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ORIGINAL RESEARCH

Effects of Menstrual Cycle Phases on Selected Fitness Variable: In Case of Female Volleyball Players of Azazo Dimaza High School, Gondar City, Amhara Region, Ethiopia

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Abstract

The purpose of this study was to investigate the effects of menstrual cycle phases on strength and explosive power performance in female volleyball players at Azezo Dimaza secondary school. The study was used longitudinal research type and prospective design. According to the inclusion criteria 25 female volleyball players were selected from grade nine students purposively. The data was collected using three performance tests at different time point. These tests were pushes up, sit ups and standing long jump. Participants were exposed for three separate occasions during each menstrual cycle phases, consisting of two familiarization sessions and one actual test for each performance measurements. Then mean and standard deviation were computed and data were reported as mean ± SD. As well as, Repeated Measure ANOVA followed by a Bonferroni post hoc test at $p < 0.05$ were used. In the present study, the subject's menstrual cycle was 28.32 ± 1.69 days, their average age, height, weight and BMI was 15.76 ± 1.25yrs, 1.64 ± .049 m, 47.72 ± 5.07kg and 17.73 ± 1.98 kg/m^2. The push up test mean scores during follicular phase, menstrual phase and luteal phase were statistically significantly different ($F (1.063, 25.501) = 4.780$, $p < 0.05$). Likewise, the sit up and standing long jump tests mean scores for during follicular phase, menstrual phase and luteal phase were statistically significantly different ($F (1.433, 34.386) = 5.651$, $p < 0.05$) and ($F (1.991, 47.779) = 17.947$, $p = 0.00$) in that order.

Keywords: Menstrual cycle phase, female, volleyball, muscular endurance, muscular strength, power

Introduction

Volleyball is one of the big five international sports being played today, relying on 220 affiliated national federation with an estimate of 800 million players who play volleyball at least once a week (Kilic et al., 2017). Moreover, it is the only ball game which is involved in both modern Olympic and Paralympic sports competitions: six players on each team are used in an indoor version, and a two-players per volleyball outdoor game typically played on sand known as beach volleyball (Desalegn, 2016).

Due to its worldwide popularity, Volleyball is one of the well-known most exhilarating, fast, and dynamic sports on the globe (Desalegn, 2016). While being undoubtedly beneficial to physical, mental and social well-being was people muck in this sport. The menstrual cycle is a common biological process in healthy women

who reach puberty. It occurs monthly and lasts 28 days on average, and its main characteristic is the interactions offset hormones in the female body due to changes in the ovarian follicle (Ramos *et al*., 2018). These interactions are responsible for the good functioning of the cycle. This process entails three main distinct phases: the follicular phase, ovulation, and the luteal or premenstrual phase (Silva and Pires, 2021).

Menstruation in women players may lead to several physiological difficulties and performance loss in training or competitions. They often try to abstain from training or competitions psychologically during menstruation periods. Several scholars have attempted to illuminate the effect of menstruation on performance but no conclusive evidence related to if there was a negative or positive effect was found (Kalyon, 2000; Lebrun, 1993; On, 2012; Ön et al., 2014; Sevim, 2002; Tsampoukos et al., 2010).

Research on the topic has focused on sportive performance in four cycles of menstruation period and revealed that women players perform worse during their menstruation periods. However, there have been several studies concluding that players get the best performance at the beginning of their menstruation periods. Some others also suggest that menstruation and sportive activities affect one another and some extraordinary sportive achievements have been witnessed in each phase of menstruation periods of women (Ertas and Ersoz, 2002; Karacan et al., 2013; Karakas, 1987; Ön, 2012; Ön et al., 2014). On the other hand, a line of research focusing on performance of women during menstruation periods concluded that there is no change in power output values in terms of sprint tests in menstruation period.

In another study, it has been found that muscle endurance is at the highest level in the middle of the follicular phase, whereas it is at the lowest level in the half of the luteal phase. Additionally, it has been found that performance is better at early luteal phase. Finally, other studies have concluded that the best performance values have been measured after ovulation and menstruation phases, while the worst performance values were obtained during pre-menstruation period (Lebrun, 1993; Fomin et al., 1989; Lind and Petrofsky,1976, Ön, 2012; Ön et al., 2014, Özdemir and Kucukoglu,1993; Tsampoukos et al., 2010).

