	66	60	54
4.	78	78	72
5.	84	84	84
6.	96	78	72
$\bar{X}$ =	77	72	68
S.D. =	11.64	12.00	11.79
S.E.M. =	4.75	4.89	4.81

TABLE 4

INDIVIDUAL HEART RATE SCORES OF MODERATE DRINKERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	72	96	66
8.	60	66	72
9.	72	84	78
10.	60	66	48
11.	84	78	90
12.	60	60	66
$\bar{X}$ =	68	75	70
S.D. =	9.79	13.54	14.02
S.E.M. =	4.00	5.53	5.72

TABLE 5

INDIVIDUAL HEART RATE SCORES OF ABSTAINERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	72	72	78
2.	72	84	84
3.	60	66	60
4.	72	78	66
5.	84	90	90
6.	96	78	84
$\bar{X}$ =	76	78	77
S.D. =	12.39	8.48	11.64
S.E.M. =	5.05	3.46	4.75

TABLE 6

INDIVIDUAL HEART RATE SCORES OF MODERATE DRINKERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	88	90	78
8.	72	72	72
9.	78	78	72
10.	60	78	90
11.	78	78	90
12.	66	66	90
$\bar{X}$ =	73	75	77
S.D. =	9.91	9.09	11.64
S.E.M. =	4.04	3.71	4.75

TABLE 7

INDIVIDUAL HEART RATE SCORES OF ABSTAINERS AT 360 KPM./ MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	72	84	96
2.	84	102	102
3.	108	96	90
4.	78	90	90
5.	114	108	132
6.	132	108	120
$\bar{X}$ =	98	98	105
S.D. =	23.59	9.79	17.28
S.E.M. =	9.63	4.00	7.05

TABLE 8

INDIVIDUAL HEART RATE SCORES OF MODERATE DRINKERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	108	114	120
8.	102	90	96
9.	102	102	114
10.	72	90	84
11.	126	126	114
12.	96	96	102
$\bar{X}$ =	101	103	105
S.D. =	17.56	14.40	13.54
S.E.M. =	7.16	5.88	5.53

TABLE 9

INDIVIDUAL HEART RATE SCORES OF ABSTAINERS AT 720 KPM./ MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	108	126	132
2.	102	126	120
3.	132	132	132
4.	108	114	114
5.	150	144	168
6.	168	150	156
$\bar{X}$ =	128	132	137
S.D. =	26.74	13.14	20.92
S.E.M. =	10.91	5.36	8.54

TABLE 10

INDIVIDUAL HEART RATE SCORES OF MODERATE DRINKERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	126	126	132
8.	138	120	132
9.	132	132	138
10.	114	120	120
11.	174	174	168
12.	120	126	126
$\bar{X}$ =	134	133	136
S.D. =	21.35	20.58	16.82
S.E.M. =	8.71	8.40	6.87

TABLE 11

INDIVIDUAL HEART RATE SCORES OF ABSTAINERS AT 1,080 KPM./ MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	144	156	150
2.	132	144	144
3.	162	156	150
4.	132	144	138
5.	174	168	192
6.	186	174	174
$\bar{X}$ =	155	157	158
S.D. =	22.58	12.24	20.66
S.E.M. =	9.21	5.00	8.43

TABLE 12

INDIVIDUAL HEART RATE SCORES OF MODERATE DRINKERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	150	156	156
8.	162	150	156
9.	162	162	162
10.	144	138	144
11.	192	192	186
12.	150	156	156
$\bar{X}$ =	160	159	160
S.D. =	17.25	18.09	14.02
S.E.M. =	7.04	7.38	5.72

TABLE 13

INDIVIDUAL HEART RATE SCORES OF ABSTAINERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	162	162	162
2.	126	114	120
3.	156	138	156
4.	120	132	126
5.	174	168	180
6.	180	168	162
$\bar{X}$ =	153	147	151
S.D. =	24.81	22.36	23.21
S.E.M. =	10.12	9.13	9.47

TABLE 14

INDIVIDUAL HEART RATE SCORES OF MODERATE DRINKERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	132	150	138
8.	156	156	156
9.	138	138	144
10.	120	108	120
11.	174	180	168
12.	174	180	174
$\bar{X}$ =	149	152	150
S.D. =	22.58	27.27	20.07
S.E.M. =	9.21	11.13	8.19

TABLE 15

INDIVIDUAL HEART RATE SCORES OF ABSTAINERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	132	126	114
2.	102	96	102
3.	108	102	108
4.	96	96	96
5.	138	126	144
6.	126	126	132
$\bar{X}$ =	117	112	116
S.D. =	17.28	15.49	18.46
S.E.M. =	7.05	6.32	7.53

TABLE 16

INDIVIDUAL HEART RATE SCORES OF MODERATE DRINKERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	114	114	120
8.	120	126	120
9.	108	96	108
10.	84	78	72
11.	150	144	150
12.	138	138	144
$\bar{X}$ =	119	116	119
S.D. =	23.21	25.36	27.99
S.E.M. =	9.47	10.35	11.42

TABLE 17

INDIVIDUAL HEART RATE SCORES OF ABSTAINERS DURING TEN MINUTE RECOVERY AFTER INTESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	114	126	102
2.	102	84	84
3.	102	84	96
4.	84	96	90
5.	138	108	126
6.	102	108	108
$\bar{X}$ =	107	101	101
S.D. =	17.96	16.28	14.89
S.E.M. =	7.33	6.64	6.08

TABLE 18

INDIVIDUAL HEART RATE SCORES OF MODERATE DRINKERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	108	108	108
8.	96	114	108
9.	84	90	90
10.	84	78	72
11.	132	126	114
12.	126	114	120
$\bar{X}$ =	105	105	102
S.D. =	20.69	17.69	17.79
S.E.M. =	8.44	7.22	7.26

TABLE 19

SYSTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	120	129	121
2.	122	118	120
3.	104	112	112
4.	109	110	120
5.	110	130	110
6.	130	130	108
$\bar{X}$ =	115	121	115
S.D. =	9.76	9.33	5.81
S.E.M. =	3.98	3.81	2.37

TABLE 20

SYSTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	130	132	131
8.	120	120	131
9.	120	118	112
10.	129	120	124
11.	121	121	115
12.	130	121	119
$\bar{X}$ =	125	122	122
S.D. =	5.13	5.01	8.04
S.E.M. =	2.09	2.04	3.28

TABLE 21

SYSTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	125	110	118
2.	106	118	120
3.	105	108	108
4.	108	110	110
5.	120	128	128
6.	126	118	118
$\bar{X}$ =	115	115	117
S.D. =	9.75	7.55	7.23
S.E.M. =	3.98	3.08	2.95

TABLE 22

SYSTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	140	126	156
8.	110	108	118
9.	123	120	110
10.	125	112	118
11.	128	110	108
12.	142	118	130
$\bar{X}$ =	128	115	123
S.D. =	11.81	6.86	17.78
S.E.M. =	4.82	2.80	7.26

TABLE 23

SYSTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	200	140	140
2.	122	128	140
3.	105	110	108
4.	112	120	118
5.	120	170	150
6.	130	118	120
$\bar{X}$ =	131	131	129
S.D. =	34.63	21.64	16.28
S.E.M. =	14.14	8.83	6.64

TABLE 24

SYSTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	152	150	164
8.	130	118	130
9.	128	125	118
10.	130	130	125
11.	120	110	108
12.	140	138	128
$\bar{X}$ =	133	128	128
S.D. =	11.14	14.27	18.99
S.E.M. =	4.55	5.82	7.75

TABLE 25

SYSTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	205	162	160
2.	132	130	140
3.	120	120	110
4.	120	120	138
5.	140	170	160
6.	160	150	140
$\bar{X}$ =	146	142	141
S.D. =	32.43	21.72	18.40
S.E.M. =	13.24	8.86	7.51

TABLE 26

SYSTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	165	180	178
8.	150	148	158
9.	136	132	142
10.	138	150	142
11.	140	140	120
12.	150	154	142
$\bar{X}$ =	146	150	147
S.D. =	10.87	16.37	19.42
S.E.M. =	4.44	6.68	7.92

