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CORRELATION OF ISOMETRIC STRENGTH OF POSTERIOR SLING MUSCLES WITH DIFFERENT PHASES OF MENSTRUAL CYCLE IN YOUNG ADULTS – A MIXED METHOD CORRELATION STUDY

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ABSTRACT

Background: Menstrual cycle is a series of cyclic changes that happens in the reproductive life of women. Muscle strength is affected by different stages of menstrual cycle in women. Each phase of the cycle is influenced by different types of hormones which have positive or negative changes in the physiological properties of the female body. Likewise, the muscle strength of the posterior sling muscles like Quadratus Lumborum, Gluteus Maximus, Hamstrings, Calf is also affected by different phases of the menstrual cycle. This strength is measured by using a dynamometer. Therefore, there is an observed effect of muscle strength in different phases of the menstrual cycle in young adults.

Methods: This study is designed as a single-group, correlational study. A sample size of 38 women with regular menses who fulfilled the inclusion criteria was selected, and the isometric strength was correlated with different phases of the menstrual cycle. The outcome measures are dynamometric isometric strength, IPAQ, and WaLLID score.

Results: There is a significant correlation between isometric and different phases of the menstrual cycle(p<0.05). And there was no significant correlation between Baseline parameters like BMI, WHR, and IPAQ with different phases of the menstrual cycle.

Conclusion: This study concludes that there is a significant variation in isometric strength of posterior sling muscles across different phases of the menstrual cycle in young adult females.

Key words: Menstruation, Muscle strength, Follicular phase, Ovulation phase, Luteal phase, Quadratus lumborum, Gluteus maximus, Hamstrings, Calf muscles, Adults.

INTRODUCTION:

The menstrual cycle is a natural, complex monthly cycle in females, typically lasting 21 to 35 days (average 28 days), though this varies individually. It involves a complex interplay of hormones, primarily estrogen, progesterone, follicle-stimulating hormone, and prostaglandins. Fluctuations in these hormones significantly influence physiological and psychological changes in the female body [4] (Palavi LC et al.).

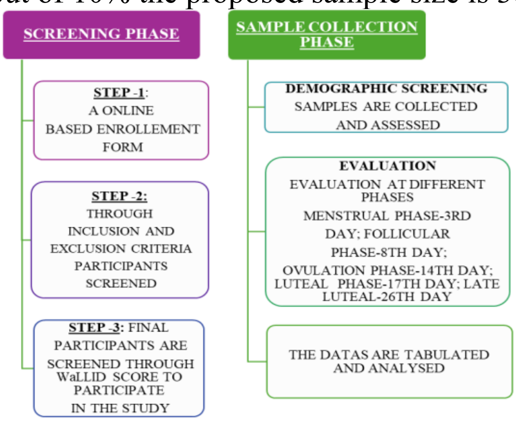
The cycle has four main phases: the early follicular phase, the ovulation phase, the luteal phase, and the late luteal phase. The early follicular phase is characterized by low estrogen and low progesterone [3] (Romero-Moraledo B et al.). The ovulatory phase has high estrogen and low progesterone, while the luteal and late luteal phases show high estrogen and high progesterone levels [5] (Miyazaki M et al.). These hormonal shifts can positively or negatively affect various physiological properties, including the muscle strength of the posterior sling muscles (e.g., quadratus lumborum, glutes, hamstrings, calves), which can be measured using a dynamometer [5] (Miyazaki M et al.,).

While the menstrual cycle may not significantly affect the mechanical properties of muscles, or their strength, fatiguability, and contractile properties [11] (X A K Janse de jonge et al.), muscle function can change due to hormone fluctuations. This is particularly observed mid-cycle, potentially due to increased estrogen before ovulation, leading to significant slowing of relaxation and increased fatiguability [21] (R Sarwar et al.). Thus, this study aims to detail the relationship between the isometric strength of posterior sling muscles and different menstrual cycle phases in young adults.

MATERIALS AND METHODS:

This Mixed method Correlational study was conducted in Malla Reddy University, School of Allied and HealthCare Sciences, Maisammaguda, Hyderabad. The duration of the study was 2 months. The target population were young adults (18-24 years) with no menstrual or reproductive abnormalities.

