

The influence of the menstrual cycle phase on the occurrence of injuries in athletes

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SUMMARY

Introduction. The menstrual cycle consists of two phases: the follicular phase and the luteal phase preceded by ovulation. Each of them is characterized by a specific distribution of hormones which cause a number of changes in the women's body. The aim of the study was to assess the influence of the menstrual cycle on the occurrence of injuries among women who train sports.

Material and methods. The study included 107 women aged 18–32 years who trained athletics, volleyball or handball and sustained injuries of the musculoskeletal system. An anonymous self-constructed questionnaire was used.

Results. All 107 women experienced musculoskeletal injuries. More than a half of the women sustained injury in the period before ovulation. The most common injury was twisted ankle.

Conclusions. A phase of the menstrual cycle has a significant influence on the occurrence of trauma in athletes.

Key words: trauma; musculoskeletal system; menstrual cycle

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Word count: 1582 **Tables:** 2 **Figures:** 0 **References:** 12

Received: 22.08.2017

Accepted: 28.11.2017

Published: 13.12.2017

INTRODUCTION

Periodical and cyclic changes in the ovary and endometrium, occurring from the menarche until menopause, are called the menstrual cycle. Normal cycle reflects normal relations within the hypothalamic–pituitary–gonadal system. This is of fundamental significance for health in terms of the reproductive function, but also for broadly understood well-being [1–3].

Menarche (first menstruation) usually occurs around the age of 13 years. The time of its occurrence depends on genetic, hormonal, environmental, nutritional and race-related factors. It is believed that cycles may be irregular for the first 2 years after menarche due to the immaturity of the hypothalamic–pituitary–gonadal system [1–3].

Normal menstrual cycle (eumenorrhea) usually lasts 28 days, but its prolongation or shortening by 3 days, or even 5 days according to certain authors, can be considered physiological. The cycle is divided into two fundamental parts: the first –follicular phase, and the second– luteal phase which begins after ovulation [1–3]. The superior center responsible for hormonal regulation is the hypothalamus which secretes releasing hormones (liberins) and inhibiting hormones (statins). These hormones play the major role in the regulation of the pituitary function. The pituitary secretes tropic hormones: adrenocorticotropin, thyrotropin and gonadotropins. They regulate the activity of the pituitary's subordinate executive glands, thereby promoting the development and function of adrenal glands, thyroid and gonads, respectively. Hypothalamic–pituitary–gonadal axis regulation is executed via three types of feedback loops: long loop: feedback between ovarian hormonal function and the function of the hypothalamus and pituitary, short loop: feedback between the pituitary hormonal function and hypothalamic function, as well as ultra-short loop: changes in releasing hormone concentrations within a cell [1–3]. The peripuber-

tal period is characterized by increased activity of the generator which is located in the hypothalamus and secretes gonadotropin-releasing hormone (GnRH). This leads to increased secretion of pituitary gonadotropins (LH and FSH) that stimulate the ovaries to produce sex steroid hormones. The menstrual cycle begins with the follicular phase during which estrogen levels increase and reach the peak on the day preceding ovulation. The level of luteinizing hormone begins to increase at the end of the follicular phase with its surge on the day of ovulation. Subsequently, the concentration falls abruptly and remains on a stable level thereafter. The second phase of the menstrual cycle, i.e. the luteal phase, lasts approximately 14 days and is characterized by endometrial growth. The ovarian follicle transforms into the corpus luteum which secretes progesterone and estradiol, thereby increasing their blood levels. In this phase, the uterus prepares itself for implantation of a fertilized egg. If this does not occur, progesterone levels fall, thus resulting in menstruation, and the whole cycle repeats [1–3].

There is no unequivocal evidence to confirm that injuries tend to occur in a given phase of the menstrual cycle. Certain sources point to menstruation as the time during which a woman is more prone to injuries due to a low level of estrogens that inhibit osteolytic action of parathormone and stimulate osteoblasts to bone formation. Also, estrogens affect circulation, increase flexibility and improve hydration and tissue perfusion [4]. Other sources, on the other hand, state that women are more prone to injuries before ovulation. These phases are considerably different from each other in terms of hormone concentrations. Since it is difficult to measure the level of hormones directly after injury, no direct conclusions have been drawn concerning how hormone concentrations affect an increase in the frequency of injuries in professional athletes [5].

AIM

The aim of the study was to assess the influence of the menstrual cycle on the occurrence of injuries in women who trained athletics, volleyball and handball. A relatively small sample was a limitation of the study. This was a survey-based investigation; the questions were not asked personally. Moreover, hormone levels were not determined, and the cycle phase was specified on the basis of patient interview.

MATERIAL AND METHODS

The group consisted of 107 women aged between 18 and 32 who regularly trained sports. The inclusion criteria were: regular sport training, regular menstrual cycles, injury sustained within the past 3 years, no systemic diseases and consent to participation. The exclusion criteria were: any menstrual disorders, no injury in the past 3 years, irregular sport training or an interval in training, systemic diseases and no consent to participation.

The study utilized an anonymous self-constructed survey with 42 questions. It was divided into four parts containing questions about demographic data, gynecological history, physical activity as well as sustained injury and the course of its treatment. The questionnaire was distributed via internet forums for professional athletes training track and field athletics, volleyball and handball. The participants included players of the first, second and third volleyball and handball leagues as well as field and track athletes who took part in the Polish Championships, regional championships and university competitions.

