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The immune system of athletes of different sports

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: the comparative study of the immunity features of elite athletes of different sports.

Material: study involved athletes of the highest mastery level of cyclic and acyclic sports (n = 147, age 18-23 years). Athletes were divided into groups by kinds of sport. Skiers (n = 54), swimmers (n = 23), wrestlers (n = 49), boxers (n = 21).

Results: It was determined that athletes of acyclic sports (wrestlers and boxers) had a significant double increase in the level of secretory immunoglobulin IgA. In parallel, the level of immunoglobulins IgG is reduced. The highest indicators of lysosomal activity were recorded in skiers. Boxers, wrestlers, and swimmers had a decrease in the lysosomal activity level. The maximum phagocytic number is determined in wrestlers, and the minimum – in boxers.

Conclusions: Comparative study of the immunity features of elite athletes in various sports suggests that there is a strain on the immune status. This condition is especially expressed in acyclic sports athletes (wrestling, boxing). This is due to the loads in the preparation process. The data received allow to confirm the significance of immune protection indicators in monitoring the athletes functional status.

Keywords: athletes, immunity, progress, health, biochemistry, blood.

Introduction

The high level of sports mastery requires the stress of the body's adaptive capabilities. This determines the increased requirements for the health condition, stipulates the monitoring of its criteria. The reactivity and resistance are among the criteria which characterize the health and determined by the immunity condition. Currently, the level and dynamics of immunity are widely applied in sports. It is known that large training and competitive volumes of loads are associated with short-term suppression of several immune components.

Shaw et al [1] confirmed that intense sparring and hard training violate the T-cell immunity condition. This reduces the immune system ability to maintain an inflammatory response to an immune challenge, which can weaken the protection against intracellular pathogens and increase the infection risk.

The importance of the analysis of the athletes' immunological parameters is determined in the review of Dias et al [2]. Immunological markers, in combination with efficacy indicators and training monitoring, seem to be a promising tool for the clinical diagnosis of athlete's immune status and the prevention of overtraining syndrome.

Lamb et al [3] studied the relationship of immunity, psycho-emotional and hormonal features of female athletes in different periods of training. It is confirmed the immunity tension in the competitions season in parallel with the increase in anxiety and an increase in the cortisol concentration.

Heaney et al [4] investigated correlations of immune status and large volumes of physical activity in professional cyclists. It is confirmed the effectiveness of the applied indicators as a marker of physical activity and oral health criterion.

The review of Walsh and Oliver [5] is devoted to the correlations of physical activity, immunity condition and the prevalence of respiratory infections in athletes In athletes under heavy training, both innate and acquired immunity are often observed to decrease, typically 15-25%, but whether relatively modest changes in immunity increase URTI susceptibility remains a major gap in knowledge. With the exception of cell-mediated immunity that tends to be decreased, exercising in environmental extremes does not provide an additional threat to immunity and host defense. Recent evidence suggests that immune health may actually be enhanced by regular intermittent exposures to environmental stress (for example, intermittent hypoxia training).

Thus, the available literature data confirm the relevance of the chosen direction of scientific research.

The *purpose* of the research is a comparative study of the immunity features of elite athletes of different sports.

Material and methods.

Participants. The study involved athletes of the highest mastery level [n = 147; age 18-23 years; Candidates Master of Sports (CMS); Masters of Sports (MS)] of cyclic and acyclic sports. Participants were divided into groups by kinds of sport. Skiers (n = 54: n = 33 – CMS, n = 21 – MS), swimmers (n = 23: n = 12 CMS, n = 11 –

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MS), wrestlers (n = 49: n = 28 – CMS, n = 21 – MS), boxers (n = 21: n = 11 – CMS, n = 10 – MS).

Research Design. It was carried out the complex of immunological studies in accordance with generally accepted methods (Novikov D.K. [6]; Novikov D.K., Novikova V.I. [7]). The spontaneous and induced neutrophil secretory activity, the neutrophils ability to produce reactive oxygen intermediate, lysosomal activity parameters and the levels of the main types of immunoglobulins A, M, G were determined in the blood serum. The population and subpopulation spectrum of immune cells was determined by the specific gravity CD3, CD4, CD8, CD10, CD11b, CD16, CD25, CD34, CD56, and CD95.

Statistical Analysis. Statistical analysis of the results was performed applying licensed MS Excel (2010). The following descriptive statistics indicators were determined: arithmetic means, standard deviations, and errors of means. The significance of differences in groups was assessed applying a parametric indicator (Student t-test).

Results.

It is known that modulating neurohumoral effects determine the formation of a specific type of immunoreactivity in a particular athlete. This is accompanied by certain quantitative and qualitative shifts in the immune system. We have investigated the indicators of cellular and humoral links of the immune system, depending on the type of sports activity and the degree of sports mastery. In table 1 shows the indicators which characterize: 1) spontaneous and induced secretory activity of neutrophils; the ability of neutrophils to produce reactive oxygen intermediate; 2) lysosomal activity parameters and levels of the main types of immunoglobulins A, M, G.

The indicators of antibodies levels did not differ on average from the corresponding age standards in athletes of cyclic sports (swimming, skiing).

Athletes of acyclic sports (wrestlers and boxers) have a significant double increase in the level of secretory immunoglobulin IgA. In parallel, the level of immunoglobulins IgG is reduced.

The masters of sports boxers have the highest indicators: spontaneous and induced activity, the intensity of the production of reactive oxygen intermediates, lysosomal activity (tab. 1).

The similar indicators of a sNBT test (test with nitro-blue tetrazolium) and a high level of lysosomal activity were defined in the group of highly qualified skiers. These indicators did not essentially differ in all groups: a spontaneous and induced phagocytic activity of neutrophils, phagocytic number.

Tab. 2 demonstrates the functional activity of neutrophils and B-lymphocytes in candidates for the master of sports of various sports specializations.

We have identified similar patterns of secretory activity of neutrophils in correlation to the reactive

Table 1. Secretory activity characteristics of immune cells in masters of sports

Kinds of sport	**Skiers n = 21**	**Swimmers n =11**	**Wrestlers n = 21**	**Boxers n = 10**	**p<0,05 among groups**
Groups	**1**	**2**	**3**	**4**	
sNBT activity,%	50,7 ± 4,46	23,45 ±2,45	25,00 ± 6,27	45,20 ± 7,84	1-2,3, 2-4, 3-4
sNBT intensity, c.u.	0,43 ± 0,03	0,44 ± 0,06	0,32 ± 0,06	0,55 ± 0,09	3-4
iNBT activity,%	43,17 ± 2,03	35,97 ± 2,72	36,75 ± 4,61	59,80 ± 2,00	1-4; 2-4, 3-4
iNBT intensity, c.u.	0,59 ± 0,04	0,52 ± 0,05	0,65 ± 0,10	0,71 ± 0,03	1-3,4, 2-3,4
The activity of phagocytosis of neutrophil granulocytes (APN),%	41,60 ± 1,72	40,59 ± 2,20	44,25 ± 4,51	36,40 ± 5,74	
The intensity of phagocytosis of neutrophil granulocytes (IPN), c.u.	1,06 ± 0,08	1,10 ± 0,13	1,04 ± 0,16	0,96 ± 0,14	
Lysosomal activity of neutrophil granulocytes (LAN), c.u.	313,94 ± 23,98	294,94 ± 27,85	221,50 ± 9,73	357,40 ± 24,05	
Ig A – immunoglobulin A, g/l	1,34 ± 0,09	1,42 ± 0,12	2,81 ± 0,04	2,48 ± 0,17	1-3,4 2-3,4
IgM – immunoglobulin M, g/l	1,08 ± 0,06	0,95 ± 0,04	1,04 ± 0,09	0,72 ± 0,08	1-4 2-4 3-4
IgG – immunoglobulin G, g/l g/l	8,70 ± 0,38	8,45 ± 0,31	8,08 ± 0,23	7,22 ± 0,77	1-4 2-4

Notes: NBT – test with nitro-blue tetrazolium (sNBT – spontaneous; iNBT – induced); c.u. – conventional units.

Table 2. Secretory activity characteristics of immune cells in Candidates Master of Sports (M ± m)

Kinds of sport	**Skiers**	**Swimmers**	**Wrestlers**	**Boxers**	**p<0,05**
	n = 33	**n =12**	**n = 28**	**n = 11**	**among groups**
Groups	**1**	**2**	**3**	**4**	
sNBT activity,%	38,41 ± 3,34	22,88 ± 1,44	24,00 ± 4,97	24,20 ± 5,88	1-2,3,4
sNBT intensity, c.u.	0,45 ± 0,03	0,33 ± 0,02	0,40 ± 0,09	0,28 ± 0,07	1-2,3,4 2-3 3-4
iNBT activity,%	41,72 ± 1,81	40,47 ± 3,37	32,00 ± 4,02	56,00 ± 8,58	1-3,4 2-3,4 3-4
iNBT intensity, c.u.	0,57 ± 0,04	0,44 ± 0,04	0,54 ± 0,07	0,78 ± 0,14	1-2,3,4 2-4 3-4
The activity of phagocytosis of neutrophil granulocytes (APN),%	42,84 ±1,79	42,83 ± 2,07	47,43 ± 3,60	44,60 ± 6,82	
The intensity of phagocytosis of neutrophil granulocytes (IPN), c.u.	1,14 ± 0,07	1,28 ± 0,11	0,95 ± 0,09	1,06 ± 0,18	
Lysosomal activity of neutrophil granulocytes (LAN), c.u.	367,49 ± 28,50	263,88 ±18,22	277,86 ±14,21	341,20 ± 30,03	1-2,3 2-4 3-4
Ig A – immunoglobulin A, g/l	1,50 ± 0,08	1,41 ± 0,08	2,27 ± 0,19	2,35 ± 0,18	1-3,4 2-3,4
IgM – immunoglobulin M, g/l	1,06 ± 0,05	0,94 ± 0,04	1,00 ± 0,05	0,77 ± 0,05	1-4 2-4 3-4
IgG – immunoglobulin G, g/l g/l	7,41 ± 0,47	8,52 ± 0,28	6,23 ± 0,27	7,34 ± 0,42	

Notes: NBT – test with nitro-blue tetrazolium (sNBT – spontaneous; iNBT – induced); c.u. – conventional units.

oxygen intermediate in athletes in comparison with the indicators of the masters of sports.

The highest indicators of lysosomal activity were defined in skiers. Boxers, wrestlers, and swimmers demonstrated a decrease in the lysosomal activity level. The maximum phagocytic number is defined in wrestlers, and the minimum – in boxers.

Wrestlers and boxers had increased levels of secretory immunoglobulin A. The amount of immunoglobulin M was the lowest in boxers. The levels of immunoglobulin A were significantly higher.

The increase in the intensity of the induced production of reactive oxygen intermediate was determined in the judo group. The maximum intensity of phagocytosis, the indicator of the lysosomal activity of neutrophils is determined in the group of boxers.

We have evaluated the immunophenotypic characteristics of cells of athletes' immune system. Table 3 demonstrates a population and subpopulation spectrum of immunocytes in a group of athletes (masters of sports of cyclic and acyclic sports).

The indicators of the immune status of candidates masters of sports are defined below.

The main populations and subpopulations of immunocytes in athletes - candidates masters of sports are presented in table 4.

There are significant changes (depending on the athletes' specialization) of the population spectrum of athletes' immune cells.

Discussion.

The results confirm the informational content and relevance of immunological indicators for assessing and predicting the athletes' condition. In this case, the complex analysis included the character of the secretory activity of immune cells, the analysis of the population and subpopulation spectrum of immune cells and the characteristic of the humoral immunity of elite athletes.

The applied research design was the analysis of the athletes' condition of the highest sports mastery level which allows to determine more clearly the influence of regular physical activities on the immune status. The comparison of the athletes' condition features of differ sports allows to determine the influence specifics on the body, to identify the factors which influence on the success.

The results of tables 1,2 confirm the significance of the control of immunoglobulins A, M, and G in the monitoring of athletes conditions. The determination of the immunoglobulin A level should be recognized

Table 3. Population and subpopulation spectrum of immunocytes in masters of sports (M ± m)

Kinds of sport	Skiers n = 21	Swimmers n =11	Wrestlers n = 21	Boxers n = 10	p<0,05 among groups
Groups	1	2	3	4	
CD3,%	28,94 ±2,32	34,45 ±1,90	35,50 ±2,03	33,60 ±3,84	
CD4,%	24,40 ±1,79	24,48 ±2,15	21,25 ±1,18	22,80 ±1,89	
CD8,%	29,23 ±2,59	25,76 ±2,04	25,25 ±1,63	20,80 ±1,44	1-4
CD10,%	13,17 ±1,13	12,31 ±1,13	14,75 ±1,59	6,60 ±0,62	1-4 2-4 3-4
CD11b,%	16,77 ±0,97	19,38 ±1,36	13,50 ±1,43	11,60 ±1,51	1-3,4 2-3,4
CD16,%	11,57 ±0,99	14,21 ±1,30	13,25 ±1,99	13,00 ±1,07	1-2
CD 20,%	18,97 ±1,18	17,03 ±1,53	13,50 ±1,70	14,40 ±0,86	1-3,4 2-3,4
CD25,%	13,97 ±0,95	11,45 ±1,04	14,00 ±1,41	14,80 ±0,90	
CD34,%	12,89 ±0,85	9,24 ±1,36	16,25 ±2,08	6,20 ±1,04	1-2,3,4 2-3,4 3-4
CD56,%	16,29 ±1,48	11,48 ±0,98	15,00 ±2,28	9,80 ±0,77	1-2,4 2-3 3-4
CD95,%	20,40 ±1,55	17,14 ±1,64	17,25 ±1,63	16,00 ±1,19	1-2,3,4

Note: CD3 – T-cells (in combination with TCR – transmission of a signal with antigenic recognition by T cell); CD4 – T-helper cells, monocyte subpopulations, cortical thymocyte subpopulations, EBV transformed B-cells (MNC class II co-receptor, HIV receptor); CD8 – T-cytotoxic, NK-cells subpopulations, cortical thymocyte subpopulations, (MNC class I co-receptor); CD10 – subpopulations of immature B-cells, B-cells subpopulations, cortical thymocyte subpopulations, granulocytes (CALLA, endopeptidase); CD11b – granulocytes, monocytes, NK-cells (adhesion molecule Mac-1, integrin, IC3b receptor; phagocytosis of opsonized particles); CD16 – NK-cells, granulocytes, macrophages (Fcg RIII); CD20 – subpopulations of B-cells precursors, mature B-cells; CD25 – activated T and B cells; activated macrophages (IL-2Ra chain, Tac; lymphocytic activation marker); CD34 – hematopoietic cell precursors, endothelial cells (sialomucin, ligand for L-selectin); CD56 – NK-cells, some T-cells (NK adhesion molecule of N-CAM cells); CD95 – many types of cells (Fas antigen, APO-1; central role of apoptosis).

as particularly significant. This confirms the available literature data.

Minic et al [8] studied the reactivity of the humoral immune system in professional athletes. The high informational significance of IgG, IgM, and IgA was confirmed for the analysis of the immunity features. Coad et al [9] confirmed the high significance and reliability of the determination of IgA of saliva. Teixeira et al [10] compared the immune response in triathlon athletes and runners. It was confirmed the high informational significance of IgA of salivary, its correlation with physical activity level. Coad et al [11] showed that weekly training load depending on the season of the Australian Football League can lead to a delay in the immunity recovery after the match. It is proposed to use the definition of IgA in monitoring the status of athletes, especially in the case of impaired dysimmunity. Moraes et al [12] evaluated the relationship between the intensity of training young male basketball players and the level of IgA saliva. It is confirmed that intense physical loads promote the suppression of immunity.

Analysis of the population and subpopulation spectrum of immune cells confirmed the presence of differences in athletes of cyclical and acyclic sports, especially expressed for CD10, CD20, CD34, and CD56. It allows to suggests the presence of tension in athletes immune system. There was a decrease in the proportion of these immune cells in acyclic sports in comparison with cyclic. The results received are close to the available data.

Blume et al [13] performed a longitudinal prospective study of the immune status in young athletes. The increase in training loads promoted the increase in tension.

Table 4. Characteristics of immune cells composition in candidate master of sports (M ± m)

Kinds of sport	Skiers n = 33	Swimmers n =12	Wrestlers n = 28	Boxers n = 11	p<0,05 among groups
Groups	1	2	3	4	
CD3,%	30,39 ±2,16	34,05 ±1,89	38,43 ±3,31	31,80 ±2,92	
CD4,%	25,18 ±1,56	25,95 ±1,44	22,57 ±1,40	19,40 ±1,29	1-4 2-4
CD8,%	29,32 ±2,73	29,39 ±1,84	18,71 ±1,27	21,00 ±2,00	1-3,4 2-3,4
CD10,%	13,39 ±1,09	8,98 ±0,68	15,14 ±2,02	5,20 ±0,49	1-2,3,4 2-3,4 3-4
CD11b,%	17,29 ±0,91	17,73 ±0,97	18,00 ±0,70	16,60 ±2,00	
CD16,%	13,16 ±0,82	15,20 ±0,63	12,57 ±1,14	11,20 ±1,47	2-3 2-4 1-4
CD 20,%	18,97 ±1,18	17,32 ±1,11	18,00 ±1,92	10,20 ±1,36	1-4 2-4 3-4
CD25,%	13,95 ±0,83	13,83 ±0,81	12,86 ±0,75	14,60 ±2,27	
CD34,%	12,68 ±0,74	8,56 ±1,22	13,43 ±1,13	5,40 ±1,29	1-2, 4 2-3,4 3-4
CD56,%	16,13 ±1,15	11,83 ±0,76	15,43 ±1,32	10,00 ±1,19	1-2,4 2-3 3-4
CD95,%	22,05 ±1,61	17,71 ±1,28	15,00 ±1,24	14,00 ±2,07	1-3,4 2-3,4

Note: CD3 – T-cells (in combination with TCR – transmission of a signal with antigenic recognition by T cell); CD4 – T-helper cells, monocyte subpopulations, cortical thymocyte subpopulations, EBV transformed B-cells (MNC class II co-receptor, HIV receptor); CD8 – T-cytotoxic, NK-cells subpopulations, cortical thymocyte subpopulations, (MNC class I co-receptor); CD10 – subpopulations of immature B-cells, B-cells subpopulations, cortical thymocyte subpopulations, granulocytes (CALLA, endopeptidase); CD11b – granulocytes, monocytes, NK-cells (adhesion molecule Mac-1, integrin, IC3b receptor; phagocytosis of opsonized particles); CD16 – NK-cells, granulocytes, macrophages (Fcg RIII); CD20 – subpopulations of B-cells precursors, mature B-cells; CD25 – activated T and B cells; activated macrophages (IL-2Ra chain, Tac; lymphocytic activation marker); CD34 – hematopoietic cell precursors, endothelial cells (sialomucin, ligand for L-selectin); CD56 – NK-cells, some T-cells (NK adhesion molecule of N-CAM cells); CD95 – many types of cells (Fas antigen, APO-1; central role of apoptosis).

Kurowski et al [14] confirmed that significant physical loads promoted dysimmunity in athletes. The significant decrease in CD14 leukocytes was observed in swimmers and skaters. Komano et al [15] confirmed the significance of CD86 as a marker of sufficient immunity. Schlabe et al [16] demonstrated the improvement in metabolic and immunological parameters in HIV-infected patients who have undergone moderate endurance training. The significant increase in absolute CD4 T cells was observed. Cury-Boaventura et al [17] studied the activation status of lymphocytes before and after the futsal match. The futsal match induced lymphocytosis and lymphocyte apoptosis, as evidenced by the externalization of phosphatidylserine, the expression of CD95 and DNA fragmentation. In addition, the competitive match caused necrotic death of lymphocytes. There were no differences in the percentage of CD4 + and CD8 + T-cells or in the profile of T-helper / suppressor between before and immediately after the match. In addition, after the futsal match, the expression levels of CD95 and CD28 decreased.

The work of Melnikov et al [18] should be recognized as the closest in the goal and tasks to be solved. The authors performed a quantitative analysis of immunoglobulins A, G, M, hemolytic activity of complement and its fragments C1-C5 in the blood serum of professional athletes-skiers, swimmers, wrestlers, boxers of the highest sports qualification. In the group of athletes belonging to acyclic sports (wrestlers and boxers), the authors found

a double increase in IgA levels with a parallel decrease in immunoglobulins of the secondary immune response (IgG). In representatives of cyclic sports (swimming, skiing), the parameters of antibodies did not differ from the corresponding age norms. The linear increase in IgA and IgM products is demonstrated as a qualification and adaptation of athlete to increased physical activity. The highest level of IgG was detected in the group of high-class athletes. The authors conclude that the athletes' qualification influences significantly on the parameters of humoral immunity, forming the so-called profile of changes. At the same time, these changes can be viewed as a characteristic of the athlete's belonging to a certain specialization and sports qualification, as well as cyclic, mainly aerobic, sports such as swimming, skiing or acyclic anaerobic sports, such as boxing or wrestling. The detected changes can be mediated through desynchronosis in the dynamics of adaptive processes of different intensity at the level of the humoral immunity system in the process of improving sports scores.

