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Health related applied technology of special health
group girl students’ physical training

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Abstract
Purpose: to work out health related applied technology for special health girl students (with health problems) and assess its influence on their physical condition.

Material: 1st-3rd year girl students were the object of the research. All girl students were trained by discipline “Physical culture”. Somatic (body length and mass) and physiometrical (vital capacity of lungs) indicators were studied.

Results: confident changes in morphological indicators (body mass and vital capacity of lungs) were determined. We also noted demand in change of students’ approaches to assessment their physical condition. Principally new methods of students’ health protection and strengthening are offered. In its base there is methodology of human individual health, person’s deeply motivated social demands in being healthy.

Conclusions: For strengthening girl students’ physical condition we recommend the following: prophylaxis health related physical measures; new approaches to assessment of own health; teachers’ pedagogic control; working out individual recommendations on correction of health related applied trainings.

Keywords: physical condition, girl students, physical culture, healthy life style, health related, applied technology.

Introduction
In higher educational establishments health strengthening of girl students, who have health problems (special health groups – SHG) is of great pedagogic importance. Recent years there has appeared a contradiction between demand in intensification girl students’ motor activity and absence of any opportunities for university to create all required for this purpose organizational-pedagogic condition. All these push to find more effective ways and approaches to solution of the mentioned problem [1, 2]. Some authors offer to form knowledge for projecting special health group girl students’ physical culture on the base of the following: acquiring practical skills [29]; theoretical knowledge about physical exercises’ practicing on the base of specially created programs [35]; prophylaxis and health strengthening in the future [36]. Other authors put forward idea about health protection and strengthening of rising generation through physical education in universities. An integral part of physical education shall be the following games and exercises: run, wrestling, riding, fencing [13].

The problem of youth’s health protection and strengthening has been bringing up to concern since long ago. Ya. A. Komensky worked out main questions of educational work’s organization with principles of hygiene and everyday safe exercises [7]. John Lock in his pedagogic theory of education put aims of physical and moral education in context “discipline of body” and “discipline of spirit”. The author preferred physically healthy “gentleman”. He was a follower of severe regime and hardening of organism [11]. J.J. Rousseau also expressed his view on health protection and strengthening of pupils in natural conditions. He thought that the basis of growing organism’s development is hardening in the nature in combination with physical, labor, mental and moral education. Pestalocci I.G. paid special attention to run and jumping in the fresh air in intervals between lessons [13].

In context of already existing researches on students’ health strengthening we can assume some other approaches to effective solution of this problem. Increase of informational, psycho-emotional loads in the process of students studying does not facilitate their health improvement. Besides, immobility, irrationally organized way of life, harmful habits result in worsening students’ physical condition and health [6, 12, 14, 16]. The problem of health related education of special health group students is aggravated by their chronic diseases. May be this problem can be solved with the help of the most feasible activity, directed on health improvement: regular physical exercises’ practicing. The importance of the present work is resulted from the following: understanding, high social significance of physical culture; insufficient effectiveness of pedagogic maintenance of special health group students’ health related education.

At present time role of physical culture in formation of students’ general culture, in their resistance to harmful computer habits is still increasing [10, 32, 34]. The authors consequently develop the topic of students’ involvement in common human values and healthy life style [8, 9]. Of not less importance is implementation of students’ (with different nosologies) physical education pedagogic technology in teaching process [17]. Such
technology implies solution of teaching, health related and educational tasks. It is possible through creation of conditions for motor skills’ training during all period of study. In other work approaches to solution the problems of gender stereotypes and imbalance in adolescents’ physical education [37]. The author thinks that it is necessary to develop a concept of gender approach to education. It will permit to facilitate development of individual bents and abilities in different sex pupils; to overcome sex-role stereotypes; more effective formation of physical culture values.

The studies of many authors are oriented on formation of students’ active life position in the following directions:

- Health strengthening [31, 33, 38];
- Healthy life style practicing with the help of different means of sports and physical culture [27, 42].