Initially the students of Malla Reddy University were circulated with a google form which had details of their demographic data and screening questionnaire for Reproductive health. A Total of 77 participants participated in an online survey, through which the participants were screened. Further participants aged between 18 and 25 years, who were screened for eligibility based on inclusion and exclusion criteria were invite to participate in the study. The inclusion criteria were as follows: Participants who are young adults, gave consent to participate in the study, and Participants with regular menstrual cycles. Participants with any recent injuries or falls, with menstrual/reproductive disorders, with hormonal/metabolic dysfunctions, and Participants who were on medication like OCP or nutritional supplements were excluded. The sample size was calculated by using G* Power 3.1 the calculation is based on previous work by Pournasiri.F et al., on Isometric and Isokinetic strength of lower limb muscles in female's athletes during different phases of menstrual cycle: a casual comparative study, with p-value: <0.05, effect size of - 0.5205422, power value of 0.95. With the dropout of 10% the proposed sample size is 38.



38 participants were finalized and assessed throughout each phase of the menstrual cycle. The demographic data of the participants were documented including the Last Menstrual Period Date. The anthropometric measures like BMI, WHR was analysed with the In-built body fat analyser. The physical activity level was assessed through the International Physical Activity Questionnaire- Short Form 7. The Isometric strength of the Posterior Sling Muscles (i.e., Quadratus lumborum, Gluteus maximus, Hamstrings, and Calf muscles) was assessed through 5 phases of the menstrual cycle, Menstrual phase (3 day), Follicular phase (8th day), Ovulatory Phase (14th day), Luteal Phase (17th day) and Late Luteal Phase (26th day). The Isometric strength of the Post-Sling Muscles was assessed through the Hand-Held Dynamometer at each phase (ICC-0.99,0.81) [8]. Three trials were made and the average was documented

ETHICAL APPROVAL:

The study was approved by the scientific research committee of the Department of Physiotherapy, School of Allied Health Sciences, Malla Reddy University.
(ISC/SOAHS-PT/2025/086).

RESULTS:

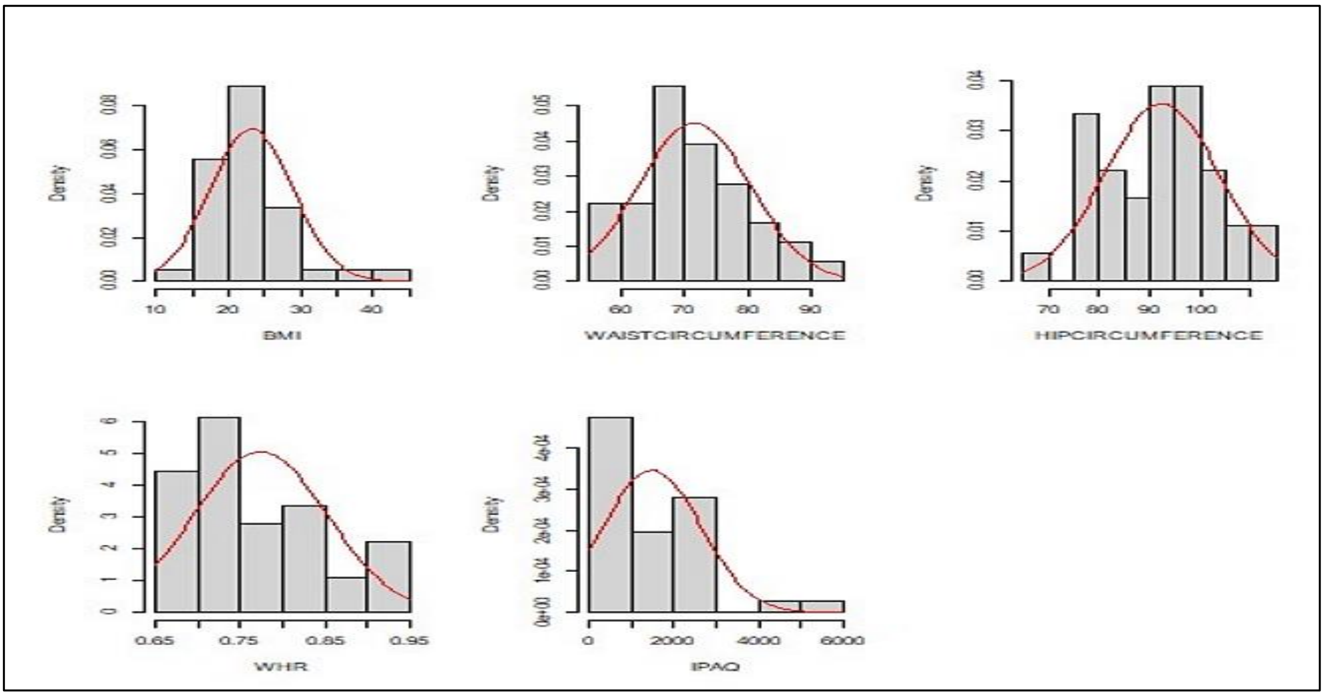
Data analysis has been done with SPSS software Version-30'. The P -value was attributed at <0.05. For the attributes at the baseline, descriptive statistics were computed. The Shapiro-Wilk test for normalcy was conducted. To determine correlation significance, A Bayesian One-way Repeated Measures ANOVA, and Spearman's correlation was performed for the baseline characteristics like BMI, WHR and IPAQ.