Conclusions.

The comparative study of the immunity features of elite athletes in different sports allows to suggest that there is a strain on the immune status. This condition is especially expressed in athletes of acyclic sports (wrestling, boxing), which seems to be related to the loads in the training process. The data received confirms the significance of immune protection indicators in the monitoring of the functional condition of athletes.

Conflict of interests

The authors declare that there is no conflict of interests.

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Comparative analysis of the functional characteristics and motor qualities of students of different generations and body types

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Abstract

Purpose: the comparative analysis of screening studies of physical fitness and functional condition of young men with different body types (the territory of Baikal region, Russia; the interval of the study is 10 years).

Material: First-year students (age 17-18 years; n = 1003; in 2008 - n = 523; in 2017 - n = 480) of Irkutsk National Research Technical University (Pribaikalye, Russia) participated into the research. All students are classified for health reasons to the main medical group (no deviations in health status). All students attended classes in the discipline "Physical Education". It was done the comparative analysis of motor skills; physiometric indicators; the content of muscle, fat and bone mass.

Results: It was revealed the significant differences ($p < 0,05$) in the values of the motor test indicators. It was determined "leading" and "lagging" motor qualities of young men with different body types. It was defined decrease of indicators' values in motor tests in young men in 2017, in comparison with the results of the survey in 2008. The decrease in the values of motor test indicators is more frequently revealed in young men of hypersthenic group (examined in 2017), in comparison with normosthenics and asthenics. There is a deterioration in the majority of the functional characteristics of young men bodies (in 2017) in comparison with 2008 data.

Conclusions: University professors (of the discipline – "Physical Education") should form a predictive database of screening observations on the development of morphofunctional and motor qualities of students with different body types. This will allow to correct the educational process on the physical education of students applying the integrative pedagogical methods and teaching methods.

Keywords: physical education, students, physical condition, somatotyping, component body type.

Introduction

The main parameters of the physical health of a person are the functional characteristics of the body and it's motor abilities to perform physical activities [1, 2]. The study of the cardiovascular system condition allows to assess the person's reserve capacity for physical training and sports [3, 4]. It also helps to determine the dependence of the vegetative regulation of blood circulation on the level of physical fitness of the body [5, 6]. The decrease in physical fitness [7, 8] and the functional indicators of modern youth in Russia is studied in the recent researches [9, 10]. There is an increase in deviations from the norm in the cardiovascular, respiratory, and immune systems of the body [11, 12]. It is considered that this is correlated with a violation of the adaptive capacity of the person [13-15]. The significant decrease in functionality is observed in regions of anthropogenic impact [16].

One of the reasons for the deterioration of the physical health of the population is low physical activity. Significant hypodynamia is registered in Europeans [17, 18], in the USA [19], Moldova [20, 21], in Russia [22, 23]. Other studies determined:

- Approximately 27% of high school students meet the aerobic component of the pediatric guidelines (60 minutes of daily moderate-to-vigorous activity), and the proportion of youth meeting the guidelines decreases with advancing age [24];
- A pilot randomized trial assessed the feasibility and effectiveness of an intervention combining Smartcare (activity tracker with a smartphone application) and financial incentives. The addition of financial incentives to Smartcare was effective in increasing physical activity and reducing obesity [25];
- Expansion of students' physical activity increases the results in motor tests [26].

It is known that the peculiarities of morphofunctional status depend on the type of human body [27]. It was performed studies of motor qualities characteristics in students with various somatotype groups [28, 29]. It is shown that representatives of the microsomatotypes have advantages over the macrosomatotype bodies in such motor qualities as speed; muscle strength of the upper limbs; coordination abilities; general endurance. The screening somatotyping of technical university students was performed in 2007-2008 (Irkutsk, Russia). It was applied the method of determining the overall, component and proportional level of variation [30, 31]. It was determined the expressed differences in the motor qualities of students with different somatotypes.

The determination of body type characteristics of youth allows researchers to recommend the best option for constructing an educational process on physical education in universities [32, 33]; the training process in athletes [34-36]; physical training of military personnel [37].

Changes in the living conditions and lifestyle of modern youth are reflected in the level of their physical

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health, in comparison with previous generations [1].

It is relevant to perform a comparative analysis of changes in the motor qualities of the youth of different generations with a significant time interval. The comparative analysis of the functional characteristics and motor qualities of students with different body types was not performed at the urbanized territories of Baikal region (Russia) [38, 39].

Hypothesis. The authors suggest that data on the comparative features of the motor qualities and functional body characteristics of students of different generations can be applied in the field of demography, medicine, pedagogy, sociology, and physical culture. Such an approach will allow to correct curricula of physical education in universities.

The purpose of the research is to perform a comparative analysis of screening studies of physical fitness and functional condition of young men with different body types on the territory of Baikal region (Russia (the study interval is 10 years).

Material and methods.

Participants. The first year students (age 17-18 years; n = 1003; in 2008 – n = 523; in 2017 – n = 480) of Irkutsk National Research Technical University (Pribaikalye, Russia) were examined. All the young men were natives of an urbanized city with a significant negative environmental background. All students are classified for health reasons to the main medical group (no deviations in health status). All students attended classes in the discipline "Physical Education". The performed research does not impair the rights and does not endanger the well-being of students in accordance with ethical standards (WMA Declaration of Helsinki, 2008 [40]).

Design of the study. The pedagogical screening of motor test indicators and the functional condition of students with different body types was performed at physical education classes at the beginning of the study year (in 2008 and in 2017). It was measured body length and chest circumference [41]. It was applied M.V. Chernorutsky's scheme with the calculation of Pigne index according to the formula:

$$(I) = L- (P + T),$$

where L – is the standing body length (cm), P – is body weight (kg), T – is chest circumference during expiration (cm).

When the index was <10, the somatotype was assessed as hypersthenic (H), in the interval of the index from 10 to 30 – as normosthenic (S) and> 30 – as asthenic (A) [42].

The young men body types were determined by Matiegka's formulas [43] with the calculation of the absolute average value and percentage of fat, muscle and bone tissues. To characterize the correlations of the body types with the functional indicators were measured:

- heart rate before the load of 20 squats in 30 s (HR, b / 10 s);
- heart rate after 20 squats in 30 s (HR, b / 10 s);
- heart rate recovery time (min) after 20 squats;
- systolic blood pressure (SBP), mm Hg;
- diastolic blood pressure (DBP), mm Hg;
- dynamometry of hands (kg).
- The index of cardiovascular system reserve – Robinson index (IRob = HRx: 100, c.u.) was applied [44] for the quantitative assessment of the energy potential of the human (SI = hand muscle strength / BM x100%) [45].
- The basic motor qualities of students were estimated. The following tests were applied:
- speed endurance and dexterity (10x5 shuttle test, sec);
- speed (100 m run, sec);
- speed-strength endurance of the flexor muscles of the body (Eurofit Sit Up Test (for 30 sec, quantity of times);
- strength and strength endurance of the muscles of the upper shoulder girdle (Pull-up bars, the quantity of times);
- the dynamic force of the muscles of the lower extremities (Standing Long Jump Test (Broad Jump), cm);
- active flexibility of the spine and hip joints (Seated Forward Bend, cm)
- general endurance (1000 m run, min, sec) [46, 47].

Statistical analysis. The software "StatSoft Statistica 6.1" and"Microsoft Excel" were applied to calculate the obtained data. The arithmetic mean of the indicators (M), the standard deviation (σ) and the standard error (m) were calculated. The assessment of the significance of differences in the mean values of independent samples was carried out by parametric methods using Student's t-test. Differences between the values of the indicators at the level of $p < 0.05$ were considered statistically significant.

Results.

The distribution of young men of different generations by somatotype is shown in Figure 1.

After 10 years, there is an increase in the number of young men hypersthenics in 8,5%. The number of asthenics decreased in 6,03%, and normosthenic in 2,48%. These data indicate that the values of indicators of some motor tests in young men (2017) are reduced in comparison with the indicators of young men (2008).

In young men (2017), the decrease in the values of motor test indicators is recorded more frequently in the group of hypersthenics.

In 2017, there is a decrease in the values of indicators of the functional characteristics of young men in comparison with data of 2008 (Table 2).

Discussion.

The comparative analysis of screening surveys in 2008 and 2017 of young men with different body types revealed significant differences in the values of motor test indicators (Table 1). "Leading" and "lagging" motor qualities of students with different somatotypes are identified (Table 3).

It is determined that the priorities of motor qualities

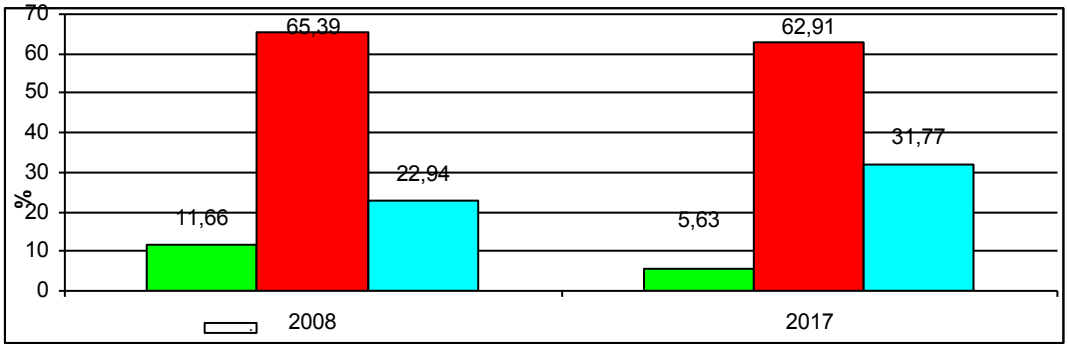

Fig. 1. The distribution of young men by somatotypes in 2008 and 2017 (in %)

Table 1. Motor characteristics of young men with different body types, examined in 2008 and 2017. (M ± SD)

Tests	2008 year H (n=120)	N (n=342)	A (n=61)	P< 0,05	2017 year H (n=151)	N (n=302)	A (n=27)	P< 0,05
10x5 shuttle test, sec	16,13± 0,12	15,79 ± 0,05	16,14± 0,30	p_1-p_2	16,58± 0,13 *	16,16± 0,09 *	16,4± 0,31	p_1-p_2;
100 m run (sec)	14,33± 0,10	14,08± 0,05	13,88±0,19	p_1-p_2; p_1-p_3	14,68 ± 0,09 *	14,14± 0,04	13,92± 0,17	p_1-p_2; p_1-p_3
Pull-Up Bars, quantity of times	12,6± 0,49	10,8± 0,23	10,6± 0,64	p_1-p_2; p_1-p_3	10,2± 0,31 *	9,9± 0,22 *	10,0± 0,66	
Eurofit Sit Up Test (for 30 sec), quantity of times	29,8± 0,40	26,4± 0,24	25,3± 0,38	p_1-p_2; p_1-p_3	26,1± 0,37 *	25,3± 0,26*	25,5± 0,85	
Seated Forward Bend, cm	15,2± 0,60	15,7± 0,37	14,1± 0,87		15,6± 0,47	15,3± 0,34	15,1± 1,84	
Standing Long Jump Test (Broad Jump), cm	233,5± 1,53	236,0± 0,84	241,4±1,81	p_1-p_3	225,7± 1,51 *	232,1± 0,86	237,8± 3,18	p_1-p_2; p_1-p_3
1000 m run (min, sec)	3,58± 0,02	3,52± 0,01	3,36± 0,02	p_1-p_2; p_1-p_3; p_2-p_3	4,25± 0,01 *	3,58± 0,01 *	3,54± 0,04 *	p_1-p_2; p_1-p_3

Note. H – hypersthenic; N – normosthenic; A – asthenic body types. *– statistically significant differences between somatotypes in 2008 and 2017 (p <0.05)

in young men of different somatotypes and different generations didn't change. In correction of the educational process in physical education, it is necessary to include exercises directed on the development of lagging motor skills of students considering the somatotype.

In all young men (2008) with the hypersthenic body, the motor qualities (strength and strength endurance of the muscles of the upper shoulder girdle, speed-strength endurance of the flexor muscles of the body) are higher in comparison with other body types (p <0,05). This is confirmed by studies by other authors [48].

According to our data, young men with asthenic somatotype (p <0,05) had better indicators: speed, dynamic muscle strength of the lower limbs, and general endurance. This is consistent with studies devoted to the dependence of body mass on the body length [37]. We determined higher results in the main motor tests in girls with asthenic body type (with the exception of the strength of the muscles of the upper extremities) [33]. This indicates that the modern youth of the asthenic type of the constitution has a higher reserve capacity of physical condition in comparison with peers of other somatotypes.

There is no significant difference (p> 0,05) in the indicators of the motor tests for flexibility in young men. This is consistent with the results of the study of senior schoolchildren in Moscow (Russia) [48].

Indicators in the motor tests of students (2017) were lower than those of young men (2008) (Table 4).

The study of motor qualities among students of different populations in Bosnia and Herzegovina also showed a decline in performance in a number of motor tests [49].

The results of our research devoted to the content of muscle, fat and bone mass in the body structure of young men in Baikal region are presented in Fig. 2.

In young men hypersthenics (2008) the content of muscle body mass (MM) was 31,7 ± 0,39 kg. This indicator was in 6,9% higher than in normosthenics.

Table 2. Functional characteristics of young men with different body types examined in 2008 and 2017. (M ± SD)

Indicators	H		N		A	
	2008 (n=120)	2017 (n=151)	2008 (n=342)	2017 (n=302)	2008 (n=61)	2017 (n=27)
Systolic blood pressure, mm Hg	114,5± 0,58	114,1± 0,53	113,9± 0,41	113,5± 0,38	111,2± 1,21	110,0± 1,63
Diastolic blood pressure, mm Hg	73,9± 0,48	74,2± 0,45	73,0± 0,34	72,5± 0,33	71,8± 0,89	72,3± 0,98
HR, b / 10 s	12,8± 0,14	13,3± 0,12 *	12,2± 0,04	12,7± 0,05 *	10,9± 0,08	10,4± 0,09 *
Heart rate recovery time (min), b / 10 s	19,7± 0,14	20,8± 0,15 *	19,1± 0,08	20,3± 0,09 *	18,3± 0,19	17,2± 0,33 *
Heart rate recovery time (min)	0,91± 0,02	0,98± 0,02 *	0,88± 0,01	0,93± 0,01 *	0,84± 0,04	0,72± 0,07 *
Robinson index, c.u.	87,9± 0,82	91,5± 0,52 *	83,4± 0,53	86,5± 0,55 *	73,2± 0,94	71,9± 0,96
Stroke volume, ml	64,5± 0,73	64,1± 0,47	65,2± 0,40	65,6± 0,42	65,3± 0,83	64,1± 0,85
Minute volume of blood circulation, ml/min	4953,6± 43,2	4919± 40,3	4772,6± 31,1	4801,9± 33,5	4270,7± 72,4	4192,1± 84,2
Left hand dynamometry, kg	44,5± 0,72	41,8± 0,37 *	42,6± 0,35	40,3± 0,28 *	41,9± 0,73	41,3± 0,68
Power index of left hand, %	57,4± 0,76	55,5± 0,42 *	65,1± 0,41	62,2± 0,34 *	70,5± 0,96	70,6± 0,95
Right hand dynamometry, kg	46,5± 0,68	42,2± 0,32 *	44,7± 0,35	41,5± 0,31 *	43,3± 0,78	42,6± 0,72
Power index of right hand, %	60,0± 0,72	56,1± 0,45 *	68,3± 0,43	64,1± 0,40 *	72,8± 0,98	72,8± 1,10

Note. H is the hypersthenic body type, S is normosthenic body type, and A is the asthenic body type. * – statistically significant differences between somatotypes in 2008 and 2017 ($p < 0.05$)

Table 3. Motor qualities priorities of young men of different generations with different body types from Baikal region

Motor qualities	Body types H		N		A	
	2008	2017	2008	2017	2008	2017
Speed endurance and dextrity		lag	lead	lead	lag	
Speed	lag	lag			lead	lead
Strength and strength endurance of the muscles of the upper shoulder girdle	lead	lead		lag	lag	
Speed strength endurance of flexor muscles of the body	lead	lead		lag	lag	
Flexibility		lead	lead		lag	lag
Dynamic muscle strength of the lower limbs	lag	lag			lead	lead
General endurance	lag	lag			lead	lead

Note. H – hypersthenic; N – normosthenic; A – asthenic body types. “lead” – leading , “lag” – lagging motor qualities

Also in 11,04% more than in asthenics ($p < 0.05$). This difference provides an advantage in the power abilities of young men hypersthenics. A similar result was obtained in the city Magadan (Russia): higher indicators were determined in the back strength of young strong-built men [27].

Among young men (2008), with the lowest content of body fat mass (FM) was found in asthenics (11,2 ± 0,26 kg). This indicator is in 20.5% less than in normosthenics (13,5 ± 0,17 kg). This indicator is also less in 25,8% than in hypersthenics (14,1 ± 0,19 kg). The maintenance of the bone mass of the body (BM) practically does not differ in young men with different body types. This is confirmed by authors’ studies which didn’t identify changes in bone mass in modern youths against the increase in fat and muscle mass [1, 50-52].

We found a decrease of MM in the young men bodies (2017) of all somatotypes $p < 0.05$. In comparison

Table 4. The decrease of indicators in motor tests in young men (2017) IN comparison with the results of tests in young men (2008) (in %)

Tests	Motor qualities	Decrease in %		
		H	N	A
Standing Long Jump Test (Broad Jump), cm	Speed endurance and dexterity	2,8	2,3	0
100 m run (sec)	Rapidity	2,4	0	0
Pull-Up Bars, quantity of times	Strength and strength endurance of the muscles of the upper shoulder girdle	19,0	8,3	0
Eurofit Sit Up Test (for 30 sec), quantity of times	Speed strength endurance of flexor muscles of the trunk	12,4	4,2	0
Seated Forward Bend, cm	Flexibility	0	0	0
Standing Long Jump Test (Broad Jump), cm	Dynamic muscle strength of the lower limbs	3,3	0	0
1000 m run (m/sec)	General endurance	18,7	1,7	5,3

Note. H – hypersthenic; N – normosthenic ; A – asthenic body type.

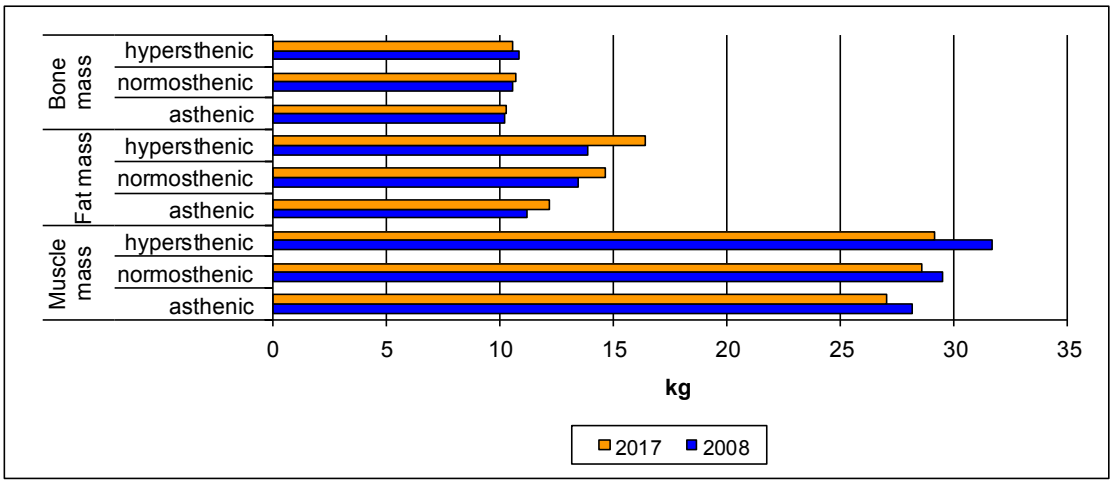

Fig. 2. The content of the main components in the body of young men of different generations and somatotypes

with the data of 2008, the decrease of MM is observed in hypersthenics in 7,9%, in asthenic in 3,9%, in normosthenics in 3,1%.

