

THE INFLUENCE OF THE MENSTRUAL
CYCLE ON PULSE RATE RECOVERY
AFTER STOOL STEPPING IN
TEEN-AGE GIRLS 14-16
YEARS OF AGE

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CHAPTER I

INTRODUCTION

Throughout the ages menstruation has been associated with mystery, supersition and folklore. In ancient Persia, a menstruating women was believed to be possessed of an evil spirit; in Rome, she was blamed for blighting crop. To this day, in East Africa, there remains a tribal belief that whatever a menstruating woman touches must be burned -- lest the entire tribe be contaminated; in a remote area of Australia, no man may go near a menstruating woman -- lest he lose his strength and grow old. This has caused fear and misunderstanding in women, which have in turn brought about unnecessary suffering from this most natural function, science has thrown light on the subject and begun to free society from these superstitions.¹

Women have always been plagued with uncertainties concerning the exact nature of the changes which take place within the body during the menstrual cycle. Until anatomy and physiology became exact sciences, it was believed that the menstrual flow and urine came from the same part of the

¹
Frederic Fluhmann, The Management of Menstrual Disorders (Philadelphia: W.B. Saunders Company, 1957), p. 1.

body.¹ Recently, as physical education has become a more universal practice, physical educators, who have also been expected to provide health instruction, have been charged with the responsibility of clarifying questions which arise in connection with this natural phenomena.

A study carried out by the Research Committee of the Division of Girls and Women's Sports of the American Association for Health, Physical Education, and Recreation focused upon the problem of menstruation among school girls. In this study, a questionnaire concerned with the problem of women's participation in sports during certain phases of the menstrual cycle, was circulated among eight qualified gynecologists and nine qualified women physicians. The following statements represent the varied responses given by those who were questioned.

The majority of those questioned felt that women who experience no difficulty or discomfort during the menstrual period may participate in vigorous activity, intensive sports competition and swimming during this time with no restrictions. A few authorities however, did express the opinion that, even for such women, moderation in such activities should be practiced particularly during the first half of the menstrual period.

Some differences of opinion were expressed with regard to physical activity of women who experience minor difficulty or discomfort during the menstrual period. The majority of those questioned recommended customary vigorous activity for such women throughout the menstrual cycle. However,

¹ Carl G. Hartman, Time of Ovulation in Women (Baltimore: The Williams and Wilkins Company, 1936), p. 2.

nearly one half recommended no strenuous activity during the first half of the menstrual period, while still more expressed the opinion that swimming should be avoided during this time.

In the case of women who experience considerable difficulty or discomfort during the menstrual period, the majority of those questioned felt that vigorous exercise and competition should be limited during the pre-menstrual periods. A few recommended complete abstinence from such activity during the menstrual period.¹

As a physical educator, the investigator has been confronted with the problem of women's participation in physical activity during the menstrual cycle and thus has been encouraged to carry out the present study.

Statement of the Problem

The problem of this study was to determine the influence of the four generally accepted phases of the menstrual cycle on the recovery pulse rate of teen-age girls after a prescribed stool stepping exercise which was administered repeatedly over a period of four months. This type of step test is frequently used to appraise physical fitness. Sixteen volunteer girls, ages fourteen to sixteen, enrolled in the required physical education classes at Nixon High School in Laredo, Texas, participated in the experimental testing program. Historical records of the menstrual cycle of the experimental subjects was begun in September, 1967.

1

Marjorie Phillips, Katherine Fox, and Olive Young, "Sports Activity for Girls," Journal of Health, Physical Education and Recreation, XXX (December, 1959), pp. 23-25.

Purpose of the Study

The purpose of the study was to determine whether or not variation in hormone flow, as evidenced by appearance of the various phases of the menstrual cycle, influences the pulse rate of young teen-age girls during physical fitness appraisal tests in which, the principal evaluative criterion is a fluctuation in the pulse rate score after a prescribed period of exercise. Specifically one hypothesis was tested.

Significant fluctuations in the post-exercise pulse rate response to stool stepping may be observed in the course of physical fitness tests during certain specific phases of the menstrual cycle.

Limitations of the Study

The study was limited to sixteen freshmen girls, ages fourteen to sixteen, enrolled in the required physical education classes at Nixon High School in Laredo, Texas, during the school year of 1967-1968. Tests were conducted during four complete menstrual cycles, beginning in February, 1968, and ending in May, 1968. The subjects were tested four times monthly: during the third twenty-four hours before the menstrual flow, the second twenty-four hours during the menstrual flow, the fourth twenty-four hours after the menstrual flow, and the thirteenth day after cessation of the menstrual flow. The collection of data was limited to the resting pulse rate and the post-exercise pulse rate after three minutes of stool stepping.

