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**Original Article**

# Influence of the menstrual cycle on crawl performance in young female swimmers

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**Abstract**
To determine the influence of the phases of the menstrual cycle on swimming performance, analyzing the variation of performance in the variables time, frequency and duration of the swimming cycle in crawl style, efficiency index and average speed developed. Eleven regional high-performance swimmers were recruited. The intervention was carried out in 3 phases of the menstrual cycle (menstrual phase (FM); follicular phase (FF) and luteal phase (FL) which consisted of a 2 x 50 m test with 5 minutes of recovery in crawl style. The 50-metre time (T50), cycle frequency (CF), cycle length (CL), mean velocity (MV) and efficiency index (EI) were analyzed. For comparisons between menstrual cycle times, a T-Student for related samples was applied. Effect size was calculated using Cohen's d. There are significant differences in performance as a function of menstrual cycle phase. MP vs FP: T50 [30.41 (1.47) sec] vs [29.86 (1.56) sec] 1.91% (D=0.36); CL [46.01 (3.92) cycles/min] vs [47.15 (4.03) cycles/min] 2.5% (D=0.28); MP vs LP: CL [1.99 (0.13) cycles/min] vs [2.01 (0.14) cycles/min] 1.01% (D=0.13) FP vs LP: CL [1.97 (0.15) m/cycle] vs [2.01 (0.14) m/cycle] 2.03% (D=0.27%) IE $p<0.05$). The different phases of the menstrual cycle influence crawl performance in young high performance female swimmers. The FF was the most optimal phase due to a decrease in the total time of the test and an increase in the length of the swim cycle. It is unclear whether there is a direct influence on performance as a function of menstrual phase, which is attributed to possible inter-individual differences.
Keywords: **Physical training; efficiency; follicular phase; cycle length**

## Introduction

The female athlete during her menstrual cycle (MC) experiences a series of cyclical fluctuations of her endogenous hormones with an increase in estrogen during the course of the follicular phase and progesterone during the luteal phase (McNulty et al., 2020) developing transient but differentiated hormonal profiles in each of the phases of the cycle (Carmichael et al., 2021). All these changes appear in response to the need for human reproduction, however, they may have some influence on physical-sports performance, although according to recent literature it seems that their effects are not conclusive (Meignié et al., 2021).

Traditionally, training programmes for female athletes have been carried out based on the results of research on men (Emmonds et al., 2019), so the study of how specific aspects of women, such as the menstrual cycle, can influence sports performance is fundamental. The development of this evidence can have a positive impact in the practical field, improving the training and recovery processes of female athletes.

Due to the multiple biological processes derived from the different phases of the cycle, the physical performance of female athletes suffers alterations. Several studies show that in the follicular phase, due to the increase of estrogens, there is an increase in cardiovascular and neuromuscular functional capacity (Rechichi & Dawson, 2012; Smith et al., 2002). This may be because estrogens have an anabolic effect on skeletal muscle (Lowe et al., 2010; Pallavi et al., 2017; Del Vechio et al., 2019) by its influence on the metabolism of energy substrates through increased uptake and storage of muscle glycogen, as well as increased utilization of fatty acids (Hackney, 2016). In this line, performance improvements have been observed in speed tests during the follicular phase and ovulation, as well as improvements in the performance of long duration tests during the luteal phase (Garcia Bataller, 2019), however, in specific tests for indirect determination of maximal oxygen consumption such as the Yo-Yo Test, it appears that there may be a decrease in performance during this same phase of the cycle (Pisapia et al., 2019). Higher force values have also been seen during the follicular phase than during the luteal phase (Sung et al., 2014), just as it was found that the effects of the menstrual cycle can alter isometric endurance (Petrofsky et al., 2007). Despite all the findings described above, a recent narrative review concludes that there is insufficient evidence to state with certainty the influence of MC on the physical performance of female athletes, since most of the studies mentioned above where positive effects are described seem to have inconsistencies in their results. This disparity in the results is also influenced by the fact that it affects aerobic


