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HEMODYNAMIC, HORMONAL AND METABOLIC FACTORS OF FITNESS LEVEL AT WOMEN

Walery Zukow[1], Nataliya L Horkovenko[2], Rostyslav F Hryvnak[3], Roman Y Romans'kyi[3], Lyubov I Holovach[3]

[1]Faculty of Earth Sciences, Nicolaus Copernicus University in Toruń, Poland w.zukow@wp.pl
[2]JSC "Dnipro-Beskyd", Truskavets', Ukraine dnipro-b@bk.ru
[3]JSC "Truskavets'kurort", Truskavets', Ukraine

Abstracts

Background. It is known that the state of physical fitness of people who come to rehabilitation varies considerable range. We know also that this contingent characterized significant deviations in both sides of the gender and age norms of a number of parameters hemodynamic and autonomic regulation as well as of lipid and electrolytes exchange. Hence the assumptions listed parameters related to the state of the physical form. We set a goal by correlation analysis to detect hemodynamic and metabolic as well as hormonal factors of fitness level. **Materials and methods.** The object of observation were 29 women (average age 45 years with a range of 29-61 years) patients with chronic cholecystitis in remission who arrived at spa Truskavets' (Ukraine) for rehabilitation. Physical form evaluated on a 5-point Åstrand scale using veloergometry. State of central hemodynamics was investigated by echocardiography. Plasma levels of cortisol, aldosterone, estradiol, TSH and triiodothyronine determined by ELISA, of triacylglycerides, cholesterol in lipoproteins of different density, uric acid, phosphate, calcium, magnesium, sodium and potassium determined by methods reflometry and spectrophotometry. In addition, determined levels of sodium and potassium in erythrocytes as well as the activity of Na,K-, Ca- and Mg-ATPase of erythrocyte membranes. Testing was performed twice. **Results.** Ascertained wide variety of fitness level on a 5-point Åstrand scale: unsatisfactory in 15,5%, satisfactory in 64% and good in 20,5%. The method of correlation analysis revealed both positive (levels in plasma estradiol, cholesterol of alpha-lipoproteines, triiodothyronine, magnesium and level in erythrocytes sodium) and negative (blood pressure, levels in plasma cortisol, triacylglicerides, TTH, uric acid and Mg-ATPase activity) actotropic factors which together determine the level of physical fitness on 55%. **Conclusion.** Identified actotropic factors may be viewed as objects of targeting of fitness rehabilitation in women.

Key words: physical fitness, hemodynamics, hormonal and metabolic factors, women.

INTRODUCTION

We know that the state of physical fitness of people who come to rehabilitation varies considerable range. In particular, according to IL Popovych etc. [12] among the contingent of 66 women 40-54 years and 18 men 54-61 years who arrived for rehabilitation chronic diseases of the digestive system (noncalculous and calculous cholecystitis, biliary dyskinesia, gastritis, gastroduodenitis, duodenal ulcer, pancreatitis, colitis), physical condition on a 5-point by Åstrand scale was satisfactory (3 points) in 40.5%, unsatisfactory (2 points) - in 31.0%, extremely poor (1 point) – in 2.4% of individuals. However, 19.0% of patients received good (4 points), and 7.1% - excellent (5 points) assessment of physical condition. The authors found that this contingent characterized significant deviations in both sides of the gender and age norms of a number of parameters hemodynamic and autonomic regulation as well as of lipid and electrolytes exchange. In particular, reduced cardiac output (<80% of predicted) detected in 19.0% and high (>120% of predicted) in 33.3%. Regarding the median blood pressure corresponding values are 16.7% and 28.6%, total peripheral vascular resistance - 28.6% and 23.8%, Baevskiy's stress-index of autonomic regulation - 38.1% and 26.2%, Klimov's atherogenic index - 7.1% and 61.9%. This lower cholesterol of α-lipoproteins stated in 54.8% and below the average at 16.7%, while higher than average only at 9.6% and higher at 2.4% of patients. Body weight exceeded due to the 20% or more in 26.2% of patients, to 20÷8% rule also in 26.2%, within 107÷93% rule found in 35.7%, due to lower to 8÷20 % than predicted in 7.1%, more than 20% in 4.8%.

Hence the assumptions listed parameters related to the state of the physical form, but the correlation analysis in this vein, the authors cited was not conducted. Not registered in this group settings endocrine status, despite the well-known role of hormones in physical capacity [15].

Based on the above, we set a goal by correlation analysis to detect hemodynamic, hormonal and metabolic factors of physical forms of a typical group of patients who come to rehabilitation in spa Truskavets'.