Definitions and/or Explanations of Terms

Within the context of this study, several terms are used which may be unfamiliar to the reader. So that a common bases of understanding may be achieved, these terms are defined or explained as they are used throughout the investigation.

Pulse: The pulse is the swelling of the arteries due to the rhythmic rise in arterial pressure from the intermittent contraction of the left ventricle during the heart's systole.¹

Pulse Rate: The pulse rate is the pulse count during a designated time.

Pulse Rate Recovery: The time required for the exercise pulse rate to return to the resting level after the exercise is discontinued.

Menstrual Cycle: In describing the menstrual cycle it is customary to number the days from the termination of one flow to the termination of another. The average duration of the menstrual cycle is twenty-eight days and depends upon the secretion of hormones from the anterior pituitary gland and hormones secreted by the ovary. For convenience, the menstrual cycle is divided into four phases; the pre-menstrual period, menstrual period, post-menstrual period, and the inter-menstrual period; as is divided by Phillips.²

Pre-Menstrual Period: The pre-menstrual period consists of a five day period before the menstrual flow begins.

Post-Menstrual Period: The post-menstrual period consists of a seven day period after the menstrual flow.

Inter-Menstrual Period: The inter-menstrual period consists of that period of twelve days between the post-menstrual period and the pre-menstrual period.

1

Leonard A. Larson and Rachael D. Yocom, Measurement and Evaluation in Physical, Health and Recreation Education (St. Louis: C.F. Mosby Co., 1951), p. 46.

2

Madge Phillips, "A Testing Procedure for Studying Pulse Rate, Weight, and Temperature During the Menstrual Cycle," Research Quarterly, XXXVIII, No. 2 (May, 1967), pp. 254-262.

Menstrual Period: The menstrual period is that period during the flow.

Survey of Related Literature

To date, only three studies have concerned themselves with the influence of the menstrual cycle on recovery pulse rate after exercise. These studies used college-age women, seventeen to thirty-five years of age. The present investigation is predicated on the basis that the menstrual cycle may influence pulse rate recovery differently in teen-age girls than on more mature women with long established cycles and, therefore, it is desirable to investigate this phenomena.

The first study of importance in this area was conducted by Rockwell¹ at Pennsylvania State University. She studied the effects of the menstrual cycle on cardiovascular and muscular efficiency in college women. Using a modification of the Brouha (Step) Test,² she had her subjects step thirty times per minute on a sixteen inch stool. Her tests were conducted during the four phases of the menstrual cycle. Rockwell concluded that:

There is no significant difference in those efficiencies measured which could affect college women's performance between any of the investigated phases which could

1

Marion H. Rockwell, "The Effect of the Menstrual Cycle on Cardiovascular and Muscular Efficiency of College Women" (unpublished Master's Thesis, Pennsylvania State University, 1962).

2

Lucien Brouha, "The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," Research Quarterly, XIV (March, 1943), p. 31.

be attributed to the menstrual cycle. Performance appeared to be superior during the inter-menstrual period, but the difference was not statistically significant.¹

Phillips investigated the effect of the menstrual cycle on the pulse rate response of college-age women using a "running in place" test. The subjects ran in place for a period of one minute at a rate of ninety or 180 steps per minute, and then the post-exercise pulse was recorded. She concluded:

The pulse rate increase was higher during the flow phase than during the resting phase of the cycle, but a test of significance did not reveal a significant difference at the .01 level of confidence.²

In a second study Phillips examined the effect of the menstrual cycle on pulse rate before and after exercise of college women using a step test. Her subjects performed a one minute step test at a rate of ninety counts per minute. The tests were conducted during the four phases of the menstrual cycle. Phillips concluded:

The menstrual cycle did not have an effect on pulse rate before or after exercise; periodic fluctuations which occurred during the cycle were the result of factors other than menstruation.³

1

Marion H. Rockwell, "The Effect of the Menstrual Cycle on Cardiovascular and Muscular Efficiency of College Women" (unpublished Master's Thesis, Pennsylvania State University, 1962).

2

Madge Phillips, "A Testing Procedure for Studying Pulse Rate, Weight, and Temperature during the Menstrual Cycle," Research Quarterly, XXXVIII, No. 2 (May, 1967), pp. 254-262.

3

Madge Phillips, "Effect of the Menstrual Cycle on Pulse Rate and Blood Pressure Before and After Exercise," Research Quarterly, XXXIX, No. 2 (May, 1968), pp. 327-333.

Summary

In this chapter an introduction to the study, the statement of the problem, the purpose of the study, the limitations of the study, the definitions and/or explanations of terms, and a survey of related literature have been presented.

The procedures used in the development of the present study are described in Chapter II.

CHAPTER II

PROCEDURES

The present study was developed as a result of the writer's interest in women's participation in physical activity during the menstrual cycle. The procedures used in the development of the study are presented in this chapter.

