

# THE INFLUENCE ON MENSTRUAL CYCLE PHASES ON TRUNK FLEXION MOBILITY ASSESSED WITH FINGER FLOOR DISTANCE TEST: A PRELIMINARY STUDY

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**A** – study design, **B** – data collection, **C** – statistical analysis, **D** – interpretation of data, **E** – manuscript preparation, **F** – literature review, **G** – sourcing of funding

## ABSTRACT

**Background:** The menstrual cycle plays an important role in a woman's body and the relationship between different phases of the menstrual cycle and flexibility has not been well known.

**Aim of the study:** This study aimed to examine whether the different phases of the menstrual cycle could affect trunk flexion mobility in young, healthy, physically active women who had not used hormonal contraception and had not received hormone treatment.

**Material and methods:** In total, ten healthy female nulliparas aged 25–30 participated in the study. The inclusion criterion for the study was regular menstruation (25–35 cycle days). The exclusion criteria were: hormonal treatment, use of hormonal contraception, BMI > 25, and history of pregnancy. To assess trunk flexion mobility the finger floor distance test was used. The test was performed on each participant three times: during menstruation (follicular phase), during ovulation (ovulatory phase), and after day 15 of the cycle (luteal phase). Friedman ANOVA was used to determine the effect of the menstrual cycle phases on the finger floor distance test results. It was followed by Wilcoxon signed rank test.

**Results:** There was a significant effect of the phases of the menstrual cycle on the results of the finger floor distance test ( $p=0.03$ ). Significantly higher values for the finger floor distance test result in the follicular phase as compared to the ovulatory phase were found ( $p=0.02$ ).

**Conclusions:** The comparison of finger floor distance test results obtained in young healthy nulliparas in three phases of the menstrual cycle indicates decreased trunk flexion mobility in the follicular phase.

**KEYWORDS:** menstrual cycle, flexibility, trunk flexion mobility, finger floor distance test

## BACKGROUND

The presence of a menstrual cycle testifies to the sexual maturity of the female reproductive system and it enables procreation. It is possible thanks to hormonal changes which occur in specific phases of the cycle. The menstrual cycle consists of 3 phases: the follicular, ovulatory, and luteal. The normal menstrual cycle lasts from 21 to 35 days, the average of which are 28 days [1].

Depending on the phase of the cycle, the level of hormones in the circulating blood changes. In each phase, a different hormone dominates. Among other things, the ratio of hormones such as estrogens and progesterone influences the correct functioning of the female body. The early follicular phase is characterized by low levels of estrogens and progesterone, then these proportions change, and the amount of estrogens increases, while progesterone remains at a low level. In the middle of the luteal phase, both of these hormones assume high values [2].

Current knowledge of the impact of the menstrual cycle on physical fitness is diverse and incomplete. There are studies confirming the influence of particular phases of the menstrual cycle on the physical disposition of women [3,4,5]. The purpose of the one of the studies was to determine the effect of menstrual cycle phase and sex upon glucose turnover and muscle glycogen utilization during physical effort. The study group included 13 healthy, recreationally active young women and 11 men. The results of the research were as follows: women during the luteal phase had lower glucose rate of appearance and lower total glycogen utilization compared with women during follicular phase [3]. Another of the studies evaluated the impact of time of day and menstrual cycle phase on the determination of the lactate threshold and blood lactate concentration in response to physical exertion. The study group consisted of 11 endurance-trained female athletes. The results of the research showed that in the mid-luteal phase of the menstrual cycle specific lactate blood level occurred at a significantly higher exercise intensity, heart rate, and oxygen consumption than in the midfollicular phase [4]. Such knowledge is particularly useful regarding women training for competitive sports. Taking into account the physiology of physical effort, it has been found that parameters such as oxygen consumption, lactate threshold, plasma volume, hemoglobin concentration, and ventilation differ between phases of the menstrual cycle [5].