Among other researches we can mark out several approaches to solution of students’ health strengthening and protection problems:

- Optimization of physical loads in different orientation trainings [23, 24, 40];
- Formation of active attitude to own health [18, 21];
- Special aspects of endured tension under loads of game character [30];
- Application of modified tests for functional potentials of students with health problems [28];
- Substantiation of pedagogic control over youth’s health state [25, 26];
- Influence of physical exercises on students’ physical and psychic health [19, 22, 41];
- Trainings of specialists for health protection and physical education fields [39] and their professional maturity [20].

Such researches present the importance of physical development process itself, as very significant component in complex structure of human health. In students’ age this process is determined by hereditary factors, life conditions and physical education. This process is manifested in quantitative and qualitative changes. Assessment of physical condition with the help of anthropometric measurements permits to determine: its level and specific features; its correspondence to sex and age; improvement or worsening of physical conditions, resulted from physical exercises [1-4].

Analysis of scientific works showed that there is great number of opinions about students’ health worsening. That is why we offer to concentrate attention on problem of successful physical development of special health group girl students with the help of health related applied technology.

**Hypothesis:** the author assumes that successful solution of girl students’ physical training problem will be facilitated by introduction of specially worked out health related applied technology in physical culture program. We assume that application of this technology will substantially improve girl students’ physical condition. Trainings by this technology can improve most of the tested indicators of students’ physical condition.

**The purpose of the research:** is to work out health related applied technology for special health girl students (with health problems) and assess its influence on their physical condition.

**Material and methods**

**Participants:** 1st-3rd year girl students of pedagogic university special health group were the object of the research. All girl students were divided into two groups: experimental (EG) and control (CG).

**Organization of the research:** somatic (body length and mass) and physiometrical (vital capacity of lungs) as well as anthropometric indicators were studied.

Realization of experimental technology in semesters was fulfilled as per the following algorithm:

- First semester included: preliminary control – complex diagnosis of physical condition; lectures, talks, discussions, disputes; questioning, interviewing, pedagogic observation; different general health related exercises; teaching to feasible methodic of physical condition self-diagnostic and self control; working out of individual health related applied program by girl students; pedagogue’s control of educational process (operative, current, final).
- Second semester consisted of: further perfection of motor skills and physical abilities; prophylaxis health related physical culture measures; girl students’ assessment of own physical condition; presentation of program “Healthy life style of SHG girl student”; pedagogic control; summarizing the results; working out of individual recommendations on correction of girl students’ health related applied trainings.

Theoretical and practical content of health related applied technology in SHG girl students’ physical education was designed for 128 academic hours a year. Theoretical part is 10 hours. Practical part consists of 108 academic hours: methodic-practical portion – 10 hours, practical-training – 98 hours and control (tests) – 10 hours.

**Statistical analysis:** the research’s results were processed with method of variation statistic, with determination of mean arithmetic (М), arithmetic error (m), mean square deviation (σ) and confidence of differences by Student’s criterion (p).

**Results**

Before the beginning of experiment we measured EG and CG girl students’ physical condition indicators. In EG they were: body length (166.47±1.26 cm), body mass (65.02±5.05 kg), and vital capacity of lungs (3080.00±74.41 ml). In CG they were: 163.07±2.08 cm, 65.80±4.46 kg, 2926.67±81.85 ml. (see table 1).

Physical condition indicators of EG and CG girl students before experiment showed that there was no confidence difference (P>0.05) between groups. Both groups were homogenous (P>0.05) by physical condition indicators (see table 1).

After pedagogic experiment we fulfilled testing of girl students’ physical condition. Comparative analysis of experimental and control groups’ data showed that there appeared confident changes (P<0.05) in morphological
indicators – body mass and vital capacity of lungs. Changes of girl students’ body length indicators were insignificant (P>0.05).