Source of Data

The data used in this study were obtained through two sources, human and documentary. The human sources were sixteen junior high school girls enrolled in the ninth grade required physical education classes in Nixon High School, Laredo, Texas, during the school year of 1967-1968, and staff members of the College of Health, Physical Education and Recreation at the Texas Woman's University in Denton, Texas. The documentary sources included all the available books, pamphlets, articles, periodicals, theses, and reports of research studies containing material pertinent to the study.

Selection of Test

The use of the step test to appraise physical fitness status was given great impetus by the work of Schneider¹

¹ Edward C. Schneider, "Cardiovascular Rating as a Measure of Physical Fatigue and Efficiency," Journal of the American Medical Association, LXXIV (May 20, 1920), p. 1507.

during World War I and in women's physical education by the work of Clark¹ and Brouha and Gallagher² during the second World War. Clark used the step test to classify students for physical education programs and appraise fitness, whereas Brouha's³ principal interest was fitness appraisal. The reliability and validity of using step tests of shorter duration, three rather than five minutes has been investigated in detail by Skubic and Hodgkins⁴ using electronic pulse rate telemetering techniques.

The reliability of the step test depends upon the ability of the subjects to complete the test and the reliability with which the pulse rate is counted. Karpovich⁵ finds that the period of recovery after exercise is the most useful single measure of circulatory fitness. Brouha⁶ finds

1

Harriet L. Clark, "A Functional Physical Fitness Test for College Women," Journal of Health, Physical Education and Recreation, XIV (1943), pp. 358-359.

2

Lucien Brouha and J.R. Gallagher, "A Functional Fitness Test for High School Girls," Journal of Health, Physical Education and Recreation, XIV (December, 1943), p. 517.

3

Lucien Brouha, "The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," Research Quarterly, XIV (March, 1943), p. 31.

4

Vera Skubic and Jean Hodgkins, "A Cardiovascular Efficiency Test for Girls and Women," Research Quarterly, XXXIV, No. 2 (May, 1963), pp. 191-198.

5

Peter V. Karpovich, Physiology of Muscular Activity (Philadelphia: W.B. Saunders Company, 1965), p. 236.

6

Lucien Brouha, Physiology in Industry (New York: Pergamon Press, 1960).

pulse observations indispensable in industrial physiology for evaluation of the stress imposed by exertion and a high ambient temperature.

Although electronic transmitting techniques permit perfect pulse rate counts before, during, and after exercise, Skubic and Hodgkins¹ were able to verify the pulse counts by auscultatory techniques with a reliability coefficient of .97. The probable error in pulse rate counting with the latter technique did not exceed one beat per minute. Skubic and Hodgkins found no significant difference in the reliability between three-minute versus five-minute step tests.

Through the advise and consent of the thesis committee the stool was lower from sixteen inches, (as originally fixed for high school girls) to fifteen inches. This size was believed more appropriate because the subjects were Mexican-Americans who on the average are shorter; and because the subjects were junior high school girls.

Since the subjects in this investigation will be exposed to identical programs of physical education activity during the course of the investigation, no "training effects" with respect to pulse rate are anticipated. The fact that there are pulse rate fluctuations after controlled exercise conditions, during the various phases of the menstrual cycle, constitutes a legitimate research procedure to examine the possible influence of unidentifiable metabolic factors which may be at work during this period.

1.

Vera Skubic and Jean Hodgkins, "A Cardiovascular Efficiency Test for Girls and Women," Research Quarterly, XXXIV, No. 2 (May, 1963), pp. 191-.98.

Selection of Subjects

Permission was obtained from the Principal of Nixon High School, Laredo, Texas, to conduct the study and to use the sixteen girls enrolled in a physical education class taught by the investigator. The subjects participating in the study were ninth grade girls comprising one physical education class; all subjects were volunteers. The procedures of the study were explained to the participants in September, and their cooperation was solicited. The girls were assured that the scores made on the tests would not be used by the investigator in determining the physical education grade.

Selection and Training of Student Assistants

Two students assistants from among the girls in the participating class were selected to aid the investigator in administering and scoring the test. The girls were selected as student assistants because of their alertness, dependability, comprehension of the instructions for administering and scoring the test, and interest in the testing program. The student assistants practiced taking pulse rates for three months prior to the beginning of the testing program.

Administration of Test

The influence of the menstrual cycle on the pulse rate recovery of teen-age girls, ages fourteen to sixteen, was determined by the use of a modification of the Brouha¹

¹
Lucien Brouha, "The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," Research Quarterly, XIV (March, 1943), pp. 31-35.

(Step) Test. The equipment necessary for administering the test included a fifteen inch bench, a stop watch, a stethoscope, and a metronome.

