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Research paper

Evaluating the relationship between high blood pressure and menstrual irregularities among Ahmadu bello university students, Nigeria

Raymond T. Iorhemen [1] *, Godwin A. Ochube [2], Paul U. Ugbong [3], Roseline E. Akpa [4]

[1] *Department of Chemistry, Ahmadu Bello University, Zaria, 810282, Nigeria*
[2] *Department of Sociology, Ahmadu Bello University, Zaria, 810282, Nigeria*
[3] *Department of Geography and Environmental Science, University of Calabar, Calabar, Nigeria*
[4] *Department of Human Physiology, Ahmadu Bello University, Zaria, 810282, Nigeria*
**Corresponding author E-mail: iorhemenraymond@gmail.com*

Abstract

Purpose: Menstruation is a part of the changes in the function of the ovaries in women that occurs in women of childbearing age. High blood pressure is defined for a systolic blood pressure (sBP) of 90 mmHg and a diastolic blood pressure (dBP) of 140 mmHg. This research establishes the relationship between menstruation and high blood pressure among university athletes of menstruating age.
Methods: Ten volunteer university athletes were used for this study. The ages, height and weight of the subjects were measures. Also, the blood pressure (systolic and diastolic) and heart rates were measured before, during and after the exercise at menstruation period and also at seven days after menstruation.
Results: Results show the following; average age and height of the subjects were 25.5 years and 178 cm, weight increased significantly (at 95 % confidence level) during menstruation from 57.54 Kg to 58.35 Kg. sBP during menstruation was 121 mmHg while dBP was 66 mmHg. After menstruation, sBP gave 117 mmHg and dBP gave 44 mmHg. Resting heart rate was 70.1 bpm at the start of the menstruation, and 74.2 bpm after menstruation. For the recovery heart rate, 96.12 bpm was recorded at menstruation, while 97.9 bpm was recorded after menstruation.
Conclusion: This study infers that there is a significant difference between these activities at first day of menstruation and seven days after menstruation. The chief reason for this is the hormonal disorder that occurs during menstruation.

Keywords: *Blood Pressure; Heart Rate; Menstruation; University Athletes.*

1. Introduction

Changes in the function of the ovaries in women lead to menstruation which often occurs about monthly. Menstruation is a part of the experience of the world's women of childbearing potential, thus, ensuring menstrual hygiene is a critical part of basic hygiene practices. It occurs due to changes in the function of the ovaries in women and the frequency is about monthly (House et al., 2012; Achchi & Revathi, 2016). When the intensity, regularity, duration and frequency of menstrual cycles is experienced, which is usually influenced by a host of factors, irregular menstruation results (Sualeh et al., 2022). Most Third World countries, including Nigeria, consider menstruation to be a private matter (Patkar & Bharadwaj, 2004; Mahon & Fernandes, 2010).
An athlete's heart rate increases rapidly during exercise to meet the body's oxygen needs the it stabilizes after some minutes of exercise. Heart rate drops sharply for the first two minutes of recovery before leveling off or dropping below pre-workout levels. Blood pressure is affected by physical activity. Systolic blood pressure increases during exercise due to increased cardiac output. The resistance is reduced by dilation of the arteriolar vessels. Increased blood flow shortens the diastolic phase (Huynh et al., 2018). The delay in the age of menarche (the first phase of menstruation) affects the performance of athletes. Researchers have shown that athletes begin menstruating at a younger age, making them weaker and more retarded than their competitors (Fox et al., 1988). Amenorrhea-related changes in the menstrual cycle have been observed in female athletes who exercise intensively and over a long period of time. Reportedly, the prevalence of amenorrhea varies from between six and seventy-nine percent, depending on the amount and intensity of physical activity (Warren et al., 2001). For some women, there is no difference between premenstrual and menstrual symptoms.
In recent years, there has been increased interest in the connection between high blood pressure and menstruation abnormalities among female collegiate athletes (Zhou et al., 2023). Although it is commonly believed that college student athletes have great levels of physical activity and fitness, they have a variety of health problems as young adults (Gao et al., 2021). The potential effect of blood pressure on menstrual regularity is one of these difficulties. Hypertension is defined as a systolic blood pressure of at least 90 mmHg and a blood pressure of at least 140 mmHg. If left untreated, high blood pressure is often asymptomatic, but can have deadly side effects. High blood pressure, a common problem in developing countries, increases the risk of cardiovascular disease and stroke. Premenstrual symptoms (PMS), are a collection of behavioral, emotional, and physical symptoms that premenopausal women experience during the luteal phase of