MATERIALS AND METHODS

The object of observation were 29 women (average age 45 years with a range of 29-61 years) patients with chronic cholecystitis in remission. Physical form evaluated on a 5-point Åstrand scale, taking into account age and maximal oxygen uptake, calculated by the parameters of a two-stage (loads 0.5 and 1.5 W/kg) veloergometry (veloergometer "Tunturi", Finland [14]). State of central hemodynamics was investigated by echocardiography [5] (echocamera "Toshiba-140", Japan). Among hormonal parameters were tested in plasma cortisol, aldosterone, estradiol, thyrostimulating hormone (TSH) and triiodothyronine (ELISA [7], analyzer "Tecan", Oesterreich). Among the parameters of metabolism recorded level triacylglycerides, cholesterol in lipoproteins of different density, uric acid, phosphate, calcium, magnesium, sodium and potassium in the plasma, and the last two in erythrocytes (methods reflometry and spectrophotometry [6] sets "Reflotron" , Deutschland; "Pointe-180", USA; "SF-46", Russia). In addition, was determined the activity of Na,K-, Ca- and Mg-ATPase of shades of erythrocytes [10]. Testing was performed twice.

Digital material is processed on a PC by methods variational, correlation and canonical analysis using the software package "Statistica 5.5".

RESULTS AND DISCUSSION

Among 58 tests physical form evaluated as 1 point in 3 cases, 2 points in 6, 3 points in 37, 4 points in 6 and 5 points in 6 cases, that was unsatisfactory in 15.5% tests, satisfactory in 64%, good at 20.5% tests. Table 1 shows the estimated classic parameters of veloergometry [2,4] and proposed by IL Popovych [9,11,12,13] the indices of tachicardic (ITCR) and tachicardic-hypertensive (ITCHTR) reactions to load 1.5 W/kg that are close to the watt-pulse by NM Amosov and JL Bendet [1] as well as the index of efficiency of heart work by Aptecar [cit. by: 3], but more adequately describe the state of fitness and Baevskiy's adaptation potential [11].

The level of physical fitness in points by definition is highly correlating with VO_2max (r=0,92), also strongly associated with ITCR (r=0,77) and especially with ITCHTR (r=0,86), while less with PWC_{150} (r=0,58). Therefore, we restrict further comparative analysis of relations with hemodynamic, hormonal and metabolic factors of physical form and ITCHTR only.

Table 1. Comparison of parameters veloergometry at women with different states of fitness

Fitness quality	Parame-ters	Fitness	VO_2max	PWC_{150}	ITCR on load 1,5 W/kg	ITCHTR on load 1,5 W/kg
	Units	points	ml/min•kg	W/kg	mW/kg•beatHR	μW/kg•beat•mmHg
Unsatisfactory (n=9)	X m	1,8 0,2	27,0 0,9	1,59 0,16	9,80 0,23	55,2 2,4
Satisfactory (n=37)	X m	3,0 0,0	34,5 0,7	1,91 0,07	10,72 0,15	77,3 1,0
Good (n=12)	X m	4,4 0,2	46,5 2,3	3,03 0,24	12,95 0,22	103,2 2,6
	P u-s	c	c	ns	c	c
	P u-g	c	c	c	c	c
	P s-g	c	c	c	c	c

Note. The letter indicated the likelihood of differences between groups of unsatisfactory (u), satisfactory (s) and good (g) physical form: ns - nonsignificant; a – $p<0,05$; b – $p<0,01$; c – $p<0,001$.

As shown in table 2, the higher the physical form, the lower systolic blood pressure both at rest and after metered physical activity. The strength of negative correlation is minimal at rest (r=-0,32), intermediate after moderate load (r=-0,41) and maximum after submaximal load (r=-0,54). A similar pattern, but at significantly higher levels were found in relation ITCHTR: r=-0,41; -0,61 and -0,76 respectively. Diastolic blood pressure is somewhat less informative. This is consistent with the provisions that for an objective assessment of physical working capacity of the body must produce enough exercise [1,2,4].

Table 2. Comparative characteristics of basal and reactive values of systolic blood pressure and pulse at women with different states of fitness

Fitness quality	Parame-ters	Systolic blood pressure, mm Hg			Heart Rate, beats/min	
	Units	At rest	After 0,5 W/kg	After 1,5 W/kg	After 0,5 W/kg	After 1,5 W/kg
Unsatisfactory (n=9)	X m	127 4	146 6	165 6	108 5	142 3
Satisfactory (n=37)	X m	122 2	126 2	140 2	102 2	138 2
Good (n=12)	X m	114 5	118 3	126 3	92 3	117 2
	P u-s	ns	b	c	ns	ns
	P u-g	a	b	c	b	c
	P s-g	ns	a	c	b	c

The observed pattern also applies tachicardic response to exercise: strength correlation is higher after higher load (r=-0,48 and -0.41 vs -0.61 and -0.62 for points of fitness and ITCHTR respectively).