This study confirmed the assumption of data distribution normality using the Shapiro-Wilk test ($p<0.05$). From the (Table 1), the mean BMI of the participants was 23.21, WHR was 0.77 and the Physical activity Level was 1483.306. (Table 3) The Shapiro-Wilk's test of normality states that the baseline parameters like, BMI WHR and PA-Level were non-parametric. (Table 4) The results of the repeated-measure ANOVA of the parameters under study indicated a significant difference among each phase of the menstrual cycle with a significance of <0.001 ($p<0.05$). (Table 5) The baseline parameters like WHR, BMI and IPAQ had no significant correlation. Even though the baseline parameters are correlated with each other, the results found are that BMI and IPAQ had having mild positive correlation, WHR and IPAQ had having mild negative correlation, and BMI and WHR had no significant correlation. Therefore, the results of the repeated-measure ANOVA indicate that there is a significant correlation with the isometric strength of each muscle with different phases of the menstrual cycle.

TABLE 1: DESCRIPTIVE STATISTICS OF BASELINE PARAMETERS

Descriptives of Baseline Characteristics like Body Mass Index (BMI), Waist Circumference, Hip Circumference, Waist-Hip Ratio (WHR), Physical Activity Level (PA-Level)

Variables	N	Mean	Std. Dev.	Median	Min.	Max.	Skewness	Kurtosis
BMI	36	23.211	5.745	22.250	14.200	44.200	1.563	3.455
WAIST CIRCUMFERENCE	36	71.589	8.838	70.500	57.000	91.000	.443	-.672
HIP CIRCUMFERENCE	36	92.417	11.249	95.000	69.000	115.000	-.039	-.838
WHR	36	.774	.079	.750	.670	.930	.513	-1.020
PA-LEVEL	36	1483.306	1157.383	1129.500	99.000	5796.000	1.630	3.459



GRAPH – 1: Comparison of baseline parameters like BMI, WAIST CIRCUMFERENCE, HIP CIRCUMFERENCE, WHR, and PA LEVEL

TABLE: 2 DESCRIPTIVE STATISTICS OF ISOMETRIC STRENGTH OF DOMINANT LEG-POSTERIOR SLING MUSCLES

Descriptive Statistics of Isometric Strength of the Dominant Leg's Posterior Sling Muscles including Quadratus Lumborum, Gluteus Maximus, Hamstrings and Calf Muscle along the different phases of Menstrual Cycle (FOLLICULAR PHASE, LUTEAL PHASE, OVULATION PHASE, LATE-LUTEAL PHASE AND MENSTRUAL PHASE)

