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It was the purpose of this study to investigate the effects of an oral contraceptive on the submaximal work performance of college women. It was hypothesized that an oral contraceptive would have no significant effect on performance at submaximal work loads of 300 and 600 Kpm for any phase of the menstrual cycle.

Eleven female subjects from the sophomore class (1974) at the University of North Carolina at Greensboro were volunteers for this experiment. Open circuit respirometry was utilized to investigate the extent to which the aerobic function of women was influenced by an oral contraceptive. The subjects performed submaximal work at intensities of 300 and 600 Kpm on a Monarche bicycle ergometer. Oxygen consumption was determined using a Beckman OM-11 breath by breath oxygen analyzer. Pretest measurements were recorded for each subject on the 4th, 10th, and 26th day of her menstrual cycle one month prior to taking an oral contraceptive. A post-test was given to each subject on the 4th, 10th, and 26th day of the menstrual cycle while taking birth control pills.

Results indicated that increases in the metabolic work of the exercise took place for all phases of the menstrual cycle but reached a significant level for the 4th and 26th day of the cycle.

THE EFFECTS OF AN ORAL CONTRACEPTIVE ON THE SUBMAXIMAL WORK PERFORMANCE OF COLLEGE WOMEN

by

Louise Elaine Mozingo

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Approved by

Thesis Advisor

APPROVAL PAGE

This thesis has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

The birth control pill is the most extensively used contraceptive in our society today (6). Studies have been conducted to examine the various pharmacological effects associated with this type of contraceptive, however, these studies have not generally been concerned with the physical performance of non-athletes. Oral contraceptives have been used to manipulate the menstrual cycle of female athletes, in order to allow them to participate in various international competitions, with no regard to the physiological responses these drugs may produce with respect to athletic performance (9,11). At this time, there appears to be a paucity of studies reporting the effects of oral contraceptives on the aerobic capacity of female, non-athletes. However, Udry and Morris studied the effects of contraceptive pills on physical activity (10). A total of thirty-four women wore pedometers every day until bed-time for three complete menstrual cycles. One group of eight women took an oral contraceptive and the other group of twenty-six women acted as a control and took no contraceptive. The general physical activity level of the women taking contraceptive pills was lower than that of the women not taking pills. The investigators suggested that since subjective fatigue and depression are widely recognized as side effects of the pills, it seemed reasonable to interpret the significant difference in pedometer readings as objective evidence of a depressant physiologic effect.

Related Literature

There are apparently no studies reporting the effects of an oral contraceptive on the aerobic capacity of female non-athletes. However, there has been extensive research as to the effects of oral contraceptives on metabolism. The literature in this area is confusing to interpret because of the lack of consistent experimental design. In addition, the types of subjects, drugs, dosages, and treatment periods have been varied by different investigators. In this chapter there will be an attempt to review studies dealing with the effects of combination type oral contraceptives on carbohydrate and lipid metabolism.

Carbohydrate Metabolism

In 1966 Wynn and Doar investigated carbohydrate metabolism in a group of 105 women taking oral contraceptives for three months and in a control group of seventy-eight women (20). Eighteen percent (15 women) of oral and fifteen percent (12 women) of intravenous glucose tolerance test were found to be abnormal in the experimental group. The mean fasting-plasma-glucose was unchanged. Elevated fasting plasma non esterified fatty acid (N.E.F.A.) levels were noted and the fall after glucose administration was delayed. The most striking change observed was an increase in the maximum plasma pyruvate levels following the administration of glucose. This occurred in about 20% of the women in the test group. The investigators were uncertain as to whether the increased pyruvate levels were due to increased rates of production or impaired removal of the metabolite. Wynn and Doar