The results of screening correlation between ITCHTR at fitness, on the one hand, and hormonal and metabolic status, on the other hand, was formed three clusters. The first cluster made parameters that positively correlated with fitness parameters, are positive actotropic factors (table. 3). They were: plasma levels of estradiol (r=0,42 and 0,34 in respect ITCHTR and fitness points respectively), cholesterol of alpha-lipoproteins (r=0,41 and 0,42), triiodothyronine (r=0,31 and 0,20), magnesium (r=0,29 and 0,18) as well as sodium levels in red blood cells (r=0,35 and 0,24) as a marker of sodiumhistia.

Table 3. Comparative characteristics of positive actotropic factors at women with different states of fitness

Fitness quality	Parameter	Estra-diol	Triiodo-thyronine	HDLP Cholesterol	Sodium of erythrocytes	Magnesium
	Norm Range Units	115±8 30÷200 ng/l	2,10±0,09 1,1÷3,1 nM/l	1,53±0,05 1,40÷1,62 mM/l	17,6±0,8 13,5÷21,8 mM/l	0,95±0,04 0,7÷1,2 mM/l
Unsatisfactory (n=9)	X m	67 9*	1,21 0,26*	1,07 0,14*	24,7 2,1*	0,73 0,02*
Satisfactory (n=37)	X m	91 6*	1,77 0,17	1,25 0,05*	24,5 0,9*	0,76 0,01*
Good (n=12)	X m	120 13	2,30 0,38	1,52 0,10	30,2 1,7*	0,81 0,02*
	P u-s	a	ns	ns	ns	ns
	P u-g	c	a	a	a	b
	P s-g	a	ns	a	c	a

Note. Values significantly different from normal [cited by: 8,9,10], marked *.

This poor physical shape is associated with significantly reduced levels of estradiol (58% average rate, AR), triiodothyronine (57% AR), HDLP Cholesterol (70% AR), magnesium (77% AR) and moderately elevated levels sodium in erythrocytes (140% AR). Outstanding physical condition correspond closer to the average rate levels first three settings (79%, 84% and 82% respectively), while magnesiumemia and sodiumhistia remain at the same levels

(80% and 139% respectively). Instead, women with good physical form characterized by perfectly normal levels of estradiol (104% AR), triiodothyronine (109% AR) and HDLP Cholesterol (99% AR) combined with maximal for cohort magnesiumemia (85% AR) and sodiumhistia (171% AR).

Table 4. Comparative characteristics of negative actotropic factors at women with different states of fitness

Fitness quality	Parameter	Cortisol	TSH	TAG	Uric acid	Mg-ATPase
	Norm Range Units	165±8 80÷250 μg/l	1,90±0,15 0,3÷3,5 mIU/l	1,26±0,10 0,98÷1,41 mM/l	288±10 264÷317 μM/l	0,84±0,04 0,62÷1,06 M/l•h
Unsatisfactory (n=9)	X m	228 18*	7,5 1,4*	2,92 0,60*	288 36	0,97 0,08
Satisfactory (n=37)	X m	201 6*	5,3 0,5*	2,09 0,18*	302 11	0,97 0,03*
Good (n=12)	X m	165 10	3,4 0,6*	1,29 0,11	248 14*	0,81 0,05
	P u-s	ns	ns	ns	ns	ns
	P u-g	c	b	a	ns	ns
	P s-g	c	a	c	b	b

Parameters second cluster, conversely, the lower the higher the physical form. In particular (tab. 4), women with good physical form characterized by perfectly normal levels of plasma cortisol and triacylglycerides as well as activity of Mg-ATPase in combination with TSH levels at the upper limit of normal and minimal uricemia. Satisfactory physical form associated with cortisolemia at 122% AR, triacylglyceridemia at 166% AR, TSH level in 279% AR, activity of Mg-ATPase at 115% AR and uricemia at 105% AR.

Go to the even lower level of physical fitness is accompanied by a further rise in cortisol (up to 138% AR), TAG (up to 232% AR), TSH (up to 395% AR) while maintaining previous levels of uric acid and Mg-ATPase activity.

We detected significant inverse correlation ITCHTR and fitness points with cortisol level (r=-0,50 and -0,50 respectively), TSH (r=-0,42 and -0,45) and TAG (r=-0,47 and -0,52) and on the verge of significance with uricemia (r=-0,27 and -0,28) and the activity of Mg-ATPase (r=-0,26 and -0,21).

