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Study of Hand Grip Strength, Handgrip Endurance and Fatigue in Different Phases of Menstrual Cycle of Adults

Anupi Das[1], Dipti Bania[2], Nandita Dutta[3], Manas Krishna Borgohain[4*]

[1,4]Associate Professor of Physiology, Jorhat Medical College and Hospital, India

[2,3]Associate Professor of Physiology, Diphu Medical College and Hospital, India

***Corresponding author:** Manas Krishna Borgohain, Associate Professor of Physiology, Jorhat Medical College and Hospital, India, Email: grobnam@gmail.com

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ABSTRACT

Introduction: The various menstrual cycle stages affect how physically fit women are. The physiological characteristics of several systems change in response to changes in the blood level of the female sex hormone. Numerous studies have been conducted in various regions of the world to correlate the impact of hormones on exercise performance, particularly muscular strength and rate of tiredness throughout various periods of the menstrual cycle. However, many of these studies have shown conflicting results. The purpose of this study was to assess young adults' hand grip endurance, strength, and rate of exhaustion throughout different menstrual cycle stages.

Materials and Methods: This prospective research was carried out on medical students. 44 healthy adult female volunteers, ages 18 to 24, who had regular, healthy menstrual cycles lasting between 26 and 32 days on average during the previous six months. Mosso's ergograph was used to calculate work performed and exhaustion rate, while handgrip dynamometer strength was used to determine muscle strength. Each patient had two menstrual cycles of evaluation in each of the three phases— "Phase 1: Menstrual Phase, Phase 2: Follicular Phase, and Phase 3: Luteal Phase" — consecutively. One-way ANOVA, followed by a post-hoc Turkeys test, was used to analyse the collected data. A p-value of 0.001 or below was regarded as significant.

Results: Handgrip strength was found to be highest in follicular or proliferative phase of menstruation and the difference between the phases is statistically significant (P 0.001).

Conclusion: It was determined that the cyclical fluctuation in female reproductive hormones effects muscular strength, and it is obvious that muscle strength and endurance increase during the follicular phase of the menstrual cycle.

Keywords: *Strength, Handgrip, cycle, performance, stages*

INTRODUCTION

The body of a woman is susceptible to a number of changes during her life cycle. The menstrual cycle refers to the cycle of these positive changes that occur in women each month. It appears that this cycle is intended for pregnancy. During the menstrual cycle, a variety of female sex steroid hormones have their blood concentrations continuously fluctuate in women. "Oestrogen, progesterone, follicle stimulating hormone, and luteinizing hormone" are the main four female sex hormones that must fluctuate to regulate the ovulatory cycle patterns.

The follicular phase and the luteal phase, the two main stages of a regular/normal menstrual cycle, are also induced by fluctuations of these hormones. These two stages are separated by a shorter ovulation window in the cycle's midsection. Typically, the follicular phase is divided into two sub-phases: the "early follicular phase (EFP)", which is characterised by low serum levels of both oestrogen and progesterone, and the "late follicular phase (LFP)", which culminates in an increase in luteinizing hormone that occurs prior to ovulation and is characterised by a maximum oestrogen concentration and low progesterone levels. Once luteinizing hormone levels have stabilised, the luteal phase starts, which is characterised by high levels of both progesterone and oestrogen. Typically, the “midpoint of the luteal phase (MLP)” is when oestrogen and progesterone peak.

Over time, muscles' performance capacity declines due to muscular exhaustion. Muscle exhaustion is primarily brought on by two factors: the diminished capacity of a muscle fibre to contract and the limitations of a nerve's ability to deliver a continuous signal. Since a reduction in the maximum force or power that a muscle is capable of producing is frequently used to gauge the development of muscle fatigue, submaximal contractions can continue beyond the onset of muscular weariness (1). It can be related to a fatigue that often follows a strenuous workout or activity. When physically worn out, a person feels weaker because their muscles are moving less forcefully. Exercise frequently results in muscle fatigue, while other medical issues might also cause it.

When men's serum testosterone levels fall with age, muscle weakness results. Oestrogen, the female equivalent of testosterone, has also been linked to age-related strength reduction, albeit the evidence is less strong (2). Progesterone has been connected to catabolic pathways, whereas oestrogen is a hormone with a putative anabolic activity (2). Given these variations in hormone actions, it has been hypothesised that variations in hormone production throughout various menstrual cycle stages may affect skeletal muscle performance. The current study sought to determine if distinct female sex hormones' blood levels, which fluctuate in concentration throughout the menstrual cycle, affect women's muscular performance. Strengths, muscular endurance, and the increase of muscle mass were used to measure the physical performance.