MUSCLE	PHASE	N	RANGE	MINIMUM	MAXIMUM	MEAN	MEAN STD. ERROR	STD. DEVIATION STATISTICS
QUADRATUS LUMBORUM	FOLLICULAR PHASE	36	2.5	1.5	4.0	2.867	.1008	.6047
	OVULATION PHASE	36	3.3	1.5	4.8	3.342	.1169	.7012
	LUTEAL PHASE	36	3.0	1.4	4.4	3.078	.1237	.7422
	LATE LUTEAL PHASE	36	2.6	1.4	4.0	2.725	.0859	.5157
	MENSTRUAL PHASE	36	2.4	2.0	4.4	2.742	.0998	.5987
GLUTEUS MAXIMUS	FOLLICULAR PHASE	36	3.8	1.6	5.4	3.272	.1644	.9867
	OVULATION PHASE	36	4.0	1.8	5.8	3.725	.1777	1.0665
	LUTEAL PHASE	36	3.6	2.0	5.6	3.508	.1566	.9394
	LATE LUTEAL PHASE	36	3.2	1.8	5.0	3.289	.1570	.9420

	MENSTRUAL PHASE	36	3.4	1.4	4.8	3.408	.1401	.8405
HAMSTRINGS	FOLLICULAR PHASE	36	5.4	2.0	7.4	3.967	.2218	1.3307
	OVULATION PHASE	36	5.5	2.3	7.8	4.272	.2486	1.4916
	LUTEAL PHASE	36	3.4	2.0	5.4	3.492	.1437	.8623
	LATE LUTEAL PHASE	36	3.8	2.0	5.8	3.447	.1573	.9437
	MENSTRUAL PHASE	36	3.2	2.7	5.9	4.058	.1579	.9476
CALF	FOLLICULAR PHASE	36	5.2	2.2	7.4	4.572	.2037	1.3843
	OVULATION PHASE	36	5.2	2.4	7.6	4.969	.2591	1.5547
	LUTEAL PHASE	36	30.7	2.3	33.0	4.919	.8236	4.9414
	LATE LUTEAL PHASE	36	5.0	1.9	6.9	4.300	.2077	1.2460
	MENSTRUAL PHASE	36	5.0	2.4	7.4	4.708	.2357	1.4141

TABLE – 3 TESTS OF NORMALITY FOR THE BASELINE PARAMETERS

Shapiro-Wilk's test of Normality for the baseline parameters like, Body Mass Index (BMI), Waist Circumference, Hip Circumference, Waist Hip Ration (WHR), Physical Activity Level (PA-Level)

VARIABLE	TEST	STATISTIC	P VALUE
BMI	**Shapiro-Wilk**	**0.8688**	**0.0005***
WAIST CIRCUMFERENCE	**Shapiro-Wilk**	**0.9624**	**0.2555**
HIP CIRCUMFERENCE	**Shapiro-Wilk**	**0.9749**	**0.5731**
WHR	**Shapiro-Wilk**	**0.9189**	**0.0117***
PA-LEVEL	**Shapiro-Wilk**	**0.8319**	**0.0001***

**Indicates the significance, p<0.05*

TABLE – 4 ONE-WAY REPEATED MEASURES ANOVA- BAYES FACTOR AND TEST OF SPHERICITY FOR THE POSTERIOR SLING MUSCLES OF THE DOMINANT LEG

WITHIN-SUBJECT EFFECT	LOG BAYES FACTOR[b]	MAUCHLY'S W[c]	MAUCHLY TEST OF SPHERICITY APPROX. Chi-Square	df	Sig.
QUADRATUS LUMBORUM	20474.800[a]	.426	28.502	9	**<.001***
GLUTEUS MAXIMUS	4010.331[a]	.375	32.742	9	**<.001***
HAMSTRINGS	9502.798[a]	.364	33.750	9	**<.001***
CALF	4299.133[a]	.254	45.776	9	**<.001***

**Indicates the significance, p<0.05*

Table 5A: CORRELATION ANALYSIS OF THE BASELINE PARAMETERS OF THE TARGET GROUP

Spearman's Correlation of the variables like Body Mass Index (BMI), Waist Hip Ratio (WHR), Physical Activity Level (PA-Level)