TABLE 27

SYSTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	220	198	182
2.	138	138	160
3.	120	150	150
4.	160	140	140
5.	170	180	160
6.	180	150	160
$\bar{X}$ =	164	159	158
S.D. =	34.79	24.18	13.95
S.E.M. =	14.20	9.87	5.69

TABLE 28

SYSTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	175	200	194
8.	190	170	190
9.	146	138	170
10.	146	150	170
11.	160	150	140
12.	170	180	168
$\bar{X}$ =	164	164	172
S.D. =	17.29	23.03	19.26
S.E.M. =	7.06	9.40	7.86

TABLE 29

SYSTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	250	142	148
2.	168	160	160
3.	130	120	130
4.	150	150	162
5.	160	180	150
6.	188	160	156
$\bar{X}$ =	174	152	151
S.D. =	41.75	20.19	11.64
S.E.M. =	17.04	8.24	4.75

TABLE 30

SYSTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	210	182	
8.	138	140	148
9.	150	140	148
10.	150	178	156
11.	120	140	118
12.	150	178	166
$\bar{X}$ =	153	159	147
S.D. =	30.29	21.59	17.92
S.E.M. =	12.36	8.81	8.01

TABLE 31

SYSTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	240	152	148
2.	160	128	138
3.	140	130	132
4.	134	130	144
5.	140	170	160
6.	180	160	158
$\bar{X}$ =	165	145	146
S.D. =	40.20	18.09	11.00
S.E.M. =	16.41	7.38	4.49

TABLE 32

SYSTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	190	158	164
8.	160	158	150
9.	142	136	152
10.	144	130	140
11.	120	120	112
12.	166	160	152
$\bar{X}$ =	153	143	145
S.D. =	23.98	17.22	17.87
S.E.M. =	9.79	7.03	7.29

TABLE 33

SYSTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	230	119	122
2.	122	124	120
3.	110	108	112
4.	108	110	116
5.	110	130	126
6.	138	140	118
$\bar{X}$ =	136	121	119
S.D. =	47.26	12.17	4.85
S.E.M. =	19.29	4.96	1.98

TABLE 34

SYSTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	134	128	164
8.	108	132	108
9.	128	120	112
10.	132	120	124
11.	124	120	112
12.	150	140	138
$\bar{X}$ =	129	126	126
S.D. =	13.72	8.26	21.48
S.E.M. =	5.60	3.37	8.76

TABLE 35

DIASTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	73	89	90
2.	90	78	81
3.	70	52	70
4.	79	90	79
5.	76	90	86
6.	80	86	82
$\bar{X}$ =	78	80	81
S.D. =	6.95	14.83	6.80
S.E.M. =	2.84	6.05	2.77

TABLE 36

DIASTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	99	90	80
8.	59	72	69
9.	68	70	71
10.	68	68	84
11.	71	80	80
12.	90	70	78
$\bar{X}$ =	75	75	77
S.D. =	15.27	8.46	5.79
S.E.M. =	6.23	3.45	2.36

TABLE 37

DIASTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	65	100	98
2.	78	86	82
3.	70	78	78
4.	74	90	80
5.	80	98	82
6.	90	80	84
$\bar{X}$ =	76	88	84
S.D. =	8.68	9.09	7.15
S.E.M. =	3.54	3.71	2.92

TABLE 38

DIASTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	95	88	108
8.	80	72	78
9.	71	74	68
10.	70	78	74
11.	98	90	80
12.	100	78	88
$\bar{X}$ =	85	80	82
S.D. =	13.69	7.37	14.06
S.E.M. =	5.58	3.01	5.74

TABLE 39

DIASTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	80	100	96
2.	70	90	84
3.	70	70	70
4.	78	90	78
5.	80	100	90
6.	92	80	84
$\bar{X}$ =	78	88	83
S.D. =	8.14	11.69	9.07
S.E.M. =	3.32	4.77	3.70

TABLE 40

DIASTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	95	88	88
8.	100	78	80
9.	72	75	84
10.	74	70	80
11.	88	90	80
12.	100	84	78
$\bar{X}$ =	88	80	81
S.D. =	12.56	7.80	3.66
S.E.M. =	5.12	3.18	1.49

TABLE 41

DIASTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	74	100	96
2.	80	98	85
3.	68	70	70
4.	70	90	78
5.	80	100	90
6.	78	80	80
$\bar{X}$ =	75	89	83
S.D. =	5.27	12.35	9.21
S.E.M. =	2.15	5.04	3.76

TABLE 42

DIASTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	90	86	70
8.	90	70	90
9.	76	80	84
10.	76	70	78
11.	96	100	82
12.	70	82	76
$\bar{X}$ =	83	81	80
S.D. =	10.33	11.21	6.92
S.E.M. =	4.21	4.58	2.82

TABLE 43

DIASTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	70	100	90
2.	86	92	85
3.	70	70	70
4.	90	80	82
5.	90	100	90
6.	90	80	80
$\bar{X}$ =	82	87	82
S.D. =	9.93	12.24	7.49
S.E.M. =	4.05	5.00	3.05

TABLE 44

DIASTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	88	90	72
8.	80	70	78
9.	78	82	78
10.	80	78	78
11.	96	100	82
12.	80	80	78
$\bar{X}$ =	83	83	77
S.D. =	6.97	10.40	3.20
S.E.M. =	2.84	4.24	1.30

TABLE 45

DIASTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	72	88	80
2.	88	78	72
3.	60	52	60
4.	94	82	76
5.	85	90	90
6.	82	80	78
$\bar{X}$ =	80	78	76
S.D. =	12.27	13.70	9.87
S.E.M. =	5.00	5.59	4.03

TABLE 46

DIASTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	85	76	
8.	68	68	60
9.	74	81	62
10.	78	68	74
11.	68	90	70
12.	76	70	72
$\bar{X}$ =	74	75	67
S.D. =	6.46	8.75	6.22
S.E.M. =	2.63	3.57	2.78

TABLE 47

DIASTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	0. ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	72	90	80
2.	86	86	78
3.	60	60	60
4.	96	90	80
5.	80	90	90
6.	90	80	82
$\bar{X}$ =	80	82	78
S.D. =	13.06	11.77	9.91
S.E.M. =	5.33	4.80	4.04

TABLE 48

DIASTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	88	78	58
8.	60	68	60
9.	73	79	58
10.	76	80	82
11.	76	80	70
12.	80	70	70
$\bar{X}$ =	75	75	66
S.D. =	9.20	5.38	9.50
S.E.M. =	3.75	2.19	3.87

TABLE 49

DIASTOLIC BLOOD PRESSURE SCORES OF ABSTAINERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	65	89	98
2.	86	86	80
3.	80	80	82
4.	86	90	80
5.	70	96	90
6.	86	80	82
$\bar{X}$ =	78	86	85
S.D. =	9.21	6.21	7.22
S.E.M. =	3.76	2.53	2.95

TABLE 50

DIASTOLIC BLOOD PRESSURE SCORES OF MODERATE DRINKERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	94	92	90
8.	70	88	78
9.	76	74	68
10.	73	78	86
11.	78	80	82
12.	88	88	86
$\bar{X}$ =	79	83	81
S.D. =	9.26	7.00	7.84
S.E.M. =	3.78	2.85	3.20

TABLE 51

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF ABSTAINERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	5.3	3.8	4.5
2.	4.4	4.2	3.7
3.	4.0	4.8	3.9
4.	4.7	4.4	4.9
5.	4.0	3.1	5.0
6.	5.5	5.4	3.8
$\bar{X}$ =	4.65	4.28	4.30
S.D. =	0.64	0.79	0.57
S.E.M. =	0.26	0.32	0.23

TABLE 52

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF MODERATE DRINKERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	4.1	4.2	5.7
8.	4.5	4.4	4.3
9.	5.1	5.4	4.6
10.	4.4	4.8	4.8
11.	4.5	4.0	4.0
12.	3.5	5.1	3.4
$\bar{X}$ =	4.35	4.65	4.46
S.D. =	0.52	0.54	0.77
S.E.M. =	0.21	0.22	0.31