In experimental group we observed a little increase of body length parameters up to 166.87±1.26 cm, reduction of body mass – 62.33±4.69 kg and increase of vital capacity of lungs – 3466.67±148.82 ml. Increment of indicators was 0.24%; 4.19%; 11.81% accordingly. In control group we also registered insignificant changes of body length indicators (163.40±2.01 cm), body mass (66.06±1.26 kg) and vital capacity of lungs (3060.00±59.53 ml). Indicators increment in this group was 0.20 %; 0.40 % and 4.45 % accordingly.

Discussion
Comparative analysis of girl students body length indicators after experiment showed that in EG and CG there is no confident difference (P>0.05). It is known that physical exercises impact on a person deeply and comprehensively. When practicing physical exercises, in human organisms a number of physiological, biological and other processes, causing corresponding changes in vegetative sphere, take place. Systemic practicing of physical exercises facilitates positive reconstructions in organism’s work. However, favorable influence of physical exercises on body height is difficult to be proved [5]. Besides, in scientific literature [15] it is mentioned that from 16 to 18 years age (girls) and up to 18-19 years (boys) body height, in the whole, is formed finally. However, other physical condition indicators can be increased. That is why such theoretical statement is a proof of minimal body length increment in EG and CG (0.24% and 0.20%, accordingly).

In period of biological formation of young organism’s morphological properties body mass is rather plastic, variable and instable. Effectiveness of EG girl students’ application of specially oriented physical culture means (dozed walking, light run, health related physical culture exercises, exercises on step-platforms, skipping, exercises with hula-hoop) was assessed by changed body mass indicators. For example, body mass reduced by 2.69 kg (from 65.02±5.05 to 62.33±4.69 kg). Body weight changed confidently (P<0.05). It witnesses about influence of physical exercises. Reduction of experimental group girl students’ body mass can be considered quite logical. It is connected with the fact that with systemic muscular functioning metabolism intensifies and on this base energy processes activate. At the same time variability of physical exercises in combination with other means created unlimited opportunities for body mass optimization in experimental group.

Body mass testing in CG showed increase by 260 g (from 65.80±4.46 to 66.06±1.26 kg). We did not find any confident difference between mean values of body mass in CG (p>0.05). Insufficient increase of girl students’ body mass is connected with reduction of motor functioning share (week physical load). Optimization of girl students motor functioning implies creation of normal conditions for body mass decreasing and health preservation.

It is known that 16-21 years’ age is connected with period of organism’s maturity formation. In this time all organism’s organs and systems reach their morphological functional maturity. However, body mass can change under influence of physical education means and their correct application. It is proved by comparative analysis of experimental and control groups’ body mass indicators, which permitted to find confident difference (p<0.05) by the end of experiment (see table 1 and fig.1).

Vital capacity of lungs (VCL) is of not less importance as indicator of health, adaptation to physical loads. Practice shows that breathing in conditions of relative muscular relaxation have the so-called “expenses of civilization” in most of girl students: long sitting at table restrict chest excursion. Only systemic muscular work

### Table 1. Dynamic of control and experimental girl students’ indicators in pedagogic experiment (3rd year)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Girls CG (n=60)</th>
<th>EG (n=15)</th>
<th>Significance level p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Somatic indication</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body length (cm)</td>
<td>Before experiment</td>
<td>163.07±2.08</td>
<td>166.47±1.26</td>
</tr>
<tr>
<td></td>
<td>After experiment</td>
<td>163.40±2.01</td>
<td>166.87±1.26</td>
</tr>
<tr>
<td>Increment (%)</td>
<td>0.20</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>Before experiment</td>
<td>65.80±4.46</td>
<td>65.02±5.05</td>
</tr>
<tr>
<td></td>
<td>After experiment</td>
<td>66.06±1.26</td>
<td>62.33±4.69</td>
</tr>
<tr>
<td>Increment, %</td>
<td>0.40</td>
<td>-4.19</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&gt;0.05</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td>Vital capacity of lungs (ml)</td>
<td>Before experiment</td>
<td>2926.67±81.85</td>
<td>3080.60±74.41</td>
</tr>
<tr>
<td></td>
<td>After experiment</td>
<td>3060.00±59.53</td>
<td>3466.67±148.82</td>
</tr>
<tr>
<td>Increment (%)</td>
<td>4.45</td>
<td>11.81</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&gt;0.05</td>
<td>&lt;0.05</td>
<td></td>
</tr>
</tbody>
</table>
can form rational, physiologically perfect breathing type, which increase lung, alveolar ventilation and VCL [15].