their menstrual cycle (Usman et al., 2008). A woman is considered to have PMS if she reports at least one of the six affective symptoms and one of the four somatic symptoms for three consecutive cycles five days before the onset of menstruation. In addition, the signs and symptoms must disappear within four consecutive cycle days after the onset of menstruation and not reappear for no earlier than the 13th day of the following cycle. There is no known cause for PMS. Serotonin, progesterone, endorphin-regulated gonadotropin secretion, psychological variables, and biosocial factors are thought to play essential roles in the etiology of this condition (Yonkers et al., 2008). Headaches, breast tenderness, anxiety, social withdrawal, melancholy, food cravings, abdominal bloating, exhaustion, mood swings, irritability, and edema are among the commonly reported symptoms. While most women report experiencing repeated PMS symptoms every cycle, not all affected women experience all of these symptoms at the same time (Grosz, 1988). Little information is available about blood pressure fluctuations in Nigerian women during their menstrual cycle, and available research provides conflicting results (Shaikh et al., 2011). According to a previous study by Greenberg and colleagues (1985), systolic blood pressure (SBP) was higher during the luteal phase of the menstrual cycle, which lasted from day 17 to day 26. In contrast to this cross-sectional study, the same team discovered a significant drop in diastolic blood pressure (DBP) on days 1726 compared to other parts of the cycle in a sample of 33 women examined three times a week for eight weeks in a smaller prospective trial.

Hypertension is a significant public health problem worldwide, especially for young athletes in sports. It has been associated with damage to major organ systems such as the cerebrovascular, renal and cardiac systems showing abnormalities in homeostasis with a predominantly prothrombotic tendency. These have a major impact on morbidity and death. However, the defects are only discovered when they have led to irreparable consequences. When discussing the link between high blood pressure and menstrual irregularities, it's important to note that every woman of childbearing age struggles with the issue of menstrual hygiene. In most cases, girls lack education in school about reproductive health in general and the menstrual cycle in particular and the physical and mental changes that accompany puberty and adolescence. Menstruation is rarely discussed publicly among female athletes as it is believed to be unrelated to athletic activity. In addition, there is no need to support girls in controlling their time in educational institutions. Most schools do not have hypertension monitoring centers and staff are unprepared to provide advice or information to girls who are menstruating (Warenius et al., 2007).

Numerous physiological, endocrinological and psychological studies have been carried out in this area, since disputes between menstruation, hypertension, sports and women are an ongoing topic of discussion (Sevim, 1997; Cakmakci et al., 2005). The performance of female athletes does not decrease during the menstrual cycle. Before the flow and in the first few days, however, in addition to the well-known complaints, there is also a certain drop in performance. Menstruation, according to reports, does not affect athletic performance in this regard (Carl & Daniel, 1977; Cakmakci et al., 2005). Although women experience a decline in their physical ability, medical research at Olympic events found that women set world records at every stage of the menstrual cycle (Fox et al., 1988). The impact of the menstrual cycle on exercise is unclear due to the complex interplay between multiple elements. Pereira et al. (2020) included an experimental study that showed a statistically significant variation in motor performance between the follicular and luteal stages. These studies showed lower fatigability in the luteal phase in about half of them and in the follicular phase in the other half, despite a statistically significant difference between them. Recent extensive research has found that exercise performance is most negatively impacted in the early follicular phase of the menstrual cycle (McNulty et al., 2020). Both studies emphasize that the low quality of the data is due to the difficulties associated with conducting menstrual cycle research. Determination of menstrual cycle phase, small sample numbers, accurate determination of female hormone counts, and self-expectation of study participants are some examples of potential difficulties (Sheel, 2016; Bruinvels et al., 2017; De Jonge et al., 2019). Many studies have examined the long-term effects of exercise on blood pressure after several weeks or months of exercise, other research has examined the immediate effects of exercise on blood pressure (de Brito et al., 2019, Casonatto et al., 2016).