Thus, this research study was undertaken by the investigators to provide them the effect of the menstrual cycle on selected physical fitness components (muscular endurance, muscular strength and power).

2. Materials and Methods

Study Design

The present study was used prospective research design. Since this study involves observing the same sample (Volleyball players) repeatedly over a period. This time span was for two months (eight weeks) and different menstrual cycle phases of the participants. As well as prospective research design was selected because it allows a researcher repeatedly to examine the same individuals (participants) to detect any changes that might occur over a period of time with various menstrual cycle phases. Moreover, this design is a gold standard in descriptive and observational studies (Bookwala, Hussain and Bhandari, 2011).

Sample

For the current study among 145 female students at grade nine only 25 students fulfill the inclusion criteria, those who were eumenorrheic women, 17 years of age, Volleyball sport project trainees, No major injury history for the past two weeks and Not using contraceptives) and purposively selected.

Data collection instruments and procedures

Participants were exposed for three separate occasions during each menstrual cycle phases, consisting of two familiarization sessions and one actual test for each performance measurements. Basic information about participants such as age,

height and body weight were registered. All the performance tests were administered based on Mackenzie (2015) scientific functional test procedures.

The data was collected by using three performance tests at different time points. Prior to beginning the test administration, the nature of the tests and their procedures were explained. In addition, a 15-minute standard warming-up exercises were given by coach for the study subjects.

For the current study push-up, sit ups and standing long jump were used to measure muscular strength, muscular endurance, and leg power of the study subjects respectively.

Ethical consideration

In view of the fact that, the present study was experimental in its nature and involves human subjects, the appropriate approval to conduct the study was first received from the Department of Sport Science postgraduate coordinator. Subsequently, a child assent form was prepared and distributed to the participants to get their permission for participation.

Determination of the Menstrual Cycle Phase

The duration of the menstrual cycle and the onset of each phase were determined using LH urine kits following established recommendations (Bambaeichi et al., 2004; Tenan et al., 2013; Tenan et al., 2016). It was performed on two consecutive menstrual cycles of female students before the actual data collection was administered. Among the four phases of menstrual cycles, the ovulation phase was used at the beginning (for this research purpose) of the data collection process.

The early follicular phase was estimated to be cycle days 2-5, and the mid-luteal phase was defined as days 4-8 after ovulation (Oğul et al., 2021). The ovulation phase was detected using LH urine kits. Starting from two days before estimated ovulation, LH levels were tested using urine samples retrieved after 2:30 AM (Local time) for three days. The 24-hour period after a positive test was accepted as the day of ovulation (Oğul et al., 2021).

In the process of detecting this menstrual cycle phase, health professionals from Azezo Health Center have participated. Since it lasts about 24 hours, no performance tests were administered at this phase. Rather, for this study purpose, this phase was used as the initial point to determine the start of the performance tests.

Then, the luteal phase followed. This phase lasts for 11 to 17 days or on average it lasts 14 days. Therefore, the test was administered at the middle of this luteal phase; such as at the 7^{th} day after the ovulation phase was detected. The tests at this phase were the first performance tests.

After these the tests during menstrual phase was followed also when you get the period and it lasts 3 to 7 days (in the causes of the present study participants).The tests were administered at the middle of menstrual phase (period) of each female student's.

Lastly, follicular phase determined at the end of female student's period (it is done to avoid overlap with the menstrual phase) and it was determined up to the day of ovulation. The average follicular phase lasted for about 16 days. The performance tests were administered at the middle of this phase.

Statistical procedures

To analyze data the statistical program SPSS version 26 was used. Descriptive statistics such as mean and standard deviation were computed to determine the measure of central values and measures of dispersion of results, and data were reported as mean ± SD. As well as Repeated Measure ANOVA followed by a Bonferroni post hoc test were used to analyze the factors. This model was used to assess the differences in the menstrual cycle phases means after accounting for female volleyball players' performance. For this study the significance level was set at $p<0.05$.