The increase in FM of young men bodies (2017) was: 8,9% in asthenics, 8.8% in normosthenic , 16,3% in hypersthenic. The results of our study are consistent with the authors' data on the increase in absolute body weight, body mass index, and overweight among young men of Krasnoyarsk (Russia) [13].

The content of BM in young men bodies of Baikal region (Russia) with different somatotypes and different generations didn't change.

The decrease of the muscular component and increase of fat mass in students (2017) is an indirect confirmation of the physical inactivity growth among modern youth. The correlations between low motor activity and the increase in the content of fat mass in the body structure are indicated by surveys of young men and women aged 15-22 years (Moscow, Russia) [50, 51]. In 2015, the World Health Organization determined: in European countries, there is a general downward trend in the level of physical activity of population; more than 70% of adolescents do not follow the recommendations for the motor regime [17]. This leads to a decrease in the overall indicator of the motor qualities of modern young people.

The comparative analysis of the results of examined young men (in 2008 and 2017) did not determine the significant changes in the indicators of systolic and diastolic blood pressure ($p > 0.05$).

The increase in the heart rate at rest was registered in 2017: in the hypersthenics group – in 3,9%, in the normosthenics group – in 4,1% ($p < 0,05$). In 2017, the increase in heart rate and pulse recovery time after a physical load was registered: in hypersthenics – in 7,7%, in normosthenics – by 5,7%. The young men of hypersthenic and normosthenic body types (2017) had increase in the values of Robinson index. This testifies to decrease in the functional capabilities of the cardiovascular system of modern generation of young men. This is confirmed by the works of other researchers [53].

It is observed in young men with asthenic body type (2017) the decrease in heart rate at rest in 4,6% (p

<0.05) and heart rate after physical load (20 squats in 30 s) in 6,0%; reduction of recovery time after physical load by 14,3% and reduction of Robinson index value in 15,4%. Our results in Robinson index do not contradict the work of other authors [54]. Such indicators indicate the economization of the cardiovascular system and the increased adaptation of the young men bodies with asthenic body type to physical loads. This is consistent with the results of students' research of Kazan (Russia) [55]. The authors showed that the phenomenon of bradycardia (decrease in heart rate) is a specific effect of endurance training. We defined that young men in Baikal region with asthenic body type were more enduring. The increase in the functional reserves of the cardiovascular system of young men (in the transition of somatotypes from hypersthenics to asthenics) is noted by the authors from Krasnoyarsk (Russia) [13].

It is known that the decrease in heart rate in strong-build athletes is compensated by means of increasing the heart stroke volume. The lower is the heart rate at rest, the higher is the stroke volume [55]. We have not identified differences in the heart stroke volume indicators in young men of different generations and body types (p> 0.05). This is due to insufficient physical volume and intensity of physical activity in the classroom.

The strength of the hand's muscles refers to the indicators of a person's physical development [56]. The young men (2017) of all body types have lower strength indicators than young men (2008) (p <0.05).

The performed studies of the comparative analysis of motor qualities and the functional condition of young men allow to make the following recommendations:

1) In planning the educational process of physical education in young men with different somatotypes, it should apply physical culture and sports technologies aimed at the development of "lagging" motor qualities.

2) at the lessons of physical education of young men with hypersthenic somatotype, should pay more attention to sports and gaming technologies and cyclic endurance exercises (swimming, slow long-running, skiing). For normosthenics, it is recommended to increase the amount of exercise on the development of strength abilities. Young men with asthenic somatotype should pay more attention to the development of strength and flexibility.

3) To recommend to modern youth additional independent physical training and sports to compensate for their physical inactivity.

Conclusions

1. The young men aged 17-18 years old (born and living in Baikal region, Russia) of different generations and body types have distinctive significant indicators in a number of functional characteristics, motor abilities in body structure (p <0.05). In recent years, there was an increase in the number of hypersthenics and a decrease in the number of asthenics.

2. The young men (2017) have lower physical fitness indicators than young men (2008). The reason for the decrease in muscle and an increase in the fat component in modern young men with different somatotypes is hypodynamia.

3. Teachers of educational institutions of the discipline "Physical Education" should form a predictive database of screening observations on the development of morphofunctional and motor qualities of students with different body types. This will allow to correct the educational process of physical education with the application of integrative pedagogical and teaching methods.

Conflict of interest.

The authors declare that there is no conflict of interest.

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The individual differentiated training design of health-promoting shaping with mature age women

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Abstract

Purpose: theoretical justification, development, and approbation of individual differentiated training design of health-promoting shaping with mature age women.

Material: women aged from 21-55 years (n=86) participated in the research. It was determined the initial level of their morphofunctional state and physical fitness (it was considered phases of an individual ovarian menstrual cycle). It was revealed criteria of the individual differentiated approach to the design of health-promoting shaping training (it was considered biorhythms of the female body). It was realized the nine-months macrocycle of health-promoting shaping training. The macrocycle consisted of three stages. Two programs – power and aerobic orientation are developed for training at the main stage of a macrocycle. Distribution of loads, their duration, intensity, and volume was regulated individually. It was considered the hormonal background of a female body during an ovarian menstrual cycle.

Results: It is observed an increase in the level of a morphofunctional state and physical fitness of women. It is revealed statistically reliable changes of all physical development indicators, a functional state and physical fitness of women.

Conclusions: The individual differentiated approach to training design of improving shaping allows to operate a morphofunctional condition of women organism more purposefully. Such an approach promotes organism adaptation to training loads. It also promotes an increase in the level of morphofunctional and physical fitness and health.

Keywords: female body, mature age, shaping program, ovarian menstrual cycle, morphofunctional state, physical fitness.

Introduction

One of the problems of improving physical culture system is increasing in level of health and physical activity of mature age women. Health defines the quality of modern woman life, achievements in the professional sphere [1-3]. The health condition is reflected in all spheres of women lives, and the completeness of life diversity directly depends on the qualitative characteristics of health level. All this defines women's image and lifestyle, the degree of their activity in life and in professional work [4-6].

The last one is especially important for mature age women i.e. in this age period signs of aging begin to appear. The following factors point at this period: the decrease in working capacity; change of body weight structure; increase in a number of chronic diseases; decrease in health, mood, creative activity. The mature age period is one of the critical periods for the woman. During this period the stable stage of organism development is replaced by involution: the weakening of functional activity is observed [7-9]. The presented main characteristics defined interest to this problem at representatives of various fields of knowledge [10, 11].

Scientific research convinces that the sufficient level of physical activity is the dominant factor of aging processes delay: keep and increases in physical capacity of mature age women [12-14]. Restriction of muscular activity at mature age leads to detraining and deregulation and imperfect adaptable mechanisms [15-17]. Therefore middle age women are the category which is the least involved in sports and improving the process. The middle age women need systematic tanning [18-21].

The interest in shaping stipulates high relevance of scientific research. The data obtained by various authors allow to improve the methodology of this type of physical activity [4, 14, 20]. It is also important the fact that pedagogical design in modern conditions becomes one of the main trends of development and updating of sports and improving work in pedagogical science and practice [8, 18].

Pedagogical design provides forming of strategy and the plan of training improving programs for the selected category of persons [8]. At the same time, the pedagogical activity has to pass from reproductive (blind copying of activity) into qualitatively new productive (innovative). The last one is directed to development and approbation of new, more effective ways of process design of individual's improvement.

Hypothesis. The improving shaping training with mature age women will become pedagogically expedient and effective if the organization process will be projected on the basis of individual differentiated shaping programs. At the same time, the biorhythmic phases of the female body have to be considered.

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The purpose of the research is theoretical justification, development, and approbation of the individual differentiated technique of improving shaping training design with mature age women. The consideration of biological regularities of organism functioning is obligatory.

Material and methods

Participants. Women aged from 21-55 years (n=86) participated in a research. Women were engaged in the sports and improving center (Gomel State University named after Fransysk Skarina, Belarus). The informed consent to participation in an experiment was received from all participants.

Design of a research. It was applied an anthropometrical method (assessment of physical development), methods of functional diagnostics (monitoring of a cardiovascular and respiratory system, express assessment of physical health condition by G.L. Apanasenko's technique, assessment of physical working capacity – PWC_{170} test), pedagogical testing (determination of physical fitness level).

The following sequence of carrying out a research was chosen for the achievement of the purpose. At the first stage was performed determination of women's initial level of morphofunctional state and physical fitness. Morphofunctional diagnostics and determination of physical fitness level consider phases of the individual ovarian menstrual cycle (OMC). The above-mentioned researches were conducted for each woman in the same, optimum – post-menstrual (6-12 day from the beginning of a cycle) or – post-ovulation phases (16-24 day from the beginning of a cycle).

The main tasks' plan of improving shaping process was defined at the second stage.

The general scheme of the individual differentiated technique design of improving shaping training was developed at the third stage (Fig. 1).

Planning of shaping training programs was performed by the fundamental principle of periodicity: microcycles, mesocycles, and macrocycles are defined. The nine-months macrocycle (September-May) of improving shaping training is realized. The macrocycle consisted of three stages: preparatory, the main and stabilizing.

The preparatory stage lasted 6 weeks (1 mesocycle). The main tasks were diagnostics of body kinetics condition, adaptation of a female body to training loads, the design of individually differentiated corrective shaping programs.

The main (developing) stage lasted 24 weeks (4 mesocycles). Its purpose was a transition to a higher level of physical health condition, correction of a body constitution, change of muscular topography. It was necessary to raise a functional condition of respiratory and cardiovascular systems, to strengthen the musculoskeletal system, to correct the level of physical fitness.

The stabilizing stage lasted 6 weeks (1 mesocycle) and was directed to the maintenance of the reached level in a morphofunctional condition of women and their motor abilities.

Shaping program of training consisted of several parts which differed in various target orientation. In general, (developing) stage of a macrocycle was developed two programs of training – power and aerobic orientation.

The structure of shaping training of power and aerobic orientation is designed by the block principle. The shaping training program of power orientation included: sets of exercises oriented to force development of the main muscular groups; increase of bones density. It promoted prevention of osteoporosis and increase of exchange processes intensity. Shaping program of aerobic

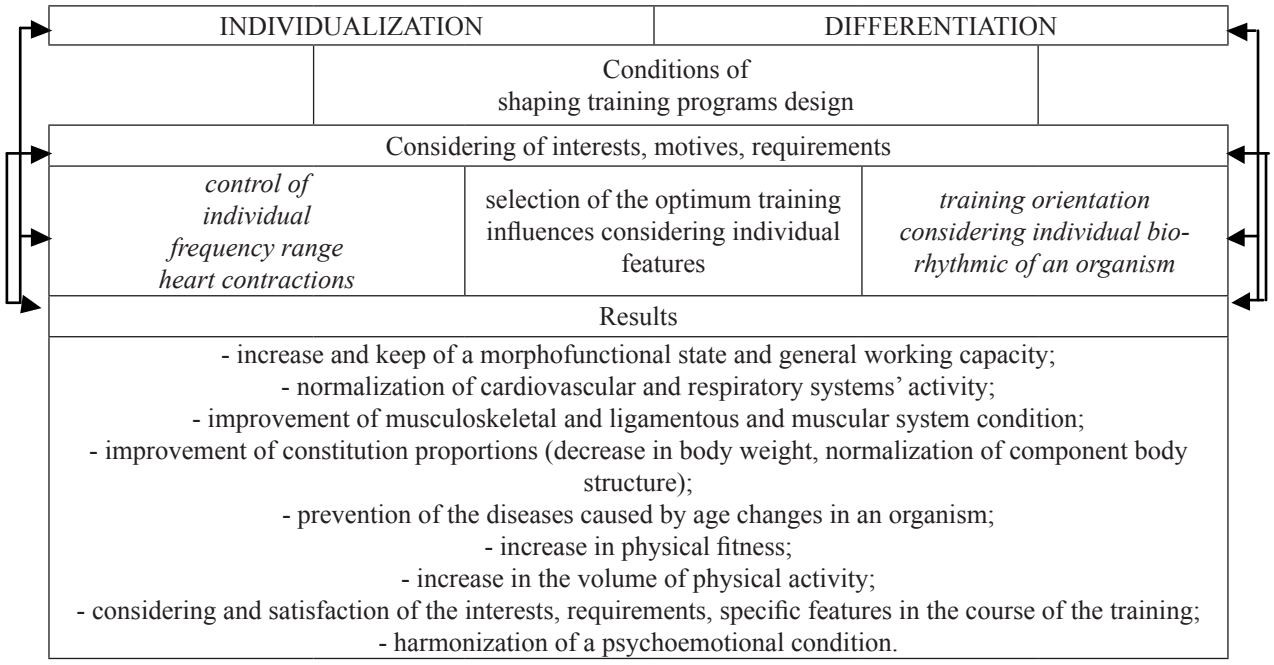

Fig. 1. The scheme of the individual differentiated technique design of improving shaping training.

orientation training contained sets of exercises devoted to increase in functionality of an organism.

The individual and group method was applied in training design. The purposes and contents of the program were equal for all participants. Distribution of loads, their duration, intensity, and volume was regulated individually (the hormonal background of a female body during OMC was considered) [22, 23]. The beginning and the end of a microcycle is caused by the duration of each phase of biorhythmic of certain woman organism (Tab. 1).

Every training the experimental group was divided into three subgroups according to an individual functional condition of women.

In the first subgroup were women who are in premenstrual, menstrual and ovulatory phases. In the second subgroup were women who are in post-menstrual phase (it was applied the catabolic load directed to decrease of fat mass). In the third subgroup were women who are in postovulatory phase (it was applied the anabolic training influences directed to increase in muscle mass). It allowed to differentiate improving process. Depending on this or that phase of OMC women had a possibility to choose a subgroup.

Women of each subgroup at the same time were engaged in the certain motor sector with the individual video instructor. Such an approach substantially protected women organisms of physical and psychophysiological overloads. During improving shaping training the contents of sets were corrected for each woman. Training sets were three times a week and their duration was 60 minutes.

At the final stage was evaluated the efficiency of the developed technique of improving shaping training design. It was defined the dynamics and reliability of indicators changes in physical development, functional state, and physical fitness.

Statistical analysis. In the processing of experimental data were calculated arithmetic mean ($\overline{X}$), errors of arithmetic mean (m), variation coefficient (V %). The Student's test (t) was applied for checking the reliability of differences between two average selective means. The difference was considered significant at $p<0,05$.

Results

At the initial stage of a research were estimated the initial level of physical development, functional condition, physical fitness of women. It was revealed deviations from standard values of the majority of indicators.

Data of initial level of women physical development indicators at the end of an experiment are presented in table 2.

The indicator of body weight is exceeded in 18.7% (on average 11 kg). The body mass index (BMI) is exceeded in 11.3%. It demonstrates the presence of overweight and is estimated as preobesity. The similar variability is traced also in indicators of the body structure. The fat content in women organism is considerably exceeded (the optimum level of a fat component is in the range from 18 to 25%).

The decrease in 21.7% is revealed in the analysis of a muscular component. The optimum level of this component is in the range from 34 to 36%. Therefore, it is determined the low level of muscle mass development at the beginning of the experiment. Such a situation is caused by the low level of women physical activity. It leads to increase in fat body mass and decrease in muscle mass.

Outside the norms of development there are indicators of a functional condition: the vital capacity of lungs (VCL) is in 15.2%; the heart rate (HR) is in 11.8%; the arterial blood pressure (ABP) in 6.7%; results of breath holding test in 13.7%; the indicator of the general work

Table 1. Structure of the mesocycle constructed according to biorhythmic phases of women organism.

Microcycle duration	OMC phases and their duration	Total training load	Motor mode
Recovering 6-8 days	Premenstrual 3-4 days, Menstrual 3-5 days	Average Small	50-60% HR max
Developing 7-9 days	Postmenstrual (estrogenic) 7-9 days	Big	60-70% HR max
Stabilizing 3-4 days	Ovulatory 3-4 days	Average	50-60% HR max
Developing 7-9 days	Postovulatory (progestrogen) 7-9 days	Big	70-80% HR max

Note: HR – heart rate; OMC – ovarian menstrual cycle.

Table 2. Dynamics of women physical development indicators ($\overline{X}$ ±m)

Indicators	Body weight, (kg)	Body mass index (kg/m²)	Fat component (%)	Muscular component (%)
Before experiment	70,5±3,2	25,6±0,9	33,8±4,2	26,6±0,5
After experiment	61,2±1,2*	22,2±0,7*	25,2±0,8*	33,6±1,2*
Change,%	13,2	13,3	25,4	26,3

Note. * - significance of differences according to Student's test at $p<0,05$.

capacity PWC_{170} in 10.2% (Tab. 3).

It is determined the low initial level of physical health (the technique of G.L. Apanasenko [22] was applied). Indicators of the body mass, length and vital index are on the level below the average. Force of wrist muscles in relation to body weight is at a low level. The functional index and time of HR recovery (after 20 squats in 30 s) correspond to the level below the average (Tab. 4).

Low level of women physical health is caused by overweight, discrepancy of VLC value to age, a reduced power indicator. It is observed the increased arterial blood pressure which is slowed down time of HR recovery after the dosed physical activity.

Level of initial physical fitness of women is also below of standard indicators. It is observed the decrease in indicators in women: force – in 44.4%; general endurance – in 34.5%; power endurance – in 38%; flexibility – in 30.7%; high-speed and power abilities – in 16.5%; explosive force – in 6.2%. (Tab. 5).

The data analysis revealed statistically significant changes on all indicators in comparison with source values (Tab. 2-5). It is observed the increase in the level of women morphofunctional condition under the influence of training. It is revealed the decrease in body weight indicator in 9.3 kg. It also caused statistically significant ($p<0,05$) reduction of BMI value characterizing proportionality of physical development. At the same time, the percentage of fat became less. It is demonstrated by the assessment of body component structure. The fat component in women organism decreased by 25.4%. The muscular component increased by 26.3%. In general, characteristics of body structure reached the standard indicators.

Table 3. Dynamics of women functional condition indicators ($\overline{X}$ ±m)

Indicators	VCL (ml)	HR at rest (bpm)	Systolic blood pressure (mm Hg)	Diastolic blood pressure (mm Hg)	Stange's test (s)	PWC_{170} (kgm/min/kg)
Before experiment	2922,6±30	82,3±1,3	134,2±3,7	82,3±2,8	35,4±4,6	10,9±0,3
After experiment	3272,6±81*	72,3±1,6*	122,8±1,9*	73,8±1,5*	45,7±2,9*	12,2±0,3*
Change,%	11,9	12,1	8,5	10,3	29,1	11,9

Note. * – significance of differences according to Student's test at $p<0,05$.

Table 4. Dynamics of indicators level of women physical (somatic) health ($\overline{\tilde{O}}$ ±m)

Indicators (indexes)	21-55 years (n=86)			
	Before experiment	Level	After experiment	Level
body mass and length (mass/ body length, gr/ cm)	425,7±19,3	low average	369,2±7,2*	above average
Vital (VCL /body mass, ml/kg)	41,4±1,3	low average	53,4±0,3*	above average
Force (dynamometry of wrist / body weight x 100,%)	34,9±1,4	low average	51,7±1,7*	average
Functional (Robinson), HR x (Systolic blood pressure / 100 c.u.)	110,4±4,8	low average	88,7±3,4*	average
Time of HR recovery after 20 squats in 30s (min)	2,1±0,2	low average	1,6±0,1*	average
General assessment of health level (score)	**-3,1±0,3**	**low**	**7,1±0,5***	**average**

Note. * – significance of differences according to Student's test at $p<0,05$.

Table 5. Dynamics of indicators of physical fitness of women (±m)

Indicators	2 km run (min, s)	Adam's forward bend test (cm)	Cadence Push-Up Test, quantity of times	Bent Arm Hang Test (two hands), (s)	Standing long jump (cm)
Before experiment	15,54±1,31	3,9±0,7	4,5±0,8	7,5±0,2	120,5±0,8
After experiment	12,18±1,24*	7,2±1,5*	10,1±0,9*	13,4±0,3*	129,1±0,9*
Change,%	21,8	84,6	124,4	78,6	7,1

Note. * – significance of differences according to Student's test at $p<0,05$.

Level of vital capacity of lungs (VCL) increased in 350 ml. The following indicators decreased at rest: HR in 10 beats/min; systolic arterial blood pressure in 11.4 mm Hg; diastolic in 8.5 mm Hg ($p<0,05$). Results of functional tests also considerably improved. First of all, it concerns timed inspiratory capacity test (increase in 10.3 s) and PWC170 test (increase in 1.3 kgm/min/kg). These changes reach statistically significant values in 5% of significant value.