The subjects, bases upon their personal records and the records of the investigator, participated in the step test program at a prescribed interval during their menstrual cycle.

The test consisted of stepping up and down on a stool fifteen inches high to the rhythm of a metronome at the rate of twenty-four steps per minute (a rate of ninety-six counts) for a period of three minutes. Immediately after the completion of the exercise, the pulse rate was counted by auscultatory techniques using a stethoscope and a stop watch. The recovery pulse rate counting procedure was as indicated below:

TAKE RESTING PULSE

0---3	minutes	Exercise
3---4	minutes	Count Pulse
4---4 $\frac{1}{2}$	minutes	No Pulse Count
4 $\frac{1}{2}$ ---5 $\frac{1}{2}$	minutes	Count Pulse
5 $\frac{1}{2}$ ---6	minutes	No Pulse Count
6---7	minutes	Count Pulse
7---7 $\frac{1}{2}$	minutes	No Pulse Count
7 $\frac{1}{2}$ ---8 $\frac{1}{2}$	minutes	Count Pulse

SCORE SUBJECT

The pulse rate was counted immediately after work rather than after a one minute delay as originally used by Brouha. The reason for this was that pulse rate decelerates rapidly upon the discontinuation of work. Cotton and Dill¹

¹
F.S. Cotton and D.B. Dill, "On the Relation Between Heart-Rate During Exercise and That of Immediate Post-Exercise Period," American Journal of Physiology, CXI (1935), p. 554.

showed that, in ten seconds immediately after the cessation of strenuous exercise, the heart rate decreases on an average of about one beat per minute, after that the decline is more rapid.

The purpose of the investigation was not to appraise the "fitness" of the subjects. The activity programs for the experimental subjects, for all practical purposes, were identical. The principal concern of this investigation was to determine the difference in pulse rate from test to test within a given menstrual cycle, and between completely different menstrual cycles one to four months apart.

Treatment of Data

A modification of the Brouha (Step) Test was used to determine the influence of the menstrual cycle on the pulse rate recovery of young teen-age girls. The variables used were the four phases of the menstrual cycle: the pre-menstrual period, menstrual period, post-menstrual period, and inter-menstrual period.

Organization and treatment of the data was concentrated upon the examination of the INTER menstrual cycle pulse rate scores during stool stepping and the INTRA menstrual cycle phases designated by the symbols T_1 , T_2 , T_3 , and T_4 . The four months of testing were designated into a series represented by the symbols M_1 , M_2 , M_3 , and M_4 , for the sake of the data treatment. Statistical tables were prepared in the above mentioned manner.

Since the same subjects were tested throughout the experimental program and since the pulse rate count of any

one single individual is a highly reliable index of the individual's physical status at the time of the test, the assumption was made that the principal metabolic variable that could conceivably influence the pulse rate response of the subjects, excluding illness, was the menstrual cycle. Duncan's Multiple Range Test was used to evaluate the inter and intra menstrual pulse rate scores and to determine whether significant differences were evident.

Summary

In Chapter II, the procedures for the development of the present study were presented including sources of data, the selection of the test, selection of the subjects, selection and training of student assistants, administration of test, and treatment of data.

The analysis and interpretation of the findings are presented in Chapter III.

CHAPTER III

PRESENTATION OF FINDINGS

Presented in this chapter are the results of the study conducted to determine the influence of the menstrual cycle on recovery pulse rate after stool stepping in sixteen teen-age girls fourteen to sixteen years of age enrolled in Nixon High School, Laredo, Texas, during the school year of 1967-1968. A modification of the Brouha (Step) Test was used to test the subjects. The data obtained from the administration of the test were subjected to statistical treatment, and results have been presented in four tables. Interpretations of the data presented in table form will be discussed in this chapter.

Analysis and Interpretation of Findings

Duncan's Multiple Range Test

In this study the primary concern was with comparing the fluctuations in the recovery pulse rate scores of individuals in the group with themselves during the same phase of the menstrual cycle during four successive months of testing. The second interest was in comparing the pulse rate score fluctuations of the individuals in the group with themselves during the four phases of the menstrual cycle during any given one month period. The analysis of the variance of the

data was facilitated by the utilization of the Duncan Multiple Range Test since it permits a simultaneous variance analysis and estimates of the significance of the variances observed.

Intra-Menstrual Cycle Variance Analysis

The recovery pulse rate scores were calculated in the following manner.