In experimental group we found improvement of VCL (from 3080.00±74.41 to 3466.67±148.82 l), that was statistically confident (p<0.05). Increment of indicators was 11.81%. In our opinion change of VCL parameters in experimental group is a result of systemic health related applied functioning. It proves the data of V.V. Gorinevsky [4]. He says that different muscular groups participate in movements, especially legs’ muscles. It increases organism’s demand in oxygen. For breathing improvement and VCL increase such exercises are the most useful and valuable.

In control group VCL indicators did not change confidently after experiment (p>0.05): before experiment it was 2926.67±81.85 and after it - 3060.00±59.53 l. Our research proved that involvement of large muscular group in work, accurate rhythm of movements, being in the fresh air favorably influenced on breathing function (deep inhale, forced exhale).

Comparative analysis of final testing of experimental and control group girl students’ VCL permitted to determine difference of VCL increment. In EG results are higher than in CG by 7.36%. In table 1 we can see that there is confident difference between groups (p<0.05).

Results of our research show that conducted pedagogic experiment opens qualitatively new pedagogic process of cognitive and health related applied activity with students. For ensuring health related orientation of SHG girl students’ physical education it is necessary to purposefully orient them for the following: formation of motivated demand in health protection; understanding of health’s psycho-physical base; continuous acquiring of skills in individual and independent trainings. Health related orientation in SHG girl students’ physical education includes: demand-motivational, valuable-reflexive and acting-transforming components.

In prospects’ aspect health related applied orientation in SHG girl students’ physical education is regarded as targeted process of their health protection. Such approach can be introduced also in educational spheres of children and adolescents with health problems. The novelty of our research implies also that students will be targeted at the following: actualization of individual health protection; continuous acquiring of health protection skills by means of physical culture; monitoring and self diagnostic of own physical condition; change of approaches to self assessment of own physical status. Such approach implies principally new solution of students’ health protection and improvement tasks. In its base there is methodology of human individual health, its deeply socially motivated demand in being healthy. It permits to regard goal setting of health related education and mechanisms of its practical realization under other angle [14].

The sense of this situation’s problem is that in universities students are from the very beginning oriented on passing physical culture test. It means that success of SHG students’ health related education to large extent depends on their individual physical condition.

**Conclusions**

For strengthening of girl students’ physical condition it is recommended: prophylaxis health related physical culture measures; new approaches to assessment of own physical status; pedagogic control by instructors; working out of individual recommendations on correction health related applied trainings.

Positive changes in experimental group girl students’ physical condition indicators witness about effectiveness of health related applied technology in physical education.

**Conflict of interests**

The author declares that there is no conflict of interests.
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Individualization factors of students’ physical education at modern stage of its realization

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Abstract

Purpose: determination of main conditions for complying individual potentials of physical condition and students’ physical fitness for practicing appropriate kind of sports.

Material: In the research students attending sport circles participated (n=960). Sport qualification of the participants was in the range from beginners to international masters of sports. The contingent of the tested consisted of different age groups and sport specializations.

Results: for satisfaction of students’ individual interests to definite kinds of sports it is necessary to have professional graphs of motor functioning in sports and ergo-graphic characteristic of competition exercises. Students shall have information about their physical condition and physical fitness. Besides, it is necessary to have the data about students’ current physical condition, which determines students’ workability. Passport data about medium of motor functioning and individual’s physical potentials permit to find adequacy of combining and success of object-medium interaction. It results in enthusiasm in practicing certain kind of sports.

Conclusions: The presence of adequate compliance between determined analytical links of physiological processes of individual’s adaptive behavior and requirements to the chosen medium of sport functioning permits to maximally effectively solve the problems of students’ physical education’s individualization.