conducted another study in 1969 and reported results similar to those found in their first study (19). Sixty-seven women were tested before using oral contraceptives and again while receiving oral contraceptive therapy. Eight different estrogen-progestogen combination oral contraceptives were used for the experiment. Subjects were tested serially for twenty-three months. Results showed impaired oral and intravenous glucose-tolerance and elevated venous blood pyruvate levels both before and after oral/intravenous glucose administration. The investigators were unable to determine whether the increased fasting blood pyruvate levels were due to an increased rate of formation or impaired degradation. No relationship was found between impaired glucose tolerance, increased fasting pyruvate levels and duration of therapy, day of cycle, or type of estrogen progestogen combination. Cramp, Wynn and Doar substantiated these findings in a study also conducted in 1969 (4). They administered oral and intravenous glucose tolerance tests to 129 women receiving oral contraceptive therapy. All subjects consumed at least 200 grams of carbohydrate for three days before each test. Several different types of combination oral contraceptives were used in the experiment and the mean duration of the therapy was eighteen months. Mean venous blood pyruvate levels were significantly elevated in the subjects of the test group in the fasting state and during oral and intravenous glucose tolerance tests. No relationship between the fasting blood pyruvate level and type of estrogen-progestogen combination oral contraceptive, duration of therapy, or day of cycle was found. No significant correlation was found between the rate removal constant (K_1) for lactate, and the fasting blood lactate level.

According to the investigators, these findings suggest that the elevated fasting blood pyruvate and lactate levels found in some subjects receiving oral contraceptive therapy are due to increased rates of production rather than impaired removal of the metabolites.

In 1971 Spellacy, Buhi, Burk, and McCreary administered an oral glucose tolerance test to 54 women before taking an oral contraceptive and then repeated serially during therapy for a year. There was a significant elevation of the mean glucose values after the use of the drug (15).

Spellacy's study completed in 1972 confirmed these findings (16). Thirty-seven women had a 3-hour (100gm) oral glucose tolerance test performed on two different occasions. The first test (control) was at least four weeks post partum and before any steroid contraceptive was administered. The women were then given a combination type oral contraceptive to take in the cyclic manner. The second test was carried out in an identical manner during the sixth month of oral contraceptive treatment. All of the mean blood glucose values were elevated in association with oral contraceptive usage.

Lipid Metabolism

In 1969 Wynn and Doar investigated fasting serum triglyceride and cholesterol levels in a group of 68 women before and during oral contraceptive therapy (18). Several different types of combination oral contraceptives were used for the experiment. Samples of venous blood were taken after an overnight fast of at least twelve hours. The mean duration of the study was six months. The mean fasting serum triglyceride

level was increased during oral contraceptive therapy, but the mean fasting serum cholesterol level was unchanged. As pointed out by the investigators, it is not known whether the elevated serum triglyceride levels are due to an increased rate of production or impaired removal from the circulation. No relationship was found between the change of serum triglyceride level and the duration of therapy, nature of estrogen-progestogen combination or the day of the treatment cycle. Sach, Wolfman, and Herzia found similar results in their study also conducted in 1969 (12). Nineteen women were studied for periods of 6-18 months. After an initial control period of one month the subjects were given a combination type oral contraceptive. By the 4th week of oral contraceptive usage twelve women showed significantly increased triglyceride levels. Of the nineteen women studied, sixteen showed progressive increases in plasma triglyceride levels up to six weeks which then attained a plateau. The nineteen women patients, as a group, showed a mild but statistically insignificant rise in cholesterol levels. A rise in serum triglyceride and cholesterol in women taking a combination type oral contraceptive was also found by Barton, Freeman, and Lawson in 1970 (2). One hundred and seventy-three subjects were tested at three monthly intervals for two years. The rise in serum cholesterol and triglyceride in the subjects began early and was maintained as long as the use of contraceptives were continued. These findings were substantiated in a study conducted in 1971 by Stokes and Wynn (17). Fasting serum-lipid levels were studied in 525 women on a combination oral contraceptive. Control subjects were studied before starting on oral contraceptives and all the other subjects were investigated while receiving an oral contraceptive. Elevated mean

fasting serum-triglyceride levels were found in women on oral contraceptives. Increased values of mean fasting cholesterol was also found in women during oral contraceptive usage.

As shown in the review of literature, oral contraceptives can alter carbohydrate metabolism and often result in elevation of blood glucose levels and an increase in fasting blood pyruvate levels. Investigators are uncertain as to whether the increased fasting blood pyruvate levels are due to an increased rate of production or impaired degradation.

