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THE EFFECT OF MENSTRUATION ON CHOSEN PHYSIOLOGICAL AND BIOCHEMICAL REACTIONS CAUSED BY THE PHYSICAL EFFORT WITH THE SUBMAXIMAL INTENSITY

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Abstract. The aim of this work was to determine the influence of the menstruation phase on changes of respective indicators of the gas exchange and on biochemical parameters of blood during physical efforts with the sub-maximal intensity. Fifteen female students of the Academy of Physical Education took part in the study. Girls were aged from 19 to 22 years old and did not practice sports. The effort tests were conducted in the follicular and luteal phase of two succeeding menstrual cycles. As far the aerobic capacity determination is concerned, one cyclo-ergometric test with graded effort was conducted and it was performed till the "refusal". It allowed to mark a threshold (TDMA) and a maximal level of physiological and biochemical indicators. Basing on the results of the graded test individual loads were determined for every next effort trial (repeated 4 times in every phase of the two succeeding menstrual cycles). The aim of this trial was to evaluate the reaction of women's constitution on work with the sub-maximal intensity. The above trial consisted on two 10 min efforts divided with the 2 min pause (the first effort with the intensity of 80% of the TDMA threshold, second with the intensity bigger about 30-40% of difference between TDMA and a maximal load established by the graded test). The research did not reveal statistically significant differentiation as considering effort changes of basic physiological and biochemical indicators, determining reaction of women's organisms on work with the sub- and over-threshold intensity (TDMA). It showed that menstruation has not significant effect on the level of changes of analysed parameters caused by the physical effort with the sub-maximal intensity. ***(Biol.Sport 20:53-67, 2003)***

Key words: Physiology – Menstruation - Physical effort - Physical efficiency

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Introduction

The interest about the effect of intense effort on female organism, especially as regards physiology of the progenitive system, increased together with the intensification of the participation of women in various sports activities including the record-seeking disciplines. The aim of gaining better sport results caused the demand for determining the influence of the complex intra-constitutional changes, taking place during the menstruation, on the ability of performing physical effort with various intensity.

Fluctuations of the endogenous estradiol and progesterone while regular menstrual cycle and all reproductive period, till the menopause occurrence, seem to be influential as regards women’s effort capacity. Estrogens and progesterone display wide effect on various processes connected with the metabolism. Progesterone causes increase of the ventilation of lungs and changes in stimulation of the respiratory apparatus in the medulla oblongata [4,25]. The low concentration of the progesterone in connection with estradiol effects the amount of plasma and pure estradiol effects the energetic substrata use through weakening of the gluconeogenesis and glycogenolysis [12] as well as through the increase of the accessibility and use of lipids [6]. The latter process takes place as a result of the metabolism change towards enlarging of amount of the free aliphatic acids as an energy source what flows from the increase of the fat synthesis and lipolysis in muscles and the fatty tissue [5,6]. The increase of the progesterone level causes obstruction in the aldosterone work at the level of kidneys what ends with the loss of water and soda [13]. The above processes are tightly connected with changes taking place during physical effort performance. This connection suggests that cyclic fluctuations of the progesterone and estradiol concentration during menstruation may influence the level of the physical capacity of women.

However, results gained so far do not allow to determine the effect of respective menstrual phases on the level of women’s capacity. Nevertheless, there exist premises pointing out that in the follicular phase abilities for performing efforts basing on anaerobic energetic changes and in luteal phase - basing on aerobic energetic changes are increasing [7,15,20].

Significant difference of opinions in references as considering menstrual cycle influence on changes of physiological and biochemical indicators during performing physical efforts with the sub-maximal intensity became an inspiration for conducting this kind of research.

Material and Methods

Fifteen female, non-athlete students of the Academy of Physical Education in Cracow took part in the research. Their activity resolved itself into obligatory classes of the studies programme.

The precondition of the enrolment was the regular, two-phase menstrual cycle as well as the declaration of taking any hormonal concoctions including oral contraceptives and proper result of basic gynaecological examination.

The accordance and regularity of menstruation was confirmed by the measurement of every day body temperature during three succeeding months. This measurement continued also in period of research what allowed verification of the length of the respective menstrual phases. The proper assignment of the examination terms was being confirmed through the marking of level of the estradiol and progesterone in plasma.