TABLE 53

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF ABSTAINERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	5.4	4.5	3.5
2.	3.4	3.7	4.0
3.	4.9	3.2	3.5
4.	4.1	4.7	4.1
5.	4.9	4.7	5.5
6.	6.3	5.4	4.4
$\bar{X}$ =	4.83	4.36	4.16
S.D. =	1.00	0.78	0.74
S.E.M. =	0.41	0.32	0.30

TABLE 54

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF MODERATE DRINKERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	4.0	3.4	4.7
8.	4.6	4.2	4.8
9.	6.1	4.7	4.6
10.	5.3	4.8	5.4
11.	4.2	3.8	4.9
12.	5.1	4.5	4.4
$\bar{X}$ =	4.88	4.23	4.80
S.D. =	0.77	0.54	0.34
S.E.M. =	0.31	0.22	0.13

TABLE 55

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF ABSTAINERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	14.8	14.2	17.4
2.	10.5	9.0	10.4
3.	15.3	15.3	14.4
4.	10.8	15.7	14.8
5.	15.2	14.6	16.8
6.	12.6	16.5	17.9
$\bar{X}$ =	13.20	14.21	15.28
S.D. =	2.20	2.68	2.77
S.E.M. =	0.90	1.09	1.13

TABLE 56

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF MODERATE DRINKERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	12.4	12.8	13.3
8.	14.0	14.5	14.7
9.	14.4	18.3	16.8
10.	15.6	15.5	15.8
11.	17.5	14.3	14.5
12.	17.4	16.5	15.7
$\bar{X}$ =	15.21	15.31	15.13
S.D. =	2.01	1.91	1.22
S.E.M. =	0.82	0.78	0.49

TABLE 57

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF ABSTAINERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	25.8	24.0	26.5
2.	19.0	19.3	19.0
3.	26.8	26.6	26.1
4.	25.5	22.3	26.4
5.	23.5	24.5	27.1
6.	28.8	25.5	27.5
$\bar{X}$ =	24.90	23.70	25.43
S.D. =	3.36	2.59	3.19
S.E.M. =	1.37	1.05	1.30

TABLE 58

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF MODERATE DRINKERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	19.6	17.5	19.4
8.	24.8	24.8	23.6
9.	28.8	33.3	32.0
10.	26.1	20.1	28.6
11.	25.4	24.7	24.5
12.	25.1	25.1	23.9
$\bar{X}$ =	24.96	24.25	25.33
S.D. =	3.00	5.40	4.38
S.E.M. =	1.22	2.20	1.78

TABLE 59

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF ABSTAINERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	35.3	37.4	37.5
2.	26.2	28.5	24.9
3.	35.7	38.6	37.9
4.	37.6	35.7	36.5
5.	34.7	33.7	34.0
6.	38.6	40.8	37.7
$\bar{X}$ =	34.68	35.78	34.75
S.D. =	4.40	4.31	5.03
S.E.M. =	1.80	1.76	2.05

TABLE 60

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF MODERATE DRINKERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	26.0	25.2	27.0
8.	36.2	35.1	33.7
9.	46.6	46.1	45.9
10.	38.6	35.6	40.2
11.	36.4	34.8	34.1
12.	34.9	37.2	34.2
$\bar{X}$ =	36.45	35.66	35.85
S.D. =	6.62	6.66	6.45
S.E.M. =	2.70	2.71	2.63

TABLE 61

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF ABSTAINERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	32.1	31.6	29.3
2.	21.0	19.3	16.4
3.	26.8	28.4	28.3
4.	28.0	25.0	27.3
5.	26.5	26.7	27.8
6.	33.6	32.9	29.3
$\bar{X}$ =	28.00	27.31	26.40
S.D. =	4.49	4.91	4.96
S.E.M. =	1.83	2.00	2.02

TABLE 62

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF MODERATE DRINKERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	23.0	21.9	18.9
8.	30.1	29.2	29.3
9.	34.4	29.1	29.3
10.	29.4	26.1	29.6
11.	21.2	18.2	21.5
12.	28.7	31.7	30.0
$\bar{X}$ =	27.80	26.03	26.43
S.D. =	4.87	5.09	4.90
S.E.M. =	1.99	2.08	2.00

TABLE 63

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF ABSTAINERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	13.0	13.2	14.6
2.	8.8	5.1	4.1
3.	8.7	9.9	10.6
4.	11.9	7.5	8.5
5.	8.4	9.2	9.5
6.	12.1	9.0	10.0
$\bar{X}$ =	10.48	8.98	9.55
S.D. =	2.06	2.68	3.39
S.E.M. =	0.84	1.09	1.38

TABLE 64

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF MODERATE DRINKERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	8.0	7.8	7.6
8.	11.6	12.0	10.8
9.	9.3	8.7	9.8
10.	7.3	8.4	6.6
11.	10.0	9.8	7.9
12.	12.1	13.1	12.3
$\bar{X}$ =	9.71	9.96	9.15
S.D. =	1.91	2.13	2.14
S.E.M. =	0.78	0.87	0.87

TABLE 65

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF ABSTAINERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	8.7	7.7	7.2
2.	6.3	4.1	3.7
3.	6.3	6.1	8.8
4.	5.7	5.5	5.5
5.	6.4	6.3	6.9
6.	8.0	9.3	6.8
$\bar{X}$ =	6.90	6.50	6.48
S.D. =	1.17	1.80	1.72
S.E.M. =	0.47	0.73	0.70

TABLE 66

OXYGEN CONSUMPTION (ML./KG./MINUTE) OF MODERATE DRINKERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	5.5	6.1	6.1
8.	7.9	7.7	6.1
9.	7.8	6.6	8.3
10.	7.1	7.2	5.9
11.	6.7	6.9	6.8
12.	8.9	9.8	8.7
$\bar{X}$ =	7.31	7.38	6.98
S.D. =	1.16	1.30	1.22
S.E.M. =	0.47	0.53	0.49

TABLE 67

VENTILATION (LITERS/MINUTE) OF ABSTAINERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	11.03	7.26	8.42
2.	17.29	11.66	10.77
3.	6.98	8.30	6.63
4.	8.71	7.66	9.24
5.	5.44	6.98	7.06
6.	12.82	12.55	8.20
$\bar{X}$ =	10.37	9.06	8.38
S.D. =	4.30	2.41	1.50
S.E.M. =	1.75	0.98	0.61

TABLE 68

VENTILATION (LITERS/MINUTE) OF MODERATE DRINKERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	12.27	8.23	11.23
8.	7.79	8.85	9.56
9.	6.28	5.08	6.21
10.	8.39	10.34	9.76
11.	8.56	8.87	8.98
12.	7.07	8.52	7.03
$\bar{X}$ =	8.39	8.31	8.79
S.D. =	2.08	1.74	1.85
S.E.M. =	0.84	0.71	0.75

TABLE 69

VENTILATION (LITERS/MINUTE) OF ABSTAINERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	10.26	8.22	6.44
2.	11.98	11.51	10.14
3.	7.09	6.56	6.73
4.	7.64	7.29	6.37
5.	5.96	7.20	7.94
6.	11.34	12.37	10.11
$\bar{X}$ =	9.04	8.85	7.95
S.D. =	2.47	2.46	1.77
S.E.M. =	1.01	1.00	0.72

TABLE 70

VENTILATION (LITERS/MINUTE) OF MODERATE DRINKERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	10.04	8.23	10.57
8.	8.89	8.85	11.00
9.	7.33	4.54	5.88
10.	9.66	10.34	12.31
11.	8.40	9.23	17.16
12.	9.91	8.36	13.63
$\bar{X}$ =	9.03	8.25	11.75
S.D. =	1.04	1.97	3.72
S.E.M. =	0.42	0.80	1.52

TABLE 71

VENTILATION (LITERS/MINUTE) OF ABSTAINERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	19.29	21.79	24.68
2.	33.72	24.97	26.11
3.	18.33	23.16	21.16
4.	17.43	19.54	16.60
5.	19.36	22.35	24.37
6.	22.69	18.31	24.86
$\bar{X}$ =	21.80	21.68	22.96
S.D. =	6.10	2.42	3.52
S.E.M. =	2.49	0.99	1.43