As evidenced in the literature, oral contraceptives can also alter lipid metabolism. The most marked alteration is the elevation of the blood levels of triglycerides.

According to Spellacy, who reviewed the metabolic effects of oral contraceptives in 1974, the mechanism for producing these changes in metabolism appears multifactorial but may include alteration of liver function, excessive production of pituitary growth hormone or increase in free active cortisol (14).

Apparently, there has been no research concerning the possible effects of these metabolic changes which accompany oral contraceptive usage, on the physical performance of female athletes.

Statement of Problem

The purpose of this study was to determine the effects of an oral contraceptive on the submaximal work performance of college women. A significant difference at the .05 level of confidence will be used as the criterion to determine whether the following six null hypotheses are tenable.

1. An oral contraceptive has no significant effect on performance at a submaximal work load of 300 Kpm on the 4th day of the menstrual cycle.
2. An oral contraceptive has no significant effect on performance at a submaximal work load of 600 Kpm on the 4th day of the menstrual cycle.
3. An oral contraceptive has no significant effect on performance at a submaximal work load of 300 Kpm on the 10th day of the menstrual cycle.
4. An oral contraceptive has no significant effect on performance at a submaximal work load of 600 Kpm on the 10th day of the menstrual cycle.
5. An oral contraceptive has no significant effect on performance at a submaximal work load of 300 Kpm on the 26th day of the menstrual cycle.
6. An oral contraceptive has no significant effect on performance at a submaximal work load of 600 Kpm on the 26th day of the menstrual cycle.

Definition of Terms

For interpretation in this study, the following definitions are offered:

Oxygen consumption-- a measure of the energy cost of steady state work at 300 Kpm and 600 Kpm.

Oral contraceptive-- a drug in tablet form, which chemically controls fertility by preventing ovulation.

Combination oral contraceptive-- an oral contraceptive which contains a combination of two female sex hormones, estrogen and progesterone, in each tablet.

Basic Assumptions

The investigation made the following basic assumptions:

1. It was assumed that all of the subjects responded in a similar manner while taking oral contraceptives.
2. That the differences in dosage of the hormones produced by the different weights of the subjects did not influence the results of the study.
3. That the effects of variables other than oral contraceptives on oxygen consumption would be randomly distributed among the subjects.

CHAPTER II

METHODS AND PROCEDURES

The purpose of this study was to determine the effects of an oral contraceptive on the submaximal work performance of college women. The procedures outlined in this chapter describe the methodology used.

General Procedures

Fifteen volunteers were recruited from the female student population enrolled in the Fall of 1974 at the Greensboro campus of the University of North Carolina. Selection of the subjects was based upon the following criteria:

a. They were in the age range of 19-20 years.

b. They never had taken birth control pills.

c. They agreed to maintain their normal exercise regime for the duration of the study.

d. They agreed not to take any stimulants or depressants 24 hours prior to being tested.

e. They were in good health and went to the campus infirmary to be examined by a physician, who agreed to assist with this portion of the study.

Two subjects withdrew from the experiment because of parental disapproval. Also, two subjects were unable to finish the study because of conflicts in the testing schedule.

The extent to which the aerobic function of women was influenced by

oral contraceptives was investigated on open circuit respirometry. The participants performed submaximal work at intensities of 300 and 600 Kpm on a Monarche Bicycle Ergometer. Oxygen consumption was determined using a Beckman OM-11, breath by breath oxygen analyzer. Steady state heart rate was determined by recording the electrocardiogram (E.C.G.) on an ink writing polygraph.

Each subject was tested on the 4th, 10th, and 26th day of her menstrual cycle, with the first day of menstrual flow being designated as day one. These particular days were chosen arbitrarily with the intent of testing the subjects at the beginning, in the middle, and at the end of their menstrual cycle. The subjects were tested one month prior to taking birth control pills and while taking pills.