On the other hand, Loureiro et al. [1] assessed how muscle strength changed in the 10 repetition maximum (RM) test during different phases of the menstrual cycle. The test concerned measuring muscle strength during such movement tasks as leg press

45°, bench press, leg extension, and biceps curl [6]. The study group consisted of 9 healthy, physically active women. The authors of this study did not observe statistically significant differences in the results of this test depending on the menstrual cycle phase. Similar conclusions were reached by Weis et al. [7], the aim of their study was to investigate the range of motion (ROM) of extension at the fifth metacarpophalangeal joint and rotation of the cervical spine in women during the luteal and follicular phase of menstrual cycle. Sixteen nulliparous women were recruited to the research. The test results did not show a statistically significant correlation dependent on the cycle phase. The opposite conclusion was reached by Simao et al. [8] who observed a decrease in muscle strength during the first phase of the menstrual cycle compared to the other phases. The subjects were 19 physically active women. The strength was measured using the 8RM test, performing exercises for upper and lower body. A statistically significant difference was observed in the 45° leg press exercise during the first phase of the cycle compared to the other phases.

One of the physical fitness components is flexibility, which may be influenced by different phases of the menstrual cycle [9]. The American Council on Exercise defines flexibility as the range of motion in a joint or joints or the level of extensibility of a muscle group [10]. Flexibility depends on many factors, e.g.: gender, age, anatomical structure, body temperature, and time of day. With age, a decrease in flexibility is observed, which is partly related to the aging process of the body [11].

There are many ways to assess flexibility such as the flexibility test in the frontal plane [12], the finger floor distance test (FFD) [13], and the sit and reach test [14]. In addition, flexibility can be assessed using a goniometer [15].

Research findings on the effect of the menstrual cycle on flexibility in women are divergent. One study suggested that the different phases of the cycle do not interfere with soft tissue flexibility [14]. However, another study found greater hamstring muscle extensibility during the ovulatory phase compared to the follicular phase [9].

After searching databases (Pubmed, Ebsco, Google scholar) there are currently no systematic reviews related to the discussed topic. Therefore, there is a need for continuing research to further expand knowledge on this subject. This knowledge would be particularly valuable for coaches in competitive sports training and for planning studies on the assessment of motor skills in women. Knowing the influence of the menstrual cycle phases on flexibility would allow a more accurate selection of activities for women depending on their physical disposition.

## AIM OF THE STUDY

This preliminary study aimed to investigate whether particular phases of the menstrual cycle may impact trunk flexion mobility in young, healthy, physically active women who were not using hormonal contraception and were not hormonally treated. To assess the mobility of trunk flexion, the FFD test was selected as a reliable research tool [16,17]. It was hypothesized that the test results may differ between the phases of the menstrual cycle.

## MATERIAL AND METHODS

### Sample

Ten healthy female nulliparas aged 25–30 participated in the study. The inclusion criterion for the study was regular menstruation (25–35 cycle days). The exclusion criteria were: hormonal treatment, use of hormonal contraception, BMI > 25, and history of pregnancy. The study participants were recruited from among the Academy of Physical Education students.

Before starting the study, the women were interviewed about their age, the length of their menstrual cycle, and their physical activity level. All were physically active (exercising in the gym and/or attending fitness classes at least once a week). Subject body mass and height were also measured and the body mass index (BMI) was calculated (Table 1).

### Methods

The FFD test was used to assess trunk flexion mobility [16,17]. The test was performed on each

woman three times: during menstruation (follicular phase), during ovulation (day 10–14 of the cycle), and after day 15 of the cycle (luteal phase). Each examination session took place at the same time of the day. For the FFD test, the subject stood on the stepper (10cm high) with her feet hip-width apart; successively, she was asked to raise her upper limbs with her elbows extended and then to bend forward, starting with a slow flexion of the cervical, and then subsequent sections of the spine. The knee joints remained extended. The women were instructed that the movement should be natural, unforced, and not be deepened. A measuring tape was used to measure the distance from the end of the longest finger of the right hand to the upper edge of the stepper. The upper edge of the stepper was a value of 0 (Figure 1). If the woman reached below the height of the upper edge of the stepper, the distance was recorded in negative values, and if she did not reach the upper edge of the stepper – it was recorded in positive values.

### Ethics

This study was carried out as a part of a research project approved by the University Bioethics Committee. Before starting the research, all participants were explained their purpose and course. They gave their consent to carry out the research.