TABLE 72

VENTILATION (LITERS/MINUTE) OF MODERATE DRINKERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	26.00	24.71	26.84
8.	19.32	22.40	21.47
9.	15.71	18.17	17.07
10.	26.96	29.16	29.31
11.	27.98	25.71	23.49
12.	27.87	25.33	24.93
$\bar{X}$ =	23.97	24.24	23.85
S.D. =	5.18	3.68	4.28
S.E.M. =	2.11	1.50	1.74

TABLE 73

VENTILATION (LITERS/MINUTE) OF ABSTAINERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	36.62	36.32	37.56
2.	56.20	49.27	44.76
3.	34.30	36.67	38.66
4.	33.51	29.65	34.30
5.	29.69	39.44	41.72
6.	42.14	39.96	42.97
$\bar{X}$ =	38.74	38.55	39.99
S.D. =	9.48	6.40	3.86
S.E.M. =	3.87	2.61	1.57

TABLE 74

VENTILATION (LITERS/MINUTE) OF MODERATE DRINKERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	40.18	33.38	40.25
8.	39.09	41.64	38.69
9.	33.01	36.34	36.81
10.	43.41	38.66	47.96
11.	46.29	47.95	48.95
12.	43.16	39.69	41.07
$\bar{X}$ =	40.85	39.61	42.28
S.D. =	4.61	4.98	5.00
S.E.M. =	1.88	2.03	2.04

TABLE 75

VENTILATION (LITERS/MINUTE) OF ABSTAINERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	55.30	58.13	58.44
2.	79.93	74.49	71.83
3.	55.60	61.42	60.65
4.	52.81	46.82	48.91
5.	50.64	55.89	57.80
6.	60.35	71.56	73.39
$\bar{X}$ =	59.10	61.38	61.83
S.D. =	10.70	10.27	9.27
S.E.M. =	4.37	4.19	3.78

TABLE 76

VENTILATION (LITERS/MINUTE) OF MODERATE DRINKERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	55.84	54.94	58.00
8.	61.35	65.91	65.55
9.	64.42	60.57	70.91
10.	74.17	73.26	75.83
11.	83.87	90.74	85.27
12.	58.18	62.58	61.61
$\bar{X}$ =	66.30	68.00	69.52
S.D. =	10.71	12.68	10.00
S.E.M. =	4.37	5.17	4.08

TABLE 77

VENTILATION (LITERS/MINUTE) OF ABSTAINERS DURING ONE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	76.75	82.06	67.43
2.	68.42	57.83	53.19
3.	58.69	68.47	77.35
4.	51.87	50.53	41.26
5.	61.59	63.11	66.28
6.	76.15	80.85	60.01
$\bar{X}$ =	65.57	67.14	60.92
S.D. =	9.95	12.57	12.55
S.E.M. =	4.06	5.13	5.12

TABLE 78

VENTILATION (LITERS/MINUTE) OF MODERATE DRINKERS DURING ONE MINUTE RECOVERY AFTER INGESTION THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	59.73	57.80	69.16
8.	85.17	91.26	90.77
9.	53.90	43.25	43.02
10.	83.44	62.89	63.47
11.	52.42	59.35	57.46
12.	94.92	91.42	93.86
$\bar{X}$ =	71.59	67.66	69.62
S.D. =	18.38	19.52	19.63
S.E.M. =	7.50	7.97	8.01

TABLE 79

VENTILATION (LITERS/MINUTE) OF ABSTAINERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	40.37	37.90	27.39
2.	47.33	23.64	22.09
3.	23.47	28.39	32.77
4.	18.93	21.69	18.33
5.	25.24	23.84	23.73
6.	29.82	27.47	27.47
$\bar{X}$ =	30.86	27.15	25.29
S.D. =	10.87	5.83	5.02
S.E.M. =	4.43	2.38	2.05

TABLE 80

VENTILATION (LITERS/MINUTE) OF MODERATE DRINKERS DURING THREE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	29.47	25.79	28.09
8.	41.38	50.58	51.79
9.	14.90	14.19	16.75
10.	25.79	22.23	18.72
11.	33.62	38.02	34.78
12.	42.47	39.11	36.36
$\bar{X}$ =	31.27	31.65	31.08
S.D. =	10.33	13.28	12.94
S.E.M. =	4.22	5.42	5.28

TABLE 81

VENTILATION (LITERS/MINUTE) OF ABSTAINERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 mk./kg.
1.	23.37	21.26	15.37
2.	33.72	13.63	12.13
3.	14.19	10.35	19.32
4.	11.02	9.87	9.25
5.	13.19	14.89	12.52
6.	16.38	19.97	13.38
$\bar{X}$ =	18.64	14.99	13.66
S.D. =	8.51	4.76	3.40
S.E.M. =	3.47	1.94	1.39

TABLE 82

VENTILATION (LITERS/MINUTE) OF MODERATE DRINKERS DURING TEN MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	15.77	17.11	16.04
8.	20.91	25.65	23.16
9.	13.13	9.08	8.21
10.	18.19	17.79	12.99
11.	18.55	23.34	22.02
12.	24.43	23.33	22.96
$\bar{X}$ =	18.49	19.38	17.56
S.D. =	3.93	6.07	6.18
S.E.M. =	1.60	2.47	2.52

TABLE 83

BLOOD LACTATE VALUES (MM./LITER) FOR ABSTAINERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	3.9	0.5	0.3
2.	2.0	0.4	0.4
3.	1.6	0.6	0.3
4.	0.8	0.3	0.7
5.	1.0	1.1	2.9
6.	1.1	0.7	0.8
$\bar{X}$ =	1.73	0.60	0.90
S.D. =	1.14	0.28	1.00
S.E.M. =	0.46	0.11	0.40

TABLE 84

BLOOD LACTATE VALUES (MM./LITER) FOR MODERATE DRINKERS AT REST BEFORE INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	2.0	2.0	1.7
8.	0.6	0.7	1.2
9.	0.9	4.0	3.0
10.	3.8	0.6	3.2
11.	1.9	0.8	0.8
12.	1.2	0.6	0.7
$\bar{X}$ =	1.73	1.45	1.76
S.D. =	1.15	1.35	1.09
S.E.M. =	0.47	0.55	0.44

TABLE 85

BLOOD LACTATE VALUES (MM./LITER) FOR ABSTAINERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	3.8	0.6	0.7
2.	3.0	0.5	0.7
3.	1.4	1.9	0.6
4.	1.0	0.4	0.5
5.	0.9	1.4	3.9
6.	1.4	1.1	1.9
$\bar{X}$ =	1.91	0.98	1.38
S.D. =	1.19	0.59	1.33
S.E.M. =	0.48	0.24	0.54

TABLE 86

BLOOD LACTATE VALUES (MM./LITER) FOR MODERATE DRINKERS AT REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	2.6	2.2	1.5
8.	0.7	1.1	2.1
9.	0.6	5.3	3.9
10.	4.3	1.3	3.9
11.	2.4	1.6	1.7
12.	1.8	0.4	1.2
$\bar{X}$ =	2.06	1.98	2.38
S.D. =	1.37	1.72	1.21
S.E.M. =	0.56	0.70	0.49

TABLE 87

BLOOD LACTATE VALUES (MM./LITER) FOR ABSTAINERS DURING FIVE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	12.6	7.1	7.4
2.	6.7	2.5	4.5
3.	9.0	7.1	5.8
4.	6.6	3.6	4.7
5.	15.0	10.0	14.4
6.	7.0	7.9	9.0
$\bar{X}$ =	9.48	6.36	7.63
S.D. =	3.53	2.80	3.72
S.E.M. =	1.44	1.14	1.52

TABLE 88

BLOOD LACTATE VALUES (MM./LITER) FOR MODERATE DRINKERS DURING FIVE MINUTE RECOVERY AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	9.2	8.2	8.0
8.	9.9	10.0	10.0
9.	9.7	8.7	11.9
10.	7.6	4.5	6.8
11.	11.6	11.6	12.8
12.	14.2	7.9	7.0
$\bar{X}$ =	10.36	8.48	9.41
S.D. =	2.27	2.38	2.55
S.E.M. =	0.92	0.97	1.04