Organization of Testing Sessions

Each subject attended the campus infirmary for an examination by a physician in order to receive a two month's supply of the Norlestrin birth control pill. Following the examination, the physician gave specific instructions as to how the birth control tablets were to be taken. He also informed the subjects that morning sickness, weight gain, and acne were frequent side effects.

Norlestrin 21, 1 mg. is a progestogen-estrogen combination oral contraceptive. The selection of this particular oral contraceptive was based on its routine prescription at the campus infirmary.

Each participant contacted the investigator by phone at the onset of her menstrual cycle. A testing schedule was arranged for the 4th, 10th, and 26th day of her menstrual cycle. After the completion of the

pre-tests each subject began taking her first series of birth control pills during the next menstrual cycle as directed by the physician.

Each subject began taking birth control tablets on day 5, with the first day of menstrual flow being designated as day 1, and continued taking one tablet daily for 21 days. She then took no tablets for seven days. The contraceptive action of the pill is established after the 21st tablet has been taken (5,6). Therefore, each subject, as instructed, contacted the investigator by phone several days before the 21st tablet was taken. A time was then arranged for the subject to be tested the day after the 21st tablet was taken, which was the 26th day of her menstrual cycle. After the seven days in which no tablets were taken, each subject began taking another series of birth control pills. At the onset of the menstrual cycle each participant again notified the investigator and a testing schedule was arranged for the 4th and 10th day of her menstrual cycle.

The exact procedure and nature of the study was explained to each subject; they were provided with an opportunity to practice on the bicycle ergometer to become familiar with its operation. Laboratory procedures and techniques were demonstrated and discussed with each subject in order to reduce test confusion and expedite data collection.

Each subject was instructed to bring two participants with her to each testing session to assist with data collection. In assisting with data collection, one of the participants recorded the volume of air inspired by the subject and the other participant recorded the volume of respired oxygen.

Testing Procedures

Each subject entered the lab and weighed herself. The electrocardiogram (E.C.G.) leads were placed in the standard V_4 position (on the body of the sternum and at the intersection of the mid clavicular line and the 5th intercostal space). The following adjustments were made for each subject on the bicycle ergometer and its associated apparatus: first, the height of the seat on the bicycle ergometer was adjusted so that the right leg of the subject was fully extended when the crank on the bicycle ergometer was completely vertical; secondly, the position of the mouthpiece for oxygen uptake was adjusted to enable the subject to sit in a comfortable, upright position on the bicycle ergometer and inhale through the Adlens triple "j" valve. Resting heart rate was determined by recording the electrocardiogram on an ink writing polygraph. The work load on the bicycle ergometer was regulated to 0 Kpm in order for the subject to adjust her rate of pedaling to the cadence set by the metronome. The metronome was set at a cadence of 100 beats per minute. Once the subject was able to maintain the speed of pedaling set by the metronome, the work load on the bicycle ergometer was changed to a submaximal work load of 300 Kpm. Heart rate was monitored every 30 seconds; when steady state heart rate was reached oxygen consumption measurements were made every 30 seconds for 1½ minutes. The work load on the bicycle ergometer was then changed to 600 Kpm and the oxygen consumption was determined after steady state heart rate had been achieved in a manner similar to that described above. All measurements were converted to standard temperature and pressure.

CHAPTER III

RESULTS

The data analysis in this chapter are the results of an investigation of the effects of an oral contraceptive on the submaximal work performance of college women. The raw data is recorded in APPENDIX A and APPENDIX B.

Eleven female subjects from the sophomore class at the University of North Carolina at Greensboro were volunteers for this experiment. The participants performed submaximal work at intensities of 300 and 600 Kpm on a Monarch bicycle ergometer. Oxygen consumption was determined using a Beckman OM-11 breath by breath oxygen analyzer. Each subject was given a pretest on the 4th, 10th, and 26th day of her menstrual cycle one month prior to taking an oral contraceptive. A post-test was given to each subject on the 4th, 10th, and 26th day of her menstrual cycle while taking Norlestrin birth control pills.

