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Original Article

Hand Grip Strength Variation in Different Phases of Menstrual Cycle in Eumenorrheic Young Adults: An Observational Longitudinal Study.

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ABSTRACT

Background: Hand grip strength (HGS) is a simple and reliable indicator of overall muscular strength and neuromuscular function. Muscular performance and fatigue fluctuate with hormonal changes during the menstrual cycle; however, evidence regarding endurance-related variations remains inconsistent.
Objective: To evaluate variations in hand grip strength fatigue time across different phases of the menstrual cycle in eumenorrheic young adult females.
Methods: This observational longitudinal study was conducted over one month among 225 eumenorrheic females aged 19–40 years attending Mandya Institute of Medical Sciences, Mandya. Participants were selected using purposive sampling based on predefined inclusion and exclusion criteria. Hand grip strength fatigue time during sustained isometric contraction was measured using a hand grip dynamometer during the menstrual, proliferative, and secretory phases of the menstrual cycle. The best of three attempts was recorded for each phase. Data were analyzed using descriptive statistics and Pearson correlation to assess associations with age, body mass index (BMI), and body weight.
Results: The mean fatigue time was highest during the proliferative phase (5.9 minutes), followed by the menstrual phase (3 minutes), and lowest during the secretory phase (2.2 minutes). A statistically significant negative correlation was observed between age and fatigue time across all phases. BMI and body weight showed a significant positive correlation with fatigue time in all menstrual phases.
Conclusion: Hand grip strength fatigue time varies significantly across menstrual cycle phases, with maximal endurance during the proliferative phase and minimal endurance during the secretory phase. These variations are likely influenced by cyclical hormonal changes, highlighting the importance of considering menstrual phase and anthropometric factors when assessing muscular performance in women.

Keywords*: Hand grip strength; Muscular endurance; Menstrual cycle; Eumenorrheic women,*

INTRODUCTION

Hand grip strength (HGS) is a widely accepted and reliable indicator of overall muscular strength and functional capacity. It reflects the coordinated performance of the neuromuscular and musculoskeletal systems and is frequently employed in both clinical assessments and research to evaluate muscle function[1]. Muscle performance, fatigue, and strength are known to fluctuate under various physiological conditions, including the menstrual cycle, which has attracted increasing research interest[2]. The menstrual cycle involves complex hormonal variations, particularly in estrogen and progesterone, which are known to modulate muscle metabolism, contractility, and recovery[3].

Sarwar et al.[5] demonstrated measurable changes in muscle strength, relaxation rate, and fatigability throughout the menstrual cycle, emphasizing the significant role of hormonal fluctuations in neuromuscular function.Handgrip strength has also been studied across athletic and non-athletic populations, suggesting that menstrual phase-related changes may vary depending on baseline physical activity. Studies examining reproductive history and muscle strength in postmenopausal women underscore the long-term influence of hormonal cycles on muscular capacity[7].

Several studies have explored the relationship between menstrual phases and muscular performance. Matsuura et al.[8] reported that handgrip strength may be influenced by menstruation-related symptoms in female university students. Similarly, Nicolay et al.[9] observed phase-dependent variations in grip strength and endurance, noting differences between eumenorrheic women and those using oral contraceptives.

Research among working women and young adults further supports the impact of menstrual phases on muscle performance. Varsha[13] and Bennal and Chavan[2] reported variations in muscular strength and fatigue across different menstrual phases, highlighting practical implications for occupational performance and sports participation. Assessment of these variations can help optimize training schedules, reduce fatigue-related injuries, and enhance overall functional outcomes.

The physiological mechanisms underlying these observations are grounded in established principles of muscle physiology and hormonal regulation. Fluctuation in estrogen and progesterone can influence muscle contractility, connective tissue elasticity, and fatigue resistance, thereby affecting performance across menstrual phases[15]. Understanding these patterns is particularly relevant for developing individualized training programs, clinical evaluations, and occupational health strategies for eumenorrheic young adults.