TABLE 89

TIME (SECONDS) ABSTAINERS WORKED AT 60 RPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	960	900	845
2.	960	610	660
3.	720	780	800
4.	840	975	960
5.	900	900	900
6.	820	780	780
$\bar{X}$ =	866	824	824
S.D. =	92.66	129.63	104.03
S.E.M. =	37.83	52.92	42.47

TABLE 90

TIME (SECONDS) MODERATE DRINKERS WORKED AT 60 RPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	960	990	985
8.	960	960	960
9.	695	660	630
10.	870	815	660
11.	540	540	540
12.	1,170	1,020	1,140
$\bar{X}$ =	865	830	819
S.D. =	221.63	195.86	240.54
S.E.M. =	90.48	79.96	98.20

TABLE 91

INDIVIDUAL RATING OF PERCEIVED EXERTION SCORES OF ABSTAINERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg
1.	7	7	6
2.	6	6	7
3.	8	7	7
4.	7	7	6
5.	10	9	9
6.	8	7	8
$\bar{X}$ =	7	7	7
S.D. =	1.36	0.98	1.16
S.E.M. =	0.55	0.40	0.47

TABLE 92

INDIVIDUAL RATING OF PERCEIVED EXERTION SCORES OF MODERATE DRINKERS AT 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	6	6	9
8.	8	7	
9.	7	7	11
10.	9	7	7
11.	7	9	9
12.	7	7	7
$\bar{X}$ =	7	7	8
S.D. =	1.03	0.98	1.67
S.E.M. =	0.42	0.40	0.74

TABLE 93

INDIVIDUAL RATING OF PERCEIVED EXERTION SCORES OF ABSTAINERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	11	12	11
2.	9	12	12
3.	11	10	11
4.	11	9	10
5.	12	11	12
6.	13	14	13
$\bar{X}$ =	11	11	11
S.D. =	1.32	1.75	1.04
S.E.M. =	0.54	0.71	0.42

TABLE 94

INDIVIDUAL RATING OF PERCEIVED EXERTION SCORES OF MODERATE DRINKERS AT 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml.kg.
7.	7	10	11
8.	11	12	12
9.	13	13	13
10.	12	11	12
11.	15	13	12
12.	9	9	10
$\bar{X}$ =	11	11	11
S.D. =	2.85	1.63	1.03
S.E.M. =	1.16	0.66	0.42

TABLE 95

INDIVIDUAL RATING OF PERCEIVED EXERTION SCORES OF ABSTAINERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	15	15	15
2.	12	15	17
3.	13	13	14
4.	13	12	13
5.	13	14	13
6.	17	18	18
$\bar{X}$ =	13	14	15
S.D. =	1.83	2.07	2.09
S.E.M. =	0.74	0.84	0.85

TABLE 96

INDIVIDUAL RATING OF PERCEIVED EXERTION SCORES OF MODERATE DRINKERS AT 1,080 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	8	13	13
8.	14	16	15
9.	17	17	15
10.	15	15	17
11.	17	15	20
12.	12	13	12
$\bar{X}$ =	13	14	15
S.D. =	3.43	1.60	2.87
S.E.M. =	1.40	0.65	1.17

TABLE 97

BLOOD ALCOHOL LEVELS (MG./ML.) OF ABSTAINERS 30 MINUTES AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
1.	.015	.055	.122
2.	.002	.051	.106
3.	.005	.034	.102
4.	.000	.033	.072
5.	.004	.076	.135
6.	.003	.041	.069
$\bar{X}$ =	.004	.048	.101
S.D. =	.005	.016	.026
S.E.M. =	.002	.006	.010

TABLE 98

BLOOD ALCOHOL LEVELS (MG./ML.) OF MODERATE DRINKERS 30 MINUTES AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Subject	.0 ml./kg.	.44 ml./kg.	.88 ml./kg.
7.	.003	.048	.114
8.	.004	.051	.104
9.	.002	.073	.126
10.	.003	.033	.065
11.	.002	.041	.109
12.	.000	.058	.118
$\bar{X}$ =	.002	.050	.106
S.D. =	.001	.013	.021
S.E.M. =	.000	.005	.008

APPENDIX F

SUMMARY TABLES OF STATISTICAL ANALYSES

TABLE 99

VARIANCE ANALYSIS OF HEART RATE (BEATS/MINUTE)
DURING PRE-INGESTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	3,452.00	313.81		
Group	1	16.00		0.05	.83
Subject Within Group	10	3,436.00			
Within Subject	24	1,440.00	60.00		
Dosage	2	134.00		1.29	.29
Group X Dosage	2	266.00		2.56	.10
Residual	20	1,040.00			
Total	35				

TABLE 100

VARIANCE ANALYSIS OF HEART RATE (BEATS/MINUTE)
DURING POST-ABSORPTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	2,444.88	222.26		
Group	1	28.44		0.12	.73
Subject Within Group	10	2,416.44			
Within Subject	24	1,018.64	42.44		
Dosage	2	30.88		0.32	.73
Group X Dosage	2	14.88		0.15	.85
Residual	20	972.88			
Total	35				

TABLE 101

VARIANCE ANALYSIS OF HEART RATE (BEATS/MINUTE) DURING EXERCISE AT 360 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	6,668.00	606.18		
Group	1	64.00		0.10	.76
Subject Within Group	10	6,604.00			
Within Subject	24	1,896.00	79.00		
Dosage	2	206.00		1.25	.30
Group X Dosage	2	38.00		0.23	.29
Residual	20	1,652.00			
Total	35				

TABLE 102

VARIANCE ANALYSIS OF HEART RATE (BEATS/MINUTE) DURING EXERCISE AT 720 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	11,336.00	1,030.54		
Group	1	36.00		0.03	.86
Subject Within Group	10	11,300.00			
Within Subject	24	1,416.00	59.00		
Dosage	2	194.00		1.70	.20
Group X Dosage	2	78.00		0.68	.51
Residual	20	1,144.00			
Total	35				

TABLE 103

VARIANCE ANALYSIS OF HEART RATE (BEATS/MINUTE) DURING EXERCISE AT 1,080 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	8,771.00	797.36		
Group	1	81.00		0.09	.76
Subject Within Group	10	8,690.00			
Within Subject	24	888.00	37.00		
Dosage	2	14.00		0.16	.85
Group X Dosage	2	18.00		0.21	.81
Residual	20	856.00			
Total	35				

TABLE 104

VARIANCE ANALYSIS OF HEART RATE (BEATS/MINUTE) DURING ONE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	15,716.00	1,428.72		
Group	1	0.00		0.00	1.00
Subject Within Group	10	15,716.00			
Within Subject	24	984.00	41.00		
Dosage	2	14.00		0.17	.84
Group X Dosage	2	126.00		1.49	.24
Residual	20	844.00			
Total	35				

TABLE 105

VARIANCE ANALYSIS OF HEART RATE (BEATS/MINUTE)
DURING THREE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	13,755.00	1,250.45		
Group	1	81.00		0.06	.81
Subject Within Group	10	13,674.00			
Within Subject	24	672.00	28.00		
Dosage	2	114.00		2.07	.15
Group X Dosage	2	6.00		0.11	.89
Residual	20	552.00			
Total	35				

TABLE 106

VARIANCE ANALYSIS OF HEART RATE (BEATS/MINUTE)
DURING TEN MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	7,803.00	709.36		
Group	1	9.00		0.01	.91
Subject Within Group	10	7,794.00			
Within Subject	24	1,728.00	72.00		
Dosage	2	126.00		0.81	.45
Group X Dosage	2	54.00		0.35	.70
Residual	20	1,548.00			
Total	35				

TABLE 107

VARIANCE OF ANALYSIS OF SYSTOLIC BLOOD PRESSURE DURING PRE-INGESTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	1,103.41	100.31		
Group	1	272.25		3.28	.10
Subject Within Group	10	831.16			
Within Subject	24	1,013.32	42.22		
Dosage	2	60.66		0.73	.49
Group X Dosage	2	120.66		1.45	.25
Residual	20	832.00			
Total	35				