The level of women physical health is also increased. The augmentation was 10.2 points ($p<0,05$) and reached to "average" assessment of health functional level. As a result of the analysis and systematization of these test exercises the significant increase in the studied indicators was revealed ($p<0,05$).

Discussion

Results of initial morphofunctional diagnostics of women at the 21-55 years are confirmed with results of scientists' researches concerned age involution changes [7, 8, 15] of physical development indicators, functionality, level of physical fitness. We confirmed and added with the data information from other authors' researches [1, 10, 24] concerning the low health level of mature age women. It allowed to reveal the low level of physical (somatic) health of women of this age.

The number of works [1, 8, 10] includes data concerning the existence of close interrelation between the ability of women to transfer physical activity and phases of an ovarian menstrual cycle. It is noted that the dynamics of women efficiency is affected significantly by changes of the hormonal status [23, 25]. In our research feature of monitoring of a morphofunctional state and physical fitness of women of mature age is considering of phases of individual ovarian menstrual cycle. Our researches were performed for each woman in an optimum phase (post-menstrual or – post-ovulation).

Modern experts of improving physical culture [1, 8, 13] have a general consensus that it is necessary to apply the differentiated approach to optimization of women psychophysical condition in the course of the improving training. However often such differentiation is performed on the basis of the techniques which consider mainly gender and age standards of physical and functional fitness of women.

We offer another approach. In our research, we choose a more rational and high-quality way of application means and methods of improving physical culture. All this corresponded to specific features of a female body in the maximum degree.

We developed a technique of the individual differentiated design of improving shaping training with mature age women. The feature of such technique is the organic combination of specific features of mature age women and phases of their specific biological cycle. It substantially protects women organism from physical and psychophysiological overloads.

The content of shaping programs assumes the selective choice of means in the form of physical exercises sets which are easily combined. Rational motor loads allow to operate more purposefully morphofunctional improvement of the organism of mature age women and to reach a higher level of their physical fitness.

The advantage of our methodology is the result of an increase in the level of morphofunctional and physical fitness, the health condition of mature age women. It is reached after the end of a nine-months macrocycle of the individual differentiated shaping training.

We confirmed and added information of other authors [1, 20, 25, 26] concerning the positive influence of occupations shaping on physical conditions of women of mature age.

Conclusions

1. The individual differentiated approach to improving shaping training design allows to operate more purposefully morphofunctional improvement of an organism of mature age women. It also allows to reach the optimum level of physical health and physical fitness.

2. The technique of the individual differentiated design of improving shaping training with mature age women includes the organic combination of consideration of their specific features, phases of their specific biological cycle. It promotes the achievement of a higher cumulative effect of organism adaptation to training loads, increases in the level of morphofunctional and physical fitness, health condition.

Conflict of interests

The authors declare that there is no conflict of interests.

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Effects of stretching before intense exercise training on hematologic and cellular injury indices

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Abstract

Purpose: The aim of the study was to investigate the effect of stretching before intense exercise on hematologic parameters and cell injury.

Material: The subjects of the present study were 12 adolescent members of the Kurdistan Province futsal team (age: 14.83 ± 0.38 years, height: 173.92 ± 5.90 cm, weight: 63.50 ± 7.94 kg, peak power: 459.42 ± 95.94 watts). The RAST test was used to estimate the anaerobic power and to create the training load. Indexes of blood including white and red blood cells, hemoglobin, hematocrit, platelet and the levels of CK and LDH enzyme activities were measured.

Results: The results of the pre and the post tests showed that among hematological parameters and cell damage indexes, the red blood cell and hemoglobin in both groups and the level of LDH in the training group were not significantly changed ($p>0.05$). Other parameters in the pre-test and post-test measures were statistically changed ($p<0.05$).

Conclusions: Based on the results of the present study, it seems that stretching before intense training decreases the cell damage and side effects of exercise training on the hematological factors.

Keywords: cell damage, anaerobic exercise, muscle soreness, hematologic parameters, adolescent.

Introduction

Stretching before physical activities is considered as an important principle in all kinds of sports and is more important than the other daily activities. Stretching is recommended by scientists, physiotherapists and coaches. Flexibility is an intrinsic property of tissues that determines the achievable range of motion without injury at a joint or a group of joints [1]. In discussing the oxygen carrying capacity of blood, RBC count, hemoglobin and hematocrit are essential elements that contribute to decrease or increase in the oxygen carrying capacity of blood to the tissues and carbon dioxide desorption [2, 3]. Many studies have shown that blood factors are changed due to physical activities. Increase in blood factors have been reported in some of these studies [4, 5], while other studies have not reported significant changes [6, 7]. Also in these studies there is no general consensus on the changes in blood factors. It means that some of them have reported increase and some of them have reported decrease in blood factors, while in other studies this factors have been fixed and in contrast, other factors have been changed. It is well known that stretching before exercise activities reduces musculoskeletal injury. However the effect of stretching before exercise on blood factors and intracellular injuries associated with physical activity has not been studied yet. Therefore, the aim of present study was to investigate the effects of stretching before intense physical activities on hematologic and cellular injury indices.

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Material and methods

Participants: 12 adolescent members of the Kurdistan Province football team (Age: 14.83 ±0.38 years, height: 173.92 ±5.90 cm, Weight: 63.50 ± 7.94 kg and maximum power: 459.42± 95.94W) participated in this study. All of them have been practicing football training programs for at latest 4 years. The study was conducted in three sessions. In the first session, individual characteristics of the subjects were recorded and the test method was illustrated. In the second session, all the participants took part in the RAST test. Then, based on the first session results, participants were divided into two groups: control group (1) and the experimental group (2). The two groups were almost identical in terms of maximal aerobic power.

Testing procedures

In the third session which was performed 72 hours after the second session, the participants were asked to stay in a rest position for 20 minutes. Then blood sampling was done from their brachial arteries. Then group 1 performed general warm up for 10 minutes before the test and the second group performed stretching exercises for 5 minutes in addition to the general warm up (for a period of 10 second per a movement). Then all the participants performed the RAST test. Blood sampling was done again after the test was conducted. The RAST test was used in order to estimate the anaerobic power and the exercise load. Two lines were identified at a distance of 35 meters from each other. Prior to the testing, subjects' weights were measured using Beurer PS06 digital. First subject

stood behind the start line in a ready position and after hearing the command "Go" each person ran a distance of 35 meters with his maximum power and the time spent was recorded by a portable Hanhart Stopwatches made in Germany. In order to increase the accuracy and reduce the measurement error, four testers were used simultaneously and the average of three close times was considered as subject record. Then subject again started to run a distance of 35 meters with their maximum power hearing the command Go (this was measured by someone else). This was repeated for six times and it was recorded for each time. Then maximal anaerobic power of participant was calculated by the following formula [8].

$$\text{Power} = \text{Weight} \times \text{Distance}^2 \div \text{Time}^3$$

$$\text{Power} = \text{Weight} \times 1225 \div \text{Time}^3$$

To measure blood parameters, blood samples were collected in the relevant tubes and immediately were transferred to the laboratory. Then blood parameters including white blood cells (WBC), red blood cells (RBC), hemoglobin (Hgb), hematocrit (Hct) and platelet (Plt) were measured using cell counter machine model (Sysmex K-1000. IVB=15.20, Japan). Also enzyme activity of CK and LDH was measured using auto analyzer system (Cobas Mira Plus; Roche, Basel, Switzerland).

Statistical analysis

To describe the general characteristics of the subjects, descriptive statistics (mean and standard deviation) were used. Also, Kolmogorov-Smirnov test was used to assess data distribution, independent t was used to compare two groups and dependent t test was used to compare intragroup results. All the statistical tests were analyzed using SPSS Software 23 and at the significant level ($p \leq 0/05$).

Results

Individual characteristics of subjects (height, age and weight) and maximum anaerobic power groups are presented in Table 1. Results of pre-test and post-test exercise and control groups (Table 2 and 3) showed that except for the red cell count and hemoglobin in both groups, other hematologic indices in the experimental and control groups did not change significantly ($p > 0.05$).

Also, CK enzyme has been increased significantly in both groups ($p \leq 0.05$). But the levels of LDH showed significant increase in only the control group ($p \leq 0.05$). Also there is no difference between the changes of two groups ($p > 0.05$).

Table1. Individual features and maximum anaerobic power of the two groups

Group	n	Age(years)	Height(cm)	Weight(kg)	Maximal power(W)
Control group	6	14.83±0.40	173.50±6.34	62.50±4.89	442.33±74.49
Experimental group	6	14.83±0.40	174.33±5.98	64.50±5.10	459.42±95.94

Table 2: Comparison of pre-test and post-test in experimental group

Variable	Pre-test	Post- test	Difference between the tests	Sig
LDH	379.17±51.8	448.33±85.51	59.16±70.19	0.94
CK	370.67±123.79	432.67±122.25	62.00±29.11	0.03*
WBC	6.8±1.33	10.36±2.43	3.56±1.14	0.001*
RBC	5.04±0.86	5.13±0.88	0.11±0.14	0.062*
Hgb	14.45±1.72	14.73±1.7	0.28±0.29	0.01*
Hct	45.16±3.55	48.71±2.96	3.56±1.41	0.002*
Plt	215.83±27.34	262.17±40.51	46.33±18.35	0.002*

*Significance between the pre-test and post-test

Table 3. Comparison of the pre-test and post-test in the control group

Variable	Pre-test	Pre-test	Difference between the tests	Sig
LDH	414.33±41.03	481.33±42.08	67.00±39.11	0.009*
CK	325.67±122.89	414.5±139.87	88.83±72.58	0.03*
WBC	6.08±0.84	9.73±1.45	3.65±0.78	0.00*
RBC	4.89±0.26	5.03±0.23	0.14±0.17	0.053
Hgb	15.21±0.81	15.45±0.67	0.23±0.46	0.012*
Hct	44.91±1.76	48.76±2.25	3.85±2.03	0.006*
Plt	214.17±33.91	247.67±52.27	60.50±21.19	0.001*

*Significance between the pre-test and post-test

Discussion

The present study has tried to examine the effect of stretching before exercise on some of the cell injury and hematological indexes. Lactate dehydrogenase enzyme (LDH) exists in different tissues of body and its concentration is high in liver, kidney, skeletal muscle and other tissues. When the muscle cell is injured due to physical activity, LDH concentration is increased [9]. Muscle cell membrane permeability is increased due to muscle activity or maybe the muscle cell is completely ruptured. Therefore, the relevant enzymes enter the blood circulation [10]. Based on the results, it seems that stretching before intense exercise may reduce the probability of cell injury associated with the physical activity. Significant increase in LDH enzyme level in the control group is consistent with Ferri et al (2006) [11].

Also, the results showed that in both groups, CK enzyme increased significantly. However, the increase was lower in the experimental group compared to control group. Measuring CK level in the blood, is another criterion to measure muscle injury [12, 13]. Normally, CK can be seen in the muscles, but when the muscles are injured, it enters the blood circulation .After exercise, those athletes who have more CK in their circulation, experience greater muscle pain [9, 12]. According to the results of the present study, although, changes in CK levels in both groups was significant, but experimental group showed less changes compared to the control group. So, it seems that stretching before severe exercise reduces cell injury.

The results showed that white blood cell count (WBC) has been increased significantly in both the experimental and control groups. However, the increase in white blood count in experimental group was lower than that of the control group. Different studies have shown that white blood cells increase significantly after exercise and this is called leukocytosis [14]. Leukocytosis is one of the clear changes appear after severe or moderate physical activities and white blood cell level remain high for several hours during these activities [3]. The results are consistent with the study by Simonson et al (2001) and Anseli et al (2007) [6, 7]. In contrast, the study is not consistent with that of Arazi et al (2011) in which they reported no significant increase in white blood cell levels [3]. Since, leukocytosis level is directly related to the severity of the exercise; it seems that this disagreement is related to the exercise protocol. Although, no significant difference has been found in both groups, but because white blood cell increase was lower in experimental group compared to the control group, it seems that stretching before intense physical activity reduces the stress on immune system and in turn reduces immune system reaction to the stress.

The results of the study showed that red blood cells count and hemoglobin level have not changed significantly in both experimental and control groups. Two possible mechanisms have been discussed in different studies on the changes in red blood cell count. First, some studies have shown that blood factors are reduced during intense physical activities (Hemoglobinuria). Second, other studies have reported that during exercise, due to the released stored erythrocytes from spleen, erythrocytes and hemoglobin are increased in the blood [18-20]. This study shows that changes in hemoglobin and erythrocytes may depend on equivalency between the two mechanisms. Schumacher et al (2002) and Choudhary et al (2011) reported that hemoglobin level remains close to the standard level in people who have exercised and increase in the release of erythrocytes from spleen may be seen in those subjects who have not exercised [21, 22]. Since the subjects of present study were athletes, our result is in agreement with this study and this accounts for the disagreement with results of the present study and those of Arazi et al (2011), Brown et al (2002) and Nazarali et al (2012) who have reported increase in the level of erythrocytes and hemoglobin [3, 23, 24].

The results of our study show that hematocrit have increased significantly in both experimental and control groups. Since hematocrit is defined as the amount of RBC in certain volume of blood, on the one hand, it is related to RBC volume and on the other hand, it is related to plasma volume [3, 17]. Therefore, given that the number of RBC and hemoglobin didn't change significantly in this study, the observed increase in hematocrit will be due to decrease in plasma volume. It has been reported that during intense exercise temporarily plasma volume decreases by as much as 6 to 20 percent [25, 26]. Three mechanisms are assumed to account for initial decrease in plasma volume: first, increase in arterial blood pressure and muscle contraction increased capillary hydrostatic pressure. This drives the fluid into the extravascular space. Second, lactic acid and other metabolites produced by contraction of muscles during intense exercising drives blood fluid into the extravascular space (osmosis). Finally, increase in intangible excretion and sweating is influenced by net decrease in intravascular plasma volume in critical conditions 27, 28]. This factor reduces plasma volume and in turn increases hematocrit.

Also this study indicates that platelet levels have been increased significantly in both the control and the experimental groups. Increase of the platelet number was due to the release of new platelet from the spleen vascular bed, marrow and other platelet storage in the body [3]. The exercise protocol used in this study leads to increase of platelet production (thrombotic factor) because it causes small possible injuries. However, Siscovick et al reported that initial cardiac arrest risk will be increased temporarily during physical activity. Therefore, it appears that on the one hand, physical activity prevents from cardiovascular disease and on the other hand it leads to sudden cardiac death [29]. This may leads to thrombosis in coronary circulation and increases the risk of cardiac arrest [30]. The results of the present study show that number of platelet have been increased significantly in both control and experimental groups. This increase was lower in the experimental group that had performed stretching exercises. Therefore, it seems that stretching before intense exercises reduces platelet changes and its effects.

Conclusions

Based on the results of present study, it appears that stretching before intense physical activities decreases cell injury and its adverse effects on blood factors. However, it is suggested that further studies investigate the effect of stretching on other factors including anaerobic exercises.

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Conflict of interests

The authors declare that there is no conflict of interest.

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The maximum oxygen consumption and body structure component of women at the first period of mature age with a different somatotypes

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Abstract

Purpose: the identification of features of the maximum oxygen consumption of women in the first period of mature age and connection with body structure component.

Material: 22-35 years old women (n=210) have participated in a research.

Results: It was determined that women with endomorphic and mesomorphic somatotype prevail according to the absolute measure $VO_{2\ max}$. They have large body weight and higher percentage content of the muscular component. The women with low body weight and low values of fat component prevail according to a relative measure $VO_{2\ max}$. Large body weight in women of endomorphic, endomorphic and mesomorphic somatotype stipulates low values of a relative measure $VO_{2\ max}$. It is indicated by the high degree of the return correlation between a relative measure $VO_{2\ max}$ and body weight.

Conclusions: The relative measure $VO_{2\ max}$ is considered more informative as its dependence on body weight is leveled. The obtained data indicate the advantage according to a relative measure $VO_{2\ max}$ of women with low body weight somatotype (ectomorphic and balanced). Such feature is explained by authentically low percentage content of the fat component in women.

Keywords: maximum oxygen consumption, the body structure, woman, body weight, somatotype.

Introduction

The doctrine concerning the constitutional types is that each somatotype has peculiar characteristics of structure and function of internal organs. Therefore somatotype defines physical development and functionality of an organism [1]. The method of exercises execution in sport corrects and performs distribution of physical activities considering somatotype [2]. This feature is widely applied for the purpose of selection and sports orientation. The efficiency of somatotype application for sports selection of mountain climbers is confirmed by the research of Davide [3]. Helena [4] proves the need to consider somatotype and body component structure for sports orientation in sports dances, modern dances, and the ballet. The consideration of morphological features didn't come into common use in practice of improving physical culture. Respectively there is a limited quantity of scientific works devoted to this subject.

The measure of the maximum oxygen consumption ($VO_{2\ max}$) characterizes the power of aerobic processes of person power supply. In the general energy potential of the person, aerobic energy supply considerably prevails anaerobic. Aerobic potentials of the person are an integrated indicator of a functional condition of many systems of an organism [1]. Our previous research has found out features of display the maximum oxygen consumption in 17-19 years old students with different somatotypes [5] and in men of the first period of mature age [6]. Also, we investigated the level of aerobic potentials in women of the first period of mature age, but differences of somatotypes weren't investigated [7]. Yoo-rim et al [8] determined the features of the maximum oxygen consumption in students with different somatotypes. Studies of Goran et al [9] defined the reliable differences of $VO_{2\ max}$ measure in the military seamen with different somatotypes. Chaouachi et al [10] prove a major role of dominating somatotype at the aerobic training. There are no scientific publications devoted to the special display of an absolute and relative measure of $VO_{2\ max}$ in women with different somatotypes of the first period of mature age.

There are publications which proved the major influence of body weight component structure on the functionality of the person. Brezdeniuk [11] investigated features of display of aerobic and anaerobic opportunities of 17-21 years old students' organism. The author determined that students with "low" and "normal" content of fat component have the "excellent" level of aerobic opportunities. Also, students with "high" and "very high" content of muscular component have the "excellent" level of aerobic opportunities. Sukanta [12] revealed that the body component structure correlates well with $VO_{2\ max}$. Venkata et al [13] define the powerful influence of body

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component structure on the possibilities of runners to increase the $VO_{2\ max}$ level. Goran et al [9] determined that higher values of percentage content of fat component have a negative effect on aerobic and anaerobic opportunities of the military seamen. The negative impact of endomorphy on aerobic opportunities is also determined in research of Alkandari and Barac [14]. Neha et al [15] have proved the connection between of growth, body weight and age with $VO_{2\ max}$ in women of the second period of mature age.

There are data that point out the variability of the component body structure in the course of a person's ontogenesis. G. Kaur et al. specify that with the increase of years the endomorphic and mesomorphic component in women decreases [16]. Salnykova S. proves that during ontogenesis from 30 to 40 years the content of the fat component in women increases, and muscular component decreases [7]. In view of contradictory information, it is important to investigate the component body structure of all age groups women.

Lizana et al [17] proved the influence of the social and economic status on the component body structure of 6-18 years old Chilean girls. We haven't found research of component structure of body weight and its influence on aerobic opportunities of women of the first period of mature age.

The research of the maximum oxygen consumption and component body structure in women of the first to the period of mature age will allow to define features of their display depending on a somatotype. Correlation connection between component body structure with $VO_{2\ max}$ will find the influence of each of the components on aerobic opportunities of women of the first period of mature age. There will be defined features of the influence of each body components on women with different somatotypes. It can be developed the improving training programs considering the morphological characteristics which will improve their efficiency on the basis of the obtained data.

The purpose of the research objective consists in the identification of features of the maximum oxygen consumption in women with different somatotypes of the first period of mature age and a research of connection with body component structure.

Material and methods.

Participants. 22-35 years old women (n=210) have participated in a research. All women were from the main medical group and didn't go in for sports the last 5 years. All investigated persons have agreed to participate in an experiment.

Design of the research. The maximum measure of oxygen consumption ($VO_{2\ max}$) was determined by the Karpman and Gudkov method [18]. Investigated person performed two loads on bicycle ergometer by 5 min. The frequency of pedaling was 60 rpm^{-1} with 3 min interval of rest. Power of the first load was 1 W on 1 kg of body weight. Power of the second load was 2 W on 1 kg of body weight. The heart rate was registered at the end of each load. The value of $VO_{2\ max}$ was calculated. The value of $VO_{2\ max}$ is calculated in $ml \cdot min^{-1}$

The component body structure was determined by the method of a bioelectric impedance with the help of OMRON BF-511. This device analyzes the passing of current through an organism. The device considers a low ability to carry electric current by fat tissue and high conductivity of the muscular tissue. The device's indicators determined the percentage of fat tissue in an organism; the percentage of skeletal muscles in an organism and body weight.