Despite growing evidence, inconsistencies remain regarding the timing and magnitude of HGS variations, highlighting the need for longitudinal studies that systematically assess grip strength across all menstrual phases in well-characterized populations. This observational study aims to address these gaps by evaluating HGS variations in eumenorrheic young adults, providing valuable insights into the physiological and practical implications of menstrual cycle-related changes in muscular performance.

Objective(s):
1. To evaluate changes in hand grip strength variations in different phases of menstrual cycle

METHODOLOGY

Study Design: An Observational Longitudinal Study.

Study duration: 1 month

Study population: Adult female patients with normal menstruation (medical, surgical and gynaecological, outpatient and inpatient) at MIMS in Mandya.

Sample size: A previous study found that the rate of fatigue in Indian women related to grip strength was 64%[10].
The formula used here is n= Z2 α/2pq/d2. where n = sample size, Zα/2 = confidence level; 1.96, p=ratio, q=100-p, d=relative error, which
is considered 10% of the ratio. The sample size was calculated as 225.

Sampling Method: Purposive sampling

Inclusion Criteria: Eumenorrheic adult females in the reproductive age group 19-40 years.

Exclusion Criteria:

- Females with a previous history of menstrual abnormality due to various causes eg. PCOD, thyroid disorders and other endocrine abnormalities.
- Females on any other medication that may interfere with the normal menstrual cycle like anti-epileptics, Blood thinners, thyroid medication, anti-depressants and anti- cancer drugs.
- Females with anatomical or genetic abnormalities of the limbs like muscular dystrophy, polio myelitis or any other debilitating traumatic injury that may interfere with the normal strength and full range of motion of the limbs.
- Females who are pregnant and breast feeding for about a year; post-partum.
- Females who are Hypertensive and Diabetic.
- Females with Renal disorders.

- Females with neurological disorders like CVA, epilepsy etc.

Method of Data Collection (study tools):
Study was conducted on 225 eumenorrheic adult females by standers of patients from medicine, surgery and gynaecology OPDs in MIMS, Mandya after obtaining approval from the Institutional Ethics Committee, Mandya Institute of Medical Sciences, Mandya.

Informed written consent was taken from the subjects after explaining to them the plan and intention of the study in the language understandable to them.

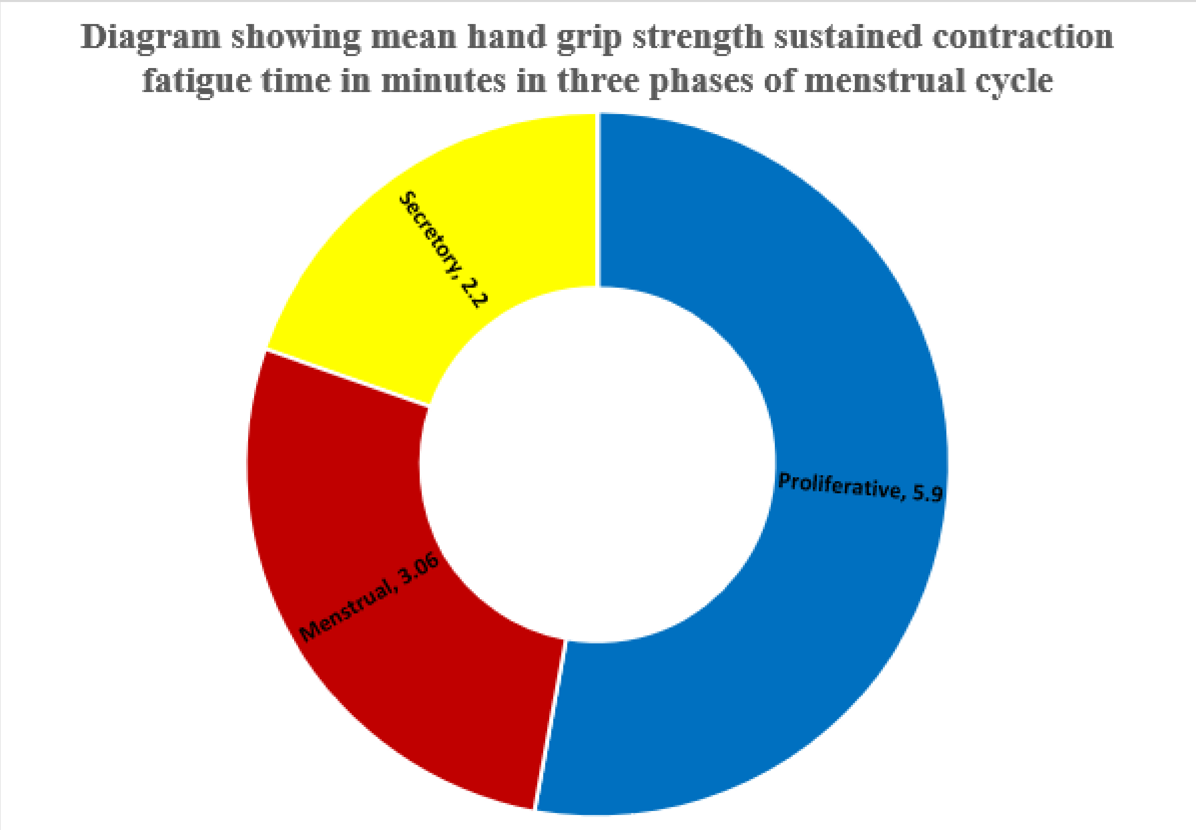
Eumenorrheic adult females in Mandya was selected for the study based on inclusion and exclusion criteria. A detailed history of menstrual status was taken from all patients with emphasis on usage of any medication that may interfere with the regularity of the monthly cycles.