TABLE 108

VARIANCE ANALYSIS OF SYSTOLIC BLOOD PRESSURE DURING POST-ABSORPTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	2,867.88	260.71		
Group	1	386.77		1.56	.24
Subject Within Group	10	2,481.11			
Within Subject	24	1,535.98	63.99		
Dosage	2	238.22		2.25	.13
Group X Dosage	2	240.88		2.28	.12
Residual	20	1,056.88			
Total	35				

TABLE 109

VARIANCE ANALYSIS OF SYSTOLIC BLOOD PRESSURE DURING EXERCISE AT 360 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	8,806.74	800.61		
Group	1	1.36		0.00	.96
Subject Within Group	10	8,805.38			
Within Subject	24	4,409.99	183.74		
Dosage	2	74.66		0.17	.84
Group X Dosage	2	28.22		0.07	.93
Residual	20	4,307.11			
Total	35				

TABLE 110

VARIANCE ANALYSIS OF SYSTOLIC BLOOD PRESSURE DURING EXERCISE AT 720 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	10,539.22	958.11		
Group	1	215.11		0.21	.65
Subject Within Group	10	10,324.11			
Within Subject	24	2,953.31	123.05		
Dosage	2	37.55		0.13	.87
Group X Dosage	2	106.88		0.38	.68
Residual	20	2,808.88			
Total	35				

TABLE 111

VARIANCE ANALYSIS OF SYSTOLIC BLOOD PRESSURE DURING EXERCISE AT 1,080 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	12,289.63	1,117.23		
Group	1	342.25		0.29	.60
Subject Within Group	10	11,947.38			
Within Subject	24	4,359.32	181.63		
Dosage	2	73.38		0.18	.83
Group X Dosage	2	276.50		0.69	.51
Residual	20	4,009.44			
Total	35				

TABLE 112

VARIANCE ANALYSIS OF SYSTOLIC BLOOD PRESSURE DURING ONE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	11,964.87	1,087.71		
Group	1	86.55		0.07	.79
Subject Within Group	10	11,878.32			
Within Subject	23	10,277.31	446.83		
Dosage	2	746.40		0.88	.43
Group X Dosage	2	1,480.16		1.75	.20
Residual	19	8.050.75			
Total	34				

TABLE 113

VARIANCE ANALYSIS OF SYSTOLIC BLOOD PRESSURE DURING THREE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	10,566.55	960.59		
Group	1	225.00		0.22	.65
Subject Within Group	10	10,341.55			
Within Subject	24	7,877.31	328.22		
Dosage	2	1,714.88		2.89	.07
Group X Dosage	2	220.66		0.37	.69
Residual	20	5,941.77			
Total	35				

TABLE 114

VARIANCE ANALYSIS OF SYSTOLIC BLOOD PRESSURE DURING TEN MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	6,660.07	605.46		
Group	1	26.69		0.04	.84
Subject Within Group	10	6,633.38			
Within Subject	24	10,056.65	419.02		
Dosage	2	718.16		0.80	.46
Group X Dosage	2	351.72		0.39	.68
Residual	20	8,986.77			
Total	35				

TABLE 115

VARIANCE ANALYSIS OF DIASTOLIC BLOOD PRESSURE DURING PRE-INGESTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	2,085.33	189.57		
Group	1	152.11		0.79	.39
Subject Within Group	10	1,933.22			
Within Subject	24	1,384.65	57.69		
Dosage	2	30.50		0.23	.79
Group X Dosage	2	20.38		0.15	.85
Residual	20	1,333.77			
Total	35				

TABLE 116

VARIANCE ANALYSIS OF DIASTOLIC BLOOD PRESSURE DURING POST-ABSORPTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	1,900.97	172.81		
Group	1	0.25		0.00	.97
Subject Within Group	10	1,900.72			
Within Subject	24	1,919.32	79.97		
Dosage	2	74.05		0.55	.58
Group X Dosage	2	501.16		3.73	.04*
Residual	20	1,344.11			
Total	35				

*Significant at .05 level of significance.

TABLE 117

VARIANCE ANALYSIS OF DIASTOLIC BLOOD PRESSURE DURING EXERCISE AT 360 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	1,503.66	136.69		
Group	1	0.11		0.00	.97
Subject Within Group	10	1,503.55			
Within Subject	24	1,577.32	65.72		
Dosage	2	23.16		0.21	.80
Group X Dosage	2	470.72		4.34	.02*
Residual	20	1,083.44			
Total	35				

*Significant at .05 level of significance.

TABLE 118

VARIANCE ANALYSIS OF DIASTOLIC BLOOD PRESSURE DURING EXERCISE AT 720 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	1,700.97	154.63		
Group	1	17.36		0.10	.75
Subject Within Group	10	1,683.61			
Within Subject	24	1,663.32	69.30		
Dosage	2	233.72		2.23	.13
Group X Dosage	2	382.38		3.65	.04*
Residual	20	1,047.22			
Total	35				

*Significant at .05 level of significance.

TABLE 119

VARIANCE ANALYSIS OF DIASTOLIC BLOOD PRESSURE DURING EXERCISE AT 1,080 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	1,500.3	136.39		
Group	1	61.36		0.43	.52
Subject Within Group	10	1,438.94			
Within Subject	24	1,129.99	47.08		
Dosage	2	146.72		1.59	.22
Group X Dosage	2	62.05		0.67	.52
Residual	20	921.22			
Total	35				

TABLE 120

VARIANCE ANALYSIS OF DIASTOLIC BLOOD PRESSURE DURING ONE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	2,285.07	207.73		
Group	1	228.80		1.15	.30
Subject Within Group	10	2,056.27			
Within Subject	23	1,127.15	49.00		
Dosage	2	165.92		1.69	.21
Group X Dosage	2	28.57		0.29	.75
Residual	19	932.66			
Total	34				

TABLE 121

VARIANCE ANALYSIS OF DIASTOLIC BLOOD PRESSURE DURING THREE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	2,700.88	245.53		
Group	1	576.00		2.71	.13
Subject Within Group	10	2,124.88			
With Subject	24	1,337.98	55.74		
Dosage	2	329.05		3.53	.04*
Group X Dosage	2	76.16		0.82	.45
Residual	20	932.77			
Total	35				

*Significant at .05 level of significance.

TABLE 122

VARIANCE ANALYSIS OF DIASTOLIC BLOOD PRESSURE DURING TEN MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	801.63	72.87		
Group	1	38.02		0.50	.49
Subject Within Group	10	763.61			
Within Subject	24	1,350.65	56.27		
Dosage	2	211.72		1.93	.17
Group X Dosage	2	42.05		0.38	.68
Residual	20	1,096.88			
Total	35				

TABLE 123

VARIANCE ANALYSIS OF OXYGEN UPTAKE (STPD) DURING PRE-INGESTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	3.95	0.35		
Group	1	0.05		0.14	.71
Subject Within Group	10	3.90			
Within Subject	24	9.66	0.40		
Dosage	2	0.08		0.10	.90
Group X Dosage	2	0.70		0.79	.46
Residual	20	8.88			
Total	35				

TABLE 124

VARIANCE ANALYSIS OF OXYGEN UPTAKE (STPD) DURING POST-ABSORPTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	9.66	0.87		
Group	1	0.30		0.32	.58
Subject Within Group	10	9.36			
Within Subject	24	9.57	0.39		
Dosage	2	1.94		2.91	.07
Group X Dosage	2	0.96		1.44	.26
Residual	20	6.67			
Total	35				

TABLE 125

VARIANCE ANALYSIS OF OXYGEN UPTAKE (STPD) DURING EXERCISE AT 360 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	111.47	10.13		
Group	1	8.80		0.86	.37
Subject Within Group	10	102.67			
Within Subject	24	55.32	2.30		
Dosage	2	6.02		1.43	.26
Group X Dosage	2	7.09		1.68	.21
Residual	20	42.21			
Total	35				

TABLE 126

VARIANCE ANALYSIS OF OXYGEN UPTAKE (STPD) DURING EXERCISE AT 720 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	362.46	32.95		
Group	1	0.26		0.01	.93
Subject Within Group	10	362.20			
Within Subject	24	79.3	3.30		
Dosage	2	12.41		1.88	.17
Group X Dosage	2	0.68		0.10	.90
Residual	20	66.21			
Total	35				