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and anaerobic performance differently, causing, in part, inter-individual differences in the subjects (Carmichael et al., 2021). Specifically in the sport of swimming, there are very few studies that have investigated performance variation across the menstrual cycle (Bale & Nelson, 1985; Brooks-Gunn et al., 1986) reporting variations in swimming test performance measured in total test execution time in the different phases of the menstrual cycle. However, this possible association has recently been questioned (Rechichi & Dawson, 2012). Therefore, the aim of the present study was to determine the influence of the phases of the menstrual cycle on swimming performance, where a variation in performance of the different variables analyzed (time, cycle frequency and cycle length) could be appreciated. It was established as an initial hypothesis that the performance of the analyzed parameters of swimming will be modified according to the phase of the menstrual cycle in which the swimmer is.

## Methods

The sample consisted of 11 female swimmers belonging to clubs of the Swimming Federation of the Valencian Community (mean age of 20.63 ± 2.01 years, mean height of 1.69 ± 0.75 m, mean weight of 59.32 ± 6.69 kg and mean BMI of 20.78 ± 1.76). To participate in the study, it was required that they had at least one year of systematized swimming training with a weekly frequency of 3 days and that they did not have any injury and/or illness that could affect their performance. In addition, swimmers under 18 years of age, who were taking oral contraceptives or who had irregular menstrual cycles were excluded from the study. All participants signed an informed consent form prior to the start of the study. The experimental procedures were designed following the guidelines and ethical norms for research in humans established in the Declaration of Helsinki updated in 2013. The study was approved by the ethics committee of the University of Valencia (Number: 1569115).

The times at which the measurements were taken throughout the menstrual cycle were 3, taking as reference the day of menstruation as day 1. The first measurement was in the menstrual phase, during days 2 and 3, where there is a low concentration of estrogens and progesterone. The second measurement was made in the follicular phase, during days 12 and 13, where estrogen concentration is high and progesterone concentration is low. The third measurement was taken during the luteal phase, on days 24 and 25, where estrogen and progesterone levels are elevated, the latter in a higher proportion.

The measurements began with the recording of the descriptive characteristics of the sample, which included: a) body temperature using a digital infrared thermometer (Quirumed JPD-FR202, Spain). After 5 minutes after entering the pool, body temperature was recorded to allow the acclimatization process; b) anthropometric measurements of height with a measuring rod (Seca 216, Hamburg, Germany) together with weight and body composition (percentage of fat and muscle mass) with a bioimpedance scale (Tanita BC-401, Tokyo, Japan). After the basal recordings were completed, the participants performed a standardized warm-up consisting of the following: 5 minutes of joint mobility; 400m (100m crawl/50 freestyle); 200m arms only (with pull); 8x25/15sec feet (4 crawl/4 freestyle); 4x50/30" progressive; 2x25 + turn /1:30 with start, test pace 11. The test consisted of 2 sets of 50m crawl style at maximum intensity with a passive recovery between sets of 5 minutes. The tests were recorded and subsequently analyzed with the program Kinovea® version 0.9.5 in order to obtain the cycle length and frequency data. The variables recorded were the following: Time in seconds (s) for the distance of 50 meters (T50), in crawl and main stroke of the swimmer, cycle frequency (CF) per minute (c/min), cycle length (CL) calculated as meters per cycle (m/c), mean velocity obtained through the product of CF and CL (MV) and efficiency index (EI) obtained through the formula: T50/ [(50 (m)/ height(m)] (Cejuela Anta, 2006).

### *Statistical analysis*

The IBM® SPSS® Statistics 26.0 program licensed by the University of Valencia was used to analyze the data obtained. The results obtained are presented according to descriptive statistics [mean ± standard deviation (SD)] together with confidence intervals (95% CI). Normality was tested with the Shapiro-Wilk test. For comparisons between times of the menstrual cycle, a T-Student for related samples was applied. A value of $p<0.05$ was established for significance. The effect size was calculated using Cohen's d (Cohen, 1988).