			BMI	WHR	PA-LEVEL
SPEARMAN'S rho	BMI	Correlation coefficient	1.000	.069	.214
		Sig.(2 tailed)	.	.688	.211
		N	36	36	36
	WHR	Correlation coefficient	.069	1.000	-.244
		Sig.(2 tailed)	.688	.	.151
		N	36	363	36
	PA-LEVEL	Correlation coefficient	.214	-.244	1.000
		Sig.(2 tailed)	.211	.151	.
		N	36	36	36

Table 5B: CONFIDENCE INTERVALS OF SPEARMAN'S rho OF THE BASELINE PARAMETERS
Parameters include Body Mass Index (BMI), Waist Hip Ratio (WHR), PHYSICAL ACTIVITY (PA-Level)

			95% CONFIDENCE INTERVALS	
	SPEARMAN'S rho	Sig. (2 tailed)	LOWER	UPPER
BMI-WHR	0.69	.688	-.275	.397
BMI-IPAQ	.214	.211	-.133	.514
WHR-IPAQ	-.244	.151	-.537	.102

**Significance at the level of $p<0.05$*

DISCUSSION:

The female reproductive system undergoes regular menstrual cycles, typically beginning around age 12.4 (menarche) and ceasing at approximately age 51 (menopause). Cycle regularity is defined by length variations: 7 days for ages 26-42, and 9 days for ages 18-25 or 42-45.

In this study of 38 participants, 36 completed all five menstrual cycle phase assessments; a 10% dropout was attained due to lack of adherence. Our results showed significant fluctuations in the isometric strength of posterior sling muscles across the menstrual cycle. Increased strength was observed during the ovulatory phase, while reduced strength occurred during the menstrual and luteal phases.

These findings support previous research on hormonal influences on muscle performance. Sarwar et al. (1996) reported an approximate 11% increase in quadriceps and handgrip strength at mid-cycle compared to the follicular and luteal phases, attributing this to elevated oestrogen during ovulation, which may enhance neuromuscular function and muscle contractility [21]. Bambaeichi et al. (2004) similarly found elevated maximal isometric lifting strength during the luteal phase, suggesting a complex interplay between hormonal fluctuations and muscle performance [13].

However, some studies contradict these findings. Janse de Jonge et al. (2001) observed no significant variations in isometric quadriceps or handgrip strength throughout the menstrual cycle, emphasizing the need to consider individual variability and methodological differences [11].

Dynamometry was used to objectively quantify isometric muscle strength in this study, providing a reliable assessment of posterior sling muscle performance. Other studies have used similar methodologies; for example, Tenan et al. (2013) found no significant differences in knee extensor isometric strength across the menstrual cycle but noted variations in muscle activation patterns, suggesting hormonal influences on neuromuscular control [27].

Participants' physical activity levels, assessed using the IPAQ, remained consistent across menstrual phases. This indicates that the observed strength fluctuations were not due to changes in activity levels. This aligns with research by Lebrun et al. (1995), who found no significant differences in physical activity patterns across menstrual phases, reinforcing that hormonal variations primarily influence muscle performance [28].

Finally, the WaLLID score assessed pain perception. Our findings revealed higher WaLLID scores during the menstrual phase, correlating with reduced isometric strength, suggesting that pain and discomfort may decrease muscle performance. De Jonge et al. (2001) similarly reported that increased pain during menstruation was associated with decreased muscle strength and endurance, highlighting the importance of pain management in physical training and rehabilitation for females [11].

LIMITATION

The overall limitations of this study are the short duration and the smaller sample size needed to generalise the effect magnitude. The majority of the samples are the student population, as there is no proper scheduled time to assess all the samples, because of which students' adherence in the study was influenced. The future research with a bigger sample size, with control designs would reveal a statistically and clinically more significant change in the study.

CONCLUSION

In conclusion, this study highlights significant variations in the isometric strength of posterior sling muscles across different phases of the menstrual cycle in young adult females. The findings underscore the influence of hormonal fluctuations on muscle performance and the importance of considering menstrual cycle phases in designing training and rehabilitation programs. By acknowledging these physiological variations, practitioners can develop more effective, individualized strategies to optimize physical performance and recovery in female populations.

CONFLICT OF INTEREST

The Author provides no conflict of interest.

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