Keywords: professional graph, ergo-graphic recording, motor, energy, static, student.

Introduction

The problem of students’ physical education at modern stage of its re-organization implies realization of individual approach, which would consider characteristics of physical condition, initial fitness, interest to definite motor functioning and degree of its importance understanding. In each age period these tasks have own specific aspects of solution. In all cases it is necessary to determine compliance between demand in motor functioning and possibility of its satisfaction with definite motor actions [1, 2, 3].

Solution of problems of students’ physical education is shown in some other directions:
- Study of students’ professional-technical maturity [25];
- Study of students’ attitude to physical activity and their intentions to be physically active [26, 33, 38];
- Study of health and physical education teacher’s in students’ training [34, 37];
- Influence of physical exercises on law faculty students’ psychic health [39];
- Analysis of students’ psychic health in globalized world [27, 28];
- Influence of internet and computer habits on students’ health [22, 35];
- Students’ leisure motor activity [31];
- Substantiation of pedagogic technology of disabled students’ physical education [21];
- Sport and health related competition activity [24, 32, 36];
- Simulation of students’ sport functioning [23, 29, 30].

Solution of the mentioned tasks require consideration individual physical condition (biological age), which, to large extent, differs from chronological age. Special aspects of individual physical growth determine bent and succession of certain motor functioning’s specificities. On the base of these specificities professional graphs of existing and appearing kinds of sport activity shall be created. With such approach age characteristics of physical condition shall be considered, as well as classification of fulfilled physical load’s heaviness: by its intensity, by qualitative orientation of the fulfilled motor activity [4]. Assessment of the fulfilled physical load’s feasibility requires ergo-graphic analysis. With it, it is necessary to consider that physical load’s feasibility is determined by current functional state of an individual. All mentioned requirements for individual approach realization in physical education building is based on mean static indicators, which do not permit to ensure its individualization.

The purpose of the research is to solve the problem of individualization of students’ physical potentials assessment. It gives rise to a group of tasks to be solved for re-organization of existing physical education system.

Material and methods

Participants: students from different Kharkov HEEs, attending sport circles’ trainings, participated in the researches. Sport qualification of the participants was in the range from beginners to international masters of sports. The contingent of the tested consisted of different age groups and sport specializations. Total quantity of participants was 960 persons.

Organization of the research: the materials for the research were collected during 2010-2013, in the period of functioning of Non-Olympic and professional sports.
scientific-research institute.  

The tasks of the research include:
- Determination of individual’s age;
- Building of professional graphs for appropriate kinds of sport functioning;
- Ergo-graphic analysis of appropriate actions in the studied kind of sport functioning;
- Working out of organism potentials’ assessment, as well as determination of certain motor functioning kind’s feasibility by dynamic of changes in organism’s potentials;
- Working out of assessment of preferable motor functioning qualitative structure;
- Determination of optimal individual regime of the offered physical load.

Studies in these directions are rather fragmentary. It rather complicates formation of holistic idea about individual criteria for assessment of norm and functional optimum of organism’s adaptation behavior. In such cases the used research methods are based on mean-statistical characteristics of population norm of physical condition. These norms have exhausted their solving potentials for them to be applied in individual assessment of organism’s adaptation potentials. It means that it is necessary to find the ways how to solve the mentioned problems. In solution of each of the set task there are a lot of approaches. It brings to demand in general principles, determining behavioral dynamic of the studied processes. For solution of the mentioned tasks in the fulfilled works the following methods were used:
- Dynamic analogy [5];
- Theory of similarity and dimension [6];
- Analysis of empiric data in attribute semantic spaces [7];
- Mathematical modeling [8, 9].

The following bio-medical methods were used:
- Clinical anthropometry [10];
- Modeling of biological age assessment [11];
- BP indicators by orthostatic test of N.Ye. Teslenko [12];
- Standard tests for physical fitness and motor qualities.

For assessment bio-mechanical characteristics the following was applied:
- Video-recording of the studied movement;
- Laws of mechanics, determining sportsman’s body mass center traveling in supported and unsupported movement.