Somatotype was defined according to the Carter method [19]. This method is based on the complex assessment of relative obesity – endomorphy; relative development of skeletal and muscular system – mesomorphy; relative linearity (elongation) of a body – ectomorphy. The following anthropometrical research was performed for this purpose: growth, body weight, circumference sizes, cross diameters and thickness of skin and fat rolls were determined. The thickness of skin and fat rolls were measured by means of KETs-100 caliper: on the back surface of a shoulder; under a bladebone; on the side surface of a body. The circumferences sizes of an intense shoulder and shin were measured in places of the greatest development by a measuring tape. Cross diameter of the distal part of a shoulder and a distal part of a hip was measured by a caliper. The numerical expression of each component was received by mathematical calculation [19]. Belonging to a somatotype was defined according to the advantage of a component in 2,5 points. In the absence of such an advantage, the investigated person was determined as the balanced somatotype. All women were conditionally distributed on groups according to different somatotypes.

It was compared the average group value of measures in women with different somatotypes.

Statistical analysis. The analysis of the obtained data was carried out with the application of Excel 2010. The independent samples were compared for the analysis of the studied measures. Ranks of distribution displayed indicators features according to women's somatotypes. Statistical processing was performed applying Student's t-criterion. It was defined as an average mean ($\overline{X}$), Student's t-criterion (t), standard error of the mean (±m), number of degrees of freedom (f), significance value (p). The difference was considered significant at $p < 0,05$.

The correlation analysis was performed to determine the interrelation between the studied measures. The correlation coefficient (r) was defined. The number of degrees of freedom (k) was calculated. The *a* is the tabular coefficient of correlation which corresponds to the certain level of significance was calculated by means of tabular data. The significance of correlation coefficient was checked in comparison the obtained data with tabular. The connection considered significant at $p < 0,05$. The gradation proposed by Cheddok was applied for the determination of constraint force. According to this technique the constraint force was estimated as follows: $0,1 \le r < 0,3$ –weak; $00,3 \le r < 0,5$ – moderate; $0,5 \le r < 0,7$ – average; $0,7 \le r < 0,9$ – high; $0,9 \le r \le 0,99$ – very

high [20].

Results

The research of the maximum oxygen consumption in women with different somatotype has allowed to find out the following features. The reliably higher values of an absolute measure of $VO_{2\ max}$ have women with large body weight somatotypes (endomorphic and endomorphic and mesomorphic). Such tendency indicates the dependence of an absolute measure of $VO_{2\ max}$ on the body weight (table 1, 2).

The women with different somatotypes have other tendencies according to relative measure of $VO_{2\ max}$. The women with low body weight somatotype have authentically higher values of a relative measure of $VO_{2\ max}$.

The women with endomorphic, endomorphic and mesomorphic somatotype have the highest percentage content of fat according to the results of bioelectric impedance. The highest percentage content of muscular component has women with ectomorphic somatotype. The reliably lowest percentage content muscular component has women with endomorphic somatotype (table 2).

The performed correlation analysis between the maximum oxygen consumption and body component structure of women with different somatotypes has found the following tendencies. The women with endomorphic somatotype have direct moderate connection only between a relative measure of $VO_{2\ max}$ and a muscular body component. The women of others somatotypes have no significant correlation connection (table 3, 4, 5, 6).

Table 1. Power measures of aerobic productivity and women body weight

Measures	Average mean, $\overline{X}$ ± m							
	endomorphy somatotype n = 49		ectomorphy somatotype n = 49		endomorphic and mesomorphic somatotype n = 58		balanced somatotype n = 54	
	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m
$VO_{2\ max}$ (ml·min^{-1})	2509,9 ●●● ■	16,59	2487,0 ●●●	34,69	2681,1	25,30	2445,2 ●●●	27,19
$VO_{2\ max}$(ml·min^{-1}·kg^{-1})	37,8	0,46	45,2 ●●● ○○○	0,56	40,5 ○○○	0,47	44,1 ●●● ○○○	0,63

Notes: The reliability of measures' difference: ○ – relating to endomorphic somatotype; ■ – relating to balanced somatotype; ● – relating to endomorphic and mesomorphic somatotype. The quantity of marks corresponds to: ■ – $p < 0,05$; ●●●, ○○○ – ($p < 0,001$)

Table 2. The body component structure and women body weight

Measures	Average mean, $\overline{X}$ ± m							
	endomorphy somatotype n = 49		endomorphy somatotype n = 49		endomorphy somatotype n = 49		endomorphy somatotype n = 49	
	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m
Indicators of a bioelectric impedance								
Content of fat in an organism (%)	34,4 *** ●●●	0,13	23,4	0,21	32,1 *** ■■■	0,20	28,7 *** ○○○	0,26
The content of muscles in an organism (%)	28,7	0,19	31,1 ○○○	0,17	30,3 ○○○ **	0,18	29,9 ○○○ ***	0,15
Body weight (kg)	66,7 *** ■■■	0,64	55,1	0,57	66,7 *** ■■■	1,06	55,8	0,63

Notes: The reliability of indicators' difference: ○ – relating to endomorphic somatotype; * – relating to ectomorphic somatotype; ■ – relating to balanced somatotype; ● – relating to endomorphic and mesomorphic somatotype. The quantity of marks corresponds to: ** – ($p < 0,01$), ***, ●●●, ■■■, ○○○ – ($p < 0,001$).

Table 3. Interrelation of the maximum oxygen consumption of with body weight and body component structure of women (endomorphic somatotype)

Measures	Fat component			Muscular component			Body weight		
	r	*a*	p	r	*a*	p	r	*a*	p
$VO_{2\ max}$ ($ml \cdot min^{-1}$)	0,056	0,304	p>0,05	0,009	0,304	p>0,05	0,345	0,304	p<0,05
$VO_{2\ max}$($ml \cdot min^{-1} \cdot kg^{-1}$)	-0,193	0,304	p>0,05	0,381	0,304	p<0,05	-0,814	0,490	p<0,001

Notes: r – correlation coefficient; *a* – tabular correlation coefficient; p – significance level.

Table 4. Interrelation of the maximum oxygen consumption with body weight and body component structure of women (ectomorphic somatotype)

Measures	Fat component			Muscular component			Body weight		
	r	*a*	p	r	*a*	p	r	*a*	p
$VO_{2\ max}$ ($ml \cdot min^{-1}$)	0,053	0,304	p<0,05	0,055	0,304	p<0,05	0,381	0,304	p<0,05
$VO_{2\ max}$($ml \cdot min^{-1} \cdot kg^{-1}$)	0,106	0,304	p<0,05	-0,109	0,304	p<0,05	-0,471	0,393	p<0,01

Notes: r – correlation coefficient; *a* – tabular correlation coefficient; p – significance level.

Table 5. Interrelation of the maximum consumption of oxygen with body weight and body component structure of women (endomorphic and mesomorphic somatotype)

Measures	Fat component			Muscular component			Body weight		
	r	*a*	p	r	*a*	p	r	*a*	p
$VO_{2\ max}$ ($ml \cdot min^{-1}$)	-0,144	0,304	p>0,05	0,154	0,304	p>0,05	0,351	0,304	p<0,05
$VO_{2\ max}$($ml \cdot min^{-1} \cdot kg^{-1}$)	-0,261	0,304	p>0,05	0,290	0,304	p>0,05	-0,792	0,490	p<0,001

Notes: r – correlation coefficient; *a* – tabular correlation coefficient; p – significance level.

Table 6. Interrelation of the maximum oxygen consumption with body weight and component body structure of women (balanced somatotype)

Measures	Fat component			Muscular component			Body weight		
	r	*a*	p	r	*a*	p	r	*a*	p
$VO_{2\ max}$ ($ml \cdot min^{-1}$)	-0,004	0,304	p>0,05	0,120	0,304	p>0,05	0,351	0,304	p<0,05
$VO_{2\ max}$($ml \cdot min^{-1} \cdot kg^{-1}$)	-0,239	0,304	p>0,05	-0,103	0,304	p>0,05	-0,663	0,490	p<0,001

Notes: r – correlation coefficient; *a* – tabular correlation coefficient; p – significance level.

The correlation relations between an absolute measure of $VO_{2\ max}$ and women body weight of all studied somatotypes are characterized as direct connection of the moderate force (tab. 3, 4, 5, 6). The women with different somatotypes have stronger correlation relations between a relative measure of $VO_{2\ max}$ and body weight. The women with endomorphic somatotypes have the reverse high level connection (tab. 3). The women with ectomorphic somatotypes have the reverse connection of the moderate force between a relative measure of $VO_{2\ max}$ and body weight (tab. 4). The women with endomorphic and mesomorphic somatotype have the reverse connection of the high force between a relative measure of $VO_{2\ max}$ and body weight (tab. 5).

The women with balanced somatotype have reverse connection of average force between a relative measure of $VO_{2\ max}$ and body weight (tab. 6).

Discussion.

It is known that the absolute measure of $VO_{2\ max}$ to a certain extent depends on body weight. The data of table 2 indicate the absence of a difference between the body weight of women with endomorphic and mesomorphic somatotype and women with endomorphic somatotype. At the same time we define significantly higher values of an absolute measure of $VO_{2\ max}$ in women with endomorphic and mesomorphic somatotype in relation to women with endomorphic somatotype. Such phenomenon can be explained to large percentage content of fat component in women with endomorphic somatotype. Besides the highest values of an absolute measure of $VO_{2\ max}$ in women with endomorphic and mesomorphic somatotype are caused by large percentage content of muscular component. Data concerning negative impact of fat component to the level of $VO_{2\ max}$ is confirmed by the research of Goran et al [9], Alkandari and Barac [14]. We have found significantly the highest values of absolute measure of $VO_{2\ max}$ in women with endomorphic and mesomorphic somatotype in relation to women with ectomorphic and balanced somatotype. It can be explained by the significantly large body weight at women with endomorphic and mesomorphic somatotype. Existence of the highest values of percentage content of fat component in women with endomorphic and mesomorphic somatotype is compensated to considerable percentage content of muscular component (tab. 2). We have found authentically the highest absolute measure of $VO_{2\ max}$ in women with endomorphic somatotype in relation to women with balanced somatotype. It can be explain by with the large body weight of women with endomorphic somatotype. The determined features of display of an absolute measure of $VO_{2\ max}$ in 22-35 years old women with different somatotypes coincide with our previous research [5].

The relative measure of $VO_{2\ max}$ is considered more informative as its dependence on body weight is leveled. The obtained data indicate advantage according to relative measure of $VO_{2\ max}$ in women with low body weight somatotypes (ectomorphic and balanced). Such feature we explain by significantly low percentage content of fat component in women of ectomorphic and balanced somatotype (tab. 2). It is revealed the advantage of women with endomorphic and mesomorphic somatotype over women with endomorphic somatotype according to the relative measure of $VO_{2\ max}$. It provides large percentage content of muscular component in women with endomorphic and mesomorphic somatotype. The obtained data coincide with our previous research performed with 17-19 years old girls [5].

We performed the correlation analysis of absolute and relative measures of $VO_{2\ max}$ with component body structure of women with different somatotypes. The analysis revealed only direct moderate connection of relative measure of $VO_{2\ max}$ with a muscular component in women with endomorphic somatotype (tab. 3). It isn't revealed other research devoted to such correlation communications in 22-35 years women which have different somatotypes. Sukanta Saha determined correlation connection of $VO_{2\ max}$ with all components of a body in students of colleges [12]. The negative correlation of $VO_{2\ max}$ with a fat component was found also by Goran et al [9] in the military seamen. Authors indicate the need to consider the content of fat and muscular component in evaluation of body weight and $VO_{2\ max}$. We take into consideration the tendencies found out by other authors. But it is incorrectly to compare our and their obtained data: the contingent of investigated persons and methods of component body structure determination is rather differs.

The analysis of dependence the body weight on absolute and relative measures of $VO_{2\ max}$ has found out the presence of the correlation relations in women of all somatotypes. The connection of an absolute measure of $VO_{2\ max}$ with body weight in women of all studied somatotype is characterized as direct moderate. The correlation analysis of a relative measure of $VO_{2\ max}$ with body weight has found out reverse connection in women of all studied somatotypes. The high force of reverse connection of a relative measure of $VO_{2\ max}$ with body weight is defined in women with endomorphic, endomorphic and mesomorphic somatotypes (tab. 3, 5). It should be noted that women of these somatotypes have significantly large body weight. The women with balanced somatotype have average reverse connection (tab. 6). The women with ectomorphic somatotype have reverse moderate connection (tab. 4). In the previous research we didn't performed the correlation analysis between an measure of $VO_{2\ max}$ and body weight of women with different somatotypes. But in the previous research we have found direct connection of moderate force between an absolute measure of $VO_{2\ max}$ and body weight in 17-19 years old girls (without considering somatotype) [5]. Also was found out the reverse connection of average force between a relative measure of $VO_{2\ max}$ and body weight in 17-19 years girls (without considering somatotype) [5]. We haven't found out in literature the available data concerning the correlation relations of $VO_{2\ max}$ with the body weight of women with different somatotypes of the first period of mature age.

Conclusions.

It is determined the features of display the maximum oxygen consumption in 22-35 years old women with different somatotypes. The women with large body weight somatotype and higher percentage content of muscular component prevail according to the absolute measure of $VO_{2\ max}$. The women with low body weight somatotype and low values of fat component prevail according to the relative measure of $VO_{2\ max}$.

Large body weight in women with endomorphic, endomorphic and mesomorphic somatotypes causes low values of a relative measure $VO_{2\ max}$. It is indicated by high degree of the reverse correlation between a relative measure of $VO_{2\ max}$ and body weight in women of these somatotypes.

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Conflict of interests.

Authors declare that there is no conflict of interests.

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Retrospective analysis of injury trends in recreational skiers and snowboarders in Erciyes Ski Centre

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Purpose: The purpose of this study is to investigate the important differences in overall rates and frequency of injury cases and injury characteristics between the recreational alpine skiers and snowboarders in Erciyes Ski Centre.

Material: The data for this research was obtained from the Erciyes Ski Centre Injury Surveillance System. A total of 834 injury cases that ski patrols registered injury cases caused by recreational alpine skiing and snowboarding during the 2002 to 2017 winter seasons were respectively examined. The injury cases were grouped according to the skiing disciplines. All data were analysed using SPSS software.

Results: Injury cases were 690 skiers (82.7%) and 144 snowboarders (17.3%). 397 (57.5%) male and 293 (42.5%) female were skiers and 91 (63.2%) male and 53 (36.8%) female were snowboarders. There was no statistically significant difference between the gender ratios in skiers and snowboarders ($p > .05$). Data analysis indicated that there were statistically significant differences in the ratios of lower and upper extremity injuries between skiers and snowboarders ($p < .05$). Skiers suffered more lower extremity injuries while snowboarders suffered more upper extremity injuries ($p < .05$). Contusion was the most common injuries type in both skiers and snowboarders ($p < .05$).

Conclusions: The lower extremity injuries in skiers and the upper extremity injuries in snowboarders were more common with respect to body location of injuries. For both the recreational activities, contusion was the most common injury type.

Keywords: injury, ski, snowboard, erciyes.

Introduction

Alpine skiing and snowboard have gained increasing worldwide popularity as both recreational activities and winter sports for the last years. However, it is well known that both activities are hazardous because it is the fact that engaging in alpine skiing and snowboarding are associated with a risk of severe injury [1]. Nowadays, the new technology ski and snowboard equipment provide the opportunity for skiing and snowboarding at the higher speed. However, the excessive speed and less skill level for both recreational alpine skiers and snowboarders are the leading cause of ski-related injuries [2,3]. Epidemiologic studies have reported that the cases of skiing injuries have increased. Moreover, these studies have shown that skiing injuries have mostly occurred for recreational alpine skiing and snowboard among children, adolescents, and adults [4,5]. Many people who participate in recreational skiing and snowboard every year suffer severe sports-related injuries such as: sprains, fractures contusions, lacerations, dislocations, and concussion [6].

Erciyes ski centre is among the most popular ski resort in both Turkey and Europe. Such as alpine skiing and snowboard, the different types of skiing are practised in Erciyes mountain slopes. The last FIS Snowboard World Cup was held in Erciyes Ski Centre. The resort hosted nearly two million local and foreign tourists each year. Recreational alpine ski and snowboard are the most popular activities in Erciyes. However, injury cases treated by ski patrollers on the slopes occur at a rate of 2.6 per 1000 skier-days [7]. Lately, numerous researchers have made efforts for the prevention of injuries in professional and recreational skiing and snowboarding. These researchers reported that the skiing/boarding injury rate is significantly related to instinct factors such as age, gender, skiing ability, experience and external factors such as snow, slope, weather and terrain conditions, obstacles including other skiers, high speeds, trees, poles, etc [1, 8]. Moreover, because alpine skiing and snowboarding are different skiing disciplines, it is likely that there are differences in the mechanisms of injury.

The preventing skiing injury is usually very difficult, expensive and complex, and thus, the people should have the information required to prevent the leading causes of alpine skiing and snowboarding injuries. The success of skiing injury prevention systems and applicability are dependent upon valid and reliable definitions of skiing injury according to the type of skiing. With this in mind, many comparative studies in different ski centres have been conducted investigating the injuries associated with snowboarding and alpine skiing [9, 10]. However, there is a need for more detailed data about skiing injury characteristics and circumstances. In order to make an

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accurate inference about the skiing injuries, numerous studies suggested that it is necessary to research for different ski centre and population groups [11]. To this end, the aim of this study is to investigate the important differences in overall rates and frequency of injury cases, injury characteristics and circumstances between the recreational alpine skiers and snowboarders in Erciyes Ski Centre.

Materials and Methods

Participants. A total of 834 injured cases were recorded in Erciyes Ski Centre from 2012 to 2017. Cases were 690 skiers (82.7%) and 144 snowboarders (17.3%).

Procedure. This research was conducted in Erciyes Ski Centre. The data for this research was obtained from the Erciyes Ski Centre Injury Surveillance System. A total of 834 injury cases that ski patrols registered injury cases caused by recreational alpine skiing and snowboarding during the 2002 to 2017 winter seasons were respectively examined.

Data Source. A Standard form was used to record age, gender, injury characteristics and mechanism of the skiing injury. In our study, the cases were grouped according to the skiing disciplines. Group 1 comprised alpine skiers and group 2 comprised snowboarders.

Statistical Analysis. Data analyses were performed with the software package Statistical Package for the Social Sciences (SPSS, Inc, Chicago, IL, USA). Descriptive statistics are presented as mean and standard deviations. Categorical variables are presented as frequency counts, proportions, and percentages while continuous variables are presented as mean ± standard deviation. The Chi-square or Fisher-exact test was carried out for categorical variables and considered significant when $p < .05$. The independent t-test was also used to compare mean values between skiers and snowboarders.

Results

The frequency distributions of injury cases for alpine skiers and snowboarders in each winter seasons are presented in Figure 1. No statistically significant difference was found between the injury frequency distributions of alpine skiers and snowboarders according to winter seasons [$X^2(4, n = 834) = 3.423$, $p = .49$].

The frequency distributions of injury cases for alpine skiers and snowboarders according to gender differences are presented in Figure 2. 397 (57.5%) male and 293 (42.5%) female were skiers and 91 (63.2%) male and 53 (36.8%) female were snowboarders. There was no statistically significant difference between the gender

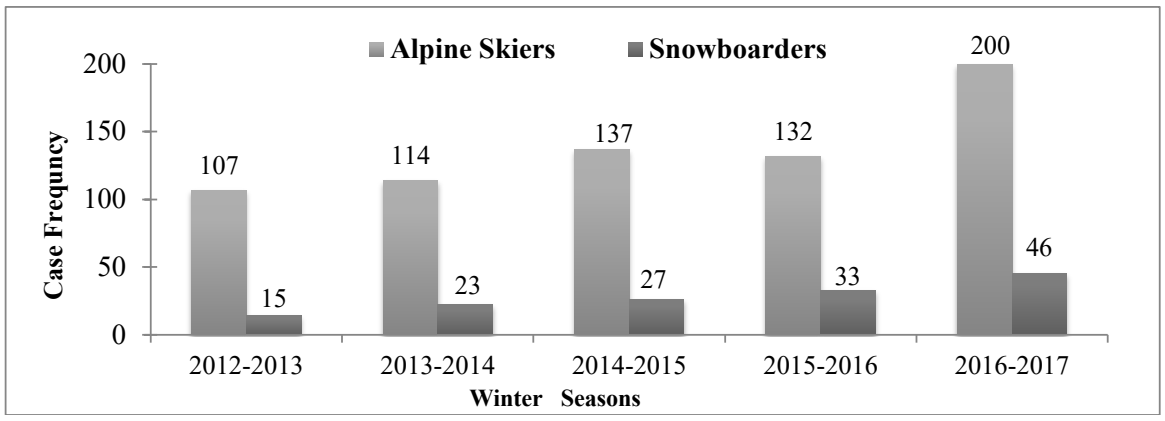

Figure 1. Injury frequency distribution for alpine skiers and snowboarders according to winter seasons.