Basic somatic parameters i.e.: height, body mass and thickness of the skin fat folds (measured at the front and the back surface of an arm, under the shoulder blade and at the abdomen) were measured before the beginning of researches. The lean body mass (LBM) was established on the basis of the fat folds thickness using Durnin's and Womersley's formula [11] (which allowed marking the body density) and Siri's formula [26] for the estimation of the proportional fat content (%F) basing on the body density.

The whole observation presented two effort tests: the graded test and the "2 x 10 min" test which was the main part of the examination. The first test was conducted only once after the random choice of the menstruation phase. The main trial ("2 x 10 min") was conducted in both phases of the menstruation during two succeeding menstrual cycles (between 6 and 9 day of the follicular phase and between 5 and 8 day of the luteal phase). All series of the examination were conducted in constant temperature of the surroundings, before noon in possibly similar hours.

The graded test was performed on the cycling ergometer. It began with 4 min effort with the load equal 1 $W \cdot kgLBM^{-1}$ and next, every 2 min the load was being enlarged about half of the initial value. The test was continued until the subjective feeling of exhaustion.

The aim of this trial was to determine the effort reaction on work with the maximal intensity as well as gaining some data about the course of parameters of the breathing apparatus needed for determining of the II ventilation threshold (which is univocal with the threshold of decompensated metabolic acidosis – TDMA).

The test “2 x 10 min” consisted of two – 10 min efforts divided with the 2 min break and was conducted on the cycling ergometer. The intensity of the first trial was lower from the threshold value and presented about 80% of it. The intensity of the second trial exceeded the threshold of decompensated metabolic acidosis about 30-40% difference between the TDMA and the maximal effort load (which was determined earlier during the graded test). Thus, the assumption emerged that the second metabolic threshold occurs when the percentage content of CO_2 in the expiratory air is the highest and the breathing equivalent for the carbon dioxide ($V_E \cdot VCO_2^{-1}$) is the lowest [2,24,27].

Basing on the analysis of the expiratory air the dimension of several indices characterizing gas change was being designated in 30–s intervals during the whole graded test and every part of the “2 x 10 min” test. Analysed were: min oxygen consumption – VO_2, min carbon dioxide emission – VCO_2, respiratory quotient – RQ, min lungs ventilation – V_E, respiratory capacity – V_T, and respiration frequency – F_R. Average levels of the above parameters assayed from the last 4 min of the trial (7-10 min) were taken for the characterisation of the state of the functional balance in sub-maximal efforts. The oxygen deficiency was also estimated.

Restful and after effort levels of the respective biochemical parameters were analysed during this research i.e.: lactate concentration – [La^-], hydrogen ions concentration – [H^+], as well as the deficiency (excess) of the blood buffer alkali [BE]. The blood samples were taken directly after every effort performance and additionally in 5, 10, and 20 restitution min after the second test effort.

All test efforts were performed on the cycling ergometer of the Monark company (type 818 E). Computerised ergo-spiro-meter “Medikro 202 E” of the Medikro OY company (Finland) was used for the measurement of breathing change parameters. For the estimation of the acid – alkali balance parameters the Corning 238/pH Blood Gas Analyser was used. The lactate concentration in blood was assayed with the calorimetric method through the enzymatic test: Lactate PAP of the BioMerieux company. The estimation of the plasmatic level of menstruation hormones was done using the chemiluminescent method in The Endocrinology Laboratory of the Laboratory Diagnostics Department of the Provincial Specialized Hospital under the name of L. Rydygier in Cracow.

Data gained during this study were compiled using the descriptive statistics method. One analysis of variance was used for determining the significance of amid phases differences.

The Regional Supervision Board over the Researches Performed on Humans by the Oncology Centre Institute under the name of M. Skłodowska-Curie in Cracow agreed for this research performance.

Results

Table 1
Age and physical characteristics of the subjects

	Age (years)	Body height (cm)	Body mass (kg)	LBM (kg)	%F
x	20.3	167.3	57.6	44.0	23.3
SD	0.8	6.0	6.2	3.6	4.1

The average age of the examined group of students amounted to 20.3 years (Table 1). The youngest one slightly exceeded 19 year and the oldest 22 year of life. The average body height amounted to 167.3 cm (160-178 cm), and the body mass to 57.6 kg (46.5-68.8 kg). The lean body mass (LBM) was measured on the basis of the thickness of skin fat folds and reached the amount of 44.0 kg. The percentage fat content (%F) ranged from 17.6 to 32.3% (average – 23.3%).