## Results

Records were obtained on body temperature, BMI, body fat percentage and muscle mass during the three phases of the cycle (MP, FP and LP). No significant changes in BMI, body fat and muscle mass were observed in the different phases of the cycle. On the other hand, a slight variation in body temperature was observed, being the lowest in the menstrual phase (36.77º) and the highest in the luteal phase (37.33º).

Significant differences were observed in the three variables analyzed. An improvement in the test execution time in FP of 0.55 and 0.58 seconds with respect to MP, which represents 1.8% and 2% of the total time, and an improvement of 0.52 and 0.55 seconds with respect to LP, which represents 1.7% and 1.8% of the total time, were observed. In cycle frequency, an increase in FP of 1.14 and 0.75 c/min could be observed with respect to MP, which translates into 2.5% and 1.6% of the total and 1.55 and 1 c/min with respect to LP, representing 3.4% and 2.2% of the total. Regarding cycle length, an increase of 0.04 m/c could be seen in LP with respect to FP, representing 2%. This increase may be due to the fact that the FP cycle frequency is higher, therefore, we can think that the cycle length will be lower. The data of the crawl test can be seen in Table 1, while Table 2 shows the comparative results of MV and EI in crawl style in FP, LP and MP.

**Table 1.** Results of tests 1 and 2 of 50 m crawl during the different phases of the cycle.

| | MP | FP | LP | MP/FP | p | MP/FP | p | FP/LP | p |
|---|---|---|---|---|---|---|---|---|---|
| T50c1 | 30,41±1,47 | 29,86±1,56 | 30,38±1,42 | 0,55 | 0,009 | 0,03 | 0,83 | -0,52 | 0,03 |
| T50c2 | 30,57±1,62 | 29,98±1,62 | 30,54±1,65 | 0,58 | 0 | 0,03 | 0,79 | -0,55 | 0,001 |
| CF50c1 | 46,01±3,92 | 47,15±4,03 | 45,6±3,87 | -1,14 | 0 | 0,4 | 0,27 | 1,55 | 0,001 |
| CF50c2 | 46,31±4,51 | 47,06±4,34 | 46,06±4,28 | -0,75 | 0,05 | 0,25 | 0,53 | 1 | 0,04 |
| CL50c1 | 1,99±0,13 | 1,97±0,15 | 2,01±0,14 | 0,02 | 0,43 | -0,03 | 0,13 | -0,04 | 0,05 |
| CL50c2 | 1,96±0,16 | 1,97±0,16 | 1,99±0,16 | -0,003 | 0,91 | -0,03 | 0,24 | -0,03 | 0,37 |

T50c1, time in seconds of 50 crawl 1; T50c2, time in seconds of 50 crawl 2; CFc1, cycle frequency 50 crawl 1; CFc2, cycle frequency 50 crawl 2; CLc1, cycle length 50 crawl 1; CLc2, cycle length 50 crawl 2; MP, menstrual phase; FP, follicular phase; LP, luteal phase.

**Table 2.** Comparison of mean velocity (MV) and efficiency index (EI)

| | c1 | c2 | IC 95% MV 1 | IC 95% MV 2 | p |
|---|---|---|---|---|---|
| VM FP vs VM MP | 0,92±0,05 | 0,91±0,43 | 0,88–0,96 | 0,88–0,94 | 0,135 |
| VM FP vs VM LP | 0,92±0,05 | 0,91±0,05 | 0,88–0,96 | 0,88-0,94 | 0,197 |
| VM MP vs VM LP | 0,91±0,43 | 0,91±0,05 | 0,88–0,94 | 0,88-0,94 | 0,336 |
| IE FP vs IE MP | 1,24±0,01 | 1,24±0,05 | 1,21–1,28 | 1,20–1,28 | 0,358 |
| IE FP vs IE LP | 1,24±0,01 | 1,26±0,01 | 1,21–1,28 | 1,22-1,30 | 0,014* |
| IE MP vs IE LP | 1,24±0,05 | 1,26±0,01 | 1,20–1,28 | 1,22-1,30 | 0,001* |