Results of the research

Understanding of analogy determines general character of regularities in different fields of knowledge. At present it permits to comprehensively use them and transfer in the conducted researches in the field of physical culture and sports. One of the most urgent problems in any professional field is clear definition of professional graph and ergo-graphic characteristic of its motor component. Solution of this problem is especially acute for theory of physical culture and sports. The first studies in this direction were made by I.M. Sechenov in 1964. In the fulfilled ergo-graphic studies of arm’s work he found dependence of workability reduction on duration and intensity of the fulfilled work. However this work had descriptive character. More profound analysis was practically impossible, because up to the middle of 19th century the conception “energy” was vague.

Characteristic of term “Energy” was based on its translation from Greek and meant power, value or efficiency of something. “Energy” was defined so in the first edition of British encyclopedia, published in 1771. In 1783 J. Watt introduces the unit of work, expressed in horse power. In 19th century conceptions of kinetic and potential energy appear; laws of one energy kind transformation to other are found; ways of energy description in particular cases are determined; energy starts to be applied to human physical functioning and to its motor component. Concept of human or animals’ potential energy still remained undefined and could not be measured [17].

In existing studies of motor functioning in different kinds of sports the most attention is paid to kinematic energy consumption. It is explained by feasibility of its measurement, providing body mass and velocity of its traveling are known.

According to scope of the consumed work, for transferring definite quantity of kinematic energy, their correlation permits to connect the values of kinematic energy \( \frac{1}{2} mv^2 \) and fulfilled work FS. From this relation \( \frac{1}{2} mv^2 = FS \) it is possible to determine the force, manifested at certain segments of distance or the structure of the fulfilled movement. Determination of potential energy consumption with fulfillment static work is not possible with the help of the above mentioned expression, because there is no velocity value and indicators of body movement under impacting force.

Static efforts require great consumption of potential energy. It is necessary to consider that in structure of any movement there is static tension. This tension determines working posture. Then, consideration of potential energy consumption in physical work (when composing its ergo-graphic description) is a necessary component.

Potential energy is directly connected with power or speed of work fulfillment. If to mean intensity of muscular tension, it is important to know the value of muscular effort and the period of its acting. These characteristics can be measured and controlled. With the help of dynamometer and stop-watch it is possible to find impulse of force (F* t).

In step-by-step method of force measurement it is possible to make a sequence of force impulse with every correlation of unbending angle between appropriate bio-kinematic links. Such measurements of force impulse in respect to unbending angle carry two informational characteristics:
1) Position of bio-kinematic links in respect to each other (to be measured by angle between them - \( \phi \)); value of effort with every observed position (F);
2) Period of its preservation (t), permitting to determine force impulse (Ft).

Consequent measurement of maximal effort (with
fixed position between connected bio-kinematic links) and ranging of their values (with uniform increment of unbending angle) permitted to find law of effort’s increment at unbending angle of joint.

This value points at velocity of maximal force increment at unbending angle \( \frac{dF}{d\varphi} \). In polar coordinates system it is logarithmic spiral. Characteristic aspect of this dependence’s individual features is flexion of logarithmic dependence, which does not change with every current state. The changes in the state of fatigue are registered only in force. Increment \( \frac{dF}{d\varphi} \) in all cases does not change. The same dependence is noticed with velocity of this dependence growing in time \( \frac{dF}{d\varphi} \). The described dependence is shown in fig. 1.

Determination of time of muscular tension duration (force impulse in every fixed position of bio-kinematic pair) was fulfilled with its different value in respect to maximum. Velocity of potential energy consumption in respect to duration of muscular tension is in exponential dependence. This manifests in different physiological processes. Its individual features are noticed only in coefficient of exponent’s flexion.

Such dependence of force impulse behavior permits to find its highest value with definite force of static muscular tension. Graphically it is shown in fig. 2.