TABLE 127

VARIANCE ANALYSIS OF OXYGEN UPTAKE (STPD) DURING EXERCISE AT 1,080 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	935.72	85.06		
Group	1	7.56		0.08	.78
Subject Within Group	10	928.16			
Within Subject	24	45.37	1.89		
Dosage	2	1.10		0.29	.75
Group X Dosage	2	5.47		1.41	.26
Residual	20	38.80			
Total	35				

TABLE 128

VARIANCE ANALYSIS OF OXYGEN UPTAKE (STPD) DURING ONE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	654.09	59.46		
Group	1	2.10		0.03	.86
Subject Within Group	10	651.99			
Within Subject	24	79.89	3.32		
Dosage	2	15.07		2.44	.11
Group X Dosage	2	2.96		0.48	.62
Residual	20	61.86			
Total	35				

TABLE 129

VARIANCE ANALYSIS OF OXYGEN UPTAKE (STPD) DURING THREE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	149.51	13.59		
Group	1	0.03		0.00	.96
Subject Within Group	10	149.48			
Within Subject	24	38.28	1.59		
Dosage	2	3.87		1.32	.28
Group X Dosage	2	5.11		1.74	.20
Residual	20	29.30			
Total	35				

TABLE 130

VARIANCE ANALYSIS OF OXYGEN UPTAKE (STPD) DURING TEN MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	46.71	4.24		
Group	1	3.24		0.75	.40
Subject Within Group	10	43.47			
Within Subject	24	18.43	0.76		
Dosage	2	0.84		0.49	.61
Group X Dosage	2	0.37		0.22	.80
Residual	20	17.22			
Total	35				

TABLE 131

VARIANCE ANALYSIS OF VENTILATION (STPD)
DURING PRE-INGESTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	140.59	12.78		
Group	1	5.42		0.40	.54
Subject Within Group	10	135.17			
Within Subject	24	65.24	2.71		
Dosage	2	4.49		0.86	.43
Group X Dosage	2	8.59		1.65	.21
Residual	20	52.16			
Total	35				

TABLE 132

VARIANCE ANALYSIS OF VENTILATION (STPD)
DURING POST-ABSORPTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	136.08	12.37		
Group	1	10.21		0.81	.38
Subject Within Group	10	125.87			
Within Subject	24	89.95	3.74		
Dosage	2	10.33		2.28	.12
Group X Dosage	2	34.25		7.57	.003*
Residual	20	45.27			
Total	35				

*Significant at .01 level of significance.

TABLE 133

VARIANCE ANALYSIS OF VENTILATION (STPD)
DURING EXERCISE AT 360 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	469.65	42.69		
Group	1	31.56		0.72	.41
Subject Within Group	10	438.09			
Within Subject	24	140.10	5.83		
Dosage	2	1.88		0.14	.86
Group X Dosage	2	4.58		0.34	.71
Residual	20	133.64			
Total	35				

TABLE 134

VARIANCE ANALYSIS OF VENTILATION (STPD)
DURING EXERCISE AT 720 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	871.01	79.18		
Group	1	29.86		0.36	.56
Subject Within Group	10	841.15			
Within Subject	24	273.46	11.39		
Dosage	2	26.25		1.07	.36
Group X Dosage	2	2.67		0.11	.89
Residual	20	244.54			
Total	35				

TABLE 135

VARIANCE ANALYSIS OF VENTILATION (STPD)
DURING EXERCISE AT 1,080 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	3,611.18	328.28		
Group	1	462.53		1.47	.25
Subject Within Group	10	3,148.65			
Within Subject	24	318.59	13.27		
Dosage	2	55.18		2.11	.14
Group X Dosage	2	1.74		0.07	.93
Residual	20	261.67			
Total	35				

TABLE 136

VARIANCE ANALYSIS OF VENTILATION (STPD)
DURING ONE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	6,801.62	618.32		
Group	1	232.30		0.35	.56
Subject Within Group	10	6,569.32			
Within Subject	24	1,202.98	50.12		
Dosage	2	67.75		0.66	.52
Group X Dosage	2	104.40		1.01	.38
Residual	20	1,030.83			
Total	35				

TABLE 137

VARIANCE ANALYSIS OF VENTILATION (STPD)
DURING THREE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	2,674.52	243.13		
Group	1	114.38		0.45	.51
Subject Within Group	10	2,560.14			
Within Subject	24	679.39	28.30		
Dosage	2	50.05		0.86	.43
Group X Dosage	2	47.22		0.81	.45
Residual	20	582.12			
Total	35				

TABLE 138

VARIANCE ANALYSIS OF VENTILATION (STPD)
DURING TEN MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	695.02	63.18		
Group	1	66.28		1.05	.32
Subject Within Group	10	628.74			
Within Subject	24	448.10	18.67		
Dosage	2	52.58		1.47	.25
Group X Dosage	2	37.22		1.04	.37
Residual	20	358.30			
Total	35				

TABLE 139

VARIANCE ANALYSIS OF BLOOD LACTATE (MM./LITER) DURING PRE-INGESTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	15.88	1.44		
Group	1	2.94		2.28	.16
Subject Within Group	10	12.94			
Within Subject	24	25.39	1.05		
Dosage	2	3.02		1.45	.25
Group X Dosage	2	1.47		0.71	.50
Residual	20	20.90			
Total	35				

TABLE 140

VARIANCE ANALYSIS OF BLOOD LACTATE (MM/LITER) DURING POST-ABSORPTION REST CONDITION

Source of Variance	df	SS	MS	F	p <
Between Subject	11	20.32	1.84		
Group	1	4.62		2.94	.11
Subject Within Group	10	15.70			
Within Subject	24	37.01	1.54		
Dosage	2	1.72		0.51	.60
Group X Dosage	2	1.44		0.43	.65
Residual	20	33.85			
Total	35				

TABLE 141

VARIANCE ANALYSIS OF BLOOD LACTATE (MM./LITER) DURING FIVE MINUTE RECOVERY

Source of Variance	df	SS	MS	F	p <
Between Subject	11	223.46	20.31		
Group	1	22.88		1.14	.31
Subject Within Group	10	200.58			
Within Subject	24	97.76	4.07		
Dosage	2	37.68		6.54	.006*
Group X Dosage	2	2.44		0.42	.66
Residual	20	57.64			
Total	35				

*Significant at .01 level of significance.

TABLE 142

VARIANCE ANALYSIS OF TIME WORKED (SECONDS) DURING EXERCISE AT 60 RPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	789,424.3	71,765.84		
Group	1	0.69		0.00	.99
Subject Within Group	10	789,423.61			
Within Subject	24	132,716.65	5,529.86		
Dosage	2	14,093.05		1.19	.32
Group X Dosage	2	209.72		0.02	.98
Residual	20	118,413.88			
Total	35				

TABLE 143

VARIANCE ANALYSIS OF RATE OF PERCEIVED EXERTION DURING EXERCISE AT 360 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	24.63	2.23		
Group	1	1.25		0.54	.48
Subject Within Group	10	23.38			
Within Subject	23	26.49	1.15		
Dosage	2	2.50		1.26	.30
Group X Dosage	2	5.11		2.57	.10
Residual	19	18.88			
Total	34				

TABLE 144

VARIANCE ANALYSIS OF RATE OF PERCEIVED EXERTION DURING EXERCISE AT 720 KPM./MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	64.29	5.84		
Group	1	0.02		0.00	.94
Subject Within Group	10	64.27			
Within Subject	24	25.98	1.08		
Dosage	2	1.05		0.42	.66
Group X Dosage	2	0.05		0.02	.97
Residual	20	24.88			
Total	35				

TABLE 145

VARIANCE ANALYSIS OF RATE OF PERCEIVED EXERTION DURING EXERCISE AT 1,080 KPM/MINUTE

Source of Variance	df	SS	MS	F	p <
Between Subject	11	132.21	12.01		
Group	1	0.44		0.03	.85
Subject Within Group	10	131.77			
Within Subject	24	52.65	2.19		
Dosage	2	10.88		2.62	.09
Group X Dosage	2	0.22		0.05	.94
Residual	20	41.55			
Total	35				