The aim of this research is to find out whether a woman's menstrual period affects her blood pressure and heart rate during exercise. The study focused on the link between menstruation and high blood pressure, as well as how people manage their health conditions while exercising.

2. Methodology

2.1. Sampling

Ten track and field female athletes (volunteers) from Ahmadu Bello University in Zaria between the ages of 10 and 34 are used in this study. The relationship between menstruation and body weight, blood pressure and heart rate are examined. The subjects were tested for a period of two months. Each volunteer received a cover letter and informed consent form outlining the objectives of the study and obtaining consent form. Medical analyses performed by the laboratory within and after the study period. The data was imported via Microsoft Excel. Volunteers were instructed not to engage in physical activity, smoke, eat, or drink prior to the test. At the same time each day.

2.2. Data collection techniques

There were two tests. The first test took place 24 hours after the menstrual cycle. Another test was carried out in seven days. Before each treadmill test, a weight check, a blood pressure check, an altitude check and a resting heart rate check were carried out. The treadmill tests had progressive incline and speed increases of up to 4 percent or 13 km/h. Five minutes were spent walking on a motorized treadmill while participants' heart rates were tracked. A seated blood pressure measurement was taken two minutes after the treadmill exercise. Heart rate during the five-minute recovery period is also recorded.

2.3. Data analysis techniques

Data collection and analysis is done on IBM charts at IBM 360 University. Heart rates during exercise and rest are compared using the BMDP2V analysis of variance method.

3. Results

3.1. Data presentation and analyses

The data used for this study was obtained from ten different female athletes who experienced irregular menstruation periods within three months before this study and had volunteered as subjects. The study evaluated the relationship between high blood pressure and menstrual

irregularities. The volunteers were subjected to a five-minute run on a motorized treadmill. Two tests were carried out at two different intervals: on the first day of menstruation and one week after menstruation. Blood pressure and heart rate were measured before and after each exercise. Heart rate was also monitored during the exercise. The information was recorded and analyzed for significant statistical differences.

3.2. Ages, heights and weights

The ages, heights, and weights (during menstruation and after seven days) of the subjects as shown in Table 1. From the result, the average age is 25.5 years with the range from 19 to 34 age. The height of the subjects ranged between 169 cm and 188 cm, with a mean of 178 cm. For the weight, the results show that the weight during menstruation was slightly elevated (58.35 Kg mean value and range: 52 Kg – 66 Kg) in comparison to seven days after menstruation (57.54 Kg mean value and range: 51 Kg – 65 Kg).
At a 95 % confidence level, the t-value of 2.743 and significance value of 0.023 was obtained for the weight measured during menstruation and after seven days of rest.

Table 1: The Ages, Height and Weight (at First Day of Menstruation and at Seven Days After Menstruation)

Subjects	Age (yrs)	Height (cm)	Weight FM(Kg)	Weight SM(Kg)
1	23.00	170.00	53.00	51.00
2	25.00	180.00	52.00	53.00
3	28.00	186.50	52.00	52.40
4	20.00	188.00	66.00	65.00
5	31.00	173.00	55.50	55.00
6	26.00	171.00	63.00	62.00
7	19.00	169.00	60.00	58.00
8	26.00	181.00	59.00	58.00
9	23.00	188.00	63.00	62.00
10	34.00	173.00	60.00	59.00

Key: Yrs = Years, Kg = Kilogram, cm = centimetre, FM = First day of Menstruation, SM = Seven days after Menstruation.