Table 2
The level of chosen physiological variables during the maximal effort and the power of TDMA intensity effort

	Pmax (W)	VO_2max ($l \cdot min^{-1}$)	VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	$V_E$max ($l \cdot min^{-1}$)	$F_R$max ($1 \cdot min^{-1}$)	$V_T$max (l)	HRmax ($1 \cdot min^{-1}$)	TDMA (W)	TDMA %Pmax
x	165.4	2.30	39.9	85.7	45.7	1.89	194.1	106.1	64.1
SD	24.1	0.38	5.0	18.6	8.4	0.36	7.9	18.5	4.6

Analysis of the level of the physiological indices characterizing the effort with the maximal intensity (Table 2) revealed that the size of maximal min oxygen intake amounted to 2.30±0.38 l min^{-1} and after the relativization to the body mass – to 39.9±5.0 ml kg^{-1}. The maximal intensity effort was also characterized by the heart rate amounting to 194.1±7.9 s·min^{-1}. The lungs min ventilation was at the level of 85.7±18.6 l·min^{-1}. The size of $V_E$max was achieved with the respiration capacity equal 1.89 l and breathing frequency about 46 breaths per min.

Table 3
The differences between follicular and luteal phases of the first menstrual cycle (x ±SD) in the mean level of chosen physiological variables

		"2 x 10 min" test FIRST CYCLE Follicular phase	Luteal phase	F-L
VO_2 (l·min^{-1})	First effort	1.28±0.23	1.30±0.20	-0.02
VO_2·kg^{-1} (ml·kg^{-1}·min^{-1})		22.08±2.98	22.31±2.69	-0.22
VCO_2 (l·min^{-1})		1.2±0.21	1.25±0.20	-0.05
RQ		0.94±0.05	0.96±0.05	-0.02
V_E (l·min^{-1})		37.46±7.41	39.34±7.15	-1.89
V_T (l)		1.33±0.31	1.40±0.24	-0.07
F_R (1·min^{-1})		28.96±4.97	28.81±4.92	0.15
Oxygen deficyt (l)		0.91±0.31	0.87±0.35	0.05
VO_2 (l·min^{-1})	Second effort	1.86±0.28	1.88±0.27	-0.02
VO_2·kg^{-1} (ml·kg^{-1} ·min^{-1})		32.24±3.63	32.27±3.31	-0.03
VCO_2 (l·min^{-1})		1.94±0.46	1.91±0.27	0.03
RQ		1.00±0.06	1.02±0.04	-0.02
V_E (l·min^{-1})		60.15±10.24	64.37±12.38	-4.22
V_T (l)		1.72±0.28	1.82±0.34	-0.11
F_R (1·min^{-1})		35.33±4.62	35.31±6.67	0.02
Oxygen deficyt (l)		1.68±0.30	1.62±0.36	0.06

*statistically significant differences (P<0.05)

The threshold of decompensated metabolic acidosis (TDMA) was established basing on the biochemical parameters at the level of 106.1±18.5 W, what presented about 64.1% P_{max}. Individual values of this parameter fluctuated from 75 to 134 W and noticed at the threshold level percentage value of the maximal effort load (%P_{max}) ranged from 54.6 to 71.0%.

Table 4
The differences between follicular and luteal phases of the second menstrual cycle (x ±SD) in the mean level of chosen physiological variables

		"2 x 10 min" test SECOND CYCLE Follicular phase	Luteal phase	F-L
VO_2 $(l \cdot min^{-1})$	First effort	1.34±0.21	1.34±0.23	0.00
$VO_2 \cdot kg^{-1}$ $(ml \cdot kg^{-1} \cdot min^{-1})$		23.35±2.82	23.14±3.38	0.20
VCO_2 $(l \cdot min^{-1})$		1.19±0.20	1.22±0.21	-0.04
RQ		0.89±0.07	0.91±0.08	-0.03
V_E $(l \cdot min^{-1})$		36.53±7.76	38.56±8.01	-2.02
V_T (l)		1.33±0.27	1.38±0.31	-0.05
F_R $(1 \cdot min^{-1})$		27.88±5.44	28.44±4.66	-0.56
Oxygen deficyt (l)		0.98±0.43	0.87±0.31	0.11
VO_2 $(l \cdot min^{-1})$	Second effort	1.98±0.30	1.95±0.31	0.03
$VO_2 \cdot kg^{-1}$ $(ml \cdot kg^{-1} \cdot min^{-1})$		34.10±4.00	33.62±4.44	0.48
VCO_2 $(l \cdot min^{-1})$		1.82±0.28	1.85±0.28	-0.03
RQ		0.92±0.07	0.95±0.08	-0.03
V_E $(l \cdot min^{-1})$		58.56±11.34	62.36±12.63	-3.79
V_T (l)		1.71±0.30	1.76±0.34	-0.06
F_R $(1 \cdot min^{-1})$		34.43±4.22	34.93±4.01	-0.51
Oxygen deficyt (l)		1.73±0.48	1.65±0.39	0.07