Date of last menstrual bleeding was asked and the different phases of the menstrual cycle will be calculated accordingly.

The hand grip strength of the subjects was assessed with HAND GRIP DYNAMOMETER on each phase of the menstrual cycle namely (Proliferative, Secretory and Menstrual phases) over a period of one month. Hand Grip Strength was evaluated using a hand grip dynamometer. The Hand Grip Dynamometer is used to measure the isometric strength of the hand and forearm muscles. The handle can be adjusted according to the size of the hand, and the procedure is performed by placing the hand next to the body and extending the elbow. The best of three attempts counts.

Data Analysis
Data entered into Microsoft Excel. Analysis was performed using descriptive statistics such as mean, standard deviation, and ratio. Analytical statistics like Pearson Correlation was used to assess the correlation between variables

RESULTS:
Diagram 1:



The average time for fatigue to set in was maximum in the proliferative phase which was 5.9 minutes (354 seconds), Secretory phase was 2.2 minutes (132 seconds) which was the least of the three phases and Menstrual phase was 3 minutes (180 seconds).

Diagram 2: Shows Age distribution with Hand Grip Strength sustained contraction time against three phases of menstrual cycle.

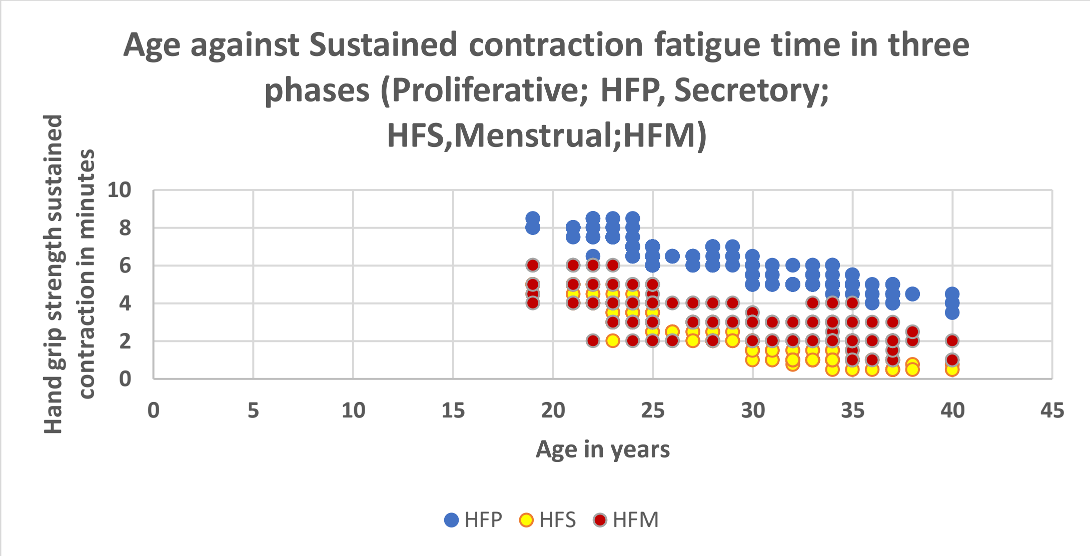


Diagram 3: Shows BMI distribution with Hand Grip Strength sustained contraction time against three phases of menstrual cycle.

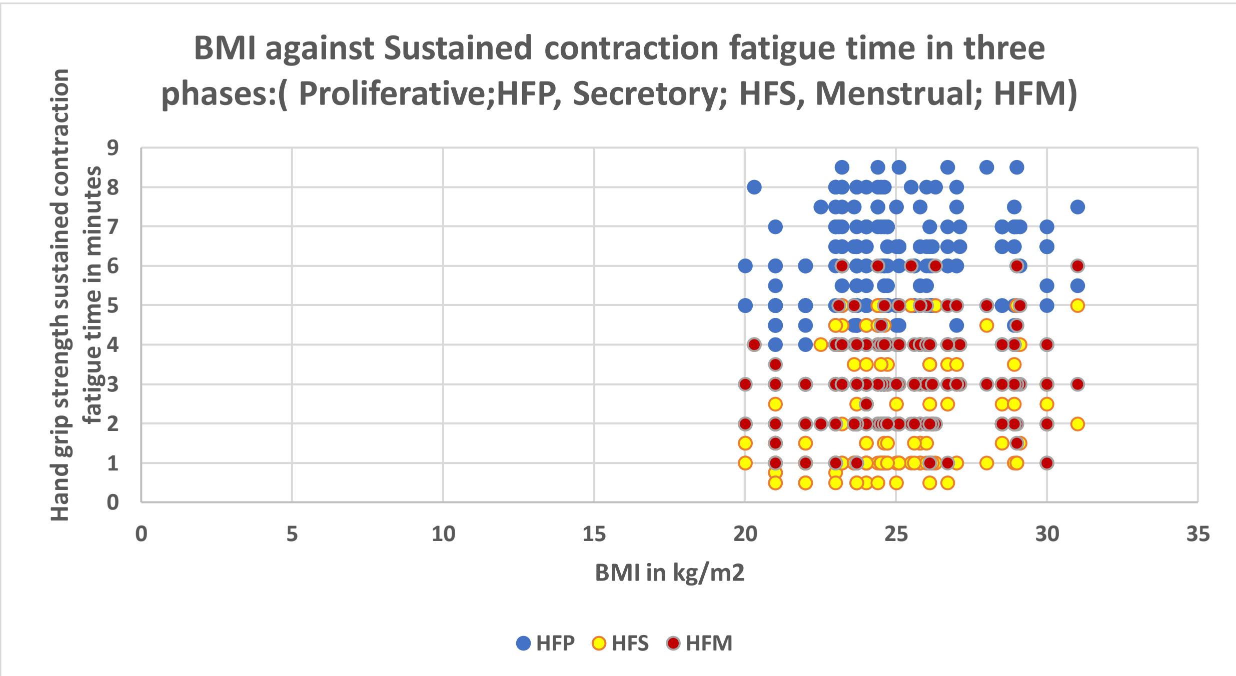
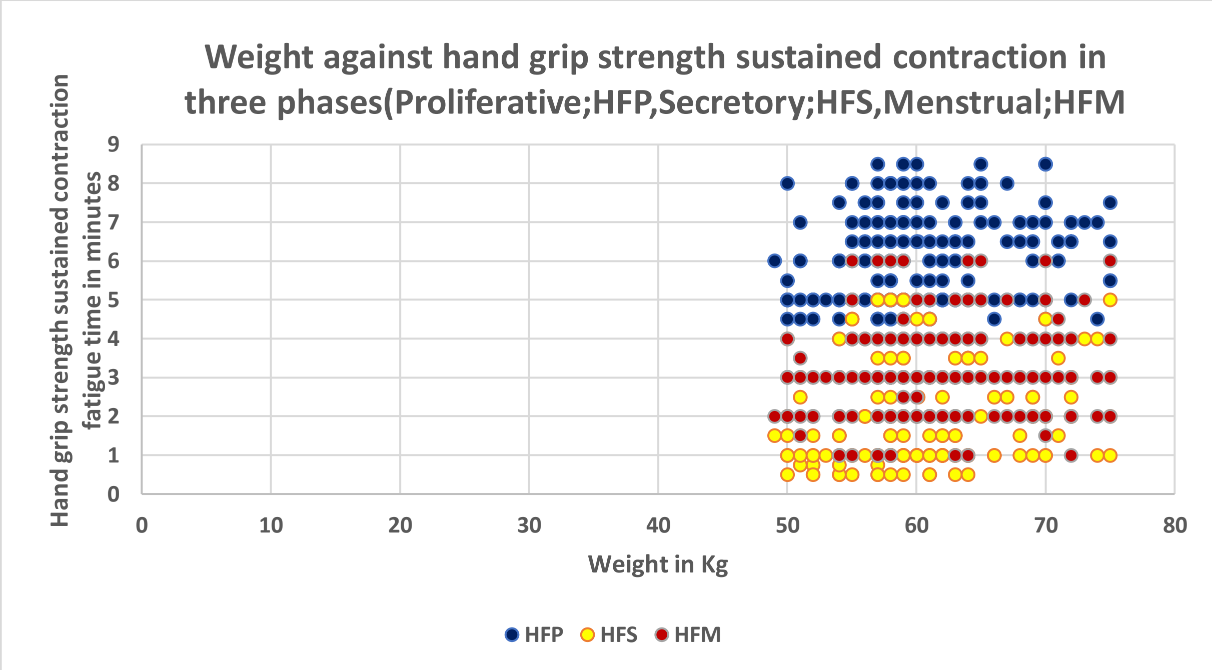