Described constellation of hemodynamic, metabolic and hormonal factors determines the level of physical fitness (for ITCHTR) by 55%, as follows from the equation of multiple regression:

$ITCHTR=733,8-0,311•Ps-0,01•Pd-0,002•Est+0,015•T_3-196,8•ALP+0,755•Na_e-17,2•Mg-1,95•Cor-2,58•TSH+16,55•TAG-0,019•Ur-0,783•Mg\text{-}ATPase$

$R=0,742; R^2=0,551; F_{(12,5)}=4,6; Chi^2=40,0; p<10^{-4}; SD=±12,2$

Canonical correlation analysis procedure makes it possible to visualize this relationship (fig. 1).

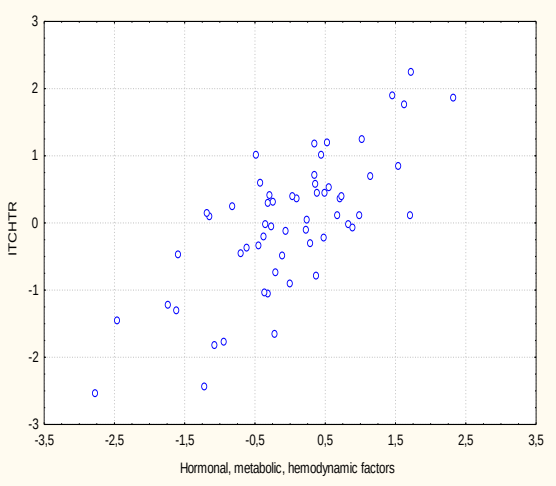

Fig. 1. The canonical correlation between hormonal, metabolic and hemodynamic factors (X-line) and index of tachicardic hypertensive reaction to dosed veloergometric load (Y-line)

Separately, we note a significant inverse relationship fitness with body mass as an integral expression of metabolism, especially lipid (r=-0,63 and -0,79 for ITCHTR and scoring respectively) and inverse relationship on the verge of importance with age (r=-0,27 and -0,25). This group of women with good form is characterized by a generally normal weight (63±4 kg vs rules for cohort 67 kg) and the youngest age (42±3 years), satisfactory form associated with a body mass 75±2 kg and an intermediate age (45±1 years) while poor fitness with obesity (95±6 kg) and a maximal age (48±4 years).

Another cluster of options was related to the physical form of nonlinear (tab. 5). In particular, satisfactory physical form is accompanied by normal levels of aldosterone, sodium and phosphate, low level of calcium and upper border activity of Na,K-ATPase. On the one hand, the listed parameters are minimal for cohort. On the other hand, both improvement and worsening forms accompanied by their increase.

The rest of the registered parameters were not related to the level of fitness.

Table 5. Comparative characteristics of hormonal and metabolic factors nonlinear related with state of fitness

Fitness quality	Parameter	Aldosterone	Calcium	Phospate	Sodium of plasma	Na,K-ATPase
	Norm Range Units	85±7 10÷160 ng/l	2,53±0,04 2,30÷2,75 mM/l	0,97±0,06 0,65÷1,29 mM/l	139±2 130÷148 mM/l	0,76±0,04 0,54÷0,98 M/l•h
Unsatisfactory (n=9)	X m	87 4	2,38 0,12	1,03 0,09	148 7	0,93 0,08
Satisfactory (n=37)	X m	85 2	2,17 0,04*	0,88 0,04	138 2	0,92 0,04*
Good (n=12)	X m	93 4	2,41 0,10	0,90 0,08	147 8	1,15 0,09*
	P u-s	ns	ns	ns	ns	ns
	P u-g	ns	ns	ns	ns	ns

	P s-g	ns	a	ns	ns	a

CONCLUSION

Thus, we confirmed the position of fitness diversity of people who come for rehabilitation. However, it is first discovered a some hemodynamic, hormonal and metabolic parameters that directly or inversely determines the state of fitness. This opens up the prospect of the opportunity to explore in the future affect the fitness of troops after the correction of these actotropic factors.

ACCORDANCE TO ETHICS STANDARDS

This study was approved by the local ethical committee of Truskavets' Scientists Assotiation. Tests in patients are conducted in accordance with positions of Helsinki Declaration 1975, revised and complemented in 2002, and directive of National Committee on ethics of scientific researches. During realization of tests from all participants the informed consent is got and used all measures for providing of anonymity of participants. For all authors any conflict of interests is absent.

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