APPENDIX G

SUMMARY OF POST HOC ANALYSES

TABLE 146

ONE-WAY ANALYSIS OF VARIANCE OF DIASTOLIC BLOOD PRESSURE OF ABSTAINERS DURING POST-ABSORPTION REST

Source of Variance	df	SS	MS	F	p <
Between Groups	2	478.77	239.38	3.22	.08
Within Groups	10	744.55	74.45		
Total	17				

TABLE 147

ONE-WAY ANALYSIS OF VARIANCE OF DIASTOLIC BLOOD PRESSURE OF MODERATE DRINKERS DURING POST-ABSORPTION REST

Source of Variance	df	SS	MS	F	p <
Between Groups	2	96.44	48.22	0.80	.47
Within Groups	10	599.55	59.95		
Total	17				

TABLE 148

ONE-WAY ANALYSIS OF VARIANCE OF DIASTOLIC BLOOD PRESSURE OF ABSTAINERS DURING 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Groups	2	300.44	150.22	2.98	.09
Within Groups	10	504.88	50.48		
Total	17				

TABLE 149

ONE-WAY ANALYSIS OF VARIANCE OF DIASTOLIC BLOOD PRESSURE OF MODERATE DRINKERS DURING 360 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Groups	2	193.44	96.72	1.67	.23
Within Groups	10	578.55	57.85		
Total	17				

TABLE 150

ONE-WAY ANALYSIS OF VARIANCE AND POST HOC ANALYSIS OF DIASTOLIC BLOOD PRESSURE OF ABSTAINERS DURING 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Groups	2	589.00	294.50	11.06	.002***
Within Groups	10	266.33	26.63		
Total	17				

$\bar{X}$		$\bar{X}$	Difference Between Means	p <
Dosage 2 89.66	vs -	Dosage 3 83.16	6.5*	N.S.
Dosage 2 89.66	vs -	Dosage 1 75.66	14.0**	.05***
Dosage 3 83.16	vs	Dosage 1 75.66	7.5*	.05***

*$p < .05$, $\bar{X}$ difference ≥ 6.61.

**$p < .05$, $\bar{X}$ difference ≥ 8.14.

***Significant at .05 level of significance.

TABLE 151

ONE-WAY ANALYSIS OF VARIANCE OF DIASTOLIC BLOOD PRESSURE OF MODERATE DRINKERS DURING 720 KPM./MINUTE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variation	df	SS	MS	F	p <
Between Groups	2	27.11	13.5	0.17	.84
Within Groups	10	780.88	78.08		
Total	17				

TABLE 152

NEWMAN-KEULS POST HOC ANALYSIS OF THREE ALCOHOL DOSAGES DURING THREE MINUTE RECOVERY MEASURING DIASTOLIC BLOOD PRESSURE

$\bar{X}$		$\bar{X}$	Difference Between Means	p <
Dosage 2	vs	Dosage 3		
79.25	-	73.33	6.92**	N.S.
Dosage 2	vs	Dosage 1		
79.25	-	78.08	1.07*	N.S.
Dosage 1	vs	Dosage 3		
78.08	-	72.33	5.75*	N.S.

*$p < .05$, $\bar{X}$ difference $\geq$ 5.81.

**$p < .05$, $\bar{X}$ difference $\geq$ 7.07.

TABLE 153

ONE-WAY ANALYSIS OF VARIANCE OF VENTILATION OF ABSTAINERS DURING REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Groups	2	4.07	2.03	1.92	.19
Within Groups	10	10.62	1.06		
Total	17				

TABLE 154

ONE-WAY ANALYSIS OF VARIANCE AND POST HOC ANALYSIS OF VENTILATION OF MODERATE DRINKERS DURING REST AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Groups	2	40.51	20.25	5.81	.02***
Within Groups	10	34.64	3.46		
Total	17				

$\bar{X}$		$\bar{X}$	Difference Between Means	p <
Dosage 3 11.75	vs -	Dosage 2 8.25	3.5 **	.05***
Dosage 1 9.03	vs -	Dosage 2 8.25	0.78*	N.S.
Dosage 3 11.75	vs -	Dosage 1 9.03	2.72*	.05***

*$p < .05$, $\bar{X}$ difference ≥ 2.36.

**$p < .05$, $\bar{X}$ difference ≥ 2.91.

***Significant at .05 level of significance.

TABLE 155

NEWMAN-KEULS POST HOC ANALYSIS OF THREE ALCOHOL DOSAGES DURING FIVE MINUTE RECOVERY MEASURING BLOOD LACTATE

$\bar{X}$			$\bar{X}$	Difference Between Means	$p <$
Dosage 3	vs	Dosage 2			
8.52	-		7.42	1.1*	N.S.
Dosage 1	vs	Dosage 2			
9.92	-		7.42	2.5**	.05***
Dosage 1	vs	Dosage 3			
9.92	-		8.52	1.4*	.05***

*$p < .05$, $\bar{X}$ difference ≥ 1.4.

**$p < .05$, $\bar{X}$ difference ≥ 1.7.

***Significant at .05 level of significance.

APPENDIX H

SUMMARY TABLES OF STATISTICAL ANALYSES FOR MAXIMAL HEART RATE, BLOOD PRESSURE, OXYGEN UPTAKE, VENTILATION, AND RATING OF PERCEIVED EXERTION

TABLE 156

VARIANCE ANALYSIS OF MAXIMAL HEART RATE (BEATS/MINUTE) AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Subject	11	4,784.00	434.90		
Group	1	0.00		0.00	1.00
Subject Within Group	10	4,784.00			
Within Subject	24	672.00	28.00		
Dosage	2	50.00		0.86	.43
Group X Dosage	2	42.00		0.72	.49
Residual	20	580.00			
Total	35				

TABLE 157

VARIANCE ANALYSIS OF MAXIMAL SYSTOLIC BLOOD PRESSURE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Subject	11	16,057.56	1,459.77		
Group	1	19.28		0.01	.91
Subject Within Group	10	16,038.28			
Within Subject	24	8,983.82	374.32		
Dosage	2	1,500.68		2.20	.13
Group X Dosage	2	997.48		1.46	.25
Residual	20	6,485.66			
Total	35				

TABLE 158

VARIANCE ANALYSIS OF MAXIMAL DIASTOLIC BLOOD PRESSURE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Subject	11	1,129.22	102.65		
Group	1	375.88		4.86	.052
Subject Within Group	10	753.34			
Within Subject	23	1,452.48	63.15		
Dosage	2	188.61		1.50	.22
Group X Dosage	2	140.12		1.18	.32
Residual	19	1,123.75			
Total	34				

TABLE 159

VARIANCE ANALYSIS OF MAXIMAL OXYGEN UPTAKE (ML/KG/MINUTE) AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Subjects	11	1,958.57	178.05		
Group	1	2.94		0.02	.90
Subject Within Group	10	1,955.63			
Within Subject	24	282.98	11.79		
Dosage	2	18.85		0.79	.46
Group X Dosage	2	26.58		1.12	.34
Residual	20	237.55			
Total	35				

TABLE 160

VARIANCE ANALYSIS OF MAXIMAL VENTILATION AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Subject	11	11,056.61	1,005.14		
Group	1	1,696.06		1.81	.20
Subject Within Group	10	9,360.55			
Within Subject	24	3,295.48	137.31		
Dosage	2	136.41		0.46	.63
Group X Dosage	2	203.12		0.69	.51
Residual	20	2,955.95			
Total	35				

TABLE 161

VARIANCE ANALYSIS OF RATING OF PERCIEVED EXERTION DURING MAXIMAL EXERCISE AFTER INGESTION OF THREE DOSAGES OF ALCOHOL

Source of Variance	df	SS	MS	F	p <
Between Subject	11	33.73	3.06		
Group	1	2.19		0.70	.42
Subject Within Group	10	31.54			
Within Subject	23	36.49	1.58		
Dosage	2	2.80		0.80	.46
Group X Dosage	2	0.59		0.17	.84
Residual	19	33.10			
Total	34				

VITA

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