Diagram 4: Shows Weight distribution with Hand Grip Strength sustained contraction time against three phases of menstrual cycle.



Further correlation between age and hand grip strength sustained contraction fatigue time in different phases in the menstrual cycle in **Table 1** was assessed with Pearson Correlation and it was shown that all the three phases of menstrual cycle; Proliferative, Secretory and Menstrual phases showed negative correlation and it was statistically significant.

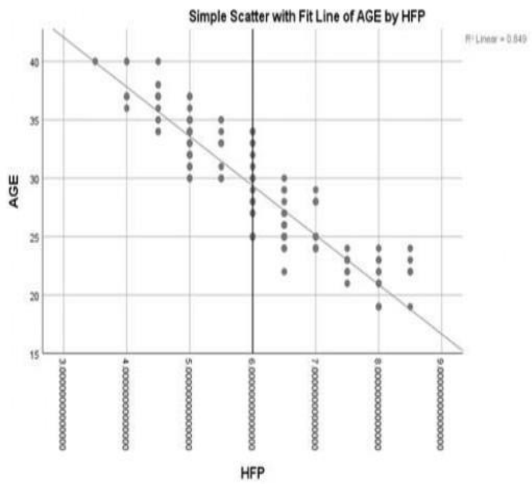
TABLE 1:

		HFP	HFM	HFS	Age
HFP	Pearson Correlation	1	.743**	.865**	-.921**
	Sig. (2-tailed)		.000	.000	.000
	N	226	226	226	225
HFM	Pearson Correlation	.743**	1	.753**	-.761**
	Sig. (2-tailed)	.000		.000	.000
	N	226	226	226	225
HFS	Pearson Correlation	.865**	.753**	1	-.914**
	Sig. (2-tailed)	.000	.000		.000
	N	226	226	226	225
Age	Pearson Correlation	-.921**	-.761**	-.914**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	225	225	225	225