Six null hypotheses were developed and a significant difference at the .05 level of confidence was determined as an adequate criterion for determining whether the null hypotheses were tenable. The six null hypotheses were:

1. An oral contraceptive had no significant effect on performance at a submaximal work load of 300 Kpm on the 4th day of the menstrual cycle.
2. An oral contraceptive had no significant effect on performance at a submaximal work load of 600 Kpm on the 4th day of the

menstrual cycle.

3. An oral contraceptive had no significant effect on performance at a submaximal work load of 300 Kpm on the 10th day of the menstrual cycle.
4. An oral contraceptive had no significant effect on performance at a submaximal work load of 600 Kpm on the 10th day of the menstrual cycle.
5. An oral contraceptive had no significant effect on performance at a submaximal work load of 300 Kpm on the 26th day of the menstrual cycle.
6. An oral contraceptive had no significant effect on performance at a submaximal work load of 600 Kpm on the 26th day of the menstrual cycle.

Pretest and Post-test Scores

Fisher's "t" for significance of differences between correlated mean differences was used to examine the differences between the pretest and post-test scores. The results were:

1. The null hypothesis that an oral contraceptive had no significant effect on performance at a submaximal work load of 300 Kpm on the 4th day of the menstrual cycle was found tenable.
2. The null hypothesis that an oral contraceptive had no significant effect on performance at a submaximal work load of 600 Kpm on the 4th day of the menstrual cycle was rejected.
3. The null hypothesis that an oral contraceptive had no significant effect on performance at a submaximal work load of 300 Kpm

on the 10th day of the menstrual cycle was found tenable.

4. The null hypothesis that an oral contraceptive had no significant effect on performance at a submaximal work load of 600 Kpm on the 10th day of the menstrual cycle was found tenable.
5. The null hypothesis that an oral contraceptive had no significant effect on performance at a submaximal work load of 300 Kpm on the 26th day of the menstrual cycle was rejected.
6. The null hypothesis that an oral contraceptive had no significant effect on performance at a submaximal work load of 600 Kpm on the 26th day of the menstrual cycle was found tenable.

The results are presented in TABLE I.

TABLE I

Mean Differences and Significance of Difference

Between Scores Pretest and Post-test

Time	Work Load Kpm	Pretest Mean VO_2 ml/kg/min	Post-test Mean VO_2 ml/kg/min	M_D	t
4th day of cycle	300	17.27	17.94	-.6791	-1.1725
4th day of cycle	600	25.96	28.53	-2.5727	-2.5699*
10th day of cycle	300	18.24	18.27	-.0355	-.0842
10th day of cycle	600	26.30	28.05	-1.7500	-1.8941
26th day of cycle	300	17.20	18.55	-1.3500	-2.5932*
26th day of cycle	600	27.32	29.07	-1.7573	-1.8785

N=11 * A t greater than or equal to 2.228 was necessary for significance at the 0.05 level of confidence.

CHAPTER IV

DISCUSSION

This study focussed upon one possible effect of oral contraceptives on the activity capability of women. The rationale for investigating this area is supported in the review of the literature; several metabolic changes are produced by oral contraceptive usage. It has been demonstrated that carbohydrate metabolism is impaired by the use of oral contraceptives (4,15,19,20). Since carbohydrate metabolism is the primary energy source in aerobic activities, and submaximal work at intensities of 300 and 600 Kpm was selected for this study, it would seem reasonable to assume that a decrease in the efficiency of carbohydrate metabolism would be reflected by an increase in the energy cost of standard work loads during the period of time oral contraceptives were used. The results of this study did, in fact, indicate that such increases took place at all phases of the menstrual cycle, but reached a significant level for the 4th day and the 26th day of the cycle. Although not significant, all increases in the metabolic work of the exercise, except for that observed for the 300 Kpm work load on day 10, were quite large. A very small increase was observed for day 10; this is atypical of the responses for the other phases of the menstrual cycle. The author is unable to offer any explanation for the phenomena at this time.

Several investigators found pyruvate levels to be significantly elevated in the fasting state and during oral and intravenous glucose tolerance tests in subjects receiving oral contraceptive therapy (4,19,20).