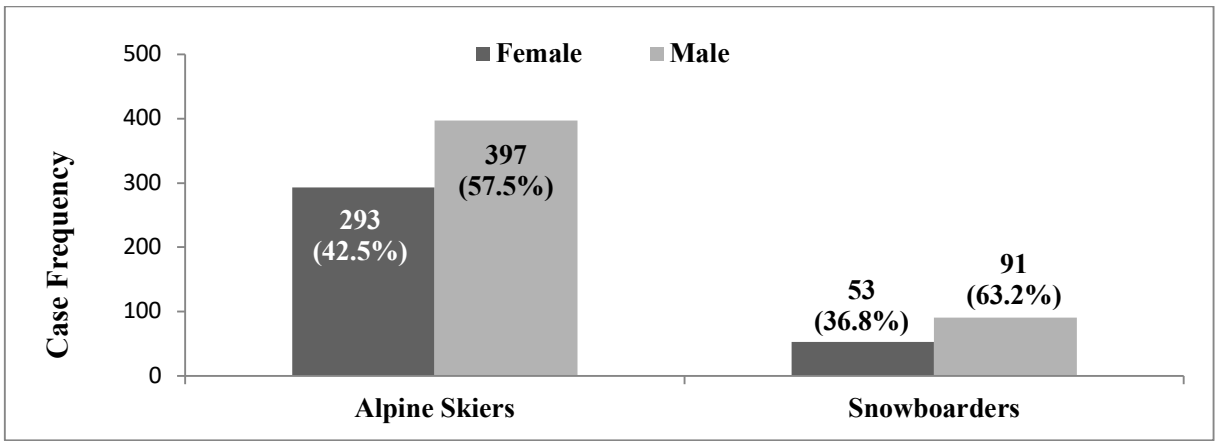

Figure 2. Injury frequency distribution for alpine skiers and snowboarders according to gender differences.

ratios in alpine skiers and snowboarders [X^2 (1, n = 834) = 1.571, p = .21].

The comparison of the mean age between alpine skiers and snowboarders is presented in Table 1. The mean age of the injured skiers was 27.10±10.5 years (range 6–65 years) and of the snowboarders 25.70±7.6 years (range 10–62 years). There were no statistically significant differences in the mean age between the skiers and snowboarders (t(832) = 1.83, p = .06).

The frequency distributions of injury cases for alpine skiers and snowboarders according to body regions are presented in Figure 3. According to body regions, the distribution of alpine skiing injuries were 60.7% lower extremity injuries (n = 419), 16.7% upper extremity injuries (n = 115), 13.9% head injuries (n = 96), and 8.7% trunk injuries (n= 60), respectively. The distribution of snowboarding injuries were 40.3% upper extremity injuries (n = 58), 22.2% lower extremity injuries (n = 32), 19.4% head injuries (n = 28), and 18.1% trunk injuries (n= 26) respectively. Statistical analysis indicated that there were statistically significant differences in the ratios of lower and upper extremity injuries between skiers and snowboarders (p < .05). Skiers suffered more the lower extremity injuries [X^2 (1, n = 834) = 71.118, p = .0001] while snowboarders suffered more the upper extremity injuries [X^2 (1, n = 834) = 44.909, p = .0001].

The type of skiing injuries distributed 54.6% contusion (n = 377), 12.2% sprains (n = 84), 9.3% open wound (n= 64), 7.4% strain (n= 51), 5.9% fracture (n= 41) 5.4% head trauma (n= 37), and 5.2% dislocation (n= 36). The type of snowboarding injuries distributed 54.9% contusion (n = 79), 9% sprains (n = 13), 7.6% strain (n= 11), 8.3% fracture (n= 12), 6.9% open wound (n= 10), 6.9% head trauma (n= 10), and %6.3 dislocation (n= 9). There was no statistically significant difference among the different injury types between skiers and snowboarders [X^2 (6, n = 834) = 6.718, p = .34]. However contusion was the most common injuries type in both skiers and snowboarders (p < .05).

Discussion

The main purpose of our study was to examine the differences in the between recreational alpine skiing and snowboarding injuries. In this context, we examined differences between injury cases of recreational skiers and snowboarders in terms of age, gender, type of injury, and anatomical distribution of the injuries during the 2002 to 2017 winter seasons. During the winter seasons examined in Erciyes Ski Centre, the injury proportion of alpine skiers (82.7%) was higher than in snowboarders (17.3%). Like our findings, many researchers revealed that alpine skiing injury cases were higher than snowboarding injury cases in the different ski centres [12-14]. However, except

Table 1. The comparison of the mean age between groups.

Variable	Group		95% CI for Mean Difference	t(832)	*p*	*Cohen's d*
	Skiers (n= 690)	Snowboarders (n= 144)				
	M (SD)	M (SD)				
Age (year)	27.1 (10.5)	25.7 (7.6)	[-.08, 2.88]	1.83	.06	0.15

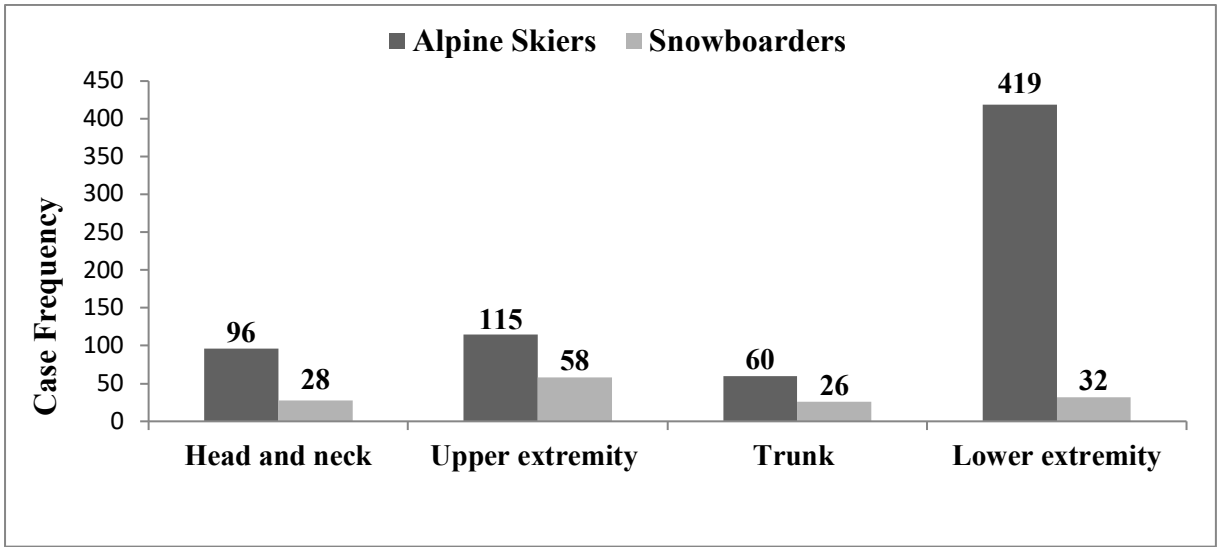

Figure 3. Injury frequency distribution for alpine skiers and snowboarders according to the body region.

*(Note: *; p < .05)*

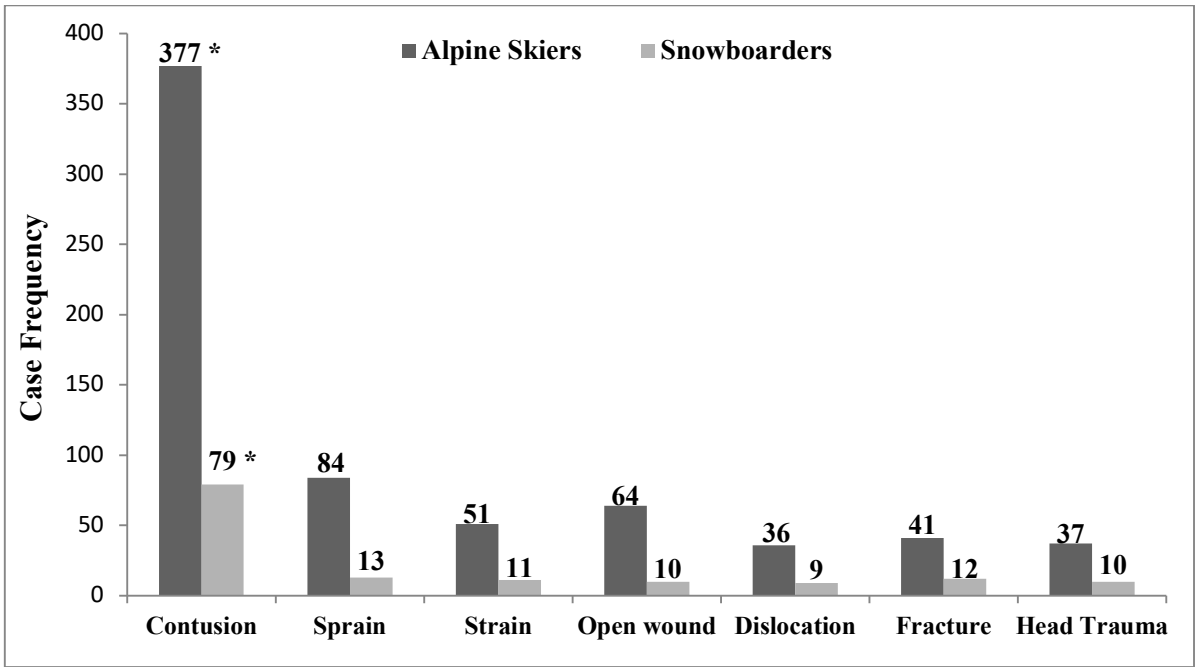

Figure 4. Injury frequency distribution for alpine skiers and snowboarders according to injury types.

for ski and snowboard races, it is not possible to determine precisely the number of skiers and snowboarder or how many times they have skiing and snowboarding in ski resorts. These injury cases have been caused probably because of the popularity of alpine skiing and the majority of participants preferred alpine skiing in the ski centres. According to winter seasons, most of the injuries occurred in alpine skiing during all seasons. Also, both alpine skiing (29%) and snowboarding (32%) injury cases peaked in the 2016-2017 season. However, no statistical difference was the between injury rates of skiers and snowboarders in terms of seasonally injury cases.

In this study, both injured skiers and snowboarders were mostly male. Males accounted for 57.5% of skiing and 63.2% of snowboarding injury cases. However, our finding indicated that there were no statistically significant differences between the ratio of male and female in both groups in terms of gender difference. Similar to our findings, the findings of Federiuk et al., show that injuries occurred more commonly in males both in snowboarding (n=27, 87.1%) and in skiing (n=53, 79.1%) [12]. Another study conducted by Ashby and Cassell, they found that of 132 injury cases male skiers were 66% and female 44% and male snowboarders were %77 and female %23 for all skiing/boarding injury cases over the period January 2004-December 2006 according to Victorian hospital-based injury surveillance datasets [15]. Flørenes et al. have reported that there was a higher risk for males compared to females in alpine athletes [16]. Our findings are consistent with the findings of these studies with regard to the ratio of male-to-female skiing and boarding injury cases. There seems to be some evidence that male skiers have a higher amount of skiing and snowboarding injury. The number of risk factors has been specified to explain the high rate in male skiers and snowboarders; the most accepted are higher participation rate, not wearing safety equipment, and more risk-taken such as; excessive speed skiing/boarding, aggressive skiing style, and dangerous maneuvers [3,16-18].

The findings of this study revealed that injured alpine skiers (27.10±10.5 years) appear to be at slightly older than snowboarders (25.70±7.6 years). However, statistical analysis showed no significant difference between the two groups ($p < .05$). Previous studies of skiing/boarding injury reported that the highest injury frequencies were observed among adolescents and young adults in groups of skiers and snowboarders [15]. A similar study published by Bridges et al., who investigated the snowboarding injuries in Eastern Canada have been reported that injured snowboarders (18.3±7.0 years) were younger than injured skiers (29.3±17.2 years) ($p < .05$) [19]. Mueller et al. (2008) stated that the higher rate of head injuries occurred 13-24 and 25-39 age groups and also the rates of using helmet were lower in these age groups [18]. A study completed by Hagel et al., who examined skiing and snowboarding injuries In Quebec has demonstrated that skiing and boarding injury cases were more common in adolescents and young adult groups [13]. Taken together, these observations and our results suggested that the injury cases of both skiing and snowboarding occurred commonly among adolescents and young skiers/boarders. Therefore, it should be paid more attention to prevent skiing/boarding injury cases in for adolescent and young people skiers/boarders.

The location of the injury on the body was examined for both the injured recreational skiers and snowboarders. Statistical analysis of our findings indicated that recreational skiers suffer mainly lower extremity injuries whereas recreational snowboarders suffer mainly upper extremity injuries ($p < .05$). Lower extremity injuries

were responsible for 60.7% of skiing injuries while upper extremity injuries were responsible for 40.3% of snowboarding injuries. Our results concur with those of Hagel et al., who reported that the upper extremity incidence of snowboarders was 3-4 times higher than injured skiers. On the other hand, they reported that snowboarders were less likely to injure a lower limb than alpine skiers [13]. Similarly, previous studies reported a higher likelihood of lower extremity injuries in alpine skiing and upper extremity injuries in snowboarding [8,11,20]. Lower extremity injuries in skiers occur more frequent because the wearing ski boot and bindings in alpine skiing restricts lower extremity range-of-motion. In alpine skiing, falling and the sudden changing of the movement direction of the lower limbs lead to an overload and overstretched of the tendons, ligaments and bones in the lower limbs thus the serious injury occurred in the lower extremity [21]. In addition, a number of researchers stated that not correctly adjusted bindings were a common cause of lower extremity injuries [22]. In this study, 79 of all the snowboarding injuries were in the upper extremity. More than half of all the reported snowboarding injuries located in the upper extremities. Snowboarders are more prone to become injured because of losing balance while riskier jumping [13]. When the snowboarders lose balance, usually snowboarders with one foot attached to the board use their hands to attempt to break the fall [10]. Therefore, it was not surprising that the upper extremity injuries occurred more likely among snowboarders.

According to the results of this study, the injured recreational alpine skiers and snowboarders were almost evenly represented in the proportions of the injury type. There was no statistically significant difference between the two groups with respect to the proportions of the injury type ($p > .05$). However, contusion was the most common injuries observed among both the injured snowboarders and skiers ($p < .05$), accounting for 54.6% of skiing injuries and 54.9% of snowboarding injuries. Other injury types have a similar incidence rate in the groups and no statistical difference was between two groups. Contusions are one of the most common sports-related injuries in many sports disciplines [23]. In the alpine skiing and snowboarding, contusion usually occurs hard and icy slopes when skiers or snowboarders fall [24]. The slopes of Erciyes Ski Centre are often hard and icy during ski seasons. For this reason, contusion injuries can be expected to be more likely occurred in Erciyes Ski Centre. In addition, the least skilled and least experienced recreational skiers and snowboarders tend to ski at slow speeds and do non-aggressive turning maneuvers [25]. Therefore the contusion among the recreational skiers and snowboarders was more common the injury type than the more serious injury types such as the sprain, fracture, strain, and head trauma. However, various clinical researches have demonstrated that contusions are usually the minor health problems and will heal fastly [23].

Conclusion

As a result, in the Erciyes Ski Centre during the 2002 to 2017 winter seasons, the rates of recreational skiing and snowboarding injuries were similar. The lower extremity injuries in skiers and the upper extremity injuries in snowboarders were more common with respect to body location of injuries. For both the recreational activities, contusion was the most common injury type. An increase in balance and skiing/boarding skills would help to prevent the contusion injury in recreational skiing activities. On the other hand, educational programmes, formal instructions, and safety initiatives targeting the prevent upper extremity injuries in recreational snowboarders and lower extremity injuries in recreational alpine skiers may reduce the injury incidence. The strength of our research was the number of injuries recorded in the Erciyes Ski Centre during 5 successive winter seasons. However, the primary limitation of this retrospective research is it was not possible the obtaining data about the number of uninjured skiers and snowboarders and their sex. A major source of limitation is due to the current data system in the ski centre does not register the gender or used equipment of the skiers/snowboarders.

Highlights

- Lower extremity injuries were most common among injured recreational alpine skiers.
- Upper extremity injuries were most common among injured recreational snowboarders
- The contusion was the most common injury type in injured recreational skiers and snowboarders.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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The relationship between watching sport events and spectators' engagement in physical activities

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Purpose: The purpose of the present research was to investigate the relationship between watching sport events in stadiums and spectators' physical activities.

Material: The population included spectators of basketball, volleyball, and handball in Tehran stadiums, which is estimated to be more than a hundred thousand people. The sample consisted of 384 spectators who were chosen using the Morgan Table in the simple random method, and they filled the questionnaire before the games started. The instrument was a researcher-developed questionnaire whose validity was confirmed by sports management and communication experts. The reliability was obtained to be 0.86 using Cronbach's alpha test. The collected data was analyzed using K-S test, chi-square test, Spearman correlation coefficient (using SPSS software), and confirmatory factor analysis (using LISREL 8.8 software).

Results: The results indicated that there is a significant positive relationship between watching sport events in stadiums and spectators' intention to do physical activities. Also, there was a significant positive relation between effective factors on spectator during watching sport events and doing physical activities. These factors are related to the stadiums, sport events and social interrelation.

Conclusions: It seems that watching sport events and the encouraging factors in sporting environment and stadiums promotes physical activity and health. Since the present research focuses on an important social effect of sport events, it can be a start point for researchers to discover if encouraging people to watch sport events is a way to maintain social health.

Keywords: physical activity, spectator, stadiums, sports.

Introduction

All the advances such as electronic and credit cash, online trade, humanoid robots, and hundreds of other achievements have made our lives easier, and modern technology made humans inactive like the machines. The result is the emergence of a variety of diseases, including heart-respiratory diseases. Sports Medicine scientists believed that not getting fifteen minutes of physical activity with no sweat at least once in a day will result in motor poverty [1]. Therefore, changing from a passive to an active lifestyle can reduce the risk of many diseases [2]. Meanwhile, the solution to these problems is taking up physical activities, especially sports. A healthy body is the most basic of human needs. Without healthy body, it is not possible to nurture the human personality and spirituality, and the mental health will be in jeopardy. By investing in sports activities, while reducing health care costs and increasing productivity in society, the mental and physical health will improve, too [3].

Public sports are considered as one of the indexes of human development in the communities because they increase life expectancy through the promotion of public health [4]. Public sport and quantitative recreation objectives are based on increasing motivation and social awareness about the role of sport in life. It also concerns the allocation of a portion of the household expenditure basket to sports [5]. In their model, Mull (2005) claim that the development of educational sports and public sports will increase public participation. If professional sports are developed, smaller groups can participate in them, and they will often watch them. What is clear is that a countless number of people interested in sports and physical activities make up spectators [6]. Spectators are people who watch physical activities and sports events for fun, entertainment, excitement, and joy. Due to their differences in behavioral characteristics, they will show different responses and reactions to different sports events in different conditions and environments [7].

Nowadays, watching sports events among individuals has increased more than ever before compared with participation in sports activities. For example, few people participate in sports as active participants, but inactive participants (spectators) can be seen in many fields. These people watch sports event as spectators note being aware of the fact that they can also take part in their favorite sports activities [8]. Spectators who spend on sports, purchase tickets, travel to watch tournaments live in stadiums will consequently be of more value and importance than those who watch the tournaments at home. Culture has a significant impact on the attendance of people in stadiums to watch sports events and participation in sports activities. Education is an important cultural factor in this regard [9]. In addition to cultural factors, socioeconomic factors also affect people's attendance in tournaments and their participation in sports activities [10].