3.3. Blood pressure

The maximum pressure exerted by the heart during heartbeat (systolic) and the pressure exerted when the heart rests between beats (diastolic blood pressure) were both measured for all the subjects. The mean values of the result obtained is presented in figure 4.1 and Appendix I below. The result showed that the average systolic blood pressure before and after exercise on the first day of menstruation were 121 mmHg (range: 117 – 125 mmHg) and 167 mmHg (range: 165 -168 mmHg) respectively, while the same test repeated seven days after menstruation gave mean values of 117 mmHg (117 – 122 mmHg) and 157 mmHg (145 – 184 mmHg) for before and after exercise. Similarly, the diastolic blood pressure of the subjects as measured presented the ranges and mean values of 63 – 67 mmHg (mean is 66 mmHg), and 41 – 46 mmHg (44 mmHg) for before and after exercise on the first day of the menstruation. The repeat of this exercise a week after menstruation gave the result as: 70 – 74 mmHg (mean is 71 mmHg), and 32 – 54 mmHg (50 mmHg) respectively.
There were significant statistical difference between the blood pressure before and after exercise on the first day of menstruation, and also before and after exercise one week after menstruation. The t – values obtained were 32.010, 11.576, -46.670, -10.703 while the significant values were 0.000 at 95 % confidence.

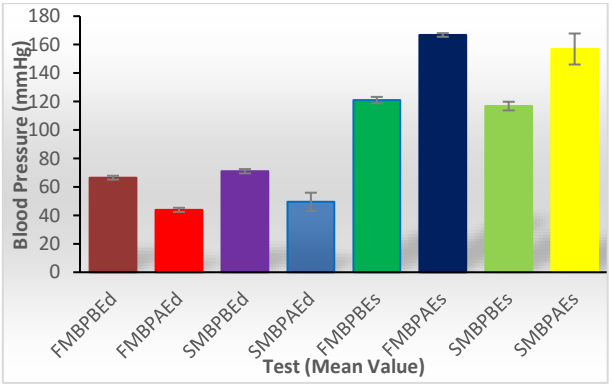

Fig. 1: Blood Pressure (Systolic and Diastolic) of the Subjects During the Study.

Key: FMBPBEd = Diastolic Blood Pressure before exercise at first day of menstruation, FMBPAEd = Diastolic Blood Pressure after exercise at first day of menstruation, SMBPBEd = Diastolic Blood Pressure before exercise at after 7 days, SMBPAEd = Diastolic Blood Pressure after exercise after seven days, FMBPBEs = Systolic Blood Pressure before exercise at first day of menstruation, FMBPAEs = Systolic Blood Pressure after exercise at first day of menstruation, SMBPBEs = Systolic Blood Pressure before exercise at after 7 days, SMBPAE = Systolic Blood Pressure after exercise after seven days.

3.4. Heart rate

The heart rate was measured both on the first day of menstruation and seven days after. For each test, measurements were taken at rest and minute by minute into the exercise for 5 minutes, then five minutes after the exercise. The resting, exercising and recovery heart rates are reported. The result is presented at Figure 4.2 below, and Appendices II, III, IV and V respectively.
The resting heart rate ranged from 50 to 100 bpm with an average of 70.1 bpm during first day of menstruation, and from 58 to 110 bpm (74.2 bpm) after a week. The t – value was 2.744 while the significant value was 0.23 at 95 % confidence.
The range of 152 to 177 bpm was recorded for the exercising heart rate on the first day of menstruation with men value of 162.8 bpm, for the one after one week of rest, the mean value stood at 148.4 bpm, while the range was from 138 to 164 bpm. The F – value for the first

day of menstruation was 51.241 while after a week rest was 27.167 (Appendix VI). There was a significance difference between the exercising heart rate at the first day of menstruation and seven days after menstruation.
The recovery heart rate was also measured at each minute for five minutes both at first day and at seven days after menstruation. The results show that the mean recovery heart rate during menstruation was 96.12 bpm (54 – 142 bpm) while after rest, the mean rate was 97.9 bpm (60 to 130). There was significant difference between the recovery heart rate at menstruation and resting period. The F – values were 7.560 and 13.526 for recovery at first day of menstruation and seven days after menstruation respectively.