### Statistical analysis

To find out whether the phases of the menstrual cycle had an effect on the FFD test result, a non-parametric repeated measure test – Friedman ANOVA – was used. As the result of the analysis was statistically significant, the Wilcoxon signed rank test was then performed. It allowed determining between which

Table 1. Characteristics of 10 young healthy, regularly menstruating women\*

Subject	Age [years]	Body mass [kg]	Body height [cm]	BMI	Cycle length [days]
1	30	64	165	23.51	30
2	25	65	164	24.17	30
3	25	64	165	23.51	28
4	26	54	163	19.95	30
5	29	55	157	22.31	31
6	26	55	172	18.59	28
7	29	53	169	18.56	28
8	25	67	164	24.91	28
9	29	73	172	24.68	28
10	27	58	165	21.30	30
Average±SD** (median)	27.1±1.97 (26.5)	60.8±6.73 (61)	165.6±4.48 (165)	22.1±2.43 (22.9)	29.1±1.2 (29)

\* Individual and average values.

\*\* SD – standard deviation.

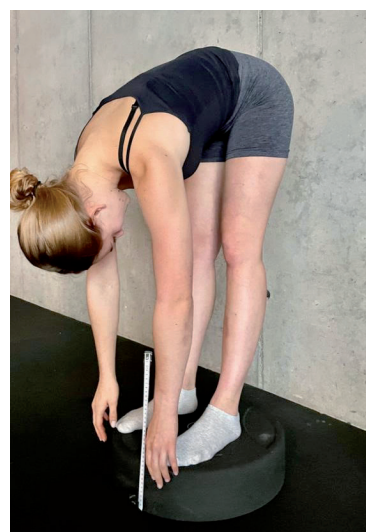


Figure 1. The participant of the study during the assessment of the mobility of the trunk flexion with the FFD test

phases of the cycle there were significant differences in trunk flexion mobility assessed with the FFD test.

The level of significance was set at  $p < 0.05$ . Analyses were performed using Statistica v.13 (TIBCO Software, Palo Alto, CA, USA).

## RESULTS

Out of approximately 20 screened patients, 10 were included in the study and statistical analysis (Figure 2). Table 2 shows the individual FFD test results for the three phases of the menstrual cycle. Friedman's ANOVA showed a significant effect of the phases of the menstrual cycle on the results of the FFD test ( $p = 0.03$ ).

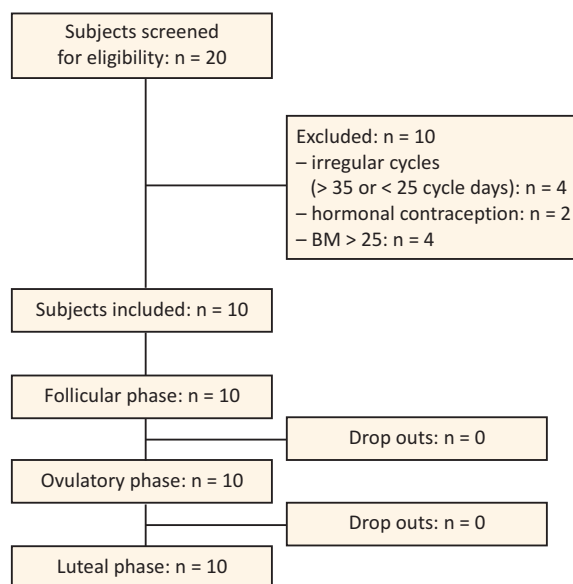


Figure 2. Study flowchart

Table 2. Individual and average results of the finger floor distance (FFD) test in 10 young regularly menstruating women at three phases of their menstrual cycles

Subject	FFD (cm)		
	Follicular phase	Ovulatory phase	Luteal phase
1	11	8	14
2	-2	-1.5	-4.5
3	14	12	13
4	8.5	6	8
5	5.5	4.5	5
6	-3	-2	-3
7	-1	-2	-1.5
8	5	3.5	3
9	8.5	4	5
10	11	8.5	9.5
Average±SD*	5.8±5.97	4.1±4.79	4.9±6.45

\* SD – standard deviation.

The Wilcoxon test showed statistically significant differences in the FFD test results between follicular and ovulatory phases of the menstrual cycle. It indicates significantly higher values for the FFD test result (“worse” trunk flexion mobility) in the follicular phase as compared to the ovulatory phase ( $p = 0.02$ , Figure 3).