Spectators choose their favorite sports based on their interests, experience, and familiarity with the sport. They participate in matches in which both teams

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are already known to them because they feel they can easily identify with them [11]. Also, Torkfar, in his research entitled "motivational factors influencing spectators' attractiveness to the Iranian soccer league", showed that the correlation between internal factors and attractiveness of spectators was 0.99. According to the presented functional pattern, the effective internal factors in attracting spectators included interest, beauty, stress, expression of personal feelings, escaping from the problems of life, fun, role playing by players, knowledge and information, motivation, attitudes and beliefs. Beauty had the greatest and attitudes and beliefs had the smallest impact on directly attracting spectators. The correlation of external factors with attracting spectators was 0.98. The effective external factors in attracting spectators included culture, social activism, community pride, family, friends, and marketing. Marketing had the greatest and social activism had the smallest impact on directly attracting spectators. Spectators create a close relationship and mutual affection with their teams and athletes at stadiums. Does this relationship result in motivating them to participate in their favorite sports activities? Motivation is a dynamic action and a relationship between human needs and the actions that creates motion and activity in people through developing tension and pressure. It then makes people behave in a purposeful way that results in the satisfaction of their needs [12].

Internal factors are related to the motivation of the spectators to watch a sport event closely and the degree of spectator's willingness to exercise. External factors on spectators during watching tournaments include such influencing factors as environmental and human factors [13]. People who have are highly motivated to exercise and commit themselves to physical activities learn to have an active lifestyle and make themselves healthier. In terms of physical power, they are also better prepared to perform daily tasks [14]. Weiss has shown that factors that influence participation in sport activities include health and wellness, enhancing the ability of the body, learning new skills, making a friendly relationship, admission to peer groups, support from others, and the joy arising from positive participation and minimal negative experience associated with physical activities [15].

It can be seen that several factors that may influence participation in physical activity have been studied. It is interesting that research has neglected sport itself in general and watching it in particular. Regarding the impact of factors such as health, social relationships, and pleasure the question arises as to whether spectators engage in exercising in addition to watching sports events or just make up the group who are only interested in watching sports events? What internal and external factors will attract spectators to physical activities? The present study aims to examine the relationship between watching sport events in stadiums and spectators' engagement in physical activity to offer desirable solutions for the further engagement of spectator's in different sports activities through obtaining comprehensive information and considering the needs.

Materials and Methods

Participants.

The population included all spectators of basketball, volleyball, and handball in Tehran stadiums whose number was estimated to be more than a hundred thousand people based on the nominal capacity of the venues and stadiums. The sample consisted of 384 spectators who had been chosen using the Morgan Table in a simple random method.

Research Design

The present study was an applied study in terms of purpose, descriptive of the correlational type in terms of strategy, and a survey in terms of conduction which was conducted as a field study. The instrument was a researcher-developed questionnaire that was set based on the objectives of the present study after studying Zhang et al (2001) questionnaires in investigating factors influencing the attendance of spectators in stadiums for ball sports and Torkfar (2009) standardized questionnaire on spectators' motivation to attend stadiums [11, 16]. This questionnaire included 27 questions on a 5-point Likert scale ranging from strongly agree to strongly disagree, as well as questions on demographic factors. After the initial stages, it was presented to 13 experts and specialists in the field of sports management to assess its validity. After applying the comments of the experts to ensure the validity of the questionnaire, a pilot study was done on 30 spectators of Mahram and Saman Bank basketball teams at Azadi stadium for more information about the reliability of the instrument. Test results showed a Cronbach's alpha of 0.86 which indicates a high reliability for the instrument. The questionnaire distributor team attended the desired field of tournament venues. The questionnaires were distributed among the spectators and were then collected. Members of the distribution team had been trained by the researchers, and the required permissions had been obtained from the organizers after taking legal measures.

Statistical Analysis

Mean, standard deviation, and frequency were used in the descriptive statistics section. In inferential statistics section, Kolmogorov-Smirnov test, chi-square test, Spearman correlation coefficients (using SPSS), and confirmatory factor analysis (using the LISREL software) were used. All the analyzes were performed in the 95 percent confidence level.

Results

According to the above table, the average age of participants in the study was 27 years, and the number of men and women were equal. Most of the participants were single (78.2 percent). Most of the participants sometimes attended stadiums to watch sports events (53%). The majority of the participants (38%) were physically active for three days a week. The maximum Time Spent to follow up sports events was for people who had been watching sports events in sport facilities for more than 5 years (42.2 %).

Based on Table 2, the results show that the data is not normally distributed at the 0.05 level. Therefore,

nonparametric tests should be used for the inferential analysis of the data.

The results presented in Table 3 show that the observed frequencies for the 11 questions on the motivation for attendance differ from the expected frequencies, and the difference is statistically significant. Therefore, the motivations of spectators to attend stadiums was significantly high among the participants.

Two methods were used to test the main hypotheses of the study. Given the ordinal nature of the questionnaire scales, Spearman correlation test was used. Also, given the multiplicity of variables in the questionnaire and the fact that several questions existed for the same variable, a confirmatory factor analysis was used as a complementary test. The results of the analysis of the research hypotheses are presented below.

The information from Table 4 shows that there was a significant relationship between watching sports events in stadiums and spectators' physical activities, given the obtained significant level. The observed correlation coefficient (R = 0.20) indicates a positive direct correlation between attending stadiums and spectators' physical activity.

The information from Table 5 shows that there was a relationship between the effective factors on spectators during watching and the spectators' physical activity, given the obtained significance level (0.0001 <0.05). The observed correlation coefficient (R = 0.342) indicates a

Table 1. Descriptive statistics for the demographic factors

Age	**Mean**	**SD**	**Range**
	27	**7.77**	**54**
Gender	Frequency	frequency percent	Cumulative frequency percent
Woman	192	50	50
Man	192	50	100
Total	384	100	
Marital Status			
Single	297	77.3	77.3
Married	83	21.6	100
Total	380	100	
Attending Status in sports venues for watching tournaments			
Rarely	64	16.8	16.8
Sometimes	202	53.0	69.8
Always	115	30.2	100
Total	381	100	
Weekly physical activity			
I do not work	35	9.2	9.2
One day a week	93	24.3	33.5
Three days a week	145	38.0	71.5
Every day	108	28.3	100
Total	382	100	
Time Spent to watch sports events			
Less than a year	66	17.5	17.5
One to three years	83	22.0	39.5
Three to five years.	69	18.3	57.8
More than five years	159	42.2	100
Total	377	100	

Table 2. Test of normality for the distribution of the data

Test	**KS**		
Variables	**Statistics**	**Degrees of freedom**	**Significance level**
Motivations	0.060	384	0.0001
Watching	0.103	384	0.001
Participation	0.162	384	0.0001
Effective factors	0.147	384	0.0001

positive direct correlation between the effective factors on spectators during watching and the spectators' physical activity.

In the following figure, the results of the estimated correlation between the main variables (shown as ovals) using the confirmatory factor analysis are shown. Rectangles inside the figure represents questions of the questionnaire.

Figure 1 marked the amount of the covariance between the main study variables in a standardized form. Fitness Indicators at the bottom of Figure 1 show the fitness of the model for extracting relationships. It should be noted that the specified fitness parameters have been approved with the assumption that the components related to each of the variable presented in the figure on the left are related to each other, which seems reasonable.

In Figure 2, significance of the coefficients is given by applying the t values. Coefficients larger than + 1.96 or less than -1.96 are considered significant. As can be seen, all the coefficients in Figure 1 are statistically significant.

Regarding the motivations, the most important motivation is related to question s7 (supporting one's favorite team) with a factor loading of 0.56, as shown in the figure. The second major motivation is related to question s9 (feeling proud) with a factor loading of 0.55, and the third most important motivation is related to question s5 (more communication with the players) with a factor loading of 0.53. All the factor loading values in Figure 2 that are related to the t significant values are shown to be significant. The lowest motivation of the spectators to attend stadiums is related to s3 (Entertainment) with a factor loading of 0.30. As it has been specified, the coefficient of variance (which is equivalent to the correlation) between watching tournaments in stadiums and spectator's participation in physical activity is equal to 0.19. t value is equal to 3.01, which is greater than +1.96, hence significant. Thus, the hypothesis of the existence of a relationship between watching tournaments in stadiums and participation in physical activities is confirmed. Also, the coefficient of variance between the effective factors on the spectators during watching tournaments in stadiums and spectators' participation in physical activities is 0.42, and the t value is equal to 7.67, which is larger than +1.96, hence significant. Therefore, the hypothesis that there is a relationship between effective factors on spectators during watching the tournaments and participating in physical activities is confirmed. Both of these sets of results were confirmed by applying Spearman's test, and the relationship between "watching tournaments in stadiums" and "effective factors on the spectators during watching" with "spectators' participation in physical activity" was significant.

Discussion

The correlation test showed that there is a significant direct positive relationship between watching sports events at stadiums and spectators' physical activities. It means that the more spectators watch sports events the more they participate in physical activities. Also, applying a confirmatory factor analysis indicated that covariance

Table 3. The results of chi-square test for the motivations to watch tournaments in sporting venues

The presence Motivations	Chi-Square	Degrees of freedom	Significant level
Attractiveness	351.5	4	0.001
Stress and mental pressure reduction	155.7	4	0.001
Entertainment	105.8	4	0.001
Vitality increasing	305.9	4	0.001
More communication with players	296.6	4	0.001
belonging in peer groups	93.2	4	0.001
Support your favorite team	170.5	4	0.001
Meeting with new people	120.3	4	0.001
Feel Proud	219.2	4	0.001
Staying away from monotony	102	4	0.001
Activities Background	125.9	4	0.001

Table 4. The relationship between watching sports events in the stadium and spectators' physical activity using Spearman correlation test

number	Spearman Correlation coefficient	Significant level
384	0.20	0.0001

Table 5. The correlation between effective factors on spectators during watching and spectators' physical activity using Spearman correlation test

number	Spearman Correlation coefficient	Significant level
384	0.342	0.0001

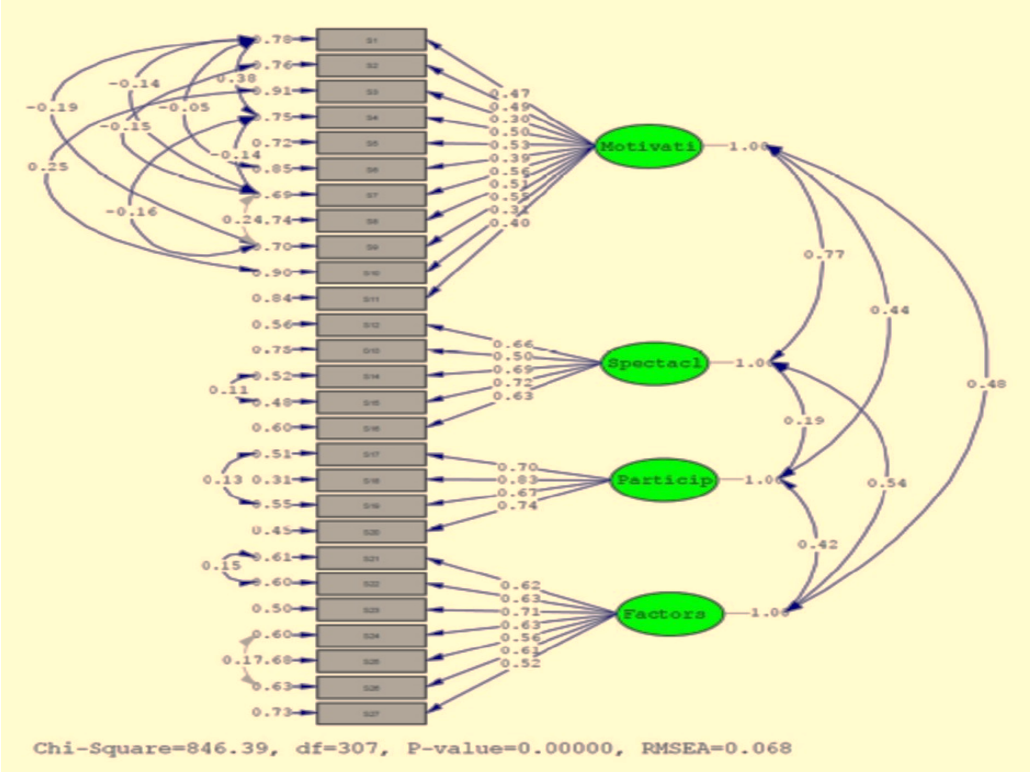

Figure 1. A confirmatory factor analysis of the main study variables with covariance coefficients between them (standardized coefficients)

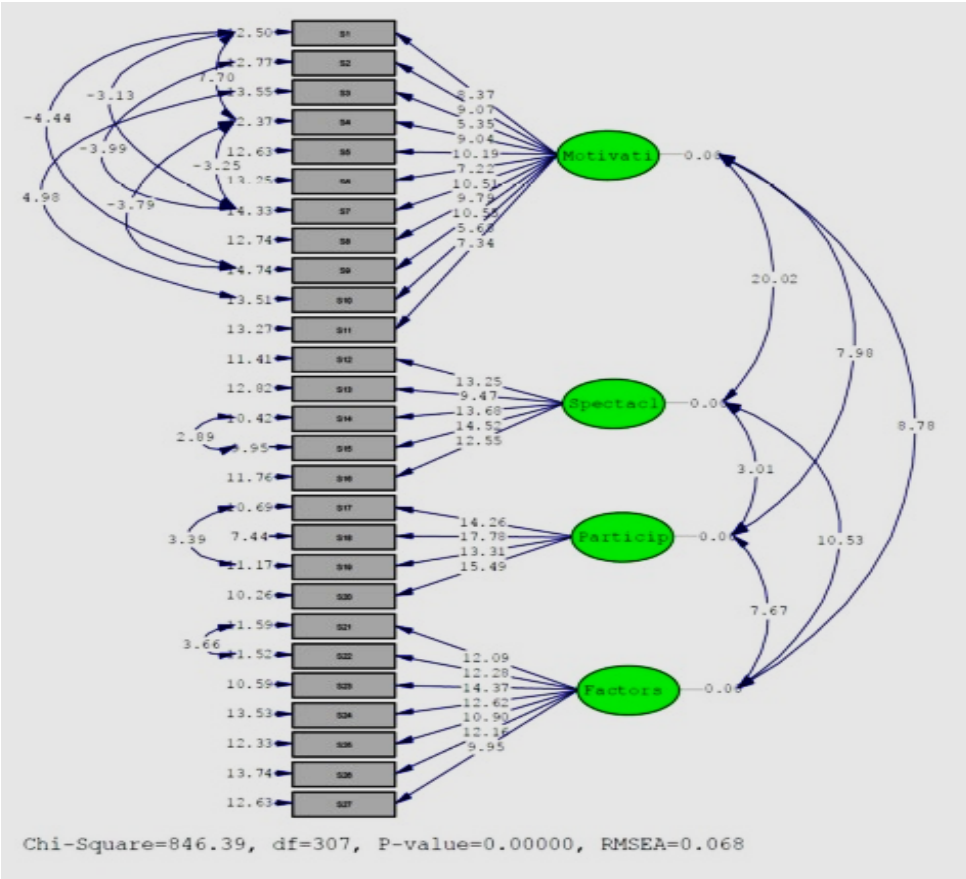

Figure 2. The t values of confirmatory factor analysis for the main study variables

coefficient (which is equal to correlation) between watching sports events at stadiums and participation in physical activities is equal to 0.19. Also the t-value is equal to 3.01, which is larger than +1.96, hence significant. It can be said that physical activity and exercising have an efficient interaction with such environmental factors as social, cultural, and personal forces, which altogether shape an individual's characteristics. Another category of physical activities has a relationship with forces that represents functional form of the physical organizations, among which physical activity and sports are of greater importance because they emerge from the relationship between the individual and culture and society.

In the third category, physical activity is related to forces that are effective in spreading or limiting physical activities. This forces are related to the surrounding natural environment as well as to social institutions such as economy, government, and politics as efficient inhibiting forces of society [17]. These factors have been considered in this study. As the results showed, the majority of those people who attend stadiums were people with high levels of education and income. It seems that cultural and social forces resulting from attending stadiums and watching tournaments and also the individuals themselves are inclined towards sports and physical activities. It is believed that watching sports can play a role in publicizing sport as an effective and active social institution in today's growing and changing modern society. Continuity and persistence on sports will be effective in the promotion of material and spiritual culture of the society and ensure the community's physical and mental health. Although there have not been any studies that directly address the relationship between watching sports events and physical activities, the results of the above hypothesis are consistent with the results of Ramezani Nejadet et al. (2009), Safania (2002), Funk and James (2004), and Lee et al. (2009) studies on factors influencing physical activity and sports. Some of these factors were mentioned in present study as motivation for attending stadiums [18-21]. Mehus (2005) and Wilson (2002) believe that participation in watching and playing sports is a social activity, and that people's amount of attendance originates from their economic and cultural background [9, 10]. Also, Funk and James (2004) stated that the individuals' attitude toward sports and their dependency toward and interest in sport teams affect the amount of time they spend on attending physical activity and sports. This attitude is initially formed under the influence of family, friends, media and advertising, and success of the sports teams. Then, attractive features of a sporting environment (convenient location, quality of services, amenities and facilities of the stadiums, etc.) play a role in shaping the attitude [20].

The correlation test showed that there is a significant direct positive relationship between the effective factors on spectators during watching sports events and spectators' physical activity. It means that the greater the effective factors on spectators during watching sports events, the more they participate in physical activities. Also, applying a confirmatory factor analysis indicated that covariance coefficient (which is equal to correlation) between effective factors on spectators during watching sports events and their participation in physical activity is equal to 0.42, and the t-value is equal to 7.67, which is larger than +1.96, hence significant. Thus, there is a significant relationship between effective factors on spectators during watching sports events and their participation in physical activities. Effective factors on spectators during watching tournaments such as environmental factors (rules and regulations have been implemented during the tournament, discipline and organization of tournament , suitable parking facilities, comfortable seating, quality of the billboard, etc.), organizational factors (functional and formal decisions during the game, the judgment, larger numbers of spectators, etc.), and human factors (coach's behavior, phenotype and physical abilities of the players, the technique of the team's stars, team effort, and team behavior) all can be related to spectators' attitudes toward sports activities. It seems that if effective factors such as environmental, organizational, and human factors are within an acceptable range – if facilities are considered desirable, if tournament managers have taken organizational factors to a desirable extent by applying appropriate strategies, if players and coaches behave in an acceptable and suitable way – spectators' behavior will improve and thus a culture of correct behavior will develop. Consequently, spectators who idolize the athletes will engage in sports under the influence of the above-mentioned factors, and this will result in the institutionalization of sports in society. The results of the present hypothesis is consistent with Kialashaki (2008), Nicholson and Hui (2005), Hooi and Yusof, (2008), and Hall; Mahony and Vieceli (2010) studies [13, 22-24]. Kialashaki (2008) stated that issues such as judgment, failure in competitions, the behavior of the rival sports teams, competition sensitivity, stimulating and exciting tournaments are among the effective factors on the behavior of their spectators during the tournament [22]. Nicholson and Hoye (2005) stated that organizational and environmental effective factors on spectators during watching sports events include environmental factors (settings, stages and levels of competition, strategies of sports organizations, interactions between authorities, coaches, and players during sports tournaments) and organizational factors (functional and formal decisions during the game, refereeing, the number of spectators over the capacity) [13]. Hooi and Yusof (2008) and Lee & Macdonald & Wright (2009) showed that there is a significant relationship between stadium environment and the quality of team with the spectators' satisfaction and their willingness to participate in a tournament [21, 23]. Hall et al (2010) also suggested that the creation of entertaining and exciting conditions and suitable facilities such as easy access to stadium seats and parking areas are effective on the sports events spectators [24]. The results from the statistical analyses showed that all motivations of spectators' for attending stadiums are significant. These motivations include attractiveness, stress and mental pressure reduction, entertainment, increasing

vitality, further communication with players, belonging in peer groups, supporting one's favorite team, meeting new people, feeling proud, being away from monotony, and activity background. As shown in Figure 2, the most important motivation is related to the question of S7 (supporting your favorite team) with a factor loading of 0.56. The second most important motivation is related to the question S9 (feeling proud) with a factor loading of .55, and the third major motivation is related to question S5 (further communication with players) with a factor loading of 0.53. The next most important motivations were meeting new people with a factor loading of 0.51, increasing vitality with 0.50, stress and mental pressure reduction with 0.49, 0.47 for attractiveness, activities Background with 0.40, Belonging in peer groups with 0.39, being away from monotony with 0.31. The lowest motivation for the spectators' attendance in stadiums is related to question S3 (entertainment) with a factor loading of 0.30. According to the results, most sports spectators are motivated by "supporting one's favorite team", "feeling proud" and "further communication with players" motivations to attend in stadiums. The motivation factor "entertainment and spending leisure time in the stadiums" have the least importance.