MV FP (m/s): mean velocity in the follicular phase; MV MP (m/s): mean velocity in the menstrual phase; MV LP (m/s): mean velocity in the luteal phase; EI FP: efficiency index in the follicular phase; EI MP: efficiency index in the menstrual phase; EI LP: efficiency index in the luteal phase; c1: crol test 1; c2: crol test 2; 95% CI: 95% confidence interval; p: significance index; *: $p<0.05$.

**Discussion**

The main objective of this research was to determine the influence of the phases of the menstrual cycle on swimming performance, where a variation in the performance of the different variables analyzed (time, cycle frequency and length, average speed and efficiency index) could be appreciated. In agreement with the initial hypothesis established and based on the results obtained in relation to the time of execution of the test, a reduction of time was observed in the follicular phase compared to the menstrual phase and the luteal phase.

These results coincide with a study mentioned by Garcia Bataller which sought to establish the influence of the different phases of the menstrual cycle on running speed (Garcia Bataller, 2019). In this study, 24 women were subjected to a 5x30m test during 5 cycles. The test was performed during 4 phases of the cycle (follicular, ovulatory, luteal and menstrual). In this study it was observed that the performance of the athletes improved in all phases, due to the state of training, which improved during those months, but it was observed that in the menstrual phase the improvements were negligible. A greater improvement was also seen in the follicular phase (Garcia Bataller, 2019). These results also coincided with those obtained in a study where poorer performances were observed during the menstrual phase in a 30-meter sprint test in soccer players (Vila, 2016).

One of the most significant results found was the increase in cycle frequency in the follicular phase with respect to the other phases, which may explain the increase in speed in the follicular phase. Despite this finding, other studies report that running speed and recovery is not affected during three carefully controlled menstrual cycle phases (Tsampoukos et al., 2010), as well as no significant differences were found between the follicular and luteal phases in a speed test (Vila, 2016). In a study with female soccer players, tests measuring dynamic balance, lower body power and anaerobic capacity also found no significant differences in performance depending on the phase of the cycle (Arias Moreno et al., 2018). This is why the results obtained may not only be affected by the hormonal variations of the menstrual cycle, but may also be due to the characteristics of the test, since both the aforementioned studies in running and the studies collected in swimming tests show discrepancies in the findings. It is possible that the duration and intensity of the test is a significant factor in determining whether the phases of the cycle have an impact on performance, since most of the studies that relate the alteration of the metabolism of energy substrates due to the variation of the hormonal profile are related to aerobic or submaximal exercise tests (Ashley et al., 2000). Therefore, in shorter and more intense performance tests such as the one performed in the present study, it reduces the ability of estrogens to influence substrate metabolism (Burrows & Peters, 2007).

This study did not aim to study the effects on endurance, but it is interesting to review the results obtained on the possible relationship between the menstrual cycle and aerobic capacity in female swimmers. This interest lies in the economy of the swim, which may be a determining factor in the final performance of both endurance and the test used in this study. In this line, Constantini et al. (2005) mentioned several studies that have suggested slight decreases in aerobic capacity or exercise efficiency during the luteal phase. An increase in oxygen consumption and metabolic rate was also noted. In addition, worse running economy was seen at 80%, but not at 55% of maximal aerobic capacity during the luteal phase. In our study, it was found that there are significant differences in swimming efficiency in the phases of the menstrual cycle. Differences were found between FM and FL, as well as between FF and FL. There are no studies that have measured swimming efficiency, but the results of this study can be explained by the fact that strength has an important relationship with cycle frequency and cycle length in swimming. According to the findings of Sung et al. (2014) where they compare the effects of a strength program between men and women, observed improvements in maximal strength and muscle fiber diameter in a training based on the follicular phase than a training based on the luteal phase. This could support the significant changes in cycle frequency, as well as the recorded improvements in swimming efficiency, recorded in the luteal phase compared to the rest of the cycle phases. However, because there are no studies conducted in swimming, further research is required to determine the influence of the menstrual cycle on these variables.