3. Result

The demographic characteristics (Age, Height, Weight, Body Mass Index (BMI), and Menstrual Cycle Days) of the 25 participants were determined. The average age, height, weight, BMI and menstrual cycle were 15.76 ± 0.436 years, 1.64 ± 0.049 meters, 47.72 ± 5.07 Kgs, 17.73 ± 1.98 Kg/m^2 and 28.32 ± 1.69 days, respectively.

Table 1. Tests of within-subjects effects on push-up test.

	Source	Partial Sum of Squares	*Df*	Mean Square	*F*	*Sig.*	Partial Eta Squared
Menstrual Phase	Sphericity Assumed	28.347	2	14.173	4.78	0.013*	0.166
	Greenhouse-Geisser	28.347	2	26.678	4.78	0.036*	0.166
	Huynh-Feldt	28.347	2	26.47	4.78	0.036*	0.166
	Lower-bound	28.347	1	28.347	4.78	0.039*	0.166
Error (Menstrual Phase)	Sphericity Assumed	142.32	8	2.965			
	Greenhouse-Geisser	142.32	6	5.581			
	Huynh-Feldt	142.32	4	5.537			
	Lower-bound	142.32	3	5.93			

*The mean difference is significant at the .05 level.

Table 1. showed the F value for the "menstrual cycle phase" factor, its associated significance level and effect size ("Partial Eta Squared"). The results revealed that there is an overall significant difference in means. As the values in the "Greenhouse-Geisser" row indicated when using an ANOVA with repeated measures with a Greenhouse-Geisser correction, the push-up test mean scores during the follicular phase, menstrual phase and luteal phase were statistically significantly different ($F(1.063, 25.501) = 4.780$, $p < 0.05$).

A repeated measure ANOVA was also performed to compare the effect of the menstrual phases, such as on the dependent variable (push-up). As shown in the above table (Table 1), there was a statistically significant difference in push-up tests between three different phases ($F = 1.063$, $p < 0.05$). Moreover, partial eta squared showed that there was a large effect size ($\mu = 0.166$) of the independent variable in the repeated measure ANOVA model.

Table 2. Pair-wise comparisons of push-up tests (N=25).

(I) Menstrual cycle Phase	(J) Menstrual cycle Phase	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Follicular	Menstrual	1.320*	0.12	0.011*	-0.189	0.429
	Luteal	-1.24	0.59	0.138	-2.757	0.277
Menstrual	Follicular	-1.320*	0.12	0.023*	-0.429	0.189
	Luteal	-1.360*	0.591	0.012	-2.882	0.162
Luteal	Follicular	1.24	0.59	0.138	-0.277	2.757
	Menstrual	1.360*	0.591	0.012*	-0.162	2.882

*The mean difference is significant at the 0.05 level. [a]Adjustment for multiple comparisons: Bonferroni.

Based on the results of the Bonferroni post hoc test, which indicates at which menstrual cycle phase the push-up test means was differed.

The above table also showed that the significance level for differences between the individual time points (menstrual cycle phases). Accordingly, there was a statistically significant difference in push-ups test scores of follicular phase compared with menstrual phase ($p < 0.05$), and luteal phase ($p = 0.138$). Accordingly, there was significant difference between follicular phase and menstrual phase ($p < 0.05$), while no significant difference between follicular phase and luteal phase ($p = 0.138$). As indicated on the above table ("Mean Difference (I-J)" column), push-up test scores was significantly reduced at menstrual phase. Therefore, the mean difference between push-up scores at follicular phase and menstrual phase was (I-J = 1.32, $p < 0.05$); the mean difference between push-up scores at follicular phase and luteal phase was (I-J = -1.240, $p = 0.138$); whereas the mean difference between menstrual phase and luteal phase was (I-J = - 1.360, $p < 0.05$).

Table 3. Tests of within-subjects effects on Sit up test.