The effect of menstrual cycle phase on physical performance is not consistently or clearly demonstrated in studies that assess anaerobic, aerobic, or strength-related performance. The total performance of an athlete may be affected by real and perceived circumstances. More study is required to quantify the impact of menstrual cycle phase on perceived and physical performance results as well as to uncover factors impacting variability in objective performance outcomes across studies in order to enhance performance and treatment of eumenorrheic female athletes.

MATERIALS AND METHODS

In 2021–2022, a prospective study on Jorhat Medical College medical students was undertaken. Research was conducted at the Jorhat Medical College's Physiology department. Prior to starting the research, Institutional Ethical approval was acquired. 44 healthy adult female volunteers between the ages of 18 and 24 with regular menstrual cycles between 26 and 32 days (on average 28 days) for the past six months or more were chosen as the subjects. Each participant completed a questionnaire to provide information on their age, body weight, height, menstrual flow, cycle length, regularity, and cycle regularity. The research did not include girls with irregular periods or those taking any medications. Also, girls who were overweight and underweight according to age were not included in the study.

The participants were called to the clinical laboratory of the Physiology department after providing them with the required written consent, and appointments were made based on the subjects' menstrual cycle phases. By quantifying the work done and fatigue rate using Mosso's ergograph and a handgrip dynamometer, the subjects' right forearm muscles' strength, endurance, and fatigability were evaluated. Phase 1: Menstrual Phase, Phase 2: Follicular Phase, and Phase 3: Luteal Phase were all sequentially assessed for two menstrual cycles in each individual. To assess the gathered data, a one-way ANOVA was employed, then a post-hoc Turkeys test. Significant results were defined as p-values of 0.001 or lower.

RESULTS

For the current study, 44 healthy female medical students volunteered their time, and statistical analysis was done on the data gathered. The participants' standard deviation was 3.63 and their mean BMI was 22.55kg/m2, both of which fell within a range of 18 12 years (table 1). According to the results of the current study, muscular strength is highest during the follicular or proliferative phase of the menstrual cycle and lowest during the menstrual phase (Table 2). Additionally, it was shown that hand grip endurance was lowest during the menstrual cycle and highest during the proliferative cycle (Table 4). In the current study it was also observed that the duration of time required for development of fatigue is maximum in secretary phase and shortest time in secretory phase (Table5).

TABLE 1: Age and demographic characters of study subjects.

PARAMETERS	MEAN ±SD
Age in years	18.886 ± 0.9205
Height in cm	156.72 ± 6.428
Weight in Kg	55.41 ± 10.502
BMI in Kg/m^2	22.55 ± 3.633

TABLE 2: Comparison of Hand-grip strength in different menstrual phases by One-way ANOVA shows that the it is highest during the follicular or proliferative stage and the difference between the phases is statistically significant (P <0.001)

Phase	N	Mean	Standard deviation	Standard error of mean	Median
Proliferative	44	21.182	6.645	1.002	21.00
Menstrual	44	15.114	5.22	0.7872	16.00
Secretory	44	19.523	5.385	0.8118	18.50

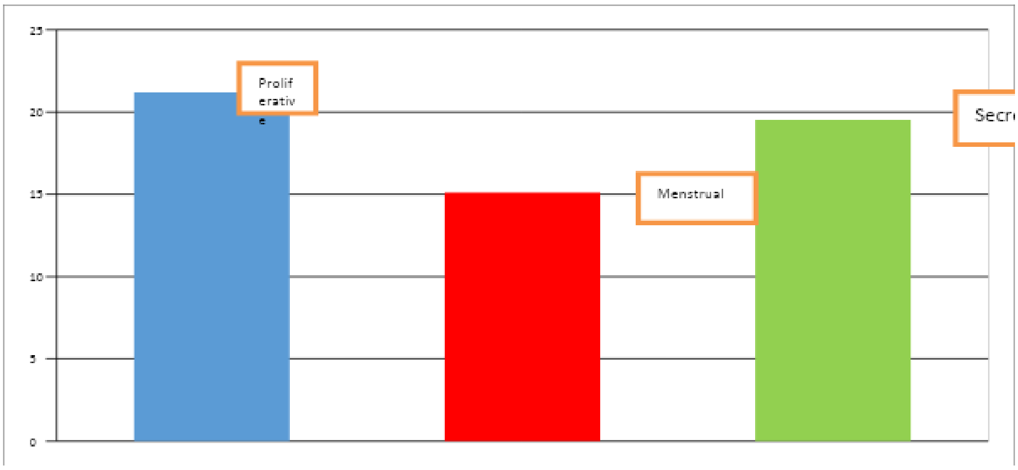

FIGURE 1: Mean handgrip strength in kg

TABLE 3: One-way ANOVA with post-test Tukey-Kramer multiple comparison test_for Hand-grip strength in different menstrual phases