Pulse Rate Score After Stool Stepping at Twenty-four Steps Per Minute for Three Minutes

			Exercise Pulse Rate	Increase in Pulse Rate (Net Difference; Exer- cise Pulse Rate Minus Resting Pulse Rate)
0--1	minute	Take Count	120	60 ^a
1--1½	minutes	No Count		
1½--2½	minutes	Take Count	100	40
2½--3	minutes	No Count		
3--4	minutes	Take Count	82	22
4--4½	minutes	No Count		
4½--5½	minutes	Take Count	71	11
			Pulse Rate Score	133 ^b

a

Resting pulse rate of 60 is assumed for this example

b

Signifies the recovery pulse rate score for a particular phase of the menstrual cycle during a particular cycle (month), after a three minute step test at a rate of ninety-six counts per minute.

The means of the recovery pulse rate scores of sixteen ninth grade girls enrolled in the required physical education classes in Nixon High School, Laredo, Texas, are tabulated in Table 1, page 18.

Since the subjects were tested over a four month period, it was possible to use the mean recovery pulse rate

TABLE 1

MEAN RECOVERY PULSE RATE SCORES
OF ALL SUBJECTS DURING EACH
OF THE FOUR PHASES OF
THE MENSTRUAL CYCLE

Raw Scores - Means				
Subjects	Pre- Menstrual (T ₁)	Menstrual (T ₂)	Post- Menstrual (T ₃)	Inter- Menstrual (T ₄)
1	110.25	166.00	120.25	156.25
2	191.00	166.00	138.00	151.25
3	118.75	118.25	100.25	90.00
4	110.00	135.75	132.25	96.75
5	151.00	137.50	160.50	173.75
6	139.00	158.00	124.25	126.50
7	144.75	167.25	155.75	164.50
8	155.50	167.75	153.25	161.50
9	141.00	153.75	129.75	117.25
10	97.50	141.00	175.25	129.50
11	137.25	132.25	113.25	172.00
12	198.25	198.25	159.25	147.50
13	192.75	178.00	155.25	156.50
14	155.50	160.50	117.25	125.00
15	125.75	123.25	124.75	158.75
16	137.75	149.75	155.50	155.00
Totals ΣX	2306.50	2453.25	2214.75	2282.00

TABLE 2

ESTIMATED ERROR VARIANCE OF MEAN RECOVERY PULSE RATE
SCORES OF ALL SUBJECTS DURING EACH OF THE
FOUR PHASES OF THE MENSTRUAL CYCLE

Period	Mean of Means $\bar{X}$	Sum of Squares $\sum X^2$	Sum of Scores Squared by No. $(\sum X)^2/n$	Summation of Squares SS
Pre- Menstrual (T ₁)	144.1562	345878.750	332496.390	13382.3594
Menstrual (T ₂)	153.3281	382879.062	376152.222	6726.8399
Post- Menstrual (T ₃)	138.4218	313312.812	306569.847	6742.9650
Inter- Menstrual (T ₄)	142.6250	335286.875	325470.250	9816.6250

S_e or Error Variance = $\frac{SS_1 + SS_2 + SS_3 + SS_4}{4(n-1)}$

$S_e = 24.735$

$df = 64 - 4 = 60$

$r_p = 3.08$

$R_p = S_e r_p \sqrt{1/n}$

$R_p = 19.04595$

Mean difference = 18.406

No significant difference at the .05 level of confidence

over the four month period for each subject. These mean recovery pulse rate scores are indicated in Table 1, page 18.

The highest mean recovery pulse rate score recorded for any individual subject was 198.25 and the lowest mean recovery pulse rate score recorded was 90.

Within the phases of the menstrual cycle, the greatest range of mean recovery pulse rate scores for all the subjects was 101.25 and the smallest range of mean recovery pulse rate scores for all the subjects was 75.

Within any individual subject the greatest range of mean recovery pulse rate scores was 77.75. The smallest range of mean recovery pulse rate scores was 11.75.

The estimated error variance of the mean recovery pulse rate scores of all the subjects during each of the four phases of the menstrual cycle are indicated in Table 2, page 19.

The summation of squares was used in the following manner to obtain the error variance (S_e).

$$\sqrt{\frac{SS+SS+SS+SS}{4(n-1)}}$$

The error variance of the mean recovery pulse rate scores of all the subjects during each of the four phases of the menstrual cycle was 24.735.

The degrees of freedom for all of the subjects during the four phases of the menstrual cycle was 60.

Assuming a five per cent level of confidence test, one enters Table 9.2¹ (Values of r_p for Duncan's Multiple Range Test at the five per cent significant level) to determine the appropriate values of r_p . The four means of means of recovery pulse rate scores make it necessary to enter Table 9.2 at the columns labeled 4, 3, and 2. With 60 degrees of freedom one finds the values of r_p to be as follows:

Number of Tests			
	2	3	4
r_p	2.83	2.98	3.08

The equation used for computing the least significant ranges (R_p) for comparisons between two phases, three phases, and four phases of the menstrual cycle is:

$$R_p = (S_e)(r_p) \sqrt{1/n}$$

The appropriate substitutions were made to determine R_p for two phase (R_2), three phases (R_3), and four phases (R_4).

$$\begin{aligned} R_2 &= (24.735) (2.83) \sqrt{1/16} = 17.50 \\ R_3 &= (24.735) (2.98) \sqrt{1/16} = 18.4275 \\ R_4 &= (24.735) (3.08) \sqrt{1/16} = 19.04595 \end{aligned}$$

R_4 signifies two extreme means of four phases of the menstrual cycle. R_3 signifies two extreme means of three phases of the menstrual cycle. R_2 signifies two means of two phases of the menstrual cycle.