Another aspect that can affect the decrease in performance can be the physical symptoms produced by menstruation, as they are one of the main difficulties suffered by female swimmers and affect their well-being and performance in the elite. During the different phases of the menstrual cycle, women can suffer up to 300 different types of physical and psychological symptoms, the vast majority of which appear from the late luteal phase up to menstruation (Caballero-Guzmán & Lafaurie-Villamil, 2020). In a study it was observed that the intake of calcium, vitamins and magnesium during this period helps to reduce the typical menstrual manifestations. Thus, it is explained that the contact with water, swimming, favors the regulation of hormone secretion during the menstrual cycle, by the activation of various nerves located in the dermis (Maged et al., 2018). Therefore, it is possible that the variations recorded in the performance of female swimmers are more affected by inter-individual athlete factors than by fluctuations between estrogen and progesterone production.

The main limitations of the present study were, firstly, not having analyzed the specific hormone concentrations of the menstrual cycle, secondly, not having followed up a greater number of menstrual cycles and finally the size of the sample.

In view of the results of the present study, as well as its limitations, research on this subject is warranted by adding the analysis of hormone concentration, as well as its repercussion on neuromuscular capacity and its effects on the swimming performance of young female swimmers.

**Conclusions**

In accordance with the objective of this work, the following conclusions can be drawn: a) the performance developed by the swimmers during the execution of the test was influenced by the different phases, being in the follicular phase when the best results were obtained; b) the frequency of the swimming cycle was the performance component studied that experienced the greatest changes in the different phases of the menstrual cycle, being in the follicular phase where the highest values were obtained; c) the interindividual differences of the swimmers on how the menstrual cycle affects their sport performance, is the main influential factor since if the training is going to undergo modifications based on the CM, the performance variable used, the objectives to be developed and therefore, how the individual changes of the subject are related to the sport modality, must be taken into account.

**Conflicts of interest**

The authors declare that they have no conflict of interest.

**References**

Arias Moreno, E. R., Martínez Benítez, J. E., Goyes Acaro, F. O., Ortiz Aldea, V. F., & Montero, S. (2018). Variability in the physical performance of female football players according to the phases of the menstrual cycle [in spanish]. *EmásF: Revista Digital de Educación Física, 51*, 11–30.

Ashley, C. D., Kramer, M. L., & Bishop, P. (2000). Estrogen and substrate metabolism: a review of contradictory research. *Sports Medicine*, *29*(4), 221–227.

Bale, P., & Nelson, G. (1985). The effects of menstruation on performance of swimmers. *Australian Journal of Science and Medicine in Sport*, *17*(1), 19–22.

Brooks-Gunn, J., Gargiulo, J. M., & Warren, M. P. (1986). The Effect of Cycle Phase on the Adolescent Swimmers. *The Physician and Sports medicine*, *14*(3), 182–192.

Burrows, M., & Peters, C. E. (2007). The influence of oral contraceptives on athletic performance in female athletes. *Sports Medicine*, *37*(7), 557–574.

Caballero-Guzmán, A., & Lafaurie-Villamil, M. M. (2020). Swimming with menstruation: a qualitative study of elite female swimmers [in spanish]. *Revista de La Facultad de Medicina*, *68*(3), 356–362.

Carmichael, M. A., Thomson, R. L., Moran, L. J., & Wycherley, T. P. (2021). The impact of menstrual cycle phase on athletes' performance: a narrative review. *International journal of environmental research and public health*, *18*(4), 1667.

Cejuela Anta, R. (2006). Swimming análisis: efficiency index [in spanish]. *Sport Training Magazine*, *9*, 24–27.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*, *2*(1).