Conclusions

The results of the statistical tests showed that there is a significant relationship between watching sports events in stadiums and doing sports activities by spectators. It seems that watching sports events and the positive factors in sports environments and stadiums result in increased levels of physical activity, vitality, and health in spectators as people who are interested in sports activities. On the community level, in addition to the development of culture, an increase in correct behaviors results in the institutionalization of sports culture, vitality, and, as a result, community health. Given the evidence on the spectator-attracting nature of professional sports and given the existing ambiguities on the relationship between watching sports events and such health complication as obesity and inactivity [6]. the results of the present study deserve being paid attention to. Given the psychological and social differences in inclination towards individual and social sports, future studies can focus on individual sports. Researchers can also investigate the type of sports that spectators trend tend to follow or avoid after watching a special sports tournament. For instance, does watching high-collision sports such as boxing and wrestling develop interest or disgust in spectators? Also, a comparison can be made between the new delicate and fancy sports (like curling, Frisbee, ice skating, etc.) and high-collision professional sports (even professional football in which players sometimes injure their opponents on purpose).

Conflict of interest

The authors declare that there is no conflict of interest.

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Mode and food habits of athletes of Kazakhstan

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Abstract

Purpose: The aim of the study was to evaluate the mode and the eating habits of some sports athletes as well as to find out the sources of received knowledge about nutrition athletes.

Material: In the evaluation of actual nutrition in 2017, 60 participants took part, including 15 volleyball players of the Burevestnik team, 15 judo wrestlers of the national team of Kazakhstan, 15 wrestlers of the club team and 15 triathletes of the national team of Kazakhstan. To study data on the regime and eating habits, a valid questionnaire was used, directly interviewing each researcher. The statistical analysis of the survey data was carried out, the percentage distribution of responses on the questionnaire was calculated. For the analysis of categorical data χ2 test (chi-square) have been applied.

Results: The results of the study have shown that Kazakhstan sportsmen diet is not optimal, not enough of the studied athletes eat 4 or more times a day. 22.7% of the respondents are snacking not enough - only once per day, and 11.7% of the respondents do not snack at all. More than half of the subjects (52%) regularly eats every day at the same time, while 48% - not always eat regularly.

Conclusions: The main criterion for the selection of food is taste, paying too little attention to the specificity of sport and on a special diet. Basic information about nutrition investigated Kazakh athletes receive from coaches and family members, and the share of doctors and nutritionists have to too small impact here. Public information systems are relatively ineffective.

Keywords: athletes, diet, eating habits, food, knowledge about nutrition.

Introduction

The organization of rational nutrition of athletes implies the existence of a certain regime, including the distribution of meals throughout the day, the number of meals and must be strictly coordinated with the training process [1, 2]. The distribution of the food ration for a day depends on what time of day the basic physical load is being performed, what is its frequency and nature [3, 4]. The optimal distribution of food consumed during the day is also important. For example, the optimal diet athlete, calculated consumption of 5500 kcal (Sports Endurance with two training sessions), with 5-course meal on the distribution of caloric intake as follows: first breakfast - 10% of the total number kilocalories, morning training, second breakfast - 25%, lunch - 35%, afternoon snack - 5%, evening training, dinner - 25% of the total volume of kilocalories [2, 5, 6]. There is no doubt that, by eating 4-5 times a day, eating between meals, you cannot only avoid the disorder of the digestive tract, but also provide the body with essential nutrients. Many scientists [6-9] believe that eating habits to determine the health of 25-30%. The scientific literature emphasizes that it is the way of life, good hygiene, eating habits, working conditions, physical activity and rest that have a major impact on health [10].

The appropriate diet regimen determines the adaptation of the body to physical activity and helps achieve the highest sporting results [11, 12]. Due to the heavy workload, lack of time, athletes nutrition habits do not always comply with the recommendations of a balanced diet [13]. One of the factors that are not conducive to compliance with the rules of rational nutrition of athletes - the lack of knowledge about nutrition [14-16]. Although athletes learn about nutrition from number of information sources, the most important sources of nutrition knowledge are coaches, close friends, radio and television broadcasts [17]. On the other hand, as some researchers note, the data presented do not always correspond to the truth, which implies that athletes do not always receive the right information about [16, 18, 19]. Therefore, although the flow of scientific information about nutrition is sufficiently large, the athletes do not have the right information about nutrition, they do not understand the basic concepts of nutrition, so in the training process it is necessary to prepare and implement special educational programs that provide basic knowledge about nutrition [20-22].

In Kazakhstan, the regime and the eating habits of athletes still insufficiently investigated, uncertain principal criteria governing regime and eating habits; the value of the acquired knowledge on the formation of habits of athletes of different sports has to be investigated.

It has defined the aim of our research: to evaluate the mode and the eating habits of some sports athletes as well as to find out the sources of the athletes received nutritional knowledge.

Material and Methods

Participants.

In the process of evaluation of actual nutrition in 2017, 60 athletes were studied, including 15 volleyball players of the Burevestnik team in Almaty, playing at the

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national championship, 15 judo wrestlers of the national team of Kazakhstan, 15 wrestlers of the club team and 15 triathletes of the national team of Kazakhstan. The age of volleyball players was 19-22 years, their height averaged 188.0 ± 8.38 cm, body weight - on the average 78.11±7.68 kg, BMI averaged 22.1. The age of judoists was 20-28 years old, their average height was 174.3±8.3 cm, body weight - on the average 78.0±18.9 kg, BMI was on average 25.74. The age of judoists of the club team was from 17 to 21 years, their average height was 171.9±6.0 cm, body weight - 71.0±16.1 kg, BMI - on average 24.07. The age of the triathletes studied was 21-30 years old, their average height was 180.0±7.2 cm, body weight - on average 65.5±7.1 kg, body mass index (BMI) averaged 20.2.

Research Design.

Aiming to investigate data on the regime and eating habits, validated questionnaire [23] had been applied for direct examination of every testee. The questionnaire included questions about sociodemographic data of athletes, eating habits (product selection criteria), frequency of consumption of individual foods, regularity of nutrition, information sources on nutrition. The length of the questionnaire was not limited and averaged 30-45 minutes. The survey was carried out during training camps at the place of their conduct. For the study, permission was obtained from the ethics committee of the Al-Farabi Kazakh National University with voluntary consent to participate in the research. Confidentiality of the research data was observed.

Statistical analysis. Statistical analysis of the survey data was carried out using the "Statistical Package for Social Sciences" program (SPSS, version 16). Analyzing the data was calculated the percentage distribution of the responses on the questionnaire. For analysis of categorical data applied $\chi 2$ test (chi-square). Statistical significance was at p less than or equal to 0.05.

Results

The essence of rational and balanced nutrition is to satisfy increased demand of the body when performing physical exertion. Evaluating opinion of respondents on their rational and balanced nutrition, in general can be noted that 60% participants consider their nutrition as such and 28.3% found it difficult to answer. 93.3% judoists of national team consider their nutrition rational and balanced, 60% triathletes found it difficult to respond positively (Table 1).

Athletes are obliged to observe the correct diet, eating 3-4 times a day at the same time, and 2-3 times a snack between meals. Analyzing the answers Kazakh athletes to the question "How many times a day eat" the majority of respondents (78%) said that the day they eat three times, twice - 12%, four times or more - 10% of the study (Figure 1).

Among all investigated, 60% of volleyball players, 100% judo national team, 80% of the club's judo team and 73.3% of triathletes eat three times a day. This quantity corresponds to recommended eating rate ($\chi 2 = 14.800$, $p = 0.01$).

Analyzing the frequency of snacking, it was found that 33.3% of our study Kazakh athletes snack twice, and 18.3% - three times, 10% - four times and more. It should be noted that the most common snacking among triathletes, including snacking twice (40%), three times - 40%, four times or more - 10%. Not enough, only once snacked 21.7% of respondents, and not snacked – 16.7% of respondents (Table 2).

By analyzing the respondents' answers to the question "Do you eat at the same time", it turned out that every day on a regular basis at the same time, eat 52% of the study, 3-5 times a week - 25% 1-2 times a week - 18% and 5% of the study direct supply is not regular (Fig. 2).

Statistically significant are the responses of judoists of both groups who believe that they eat at the same time every day ($\chi 2 = 19{,}200$, $p = 0{,}00$ and $\chi 2 = 18{,}867$, $p = 0{,}00$), while the answers of volleyball players and triathlonists did not reveal a significant difference in choosing a constant time of eating.

When possible, choose a few answers, most of the subjects (78.3%), the main criterion by which they choose foods are palatability. Opportunity to improve the health of selection of certain products considered 46.7% of athletes we investigated. Relatively rarely athletes pay attention to the choice of food products for the specificity of sports - only 8.4% of those surveyed and on the possibility of a special diet (6.7%) (Table 3).

Evaluating the athletes' answers to the question "Where do you get knowledge about nutrition?" Was determined the source of information about nutrition. According to our study 36.7% of respondents receive information about nutrition from the coach, 20.0% - from

Table 1. The Results of the Participant's Opinion About Quality of their Nutrition

Criteria	Volleyball players n=15	National team judoists n=15	Judoka club team n=15	Triathletes n=15	$\overline{X}$
Rational and balanced	53.3	93.3 χ^2=11.267 p<0.01	66.7	26.7	60.0
Not rational and balanced	13.3	0	20.0	13.3	11.7
Difficult to answer	33.4	6.7	13.3	60.0	28.3

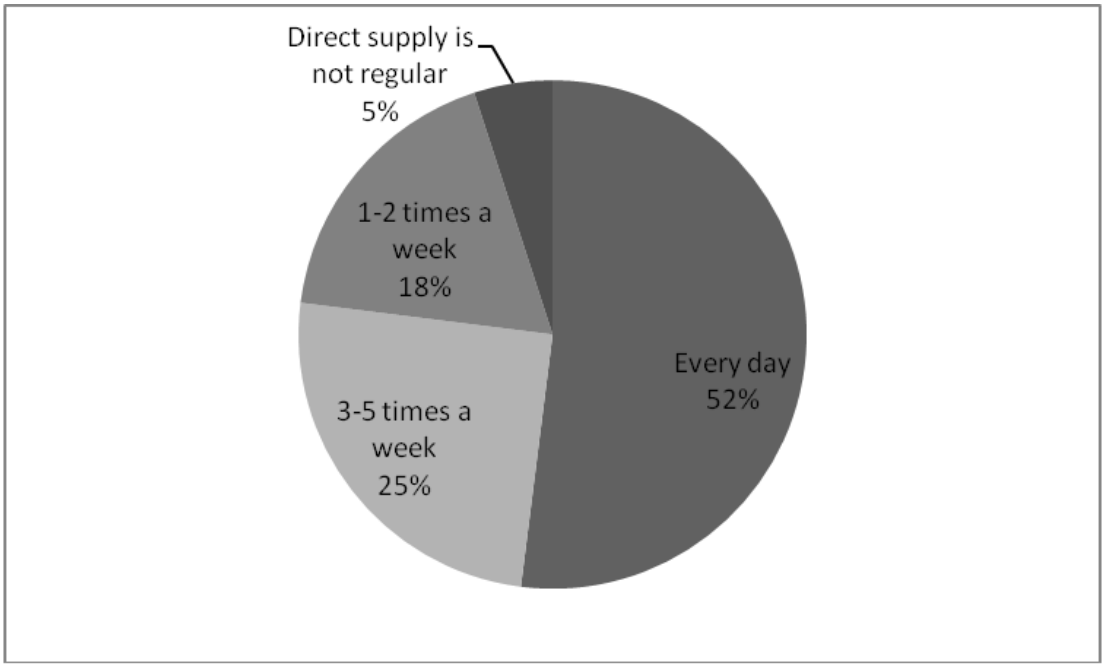

Figure 1. The results of the answer to the question "How many times do you eat per day?"

Table 2. Percentage Distribution of Athletes According to the Number of Snacks Depending on the Sport

Groups of athletes	Do not snack %	Once a day %	Twice a day %	Three times a day %	Four times and more per day %
Volleyball players	13.3	46.7 χ^2=4.467 p=0.30	26.7	0	13.3
National team judoists	40 χ^2=4.000 p=0.35	20	13.3	13.3	13.3
Judoists of the club team	13.3	13.3	53.3 χ^2=6.600 p=0.25	20.0	0
Triathletes	0	6.7	40 χ^2=5.533 p=0.15	40	13.3
$\overline{X}$	16.7	21.7	33.3	18.3	10.0

family members, 16.7% - from other sources, at least - by a nutritionist (10.0%) and doctors (8.3 %) (Table 4).

It should be noted that the level of knowledge essentially determines a more healthy, appropriate rational nutrition.

Discussion

Athletes eat not efficiently 3 times a day, because they do not support the need for the concentration of glucose in the blood, and during the meal they consume large amounts of food. Many authors investigating diet believe that athletes should eat 4-5 times at the same time [24-26]. According to our study, only 10% of respondents eat 4-5 times a day, whereas according to J. Lee et al. [25] - 60-70%. Z. Szygula et al [6] assessing the diet of Polish athletes, found that, 55% of athletes eat 4-5 times a day. The same authors have shown that 28% of the studied triathletes 5 times a day, and 50% of triathletes eat 4 times a day. Incorrect diet was detected during the examination of basketball players and football players. Most of these athletes (48%) eat only 3 times, 34% - 4 times, and only 13% - 5 times a day [27].

Along with the basic eating habits it is important for athletes to snack throughout the day. As the authors point out [28, 29], the amount of snacking should be 2-3 times a day. These recommendations are followed by 59% of the athletes we surveyed.

78.3% of the Kazakhstan athletes we studied choose food products mainly guided by taste, paying little attention to the specifics of the sport and a special diet. The positive thing is that by choosing the products they pay attention to their impact on improving health. This opinion is shared by 46.7% of respondents. Some authors, aiming to improve the level of knowledge

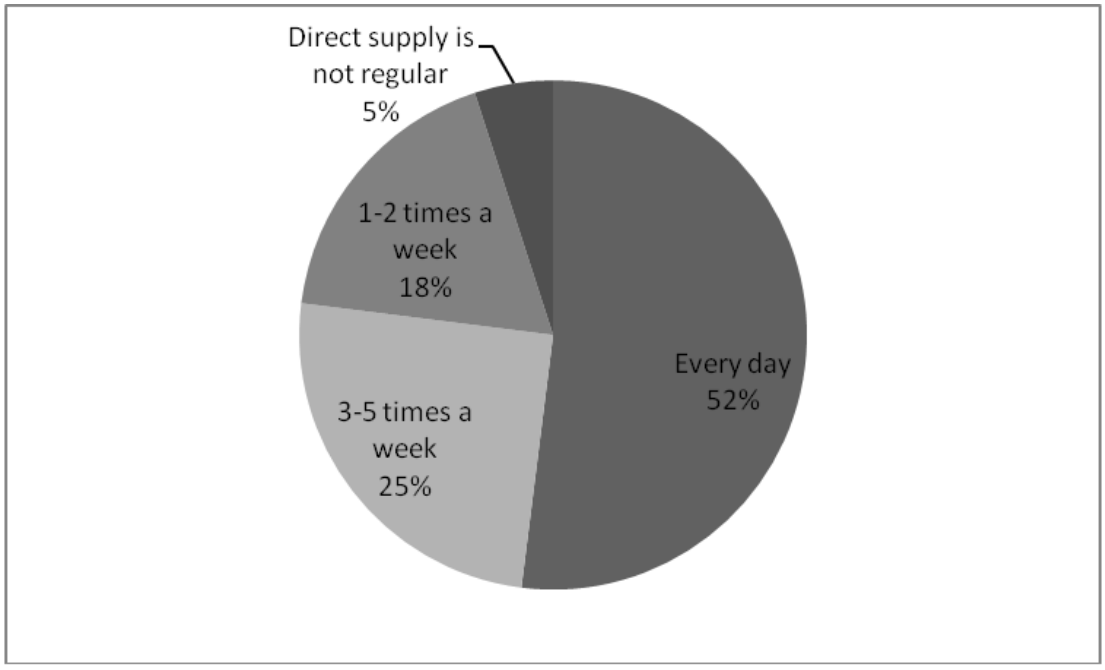

Figure 2. The results of the answer to the question "Do you eat at the same time?"

Table 3. Percentage Distribution of the Main Criteria by Which Athletes are Selected Products

Criteria	Volleyball players n=15	National team judoists n=15	Judoka club team n=15	Triathletes n=15	$\overline{X}$
Improving health	73.3	20.0	60.0	33.3	46.7
Special Diet	13.3	6.7	0	6.7	6.7
Price	26.6	0	13.3	6.7	11.7
Taste qualities	66.7	93.3 $\chi^2 = 11.267$ $p<0.01$	80.0 $\chi^2 = 11.267$ $p<0.01$	73.3 $\chi^2 = 8.067$ $p=0.06$	73.3
Influence of family members	0	6.7	6.7	0	3.4
The influence of the coach	6.7	20.0	26.7	13.3	16.7
Specificity of the sport	26.7	0	0	6.7	8.4

Table 4. Percentage Distribution Source of the Received Information About Nutrition

Information sources	Volleyball players n=15	National team judoists n=15	Judoka club team n=15	Triathletes n=15	$\overline{X}$
From TV and radio	13.3	0	0	6.7	5.0
From doctors	13.3	13.3	0	6.7	8.3
Reading popular literature	6.7	0	0	0	1.7
From a nutritionist	6.7	20.0	0	13.3	10.0
From the coacher	40.0	20.0	53.4 $\chi 2 = 6.600$ p=0.25	33.3	36.7
From friends	6.7	0	0	0	1.7
From family members	13.3	26.7	33.3	6.7	20.0
From other sources	0	20.0	13.3	33.3	16.7

offered to introduce education program [20-22], having in mind that between the athlete and the coach there is a close relationship. In this regard, the ongoing educational programs that provide information on nutrition should be targeted not only at athletes, but also at coaches, since athletes' nutritional mistakes are based on insufficient coverage of the recommendations of rational nutrition.

According to our research, the main source of information is the coach. On the other hand, knowledge of nutrition can be determined by socio-demographic factors: gender, age, specificity of the sport, education [8]. Authors who have studied the level of knowledge, determined that it depends on the athlete's education [6, 30]. However, there is evidence that many athletes do not have enough knowledge about rational nutrition, proper diet [15, 17, 20, 23, 30, 31]. D. Dunn et al. [6] note that the main problem that today confronts the youth of American colleges and universities is the easy accessibility of fast foods or easily cooked foods. Current research shows that as the knowledge of athletes increases, the quality of food consumption improves [32]. In the scientific literature it is noted that qualified knowledge about nutrition can improve the nutritional status. B. Jacobson et al. [16], L. Zawila et al. [20], M. Jessri et al [31] note that athletes receive information about nutrition from public audio-visual aids, the Internet, from popular literature, friends, family members. L. Birch., J. Fisher [33] focuses on the role of parents in feeding athletes, especially the young, determining what, when and how much they should eat excluding their self-control. However, athletes receive the greatest amount of knowledge about nutrition from coaches [19, 26]. C. Juzwiak, F. Ancona-Lopez [34] note that specific dietary advice on nutrition to Brazilian athletes before and after the competitions recommended respectively - 93 and 46% of the interviewed trainers. No exception and our respondents - Kazakhstani athletes, 36.7% had a basic knowledge of nutrition is obtained from the coach. In this regard, the coach must possess not only the methodology of training, but a sufficient number of physiological knowledge. On the other hand, the results of some researchers show that the level of knowledge of coaches about nutrition is not sufficient [31, 35, 36], and information sources (TV, radio programs, popular literature , friends, family members) do not always provide qualified nutrition information to athletes [8, 16].

Conclusions

1. An insufficient amount of researched kazakh athletes consider their nutrition rational and balanced.
2. The nutrition regime of Kazakhstani athletes is not optimal, not enough of the athletes under study eat 4 or more times a day. 22.7% of the respondents are snacking not enough - only once per day, and 11.7% of the respondents do not snack at all.
3. More than half of the subjects (52%) regularly eat every day at the same time, while 48% - not always eat regularly. The main criterion for the selection of food is taste, thus paying too little attention to the specificity of sport and on a special diet.
4. Basic information about nutrition investigated Kazakh athletes receive from coaches and family members, the share of doctors and nutritionists have to too small an amount it. Public information systems are relatively ineffective.

Conflicts of Interest

There isn't any conflict of interest to be declared regarding the manuscript.

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