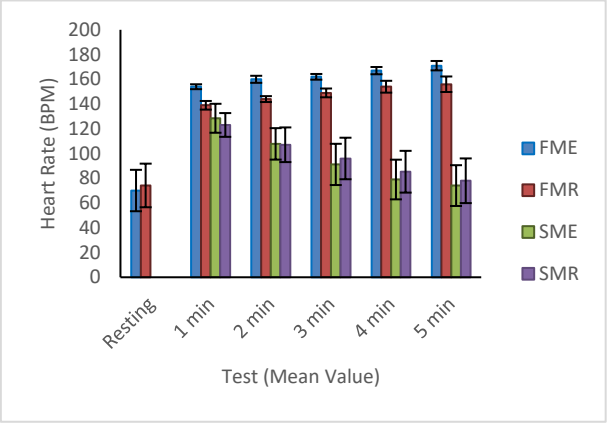

Fig. 2: Mean Values of Heart Rate for Resting, Exercising and Recovery Tests at First Day of Menstruation and After Seven Days.

Key: FME = Exercising heart rate at first day of menstruation, FMR = Recovery heart rate at first day of menstruation, SME = Exercising heart rate after seven days, SME = Recovery heart rate after seven days of menstruation

4. Discussions

Generally, menstrual irregularities have been reported to be associated with female athletes due to the fact that during the sporting activity, there is always insufficient oxygen available for the body. This is because the physical activity often exceeds the intake of food energy (Stefani et al., 2016). However, whether or not there is a relationship between these irregularities and high blood pressure is what this study explores.

4.1. Ages, heights and weights of the volunteers

The average age of the ABU students who volunteered for this study is 25.5 years. From here, it implies that this is the age grade that is mostly affected by the irregular menstruation among female athletes. Kwak et al. (2019) reported an age range from 19 to 54 years, of athletes in this category. Based on their submission, the above mean age may also have a role to play in the menstrual irregularities experienced. While El-Bandrawy et al. (2018), implicated body weight in their findings, Gao et al. (2021) reported age as a factor in menstrual irregularities among female athletes. Munro et al. (2022) reported a combination of age, body weight and height as factors responsible for menstrual irregularities.
The results showed that there was a significant difference in the weight of the subjects ($p<0.05$) between the first day of menstruation and seven days after menstruation. This shows that menstruation has an effect on the weight of the athletes. These findings corroborate the research reported by Thein-Nissenbaum et al (2012) in whose study, the weight of the athletes significantly changed during menstruation. Also, weight loss from 58.35 kg during menstruation to 57.54 Kg one week after menstruation is an expected occurrence as many las reported (Huhmann et al., 2020). The weight gain associated with menstrual period is linked to hormonal fluctuations, gastrointestinal issues and period bloating (Kirsten, 2018).