Source		Partial Sum of Squares	*Df*	Mean Square	*F*	*Sig.*	Partial Eta Squared
Menstrual Phase	Sphericity Assumed	22.107	2	11.053	5.651	0.006*	0.191
	Greenhouse-Geisser	22.107	2	15.429	5.651	0.014*	0.191
	Huynh-Feldt	22.107	2	14.752	5.651	0.013*	0.191
	Lower-bound	22.107	1	22.107	5.651	0.026*	0.191
Error (Menstrual Phase)	Sphericity Assumed	93.893	8	1.956			
	Greenhouse-Geisser	93.893	6	2.731			
	Huynh-Feldt	93.893	4	2.611			
	Lower-bound	93.893	3	3.912			

*The mean difference is significant at the .05 level.

The above table showed that the F value for the "menstrual cycle phase" factor is associated with significance level and effect size ("Partial Eta Squared"). The results presented in this table revealed that an overall significant difference was observed on means. As the values in the

"Greenhouse-Geisser" row indicated when using an ANOVA with repeated measures with a Greenhouse-Geisser correction, the sit-up test mean scores for during follicular phase, menstrual phase and luteal phase were statistically significantly different (F (1.433, 34.386) = 5.651, $p < 0.05$).

A repeated measure ANOVA was also performed to compare the effect of the menstrual phases, such as on the dependent variables (sit-up performance). As shown on the above table, there was statistically significant difference in sit up scores between three different menstrual cycle phases (F = 5.651, $p < 0.05$). In addition, partial eta squared showed that, there was a large effect size ($\mu = 0.191$) of the independent variable in the repeated measure ANOVA model.

Table 4. Pair-wise Comparisons of Sit up tests (N=25)

(I) Menstrual cycle Phase	(J) Menstrual cycle Phase	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference [a]	
					Lower Bound	Upper Bound
Follicular	Menstrual	1.320*	0.39	.007*	0.315	2.325
	Luteal	0.52	0.494	0.908	-0.751	1.791
Menstrual	Follicular	-1.320*	0.39	.007*	-2.325	-0.315
	Luteal	-.800*	0.271	.021*	-1.497	-0.103
Luteal	Follicular	-0.52	0.494	0.908	-1.791	0.751
	Menstrual	.800*	0.271	.021*	0.103	1.497

*The mean difference is significant at the .05 level. [a]Adjustment for multiple comparisons: Bonferroni. Based on estimated marginal means.

Table 4 showed that among the three different phases of menstrual cycle, where an overall significant difference in means occurred. As well as the results of the Bonferroni post hoc test, which indicates at which menstrual cycle phase the sit-up test means was differed.

As indicated in the above table the significance level for differences between the individual time points (menstrual cycle phases). Accordingly, there was a statistically significant difference in sit ups test scores of follicular phase compared with menstrual phase ($p < 0.05$), and luteal phase ($p = 0.908$). The table revealed that there was significant difference between follicular phase and menstrual phase ($p < 0.05$), while no significant difference between follicular phase and luteal phase ($p = 0.908$), ("Mean Difference (I-J)" column), sit up test scores was significantly reduced at menstrual phase. Therefore, the mean difference between sit up scores at follicular phase and menstrual phase was (I-J = 1.32, $p < 0.05$); the mean difference between sit up scores at follicular phase and luteal phase was (I-J = 0.520, $p = 0.908$); whereas the mean difference between menstrual phase and luteal phase was (I-J = - 0.800, $p < 0.05$).

Table 5. Tests of Within-Subjects effects on Standing long jump test.

Source		partial Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Menstrual Phase	Sphericity Assumed	259.280	2	129.640	17.947	.000*	.428
	Greenhouse-Geisser	259.280	2	130.239	17.947	.000*	.428
	Huynh-Feldt	259.280	2	129.640	17.947	.000*	.428
	Lower-bound	259.280	1	259.280	17.947	.000*	.428
Error(Menstrual Phase)	Sphericity Assumed	346.720	8	7.223			
	Greenhouse-Geisser	346.720	6	7.257			
	Huynh-Feldt	346.720	4	7.223			
	Lower-bound	346.720	3	14.447			

*The mean difference is significant at the .05 level.