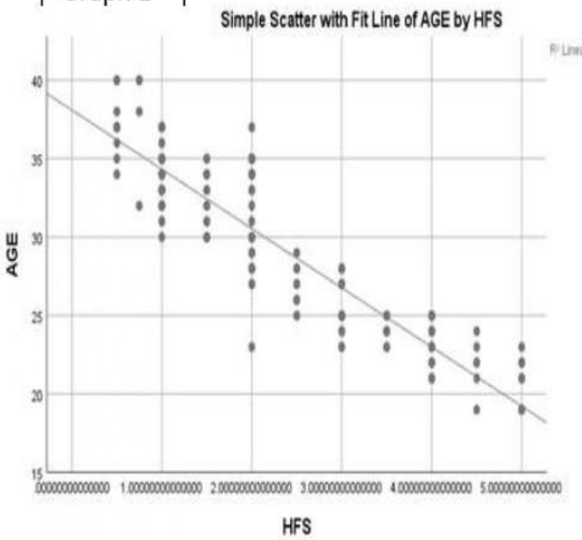
**. Correlation is significant at the 0.01 level (2-tailed).

Graphical representation of Age with respect to Hand grip strength fatigue time in Proliferative phase, Secretory phase and Menstrual phase in Graph1, Graph 2, Graph 3 respectively:

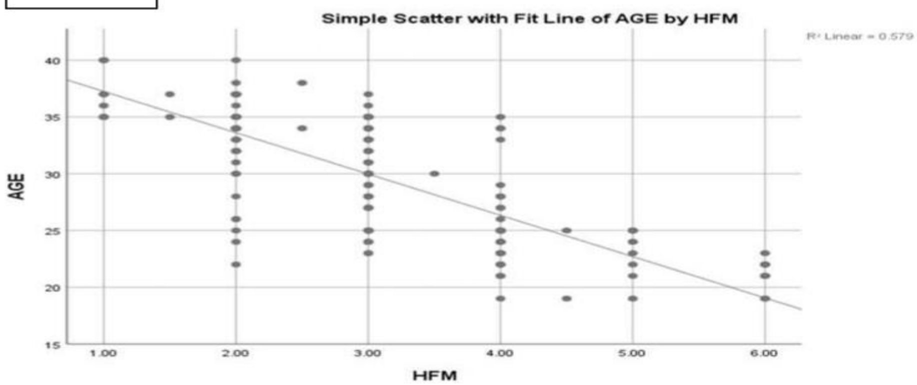
Graph 1



Graph 2



Graph 3



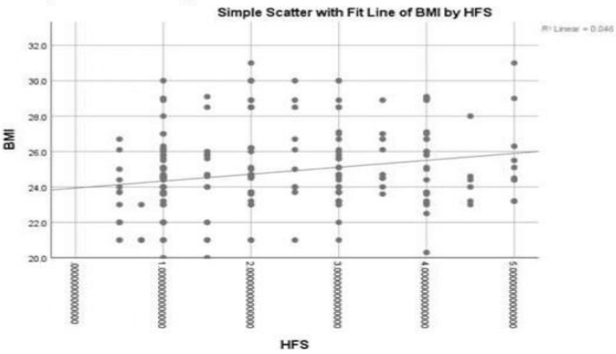
The correlation between BMI and the hand grip strength sustained contraction fatigue time in the three phases of the menstrual cycle in **Table 2**; further revealed that in all three phases of the cycle it was found to be positive correlation which was statistically significant.

		BMI	HFP (Proliferative phase)	HFM (Menstrual phase)	HFS (Secretory Phase)
BMI	Pearson Correlation	1	.185**	.183**	.214**
	Sig. (2-tailed)		.006	.006	.001
	N	225	225	225	225
HFP	Pearson Correlation	.185**	1	.743**	.865**
	Sig. (2-tailed)	.006		.000	.000
	N	225	226	226	226
HFM	Pearson Correlation	.183**	.743**	1	.753**
	Sig. (2-tailed)	.006	.000		.000
	N	225	226	226	226
HFS	Pearson Correlation	.214**	.865**	.753**	1
	Sig. (2-tailed)	.001	.000	.000	
	N	225	226	226	226