4.2. Blood pressure

The relationship between blood pressure and menstrual irregularities among female university athletes has gained attention in recent years. While college student athletes are often assumed to have high levels of physical activity and fitness, they face various health challenges during their young adulthood(Gao et al., 2021). One of these challenges is the potential impact of blood pressure on menstrual regularity. A study conducted by researchers suggested that there should be a distinction between different types of athletic menstrual irregularities based on factors such as hormonal profile, body weight and energy availability.
Both systolic (sBP) and diastolic blood pressures (dBP) were monitored. From the result, the sBP during menstruation (121 mmHg and 167 mmHg) was higher compared to 117 mmHg and 157 mmHg obtained after menstruation. The dBP which was the reverse of the sBP increased in reverse pattern – form 66 mmHg and 44 mmHg during menstruation to 71 mmHg and 50 mmHg after seven days of rest respectively. Thus, sBP increased and the dBP decreased during menstruation which agree with Solera-Herrera et al., (2019) and Gamboa-Granados and Solera-Herrera, (2017). The systolic BP increment is determined by the heart rate as diastolic BP is by volume. As reported by Solera-Herrera et al., (2019). Exercise is responsible for this behaviour. On the other hand, the Total Peripheral Resistance (TPR) determines the dBP, which decreases after concluding exercise. The reason for this decrease is the reduction in the sympathetic tone and an increase in liberating vasodilator substances like nitric oxide and histamine (Hammer, 2006). More so, oestrogen is also reported to play an important role in increasing blood pressure by affecting vascular contraction (Park et al., 2017).

4.3. Heart rate

Regular exercise normally causes a reduction in heart rate. This heart rate normally increases during a strenuous activity or during anxiety (Reimers, et al., 2018). Low values of 70.1 bpm and 74.2 bpm were recorded for both during menstruation and seven days after for the

resting heart rate. This is in agreement with the value of 72.4 bpm reported in literature (Reimers, et al., 2018). This resting heart rate is often used as an indicator for cardiovascular diseases risk (Laukkanen, et al., 2004; Carter et al., 1999). There was a significant difference in the resting heart rates recorded at first day of menstruation and the one after seven days.

For the exercising heart rate, first day of menstruation recorded a higher value (162.8 bpm) compared to a week after menstruation (148.4 bpm). Triggered by the activity, there is always a sharp increase at the start of the exercise and this sustains till after the exercise where there is usually a sharp decline in the elevated rate (Paulo et al., 2001). During exercise, a menstruating lady's heart rate is reported to increase hence, the reason for the variation (Esformes et al., 2006). The difference in the values obtained is also statistically significant ($p<0.05$).

The recovery heart rate of 96.12 and 97.9 bpm were recorded for both first day of menstruation and seven days after menstruation. This difference was significant also.

5. Conclusion

The relationship between body weight, blood pressure and heart rate were evaluated at the first day of menstruation and one week after menstruation. All the indicators showed that there is a significant difference between these activities at first day of menstruation and seven days after menstruation. The chief reason for this is the hormonal disorder that occurs during menstruation.

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Appendices

Appendix 1

Blood Pressure of the Volunteered Subjects at first day of Menstruation and after seven days.

Subjects	FMBPBE(mmHg)	FMBPAE(mmHg)	SMBPBE(mmHg)	SMBPAE(mmHg)
1	122/65	168/44	117/71	157/50
2	120/65	168/45	122/73	145/53
3	121/67	166/41	117/73	157/49
4	123/64	168/44	115/70	155/50
5	118/66	167/46	114/74	159/48
6	120/67	168/44	117/70	184/46

7	121/65	169/42	118/71	166/54
8	121/67	167/43	118/72	158/51
9	125/63	165/43	121/70	146/32
10	117/66	169/42	116/70	155/54

Key: FMBPBE = Blood Pressure before exercise at first day of menstruation, BPAE = Blood Pressure after Exercise at first day of menstruation, SMBPBE = Blood Pressure before exercise after seven days, SMBPAE = Blood Pressure after Exercise after seven days.