This suggests that liver function is impaired with oral contraceptive usage since pyruvate metabolism takes place mainly in the liver. It might be of value to study recovery rate after anaerobic activities since both lactate and pyruvate are produced during anaerobic work and their metabolism is predominantly in the liver. As such, a significant increase in recovery time would support the thesis that liver function is impaired with oral contraceptive usage. However, it has been suggested that the elevated pyruvate levels reflect an increase in production of pyruvate rather than a decrease in its rate removal constant (4). An increased production of pyruvate would indicate an increase in the general metabolic rate which would be reflected by an increase in the energy cost for any given work load. These general increases were observed for all phases of the menstrual cycle, but reached significance on day 4 and day 26 only. The fact that pyruvate levels were reported to be elevated in the fasting state indicates an increase in resting or baseline metabolic rate. A higher resting metabolic rate would result in a higher energy cost for any work load, although the energy cost of the work may remain constant. An investigation of the effects of oral contraceptives on basal metabolism might indicate whether the increase in resting metabolic rate is due to a higher basal metabolic rate or an increase in metabolism of the skeletal musculature. No significant increase in the basal metabolic rate would suggest that the increase in resting metabolic rate is due to a higher rate of metabolism in the skeletal musculature.

If both carbohydrate metabolism and general metabolic levels are altered by using oral contraceptives, then the degrees to which one or

both of these phenomena contribute to the increased energy cost of the exercise could not be determined from the results of the present experiment.

A rise in serum triglyceride and cholesterol in women taking oral contraceptives was reported by several investigators (2,12,17). The work performed by subjects in this study was of relatively short duration therefore the role of free fatty acids as a preferred substrate would be minimal. It could be argued that this increase might prove to be beneficial for athletes competing in endurance type activities where fats play an important role in the total energy production.

Suggestions for Further Study

As suggested earlier, it might be of value to study recovery rate after anaerobic activities since both lactate and pyruvate are produced during anaerobic work and their metabolism takes place mainly in the liver. A significant increase in recovery time would support the thesis that liver function is impaired with oral contraceptive usage. In view of the fact that a rise in free fatty acids in subjects taking oral contraceptives was reported in the literature, it might be of value to study the effects of oral contraceptives on prolonged physical performance since fats play a major role in supplying the energy needed for endurance type activities. Also, as discussed earlier, in the review of literature resting metabolic rate was found to be increased with oral contraceptive usage. An investigation of oral contraceptives on basal metabolism might indicate whether the increase in resting metabolic rate is due to a higher basal metabolic rate or an increase in metabolism

of skeletal musculature. No significant increase in the basal metabolic rate would suggest that the increase in resting metabolic rate is due to a higher rate of metabolism in the skeletal musculature.

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APPENDIX A

PRETEST RAW DATA

Subject	Weight	Time	VO_2 ml/kg/min at 300 Kpm	VO_2 ml/kg/min at 600 Kpm
1	50.9 kgs	4th day of cycle	22.79	35.36
1	50.5 kgs	10th day of cycle	25.94	32.28
1	51.8 kgs	26th day of cycle	21.33	37.55
2	70.5 kgs	4th day of cycle	11.49	15.18
2	70 kgs	10th day of cycle	14.43	17.71
2	70.9 kgs	26th day of cycle	14.04	17.57
3	64 kgs	4th day of cycle	17.03	20.16
3	64 kgs	10th day of cycle	16.09	20.89
3	65 kgs	26th day of cycle	14.12	21.38
4	61.1 kgs	4th day of cycle	16.55	24.76
4	61.4 kgs	10th day of cycle	17.85	25.26
4	64.1 kgs	26th day of cycle	17.78	26.68

APPENDIX A (Continued)