As indicated in the above table the F value for the "menstrual cycle phase" factor, is associated with its significance level and effect size ("Partial Eta Squared"). The results presented in this table showed that the overall significant difference obtained in means. As the values in the "Greenhouse-Geisser" row indicated when using an ANOVA with repeated measures with a Greenhouse-Geisser correction, the Standing Long Jump test mean scores for during the follicular phase, menstrual phase and luteal phase were statistically significantly different ($F(1.991, 47.779) = 17.947$, $p = 0.00$).

A repeated measure ANOVA was also performed to compare the effect of the menstrual phases, such as on the dependent variables (leg power performance). As shown on the above table, there was statistically significant difference in Standing Long Jump scores between three different menstrual cycle phases ($F = 17.947$, $p < 0.05$). As well as, as shown on the above table, partial eta squared showed that large effect size ($\mu = 0.428$) of the independent variable in the repeated measure ANOVA model.

Table 6. Pair-wise Comparisons of Standing long jump tests (N=25).

(I) Menstrual cycle Phase	(J) Menstrual cycle Phase	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference [a] Lower Bound	Upper Bound
Follicular	Menstrual	3.320*	0.78	.001*	1.311	5.329
	Luteal	-1.04	0.736	0.511	-2.934	0.854
Menstrual	Follicular	-3.320*	0.78	.001*	-5.329	-1.311
	Luteal	-4.360*	0.764	.000*	-6.325	-2.395
Luteal	Follicular	1.04	0.736	0.511	-0.854	2.934
	Menstrual	4.360*	0.764	.000*	2.395	6.325

*The mean difference is significant at the .05 level. [a]Adjustment for multiple comparisons: Bonferroni.

In the above table the significance level for differences between the individual time points (menstrual cycle phases) have been illustrated. Consequently, there was a statistically significant

difference in Standing Long Jumps test scores of the follicular phase compared with the menstrual phase ($p < 0.05$), and luteal phase ($p = 0.511$). The table revealed that there was a significant difference between the follicular phase and menstrual phase ($p < 0.05$), while no significant difference between the follicular phase and the luteal phase ($p = 0.511$). As indicated in Table 6 above ("Mean Difference (I-J)" column), Standing Long Jump test scores were significantly reduced during the menstrual phase. Therefore, the mean difference between Standing Long Jump scores at the follicular phase and menstrual phase was ($I\text{-}J = 3.320$, $p < 0.05$); the mean difference between Standing Long Jump scores at the follicular phase and luteal phase was ($I\text{-}J = -1.040$, $p = 0.511$); whereas the mean difference between menstrual phase and luteal phase was ($I\text{-}J = -4.360$, $p < 0.05$).

4. Discussion

The aim of this study was to investigate the effects of menstrual cycle phases on strength, endurance and power performances in female volleyball players at Azezo Dimaza Secondary School. In the present study there was a significant difference on upper-body part muscular endurance and power performances during menstrual cycle phases.

Previous studies have revealed that women players sometimes experience difficulties in taking part in sportive activities during menstruation cycles. On the other hand, some other studies have provided compelling evidence suggesting that menstruation cycles pose different effects on women and some women do not experience any effect in menstruation phases even though many others have some physical and psychological health problems, including pain, weakness, nervousness and coordination problems. Therefore, it has a well-known fact that women become very sensitive and stressed during menstruation periods (Özdemir and Kucukoglu, 1993). In this regard, it can be concluded that findings of the studies dwelling on performance varieties of women players during menstruation periods may vary. In a study conducted by On (2012), for example, the effect of the menstruation period on anaerobic power and active jumping performance of female volleyball players was examined and no significant evidence was obtained. Dibrezzo et al. (1988) performed a study on dynamic power and performance variables during the three cycles of the menstrual period and found no significant difference between power variables during the three cycles of the menstruation period. In a similar study conducted by Özdemir and Kucukoglu (1993), the authors investigated the effect of menstruation on speed and endurance, it was concluded that the menstrual phase did not affect speed and endurance scores of the women players, but it adversely affected those with a painful menstruation period in terms of endurance. In another one conducted by Giacomoni et al. (2000), 10 players who used any regulatory medical supplement (oral contraceptive) and 7 healthy players who did not use any medicine were recruited and no statistical difference was found between and in-group comparisons of squat jumping. Hazir et al. (2011) dwelled on menstrual cycles' effect on repetitive sprint performance and the speed of removing of lactic acid from the blood during active recovery and conducted 5×6 sec power loss test which are against to the resistance corresponding 10% of body weight in mechanic ergometer cycling after anthropometric measurements during follicular and luteal phases of 11 women players with regular menstruation cycles but found no significant differences among the values including 5×6 sec repetitive sprint maximum power measured during follicular and luteal phases, total power and power loss values. They concluded that no negative effect of menstrual cycle on repetitive sprint performance and then the speed of removing of lactic acid from the blood during active recovery were found. In another study conducted by Cakmakci et al. (2005), Wingate Test was conducted on women students of physical education teaching at the 2nd and 14th day of their menstrual periods and no significant difference was obtained between anaerobic performance measured menstrual and