Appendix II

Heart rate during exercise on the first day of menstruation

Subjects	Resting Rate	Heart Rate at Intervals During the Exercise (BPM)				
		1min	2min	3min	4min	5min
1	50.00	156.50	163.00	163.58	166.00	177.00
2	64.00	154.00	163.00	163.00	170.50	175.00
3	54.00	155.00	161.00	159.00	167.00	173.00
4	69.00	157.50	163.00	165.00	169.00	169.00
5	80.00	153.00	158.00	161.50	166.50	169.00
6	54.00	152.50	160.00	161.00	164.00	168.00
7	100.00	152.17	157.84	165.00	161.00	165.50
8	82.00	152.00	154.00	158.00	164.50	168.50
9	60.00	156.50	159.50	162.00	168.00	171.50
10	88.00	154.50	160.00	162.00	170.00	175.50

Key: min = minute(s), BPM = Beats per minute.

Appendix III

Heart rate during rest on the first day of menstruation

Subjects	Heart Rate at Intervals During Rest (BPM)				
	1min	2min	3min	4min	5min
1	120.00	84.00	62.00	55.00	54.00
2	142.00	120.00	80.00	71.00	68.00
3	132.00	105.00	85.00	68.00	60.00
4	140.00	110.00	92.00	75.00	70.00
5	123.00	100.00	95.00	88.00	85.00
6	130.00	109.00	88.00	69.00	60.00
7	140.00	128.00	119.00	109.00	105.00
8	112.00	104.00	95.00	90.00	86.00
9	110.00	98.00	81.00	70.00	63.00
10	136.00	120.00	115.00	95.00	90.00

Key: min = minute(s), BPM = Beats per minute.

Appendix IV

Heart rate during exercise after seven days of rest

Subjects	Resting Rate	Heart Rate at Intervals During the Exercise (BPM)				
		1min	2min	3min	4min	5min
1	60.00	138.00	144.00	150.00	153.50	155.00
2	62.00	140.00	142.50	151.00	154.00	158.00
3	58.00	139.00	147.00	153.00	156.00	162.00
4	70.00	139.00	142.00	151.00	160.00	162.00
5	90.00	138.50	143.00	149.00	155.00	158.00
6	60.00	130.00	141.00	143.50	143.50	143.50
7	110.00	139.00	142.50	144.50	149.00	150.00
8	80.00	143.50	146.00	146.00	155.00	155.00
9	62.00	141.50	148.00	154.00	159.00	164.00
10	90.00	138.00	142.00	147.00	152.00	152.00

Key: min = minute(s), BPM = Beats per minute.

Appendix V

Heart rate during rest after seven days of menstruation

Subjects	Heart Rate at Intervals During Rest (BPM)				
	1min	2min	3min	4min	5min
1	120.00	92.00	85.00	70.00	62.00
2	112.00	95.00	80.00	78.00	70.00
3	118.00	91.00	73.00	66.00	60.00
4	122.00	103.00	96.00	77.00	70.00
5	130.00	122.00	115.00	103.00	95.00
6	123.00	108.00	96.00	79.00	68.00
7	135.00	128.00	122.00	118.00	115.00
8	135.00	120.00	108.00	90.00	82.00
9	106.00	94.00	78.00	72.00	64.00
10	130.00	118.00	107.00	100.00	94.00

Key: min = minute(s), BPM = Beats per minute

Appendix VI

Analyses of variance for the exercising heart rate both during and after menstruation.

		Sum of Squares	df	Mean Square	F	Sig.
FM	Between Groups	1653.342	4	413.335	51.241	.000
	Within Groups	362.995	45	8.067		
	Total	2016.336	49			
SM	Between Groups	2013.650	4	503.412	27.167	.000
	Within Groups	833.850	45	18.530		
	Total	2847.500	49			

Key: FM = First day of Menstruation, SM = Seven days after Menstruation.

Appendix VII

Analyses of variance for the recovery heart rate both during and after menstruation.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
FMR	Between Groups	7416.480	4	1854.120	7.560	.000
	Within Groups	11036.100	45	245.247		
	Total	18452.580	49			
SMR	Between Groups	12780.600	4	3195.150	13.526	.000
	Within Groups	10629.900	45	236.220		
	Total	23410.500	49			

Key: FMR = First day of Menstruation Recovery time, SM = Seven days after Menstruation Recovery time