¹
F. J. McGuigan, Experimental Psychology, (New Jersey: Prentice-Hall, Inc., 1963), p. 175.

The means of the means of the recovery pulse rate scores of all the subjects during the four phases of the menstrual cycle were ranked from the lowest to the highest.

	T_3	T_4	T_1	T_2
$\bar{X}$:	138.4218	142.6250	144.1562	153.3281

The significance of the differences among the various pairs of recovery pulse rate means of the phases of the menstrual cycle were compared starting with the highest (T_2) and the lowest (T_3). The difference between the mean was 18.406; R_4 was 19.04595. Since the difference between the extreme means did not exceed R_4 , by deduction there was no significant difference between the extreme means T_3 and T_2 . Because the difference between the extreme means did not differ significantly, there was no necessity for testing the lesser differences.

The fact that there is no significant difference in administering step tests to these girls during any of the four phases of the menstrual cycle indicates that young teenage girls may be given step tests to measure physical fitness at any time during the month without fear of the menstrual cycle influencing their scores.

Between Four Menstrual Cycles Variance Analysis

The means of the recovery pulse rate scores of the subjects during the four months of testing were compared to obtain an estimate of the reliability of the testing procedures and appear in Table 3, page 23.

TABLE 3

MEAN RECOVERY PULSE RATE SCORES
OF ALL SUBJECTS DURING THE
FOUR CYCLES (MONTHS)

Subjects	Raw Scores - Means			
	February (M ₁)	March (M ₂)	April (M ₃)	May (M ₄)
1	104.00	124.25	120.25	156.25
2	162.75	165.00	192.00	172.00
3	80.50	95.50	120.00	133.75
4	112.00	132.00	105.00	100.75
5	148.75	192.25	115.50	166.25
6	111.25	122.50	133.00	80.25
7	131.75	174.75	175.25	100.50
8	167.00	170.00	135.00	163.50
9	180.75	122.75	118.00	120.25
10	126.75	135.50	133.50	147.50
11	92.50	166.50	158.50	112.25
12	195.25	180.25	155.75	172.25
13	154.75	167.25	170.75	190.25
14	142.75	113.50	140.25	162.25
15	131.25	120.50	162.00	118.75
16	153.75	156.25	115.00	148.25
Totals ΣX	2195.75	2338.75	2265.11	2345.00

TABLE 4

ESTIMATED ERROR VARIANCE OF MEAN RECOVERY PULSE
RATE SCORES OF ALL SUBJECTS DURING
THE FOUR CYCLES (MONTHS)

Month	Mean of Means $\bar{X}$	Sum of Squares $\sum X^2$	Sum of Scores Squared ÷ by No. $(\sum X)^2/n$	Summation of Squares SS
February (M ₁)	137.2343	316683.687	301332.378	1535.3088
March (M ₂)	146.1718	354040.437	341859.472	12180.9655
April (M ₃)	141.5698	326337.125	320672.217	5664.9081
May (M ₄)	146.5625	356085.500	343689.062	12396.4380

$$S_e \text{ or Error Variance} = \frac{SS_{SS} + SS_{SS} + SS_{SS} + SS_{SS}}{4(n-1)}$$

$$S_e = 23.024$$

$$df = 64 - 4 = 60$$

$$r_p = 3.08$$

$$R_p = S_e r_p \sqrt{1/n}$$

$$R_p = 17.72848$$

$$\text{Mean difference} = 9.382$$

No significant difference at the .05 level of confidence

The scores previously recorded for each subject during a particular month were added and divided by 4 (number of phases) to obtain the mean of the scores for each subject for each cycle (month).

The highest recovery pulse rate recorded for any one subject was 195.5; the lowest recovery pulse rate scores recorded by any one subject was 80.5. Within a given month the greatest range of recovery pulse rate scores for all the subjects was 114.75; the smallest range of recovery pulse rate scores for all the subjects was 87. Within the subjects the greatest range of recovery pulse rate scores recorded was 76.75; the smallest range of recovery pulse rate scores recorded was 20.75.

The estimated error variance of the mean recovery pulse rate scores of all the subjects during each of the four testing periods (February-May) is indicated in Table 4 page 24.