*-statistically significant differences (P<0.05)

The differentiation of physiological indices while efforts with the sub-maximal intensity (test “2 x 10 min”) between follicular and luteal phase of menstruation turned out insignificant in both analysed cycles. In case of some parameters those differences did not exist (Table 3 and 4).

Detailed analysis of the min oxygen intake did not display differentiation between both phases of the menstrual cycle. The lack of the amid phases difference was also noticed regarding the size of VO_2 converted to the body mass kilograms. During the effort with the smaller intensity these differences amounted to ±0.2 $ml \cdot kg^{-1} \cdot min^{-1}$ and slightly higher level (about 0.5 $ml \cdot kg^{-1} \cdot min^{-1}$) was observed in the follicular phase of the cycle during more intense effort. As considering oxygen intake level more significant differences were noticed in the same phases of various menstrual cycles.

Differences considering other parameters (VCO_2, V_T, F_R, O_2 deficiency) also turned out insignificant.

The biggest differentiation between the follicular and luteal phase was observed - in both succeeding cycles – in the min lungs ventilation. The difference in the first cycle amounted in succeeding efforts to - 1.9 and 4.2 $l \cdot min^{-1}$ and in the second cycle respectively to - 2.0 and 3.8 $l \cdot min^{-1}$. Higher values of V_E were noticed in the luteal phase. However, this differentiation was not statistically significant as it not exceeded 0.7% of the real value of the lungs ventilation measured during more intense effort (60 $l \cdot min^{-1}$).

Both components of the min lungs ventilation i.e.: the breathing capacity and frequency, also did not display significant amid phases variation. Slightly higher values in the luteal phase were noticed as considering V_T (differences did not exceeded 0.11 l). Next, as regards F_R differences fluctuated from 0.2 to 0.6 breaths per min (Table 3 and 4). One factor analysis of variance did not confirm the statistically significant differentiation between the follicular and luteal phase of menstruation within the sphere of the effort level of physiological indices.

As considering the biochemical indices of blood, variations between respective phases of the menstruation as well as between the first and second cycle also turned out insignificant (Table 5 and 6). The after effort lactate concentration and indirectly connected with it loss of the alkali store reached bigger range of changes in the follicular phase. On the other hand, slightly higher concentration of the hydrogenous ions manifested itself in the luteal phase.

Lactate concentration analysis showed that the biggest – although statistically insignificant – amid phases differentiation occurred immediately after the second effort (in II examination round) and the difference (F-L) equalled 0.5 $mmol \cdot l^{-1}$ (8.0±1.6 and 7.5±0.9 $mmol \cdot l^{-1}$). The concentration of the hydrogenous ions displayed higher values in the luteal phase with the exception of some signatures in the restitution phase. The biggest amid phases difference as considering this index was noticed in the 20 min of the restitution (in I examination round). The difference (F-L) presented then: 0.9 nmol·l^{-1} (39.3±2.0 and 40.2±2.4 nmol·l^{-1}).

Table 5
The differences in biochemical blood parameters (x ±SD) between follicular and luteal phases of the first menstrual cycle

		"2 x 10 min" test FIRST CYCLE		
		Follicular phase	Luteal phase	F-L
$[La^-]$ (mmol·l^{-1})	Rest	1.8±0.5	2.1±0.5	-0.3
	I	4.1±1.1	4.0±1.0	0.1
	II	8.2±1.4	8.2±1.2	0.0
	5'	7.0±1.5	6.6±1.3	0.4
	10'	5.4±1.0	5.2±1.3	0.2
	20'	3.4±0.8	3.3±1.0	0.1
$[H^+]$ (nmol·l^{-1})	Rest	38.8±1.7	39.9±1.8	-1.1
	I	41.9±1.8	42.0±2.0	-0.1
	II	48.2±3.3	48.3±3.3	-0.1
	5'	45.8±3.2	45.5±2.8	0.3
	10'	42.4±2.4	42.6±3.0	-0.1
	20'	39.3±2.0	40.2±2.4	-0.9
[BE] (mmol·l^{-1})	Rest	0.1±1.3	-0.8±1.5	0.9
	I	-2.4±1.7	-3.1±2.0	0.7
	II	-7.2±2.2	-7.7±2.1	0.5
	5'	-6.7±2.2	-6.9±2.4	0.2
	10'	-4.7±2.3	-5.1±2.4	0.4
	20'	-1.9±1.9	-2.7±1.9	0.8