RESULTS

Among the respondents, 46 women were volleyball players (43%), 46 practiced athletics (43%) and 15 trained handball (14%). The mean age of the respondents was 22.6 \pm 2.7 years. Basic demographics as well as height and weight are presented in Table 1.

All the respondents had regular menstrual cycles, and the earliest age of menarche was 12 years. The mean length of the menstrual cycle was 30.5 \pm 3.9 days, and menstruation lasted 5.4 days \pm 1 day. Intermenstrual bleeding was reported by 19.6% of the women. Menstrual disorders in the past occurred in 48.6% of the respondents with stress being their main reported cause (18.7%). Amenorrhea usually lasted less than 3 months. Seventy-one per cent of the respondents declared training for at least 5 years. The athletes usually trained 3–5 times a week (49.5%). More than 5 trainings a week were reported by 41.1% of the women, and one training unit was usually 1–2-hour long (63.6%).

The most common time of injury was the pre-ovulatory period (58.9%), followed by menstruation (17.8%), peri-ovulatory period (12.2%) and post-ovulatory period (11.2%) (Tab. 2).

Volleyball players usually reported ankle (50%) and knee (39.1%) injuries. The same regions were the most susceptible to injury also in track and field athletes and handball players. Injuries were typically sustained during the main part of training (42.1%), and more rarely during contests (34.6%), warm-up exercises (15%) or other forms of activity (7.5%). Most respondents declare that injuries were rarer than once per 6 months (74.8%).

The recovery to the state from before injury usually took 3–4 weeks (29%). Recovery lasting 1–2 weeks concerned 6.5% of the respondents. Treatment lasting 1–4 months and 4–6 months was needed in 23.4% and 11.2% of the respondents, respectively. Treatment longer than a year concerned 1.9% of the women. Moreover, 5.6% of the respondents had no treatment at all. Trainings continued during treatment in 54.2% of the women. Full recovery was achieved in 70 women, 20 respondents did not recover fully, whereas 17 women still continued treatment during the study.

DISCUSSION

Female athletes are much more susceptible to musculoskeletal injuries than male athletes. The risk of trauma, e.g. cruciate ligament injury, is 2–8-fold greater in women than in men practicing the same sport. The literature states that changes in the hip and knee mechanics are strictly correlated with estrogen levels. These changes were much more prominent in the peri-

ovulatory phase, and the use of oral contraceptive pills reduces this correlation [6].

The literature does not specify which cycle phase is linked with an increased risk of trauma. Earlier studies in athletes have shown that the risk of injury increases directly before menstruation or in its first or second day [7]. The same results have been obtained in a study involving 86 female soccer players. It has been concluded that the risk of injury is greater in the pre-menstrual phase and during menstruation, particularly if menstruation was preceded by symptoms such as irritability, excessive stimulation, edema and breast tenderness [8]. Other studies, on the other hand, have shown that women usually sustain injuries during ovulation, whereas the follicular phase is characterized by a much lower risk of trauma. These data are not consistent with our findings [9].

According to Ekenros et al., sex hormone levels during the menstrual cycle may affect neuromuscular efficiency and the risk of muscle injuries in women. Fifteen healthy female participants with eumenorrhea had a muscle biopsy performed in three phases of the menstrual cycle. Significant differences were found between the three cycle phases in terms of mRNA, ERA protein and PR levels in the skeletal muscles. These results might influence effects of training and sport-related injuries in women [10].

Moreover, literature reports also mention that the levels of relaxin-2 increase in the luteal phase of the menstrual cycle, and that hormonal oral contraception significantly lo-

Tab. 1. Characteristics of the respondents

	Age [years]	Education [%]			Persons engaged in professional activities [%]	Height [cm]	Weight [kg]	BMI [kg/m ²]
		lower secondary	secondary	higher				
Volleyball players	23,1 +/- 3,2	2,2	47,8	50	32,6	179,1 +/- 6,6	69,2 +/- 8,2	21,5 +/- 1,5
Track and field athletes	22 +/- 2	2,2	60,9	36,9	41,3	168,5 +/- 5,6	56,6 +/- 4,8	20 +/- 1,4
Handball players	23 +/- 2,3	6,7	26,7	66,6	40	173,7 +/- 6,8	66,9 +/- 11,3	22 +/- 2,6

Tab. 2. Number of women with injuries by menstrual cycle phases

	Menstruation	Pre-ovulation	Ovulation	Post-ovulation
Volleyball players	9 (19,6%)	25(54,4%)	5 (10,87%)	7 (15,2%)
Track and field athletes	7 (15,2%)	29 (63,04%)	6 (13,0%)	4 (8,7%)
Handball players	3 (20,0%)	9 (60%)	2 (13,3%)	1 (6,7%)

wers its serum concentrations. However, further investigations are needed to assess the role of relaxin and hormonal contraception [11].

The results of published studies suggest that the level of physical performance changes across menstrual cycle phases, but there is no consensus among authors as to which of these phases is the most favorable. Certain authors observe an increase in physical performance in the progesterone phase, whereas others advocate for the estrogen phase. The menstrual cycle affects physical performance in 66% of all investigated women [12].

CONCLUSIONS

Cycle phase-dependent hormone levels affect various cells in the human organism, and physical activity associated with practicing a sport depends on the general fitness of the whole body. A phase of the menstrual cycle may have a significant influence on the occurrence of trauma in female athletes. Nevertheless, further investigations, involving more patients, are needed not only to indicate the cycle phase, but also to develop algorithms to reduce injuries in female athletes.

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