Subject	Weight	Time	VO_2 ml/kg/min at 300 Kpm	VO_2 ml/kg/min at 600 Kpm
5	80 kgs	4th day of cycle	10.63	18.63
5	80 kgs	10th day of cycle	11.59	17.56
5	80 kgs	26th day of cycle	9.225	18.80
6	66.14 kgs	4th day of cycle	14.36	25.11
6	65.1 kgs	10th day of cycle	15.93	25.36
6	65.23 kgs	26th day of cycle	15.33	24.99
7	48.9 kgs	4th day of cycle	20.51	37.42
7	49.1 kgs	10th day of cycle	19.45	38.35
7	49.9 kgs	26th day of cycle	21.00	37.49
8	52.3 kgs	4th day of cycle	19.32	28.70
8	51.8 kgs	10th day of cycle	17.84	28.96
8	51.7 kgs	26th day of cycle	18.53	28.57
9	49.5 kgs	4th day of cycle	20.36	22.63
9	49.6 kgs	10th day of cycle	18.38	22.63

APPENDIX A (Continued)

Subject	Weight	Time	VO_2 ml/kg/min at 300 Kpm	VO_2 ml/kg/min at 600 Kpm
9	49.5 kgs	26th day of cycle	20.20	27.07
10	46.8 kgs	4th day of cycle	17.95	27.93
10	48.8 kgs	10th day of cycle	24.86	34.98
10	47.7 kgs	26th day of cycle	19.48	32.70
11	52.3 kgs	4th day of cycle	18.93	29.63
11	52.4 kgs	10th day of cycle	18.26	25.35
11	52.2 kgs	26th day of cycle	18.11	27.67

All VO_2 measurements were converted to standard temperature and pressure.

APPENDIX B

POST-TEST RAW DATA

Subject	Weight	Time	VO_2 ml/kg/min at 300 Kpm	VO_2 ml/kg/min at 600 Kpm
1	51.4 kgs	4th day of cycle	22.00	38.16
1	51.4 kgs	10th day of cycle	25.76	33.39
1	51.8 kgs	26th day of cycle	21.44	37.67
2	71.4 kgs	4th day of cycle	15.41	24.66
2	71.8 kgs	10th day of cycle	15.10	24.58
2	71.4 kgs	26th day of cycle	17.43	25.64
3	65.5 kgs	4th day of cycle	18.15	27.23
3	65.5 kgs	10th day of cycle	18.20	27.39
3	65.5 kgs	26th day of cycle	17.11	26.43
4	64.5 kgs	4th day of cycle	16.46	24.29
4	65 kgs	10th day of cycle	17.49	26.85
4	64.6 kgs	26th day of cycle	17.01	24.38

APPENDIX B (Continued)

Subject	Weight	Time	VO_2 ml/kg/min at 300 Kpm	VO_2 ml/kg/min at 600 Kpm
5	80.9 kgs	4th day of cycle	12.95	19.72
5	80.5 kgs	10th day of cycle	13.19	19.75
5	79.5 kgs	26th day of cycle	13.60	18.86
6	65.7 kgs	4th day of cycle	16.05	26.00
6	65.5 kgs	10th day of cycle	16.72	26.77
6	65.5 kgs	26th day of cycle	16.33	26.54
7	50.7 kgs	4th day of cycle	19.14	37.23
7	50.8 kgs	10th day of cycle	19.55	37.45
7	50.9 kgs	26th day of cycle	20.59	36.71
8	52.8 kgs	4th day of cycle	18.53	28.86
8	52.3 kgs	10th day of cycle	16.89	28.47
8	52.8 kgs	26th day of cycle	18.53	28.75
9	50 kgs	4th day of cycle	18.56	26.48
9	50.1 kgs	10th day of cycle	18.12	25.20

APPENDIX B (Continued)

Subject	Weight	Time	VO_2 ml/kg/min at 300 Kpm	VO_2 ml/kg/min at 600 Kpm
9	49.5 kgs	26th day of cycle	21.51	31.15
10	48.6 kgs	4th day of cycle	20.60	28.82
10	48.6 kgs	10th day of cycle	21.94	31.93
10	48.7 kgs	26th day of cycle	21.05	33.90
11	53.6 kgs	4th day of cycle	19.54	32.36
11	53.2 kgs	10th day of cycle	18.05	26.80
11	53.2 kgs	26th day of cycle	19.40	29.77

All VO_2 measurements were converted to standard temperature and pressure.