*-statistically significant differences (P<0.05)
Rest - before start of the test; I - immediately after the first effort; II - immediately after the second effort
5', 10', 20' – minutes of restitution after end of the test

The size of the alkali store loss formed itself inversely proportionally in the relation to the lactic acid concentration. The biggest amid phases differences were noticed in the measurement preceding test efforts and in the 20 min of the restitution (in the I examination round). Signalled variations amounted to respectively: 0.9 and 0.8 mmol·l^{-1} (Table 5 and 6).

Table 6
The differences in biochemical blood parameters (x ± SD) between follicular and luteal phases of the second menstrual cycle

		"2 x 10 min" test SECOND CYCLE		
		Follicular phase	Luteal phase	F-L
[La$^-$] (mmol·l^{-1})	Rest	1.7±0.5	2.0±0.6	-0.3
	I	3.8±1.1	3.8±0.7	0.0
	II	8.0±1.6	7.5±0.9	0.5
	5'	6.38±1.5	5.9±0.9	0.4
	10'	4.6±1.1	4.6±0.7	0.0
	20'	3.0±0.7	3.0±0.6	0.0
[H$^+$] (nmol·l^{-1})	Rest	40.0±2.3	40.0±3.1	0.0
	I	41.6±2.5	42.1±2.7	-0.5
	II	47.4±3.4	47.9±3.2	-0.5
	5'	44.9±3.8	44.5±3.6	0.4
	10'	42.2±3.5	42.0±3.0	0.2
	20'	39.6±2.9	40.0±2.5	-0.4
[BE] (mmol·l^{-1})	Rest	-0.1±1.4	-0.7±1.8	0.6
	I	-2.2±1.8	-2.9±1.9	0.7
	II	-6.8±2.5	-7.4±2.3	0.6
	5'	-6.0±2.3	-6.3±2.2	0.3
	10'	-4.3±2.4	-4.5±2.2	0.2
	20'	-1.7±2.1	-2.3±2.1	0.6

*-statistically significant differences (P<0.05)
Rest - before start of the test; I – immediately after the first effort; II - immediately after the second effort
5', 10', 20' - minutes of restitution after end of the test

One factor analysis of variance did not confirm significant differentiation between both menstruation phases within the field of the biochemical parameters of blood.

Discussion

The references considering sports physiology do not allow to state explicitly whether the menstruation phases have significant influence on women's effort capacity. According to Turner and Forthey [32], Bunt [6] and Hackney [15] big concentration of the progesterone and estrogens leads to holding the constitutional fluids [12] and saving the glycogen during the physical effort. Thus, the glycogen use is reduced and the production of the lactic acid in muscles is lower [7] while the lipid amount in working muscles is growing [6,20]. The change of metabolism towards enlarging of the amount of the free fat acids as an energy source is caused by the growth of the fat synthesis and lipolysis in muscles and the fatty tissue [5].

Basing on the data gained by mentioned above authors it can be stated that the luteal phase favours the performance of efforts which are based on aerobic energetic changes (i.e.: efforts with moderate intensity) while the follicular phase – performance of the anaerobic work (i.e.: with the maximal and supra-maximal intensity) [16]. Better predisposition for endurance efforts in the progesterone's phase in women were also observed by Sykut [30,31] in her evaluation of the capacity of female skiing runners as well as other sports female representatives in juxtaposition with reached sports results depending on the menstruation phase. Other authors also gained similar results [6,9,17] explaining this phenomenon with the influence of the estradiol on the lipid and carbohydrate metabolism regulation. During the effort, especially in the luteal phase, the estradiol hormone causes the restriction of the liver gluconeogenesis, the thrift of glycogen and the enforcement of the fat metabolism. It leads to the lowering of the lactate production in this phase.