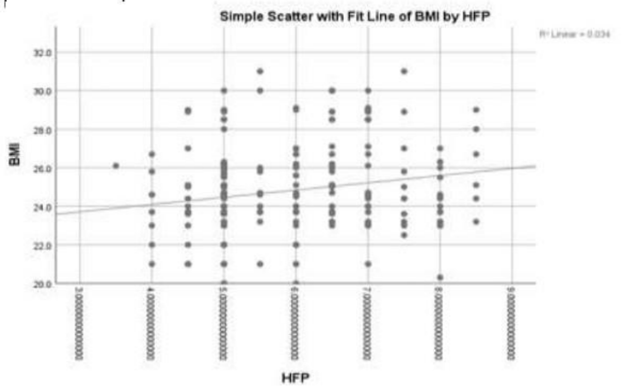
**. Correlation is significant at the 0.01 level (2-tailed).

TABLE 2:

Graph 5

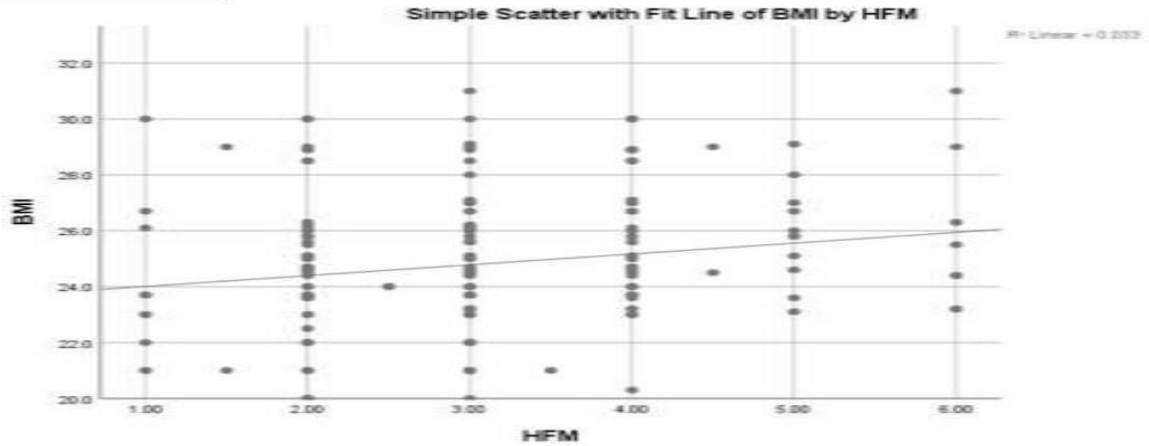


Graph 4



Graphical representation of BMI with respect to Hand grip strength fatigue time in Proliferative phase, Secretory phase and Menstrual phase in Graph 4, Graph 5, Graph 6 respectively:

Graph 6



The correlation between Weight and the hand grip strength sustained contraction fatigue time in the three phases of the menstrual cycle in **Table 3**; further revealed that in all three phases of the cycle it was found to be positive correlation which was statistically significant.

		HFP	HFM	HFS	Weight
HFP	Pearson Correlation	1	.743**	.865**	.187**
	Sig. (2-tailed)		.000	.000	.005
	N	226	226	226	225
HFM	Pearson Correlation	.743**	1	.753**	.161*
	Sig. (2-tailed)	.000		.000	.015
	N	226	226	226	225
HFS	Pearson Correlation	.865**	.753**	1	.208**
	Sig. (2-tailed)	.000	.000		.002
	N	226	226	226	225
Weight	Pearson Correlation	.187**	.161*	.208**	1
	Sig. (2-tailed)	.005	.015	.002	
	N	225	225	225	225

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

TABLE 3:

DISCUSSION:

The present observational study evaluated variations in hand grip strength (HGS) fatigue time across different phases of the menstrual cycle in eumenorrheic young adult females. The findings demonstrated clear phase-dependent differences in muscular endurance, with the longest fatigue time observed during the proliferative phase, followed by the menstrual phase, and the shortest fatigue time during the secretory phase. These results support the growing evidence that cyclical hormonal fluctuations significantly influence neuromuscular performance.