Comparison	Mean difference	q value	P value
Proliferative Vs Menstrual	6.068	6.597	Significant, P<0.001
Proliferative Vs Secretory	1.659	1.902	Not significant, P>0.05
Menstrual Vs secretory	-4.409	5.055	Significant, P<0.01

The P value is < 0.001, considered extremely significant.

TABLE 4: Comparison of Hand-grip endurance in different menstrual phases by One-way ANOVA shows that the it is highest during the follicular or proliferative stage but the difference is not statistically significant (P = 0.2382).

Phase	n	mean	Standard deviation	Standard error of mean	Median
Proliferative	44	115.68	82.9	12.49	96.5
Menstrual	44	86.38	64.15	9.67	71
Secretory	44	106.45	71.02	10.7	88

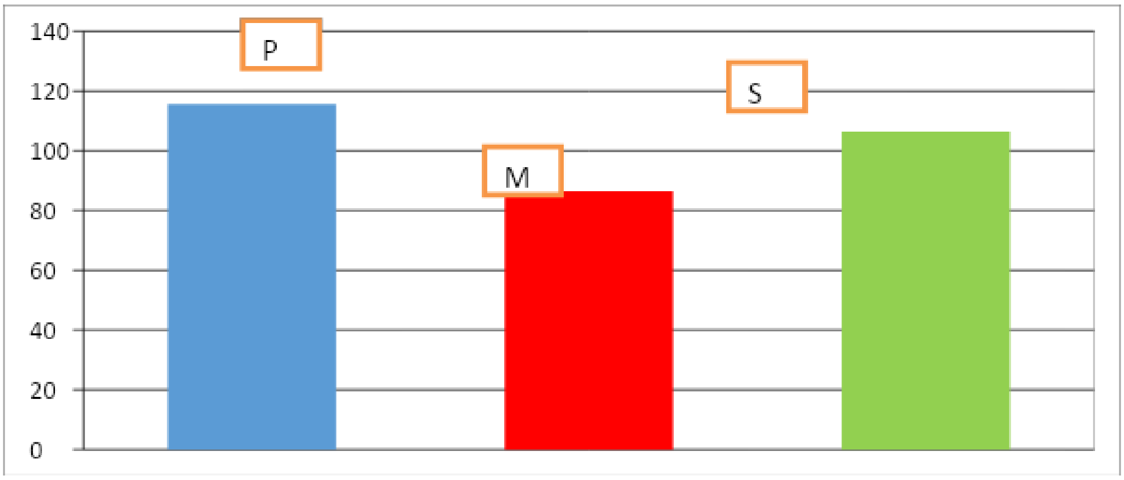

FIGURE 2: Comparison of mean handgrip endurance in seconds in different phases of menstrual cycle

TABLE 5: Mean and standard deviation of fatigue in different phases of menstrual cycle.

Phase	n	Mean (seconds)	Standard deviation	Standard error of mean	Median
Proliferative	44	90.205	53.4	8.05	87
Menstrual	44	63.545	25.72	3.87	63.5
Secretory	44	98.523	68.09	10.26	81.5

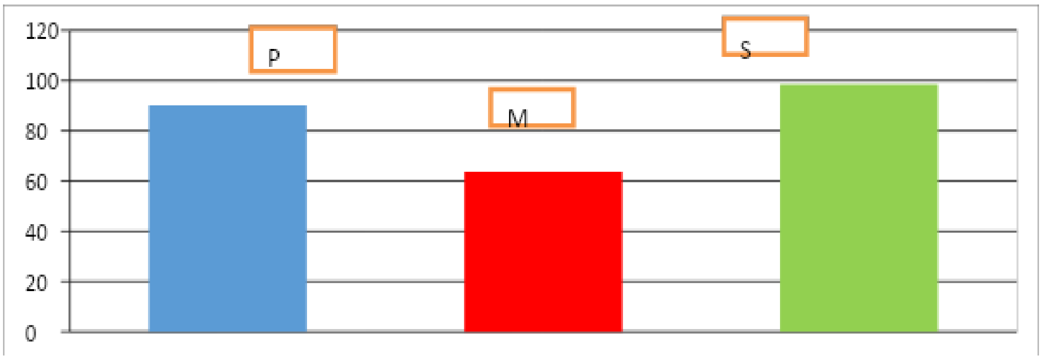

FIGURE 3: Comparison of mean fatigue in seconds in different phases of menstrual cycle