Schoene *et al.* [25] proved that the progesterone causes the increase of lungs ventilation and changes in the breathing apparatus stimulation. Results gained by Jurkowski *et al.* [17] confirmed this statement. They noticed higher values of the maximal min lungs ventilation in the luteal phase. This accordance was also observed in our own researches where differences within the space of lungs ventilation between luteal and follicular phase during the effort with the maximal intensity turned out the biggest of all analysed physiological indices in the luteal phase advantage. Amid phases differences reached the level of 2.5 $l \cdot min^{-1}$ with the V_E close to 50 l.

Considering the clarity of the physiological bases (changes of the sex hormones concentration), which should have the influence on changes of the physical effort performance with different intensities, the variety of results gained by respective authors is astonishing. Numerous studies are pointing at the improvement of the effort capacity in the follicular phase. According to Döring [10] functions that have the effect on the psychomotor fitness display their highest abilities after menstruation (muscles strength, balance regulation, comfort). Minimal abilities usually occur before menstruation (in the luteal phase). Other researches [3] showed that the optimal regeneration ability and the highest after effort potential are reached in 10 day of the cycle (follicular phase). Lower level of the subjective evaluation of the work load in the follicular phase was noticed simultaneously by other authors [21]. Bale and Nelson [1] in the research conducted on swimmers also noticed better results gaining in the follicular phase.

Some positions proving increase of the effort capacity in the luteal phase can be found in references. Over 80% of 348 female athletes taken under the examination reached better sports results in the pre-menstrual period [23]. Similar results gained other authors [33] who stated advantageous changes of physical capacity in women's organisms in the luteal phase. The follow up study has confirmed this accordance [17,19].

The references considering this subject do not give bases for the statement that the menstrual cycle has the effect on production of lactic acid in muscles during the physical work. Numerous researches point that the menstrual cycle does not influence the effort concentration of lactate in blood [8,9]. It was also confirmed by our own study. However, it is enhanced in many works that the lactic acid production is significantly higher in the follicular phase [7,17]. It is a result of smaller production of La in the luteal phase caused by the fact that the concentration of ions [HCO_3^-] has an impact on the transport of lactate and hydrogenous ions from muscles to the blood – [17] which is smaller in this phase. These discrepancies may also be the effect of using carbohydrates during work as it was stated that the higher level of the estradiol and progesterone in blood in the luteal phase have an influence on the glycogen thrift during the physical effort [17]. It may effect in lowering of the lactate concentration in blood and lengthening of the effort time performance. Nevertheless, it is known that the lactic acid concentration is not only conditioned by its production but it is a resultant of its production and neutralisation. Thus, the discrepancies between different authors' results might be the effect of the complex influence of various factors, aiming at keeping up the constitutional homeostasis, which not always undergo the analysis during effort tests.

In the light of described above research results it is not possible to state univocally that the menstruation phases have significant effect on the physical capacity of women. Our own studies did not manifest significant differentiation as regards analysed physical and biochemical indices though, effort tests were repeated 4 times. Similar conclusions specified Sykut [29] who enhanced variety of results of both the inquiry research and laboratory experiments gained by different authors. It is probably the result of an individual character of the functional adaptation to the physical effort in different cycle phases [16]. Nicklas *et al.* [19] also determined statistically insignificant differences in average exhaustion time between the follicular and luteal phase. Similar results were gained by De Souza *et al.* [8] whose research conducted on female runners did not display differences between phases within the domain of the subjective evaluation of the work load during the effort continued till the “refusal” and at the level of the lactate concentration in plasma. Moreover, they did not notice differences between women menstruating regularly and women with the reiterated lack of menstruation. Pivarnic *et al.* [21] examined women as regards their ability to the endurance effort. They also did not observe amid phases differences considering aerobic capacity. The lack of the differentiation regarding effort and after effort metabolism in both menstruation phases was observed by other authors [9,14,18,28]. According to Pokora [22] the cycle phases do not significantly influence the sweat production as well. Mentioned discrepancies in results of various authors flow probably from the lack of conditioning between the cycle phase and the level of effort physiological reactions. As a consequence, the crucial role have the individual effort predisposition and other changeable individual factors.

Conclusions

1. The analysis of the effort level of the breathing system parameters shows the lack of significant amid phases differences considering physiological reaction of this system on work with the sub-maximal intensity.
2. After effort level of biochemical indices in blood also did not display significant differentiation in both menstruation cycles pointing at the lack of differences in aerobic changes as an answer for applied efforts with the under- and over-threshold intensity (TDMA).
3. Research results point out the lack of significant effect of menstruation phases on the level of physiological and biochemical reactions elicited by the physical effort with the sub-maximal intensity.

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