The prolonged fatigue resistance noted during the proliferative phase is consistent with earlier studies. Pallavi et al. reported enhanced musculoskeletal strength and delayed onset of fatigue during the follicular phase, which corresponds to the proliferative phase of the endometrium[10]. This phase is characterized by rising estrogen levels with minimal progesterone influence. Estrogen has been shown to exert anabolic effects on skeletal muscle by improving muscle fiber contractility, enhancing calcium handling, and increasing fatigue resistance, thereby contributing to improved endurance performance[6]. Sarwar et al. also demonstrated significant changes in muscle strength, relaxation rate, and fatigability across the menstrual cycle, attributing these variations to hormonal modulation of neuromuscular function [11]. The findings of the present study align with this observation, particularly the superior performance during the proliferative phase when estrogen levels peak. Similarly, Bennal and Chavan observed better muscular performance during the follicular phase compared to the luteal phase, reinforcing the beneficial role of estrogen on muscle function[2].

In contrast, the secretory phase showed the shortest fatigue time in the present study. This phase is dominated by elevated progesterone levels, which have been associated with increased muscle laxity, reduced neuromuscular efficiency, and enhanced perception of fatigue[3,6]. Nicolay et al. reported reduced grip endurance during the luteal phase among eumenorrheic women, suggesting that progesterone may counteract the positive effects of estrogen on skeletal muscle performance[9]. The present findings further support this hypothesis, indicating that hormonal balance rather than absolute hormone levels plays a crucial role in determining muscular endurance.

The menstrual phase demonstrated intermediate fatigue times, lower than the proliferative phase but higher than the secretory phase. This may be explained by the combined effects of declining estrogen and progesterone levels along with menstruation-related symptoms such as pain, fatigue, and reduced motivation. Matsuura et al. reported that menstruation-related symptoms negatively affect hand grip strength in female university students, which may partly explain the reduced endurance observed during this phase[8].

The study also assessed the relationship between demographic variables and HGS fatigue time. A statistically significant negative correlation was observed between age and fatigue time across all menstrual phases. This finding is consistent with previous reports indicating a gradual decline in muscle strength and endurance with advancing age, even within the young adult population[7]. Conversely, BMI and body weight showed a positive correlation with fatigue time across all phases, suggesting that greater muscle mass and mechanical advantage may contribute to improved grip endurance. Similar observations have been reported in studies evaluating grip strength across different body compositions[13].

Recent studies in athletic and non-athletic populations further support the phase-dependent variability in muscular performance. Dasa et al. demonstrated menstrual cycle-related changes in strength and power parameters among high-level female athletes, emphasizing the need for individualized training strategies[15]. Aslam et al. also reported dominant hand grip strength variations across menstrual phases, corroborating the present findings[1].

The practical implications of these findings are significant for clinical assessment, occupational health, and physical training. Understanding phase-specific variations in muscular endurance may help optimize work schedules, reduce fatigue-related injuries, and improve performance outcomes among women. However, variations in methodology, population characteristics, and outcome measures across studies may account for some inconsistencies reported in the literature, underscoring the need for standardized longitudinal research designs.

CONCLUSION

The present study concludes that hand grip strength fatigue time varies significantly across different phases of the menstrual cycle in eumenorrheic young adult females. Muscular endurance was highest during the proliferative phase, moderate during the menstrual phase, and lowest during the secretory phase. These variations are likely influenced by cyclical fluctuations in estrogen and progesterone and their effects on neuromuscular function.

Additionally, age demonstrated a negative correlation with grip endurance, while BMI and body weight showed positive correlations across all phases of the menstrual cycle. These findings highlight the importance of considering both hormonal and anthropometric factors when assessing muscular performance in women.

The results emphasize the need for menstrual cycle-aware approaches in clinical evaluations, occupational settings, and physical training programs. Future studies employing longitudinal designs with hormonal assays may further clarify the mechanisms underlying these variations and contribute to evidence-based guidelines for women's health and performance optimization.

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