follicular phases. Guvenman (2007) examined the effect of menstrual cycles on physical parameters and reaction time, compared jumping scores of 8 elite and 12 sedentary women players and found no statistical difference in the analysis. In a study conducted by Ön et al. (2014), for example, the effect of menstruation period on anaerobic power and active jumping performance of female volleyball players was examined and no significant evidence was obtained. Canpas Çakir (2006), on the other hand, conducted a study in which cardio-respiratory response on exercise in follicular and luteal cycles of menstrual cycles of normal and overweight women who don't exercise and found that luteal phase in overweight and follicular phase in normal women affect the exercise performance. In a study by Tsampoukos et al. (2010), the effect of menstrual cycle on sprint performance was examined and found no difference in sprint test scores of the participants. In this present study, we obtained significant data ($P < 0.05$) on the effect of menstruation periods of women's volleyball players on muscular strength and endurance, power performances. Our findings align with the studies mentioned above. That is to say, it can be concluded that menstruation period doesn't have a positive or negative effect on sportive performance in women players. However, Wearing et al. (1972) conducted a study on the effect of the menstruation period on physical fitness tests, examined four phases of menstrual cycle and concluded that the worst performance was noted in menstrual phases. Masterson (1999) found significant differences between two groups, those in follicular phase and the luteal phase who exercise at least 3 days in a week, by applying an anaerobic power test. Karacan et al. (2013) investigated the menstrual situations of 133 elite women players in different branches of sports and found that the menstruation period affects sportive performance psychologically and that sportive activity affects menstrual phases. In another study by Karacan and Gunay (2003), it was attempted to investigate the effect of menstruation and pre-menstrual syndrome on performance in short-term and high-level exercise parameters, such as attention, concentration, speed and promptness and found that general coordination, anaerobic power, vertical jump and 30 m sprint values were found to be significant after menstruation period when compared to premenstrual and menstrual phases ($p < 0.05$). Additionally, it was found that significant differences were found in visual reaction times ($p < 0.05$) and the best score was obtained three days after the menstruation ($p < 0.05$). Ertas and Ersoz (2002), on the other hand, concluded that women players gave the best performance during the beginning of the menstruation period. In contradiction with this, Lebrun and Rumball (2001) indicated that the best performances were obtained after ovulation and menstruation periods, while the worst ones were the result of premenstrual periods. On the other hand, Karakas (1987) noted that extraordinary achievements and world records of women players were obtained during each cycle of the menstruation period. In our study, we corroborate with the existing literature in that, we found significant differences between sportive performance and menstruation periods of women players.

5. Conclusion

On the present study in push-ups, sit-ups and standing long jump tests during different menstruation cycle phases; female volleyball players performed lower during the menstrual phase than the follicular phase and luteal phase. Thus, there was an overall significant difference in means. Accordingly, menstrual cycle phases have a large effect size on female volleyball players' upper-body muscular endurance, abdominal muscular endurance and explosive power performance ($p < 0.05$).

Conflict of interest

The authors do not have a conflict of interest in the publication of this article.

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