DISCUSSION

The current study's findings are consistent with several other research [4,5,6,7,8] that found an 11% increase in quadriceps and handgrip maximal voluntary isometric force during the late follicular phase, which corresponded to ovulation. Similar to this, Bambaeichi E. et al. showed that isometric strength performance peaked during the ovulation phase of the menstrual cycle in their study "The Isolated and Combined Effects of Menstrual Cycle Phase and Time-of-Day on Muscle Strength of Females with Normal Menstrual Pattern". These findings point to a possible link between an increase in luteinizing hormone and stronger muscles. Other research has not confirmed these findings, nevertheless, since no differences in muscular strength were discovered across menstrual cycle stages [5,6,8]. For instance, there were no variations in concentric and eccentric muscle torque between the menstrual, follicular, and luteal phases. Estradiol rapidly drops after ovulation, then rises in the luteal phase along with progesterone, creating a large secondary peak according to Gurr in 1997 and Janse de Jonge X in 2003 [9,10].

Oestrogen has crucial functions in the growth, maturation, and ageing of extra gonadal tissues including bone in addition to its function as a sex hormone [11]). Young women's natural estrogen secretion varies, rising 10- to 100-fold during the menstrual cycle. The levels of progesterone, luteinizing hormone, and "follicle stimulating hormone (FSH)", in addition to estrogen, change significantly throughout the menstrual cycle. "17-estradiol levels also rise, from 5 pg/ml in the early follicular phase to a peak of 200–500 pg/ml just before ovulation". Estradiol rapidly drops after ovulation, then rises in the luteal phase along with progesterone, creating a large secondary peak [12] .

"Assessment of Musculoskeletal Strength and Levels of Fatigue during Different Phases of the Menstrual Cycle in Young Adults" was carried out by Pallavi LC, D Souza UJ, and Shiva Prakash G. They came to the conclusion that the cyclical variation in endogenous reproductive hormones increases muscle strength in the follicular phase of the menstrual cycle [13]. This demonstrates similarities with the current study's conclusions. Another research that looked at the effects of the menstrual cycle on well-trained female athletes found that 21.2% of the athletes performed worse than they did before their period, 62.2% performed at the same level when they were menstruating, and 71% felt their worst right before it. It was reported that following menstrual phase in the first 14 days, the athletes felt improved compared to the subsequent 14 days ($p<0.01$) [12].

Review of the research reveals that the component of strength performance during the various menstrual cycle phases is inherently contradictory [17] . Although there isn't any record of the hormonal levels during the various menstrual cycle phases in the current study, all other selection criteria—such as age, physical ability, sample size, menstrual cycle history and severity—were satisfied. The subjects who were consuming meals from the communal hostel mess matched the selection criteria, which included their nutritional needs. Despite all of this, the individuals' strength and force were higher during the follicular phase, lower during the luteal phase, and worsened throughout the menstrual period. Numerous research has examined the impact of menstrual cycle-related hormonal oscillations on physical performance [19]. However, the literature presents controversial results. Various studies [16,18] have confirmed variations in hormone concentrations without change in muscular strength between phases.

Dhananjaya et al. [18] evaluated and confirmed that the women showed a substantial loss of strength during one of the workouts during the follicular period.

Thus, reviewing the literature, it can be observed that muscle strength and performance during different phases of menstrual cycle is very conflicting in nature. This study must be conducted on a bigger population with proof of future hormonal volatility in order to obtain a clearer picture.

Limitation

It was not possible to measure hormone levels in this study, which would have made it considerably more useful to categorize the various menstrual cycle phases. The current study did not take into account the sub phases of the various menstrual cycle phases, which may have provided a more thorough evaluation of the research topic. As there were few medical students included in this study, it is advised to do more research with a larger population to validate the existence of hormonal changes before extrapolating the findings to the general population.

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