Constantini, N. W., Dubnov, G., & Lebrun, C. M. (2005). The menstrual cycle and sport performance. *Clinics in Sports Medicine*, *24*(2).

Del Vecchio, A., Negro, F., Holobar, A., Casolo, A., Folland, J. P., Felici, F., & Farina, D. (2019). You are as fast as your motor neurons: speed of recruitment and maximal discharge of motor neurons determine the maximal rate of force development in humans. *The Journal of physiology*, *597*(9), 2445-2456.

Emmonds, S., Heyward, O., & Jones, B. (2019). The challenge of applying and undertaking research in female sport. *Sports Medicine-Open*, *5*(1), 1-4.

Garcia Bataller, A. (2019). Specific training for women [in spanish]. In *El deporte femenino, ese gran desconocido* (pp. 45–68). https://e-archivo.uc3m.es/handle/10016/28394

Hackney, A. C. (2016). Sex hormones, exercise and women: Scientific and clinical aspects. *Sex Hormones, Exercise and Women: Scientific and Clinical Aspects*, 1–315.

Lowe, D. A., Baltgalvis, K. A., & Greising, S. M. (2010). Mechanisms behind estrogen's beneficial effect on muscle strength in females. *Exercise and Sport Sciences Reviews*, *38*(2), 61–67.

Maged, A. M., Abbassy, A. H., Sakr, H. R. S., Elsawah, H., Wagih, H., Ogila, A. I., & Kotb, A. (2018). Effect of swimming exercise on premenstrual syndrome. *Archives of Gynecology and Obstetrics*, *297*(4), 951–959.

McNulty, K. L., Elliott-Sale, K. J., Dolan, E., Swinton, P. A., Ansdell, P., Goodall, S., Thomas, K., & Hicks, K. M. (2020). The Effects of Menstrual Cycle Phase on Exercise Performance in Eumenorrheic Women: A Systematic Review and Meta-Analysis. *Sports Medicine*, *50*(10), 1813.

Meignié, A., Duclos, M., Carling, C., Orhant, E., Provost, P., Toussaint, J. F., & Antero, J. (2021). The Effects of Menstrual Cycle Phase on Elite Athlete Performance: A Critical and Systematic Review. *Frontiers in Physiology*, *12*.

Pallavi, L. C., Souza, U. J. D., & Shivaprakash, G. (2017). Assessment of musculoskeletal strength and levels of fatigue during different phases of menstrual cycle in young adults. *Journal of clinical and diagnostic research: JCDR*, *11*(2), 11.

Petrofsky, J., al Malty, A., & Suh, H. J. (2007). Isometric endurance, body and skin temperature and limb and skin blood flow during the menstrual cycle. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, *13*(3), 111–117.

Pisapia, F., Senatore, B., & Fattore, S. (2019). Correlation between menstrual cycle and performance. *Journal of Physical Education and Sport*, *19*, 1972-1975.

Rechichi, C., & Dawson, B. (2012). Oral contraceptive cycle phase does not affect 200-m swim time trial performance. *Journal of Strength and Conditioning Research*, *26*(4), 961–967.

Smith, M. J., Adams, L. F., Schmidt, P. J., Rubinow, D. R., & Wassermann, E. M. (2002). Effects of ovarian hormones on human cortical excitability. *Annals of neurology*, *51*(5), 599-603.

Sung, E., Han, A., Hinrichs, T., Vorgerd, M., Manchado, C., & Platen, P. (2014). Effects of follicular versus luteal phase-based strength training in young women. *SpringerPlus*, *3*(1).

Tsampoukos, A., Peckham, E. A., James, R., & Nevill, M. E. (2010). Effect of menstrual cycle phase on sprinting performance. *European Journal of Applied Physiology*, *109*(4), 659–667.

Vila, M. (2016). Influence of the menstrual cycle on anaerobic capacity in women's football [in Spanish]. *Papeles Salmantinos de Educación*, *20*, 49–67.