The error of variance was 23.024. Assuming a five per cent level of confidence test with 60 degrees of freedom, the values of r_p^1 are found to be:

Number of Menstrual Cycles Studied

	2	3	4
r_p	2.83	2.98	3.08

The R_p for two cycles (R_2), three cycles (R_3), and four cycles (R_4) were:

¹
F. J. McGuigan, Experimental Psychology, (New Jersey: Prentice-Hall, Inc., 1963), p. 175.

$$\begin{aligned}
 R_2 &= (23.024)(2.83) \sqrt{1/16} = 16.28948 \\
 R_3 &= (23.024)(2.98) \sqrt{1/16} = 17.15288 \\
 R_4 &= (23.024)(3.08) \sqrt{1/16} = 17.72848
 \end{aligned}$$

The means of the means of the recovery pulse rate scores of all the subjects during the four cycles ranked from the lowest to the highest are as follows:

	M_1	M_3	M_2	M_4
$\bar{X}$:	137.2343	141.5698	146.1718	146.5625

The significant of the difference among the various pairs of the recovery pulse rate means of the cycles were tested starting with the highest (M_4) and the lowest (M_1). The difference between the means was 9.3282; R_4 was 17.72848. The difference between the extreme means of the menstrual cycles does not exceed R_4 . There was no significant difference between M_4 and M_1 ; and therefore, by deduction the variances in the cycles noted from month to month are not significant.

Summary

In chapter III, the findings of the present study were presented in table form. There was no significant difference in scores obtained from administering tests during any of the four phases of the menstrual cycles. The fluctuations in scores from one cycle to the next were not statistically significant.

A discussion of findings, conclusions, and recommendations for further studies are presented in Chapter IV.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDIES

The present study was undertaken to determine the influence of the menstrual cycle upon recovery pulse rate scores of teen-age girls after stool stepping. A modification of the Brouha (Step) Test¹ was administered to sixteen girls enrolled in the required physical education classes in Nixon High School, Laredo, Texas. The test was administered within the third twenty-four hours before the menstrual flow; within the second twenty-four hours during the menstrual flow; within the fourth twenty-four hours after the menstrual flow; and within the thirteenth day after the menstrual flow. This process of testing was conducted for four successive cycles from February through May. A survey of literature concerning the influence of the menstrual cycle on recovery pulse rate scores after stool stepping of young teen-age girls revealed no investigation identical to the present study.

The Brouha (Step) Test was modified to include stepping upon a fifteen inch stool at the rate of twenty-four steps per minute for three minutes. Immediately after exercise, four

¹ Lucien Brouha, "The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," Research Quarterly, XIV (March, 1943), p. 31.

one-minute pulse rates were taken thirty seconds apart to obtain the recovery pulse rate score.

An average recovery pulse rate score was computed for each of the sixteen subjects for each of the four phases of the menstrual cycle and for each of the four separate menstrual cycles investigated.

Duncan's Multiple Range Test¹ was used to determine if there were any significant differences between the fluctuations in the recovery pulse rate scores obtained during each of the four phases of the menstrual cycle; and to determine if there were any significant differences between the fluctuations in the recovery pulse rate scores obtained during each of the four menstrual cycles studied.

Discussion of Findings

For years there has been little, objective evidence that exercise influences the menstrual cycle or that the menstrual cycle influences performance in specific types of fitness indices. In recent years, research in this area has been concentrated on adult women. No research investigation has been concerned with young teen-age girls and the menstrual cycle as it may affect physical fitness testing such as the commonly used step test.

Upon investigating the four phases of the menstrual cycle, the investigator found that the highest mean recovery pulse rate score for the group observed during any particular

¹

F.L. McGuigan, Experimental Psychology (New Jersey: Prentice-Hall, Inc., 1963), p. 175.

period (153.3281) was in the menstrual period itself. The lowest mean recovery pulse rate score (138.4218) was noted in the post-menstrual period. The fluctuations in the mean recovery pulse rate scores recorded for the group did not reveal a significant difference between any of the four investigated phases of the menstrual cycle.

To test the reliability of the recovery pulse rate scores recorded, four individual cycles were studied. This procedure was adopted to evaluate the fluctuations of the recovery pulse rate scores from one menstrual cycle to the next. When the recovery pulse rate scores for the four menstrual cycles were examined, the investigator found that the highest mean recovery pulse rate score (146.5625) was during the month of May. The lowest mean recovery pulse rate score (137.2343) was in the month of February. The fluctuations in the recovery pulse rate scores recorded in the four menstrual cycles did not reveal a significant difference between either of the menstrual cycles.

Conclusions

The following conclusions are based upon the findings of the study:

1. Although there were fluctuations in the recovery pulse rate scores after stool stepping during the menstrual cycle in teen-age girls, these differences were not found to be statistically significant. There were fluctuations in the recovery pulse rate scores in different menstrual cycles in teen-age girls after stool stepping. These fluctuations,

however, were not found to be statistically significant.