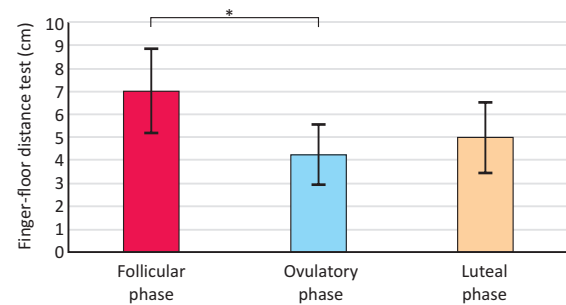


Figure 3. The results of the finger floor distance test in 10 young regularly menstruating women in the three phases of their menstrual cycle – medians and standard deviation

\*  $p = 0.02$  (Wilcoxon test)

## DISCUSSION

This preliminary study was an attempt to determine if the particular phases of the menstrual cycle may affect trunk flexion mobility assessed by the FFD test in young, healthy, physically active, hormonally untreated, and not using contraception women. The study was aimed at finding out whether the results of the FFD test differ depending on the phase of the cycle, and if so, in which phase trunk flexion mobility is the highest, and in which phase it is the lowest.

The statistical analysis revealed significantly higher values of the FFD test results in the follicular compared to the ovulatory phase. The results thus indicate that trunk flexion mobility was decreased in young women in their follicular phase of menstruation. However, the differences between the follicular and luteal phases, and the ovulatory and the luteal phases proved to be statistically not significant. Lower trunk flexibility in the follicular phase compared to the ovulatory phase may be related to the levels of estrogens and progesterone and their different ratio in these two menstrual phases.

Estrogen levels may influence connective and muscle tissues, an example of which is the postmenopausal lowering the level of these hormones resulting in a decrease in muscle mass [18]. Hawett [19] indicates that changes in female hormones are the main reason for ligament relaxation and decreased neuromuscular efficiency. Another study indicates that the elasticity of the anterior cruciate ligament is significantly higher during ovulation and pregnancy, when the level of estrogens increases [20,21]. Changes in the

level of estrogens and progesterone affect collagen metabolism which influences the properties of ligaments [22,23]. This could explain how the changes in hormone levels between follicular and ovulatory phases of the menstrual cycle may affect trunk flexibility which was assessed in the present study.

Our results are consistent with the study by Bell et al. [9] which indicates higher hamstring extensibility during ovulation in comparison to the follicular phase. The authors conducted research on eight premenopausal, not using contraception and regularly menstruating women. They measured hamstring extensibility and active muscle stiffness using a goniometer and reported that hamstring extensibility increased during ovulation and active muscle stiffness showed no changes. It was concluded that hamstring extensibility may depend on the level of estrogens in particular phases of the cycle. Campa et al. [24] in their study also observed decreased hamstring extensibility during the follicular phase in 20 female footballers. In contrast, Melagario et al. [15] suggested that particular phases of the cycle did not affect soft tissue flexibility. They conducted research on 20 women, aged 18–35, practicing gymnastics in fitness centers. The flexibility was evaluated by the goniometry measuring the range of motion of the shoulder, elbow, hip, knee, and low back in three phases of the menstrual cycle. The results of their study indicate that there were no significant differences in flexibility between individual phases of the menstrual cycle. The research results of Teixeira et

al. [14] conducted on 40 women, aged 18–40, who regularly menstruated, and did not use contraception, also indicate no differences in flexibility between the follicular, the luteal, and the ovulatory phases. The younger age of our research group and the use of different measurement tool might be the reason that our findings are different than those of this research. Divergent reports on the influence of the menstrual cycle phases on flexibility indicate the need for further research in this area. The level of physical activity, age and history of pregnancy should be taken into account in the selection criteria for inclusion in future research.

### Limitations

The limitation of the present study is a relatively small sample size, therefore, the results should be considered with caution. Future studies should be carried out on a larger sample and assess flexibility also within other parts of the female body.

### CONCLUSIONS

The values of the FFD test results in young healthy nulliparas were higher in the follicular compared to the ovulatory phase of the menstrual cycle. This indicates that trunk flexion mobility was decreased in their follicular phase.

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