2. Teen-age girls, ages fourteen to sixteen, may be given step tests to appraise their physical fitness during any of the four phases of the menstrual cycle. The use of a stool stepping fitness test wherein the post-exercise recovery pulse rate is the principal criterion will not be influenced by the menstrual cycle per se. Any menstrual cycle is a reliable source for obtaining recovery pulse rate scores in physical fitness testing, after stool stepping in teen-age girls.

Recommendations for Further Studies

As a result of this investigation, the following suggestions for further studies are presented.

1. The influence of the menstrual cycle upon other measures of physical fitness such as muscular strength, in the same age group and in other age groups.

2. The influence of the menstrual cycle upon scores achieved in selected skill tests.

3. The influence of dysmenorrhea upon physical fitness appraisal tests and upon selected skill tests.

4. The influence of abnormally short or long menstrual cycles due to menopause upon the performance of selected physical activities.

5. The influence of the menstrual cycle upon young teen-age girls of low nutritional status as compared with girls of high nutritional status upon physical fitness appraisal tests.

6. The influence of the menstrual cycle upon young teen-age girls with abnormally short menstrual periods as

compared with young teen-age girls with abnormally long menstrual periods upon physical fitness appraisal tests.

APPENDIX

POST-EXERCISE PULSE
RATE SCORE SHEET(Month)(Phase)

	Post-Exercise Pulse Rate			
Resting Pulse Rate	0 - 1	$1\frac{1}{2}$ - $2\frac{1}{2}$	3 - 4	$4\frac{1}{2}$ - $5\frac{1}{2}$
Cumulative Increase				

RECOVERY PULSE RATE SCORE
SHEET FOR EACH SUBJECT

	February (M ₁)	March (M ₂)	April (M ₃)	May (M ₄)
Pre- Menstrual (T ₁)				
Menstrual (T ₂)				
Post- Menstrual (T ₃)				
Inter- Menstrual (T ₄)				

BIBLIOGRAPHY

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Books

- Brouha, Lucien. Physiology in Industry. New York: Pergamon Press, 1960.
- Fluhmann, Frederic. The Management of Menstrual Disorders. Philadelphia: W.B. Saunders, 1957.
- Hartman, Carl G. Time of Ovulation in Women. Baltimore: The Williams and Wilkins Company, 1936.
- Karpovich, Peter V. Physiology of Muscular Activity. Philadelphia: W.B. Saunders Company, 1965.
- Larson, Leonard A. and Yocom, Rachael D. Measurement and Evaluation in Physical, Health and Recreation Education. St. Louis: C.F. Mosby Company, 1951.
- McGuigan, F.J. Experimental Psychology. New Jersey: Prentice-Hall, 1963.

Articles and Periodicals

- Brouha, Lucien. "The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men," Research Quarterly, XIV (March, 1943), pp. 31-35.
- Brouha, Lucien and Gallagher J.R. "A Functional Fitness Test for High School Girls," Journal of Health, Physical Education and Recreation, XIV (December, 1943), p. 517.
- Clark, Harriet L. "A Functional Physical Fitness Test for College Women," Journal of Health, Physical Education and Recreation, XIV (September, 1943), pp. 358-359.

Cotton, F.S. and Dill, D.B. "On the Relation Between Heart-Rate During Exercise and That of Immediate Post-Exercise Period," American Journal of Physiology, CXI (1935), p. 554.

Phillips, Madge. "A Testing Procedure for Studying Pulse Rate, Weight and Temperature During the Menstrual Cycle," Research Quarterly, XXXVIII (May, 1967), pp. 254-262.

Phillips, Madge. "Effects of the Menstrual Cycle on Pulse Rate and Blood Pressure Before and After Exercise," Research Quarterly, XXXIX (May, 1968), pp. 327-333.

Phillips, Marjorie, Fox, Katherine and Young, Olive. "Sports Activity for Girls," Journal of Health, Physical Education and Recreation, XXX (December, 1959), pp. 23-25.

Schneider, Edward C. "A Cardiovascular Rating as a Measure of Physical Fatigue and Efficiency," Journal of the American Medical Association, LXXIV (May 20, 1920), pp. 1507-1510.

Skubic, Vera and Hodgkins, Jean. "A Cardiovascular Efficiency Test for Girls and Women," Research Quarterly, XXXIV (May, 1963), pp. 191-198.

Unpublished Material

Rockwell, Marion H. "The Effect of the Menstrual Cycle on Cardiovascular and Muscular Efficiency of College Women." Unpublished Master's Thesis, Department of Health, Physical Education and Recreation, Pennsylvania State University, 1962.