Analysis of the received dependence (see fig.2) permits

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**Fig.1.** Graphic picture of static effort change \( \frac{dF}{d\varphi} \) depending on unbending angle in joint. Note: 1. Logarithmic spiral of change \( \frac{dF}{d\varphi} \) after intensive training. 2. Logarithmic spiral of change \( \frac{dF}{d\varphi} \) with sportsman’s high workability.

**Fig.2.** Graphic picture of force value dependence on intensity of impulse, generating appropriate quantity of movements. Notes: 1. Dependence curve of static tension’s intensity and duration of its conservation. 2. Curve of force impulse under different intensity of static tension. 3. Graph points corresponding o maximal force impulse and tension intensity. 4. Flex point on curve 2. Value \( \frac{1}{e} = 1/2.72 \), where \( e = 2.718 \).
to find that the most optimal regime of static tension (with which maximal impulse of force is observed) corresponds to force 1/e from its maximal manifestation (as on the moment of sportsman’s physical condition).

With it force impulse in static tension contains maximal quantity of movement, which can be transferred to body. Maximal force with static tension I function of state and taken as “one”. With physical workability weakening the value of maximum reduces. It reflects consumption of potential energy.

In fig. 1 there are two logarithmic spirals, crossing radii of force vectors. This force is manifested under different angles of bio-links’ unbending. If to observe consequent reduction of physical workability then, in respect to every state, it would be possible to obtain cross point of appropriate logarithmic spiral with radius of force vector. The ranged sequence of these points will compose logarithmic sequence of workability potential’s weakening. Its graph completely coincides with picture in fig.2. Individual aspects of these regularities are noticed only in coefficients, reflecting curvatures’ flexion.

The mentioned regularity and “function of state” is observed in all directions of vectors radii. In this case for control of current physical condition it would be quite enough to determine the character of behavior of ranged force change sequence in different physical condition. It permits (by single measurement with fixed unbending angle between bio-kinematic pair of links) to find sportsman’s current condition. The determined regularity was tested in researches of Van Sign Ny [18] and a number of other works [1-3].

The described regularity of “function of state” changes actually reflects potential energy consumption, resulted from fulfilled work and static tension. Loss of potential energy reflects organism’s condition. This loss is an indicator of current workability wakening or fatigue. Determination of current maximal applied force (by corresponding vector) permits to determine degree of fatigue in the given bio-kinematic link. Such methodic permits to find the share of appropriate total bio-kinematic structure’s links. It is purposeful to realize in the following conditions: when finding reasons of standard motor actions’ technical violations; in optimal regime of muscular group in holistic dynamic stereotype of the fulfilled movement.

For determination integral indicator of general fatigue it is purposeful to use single dynamometric static tension, related to its maximal indication:

\[ F / F_{\text{max}} = K, \]

where \( F \) is force as the moment of its measurement; \( F_{\text{max}} \) – force, demonstrated by sportsman in his the most workable condition and taken as a criterion for comparison; \( K \) – indicator of workability weakening.

Exponential character is a specific feature of coefficient \( K \) behavior. It implies that one and the same increment of function correspond to argument increment one and the same times. When argument changes by the law of geometrical progression, function will change by the law of arithmetical sequence. Actually, this function is a foundational one in organization of biological, social and physical phenomena [19].

The found analytical connection between endurance and quickness substantially changes the methods of fatigue’s study. These methods permit to realize the following: register individual aspects of the process; consider its qualitative characteristics and determine optimal load for achieving maximally possible volume of work to be fulfilled with the given intensity. When making ergo-graphic passport of sportsman’s motor functioning this regularity permits to restore complete structure of reaction to different intensity loads by value back strength.

In researches of different run distances this regularity permits to find consumption of energy for static forces, directed at keeping working posture. In this case by result of standard static force (by standard plio-metric exercise) energy consumption for certain distance is found. From its value kinetic energy, spent for distance overcoming, is deducted. The received difference reflects its consumption for working posture static tension in work’s fulfillment. Such methodic is presented for the first time. Its application opens new spectrum of researches, which earlier could not be realized.

**Discussion**

Complete solution of physical education’s individualization problem is possible only when determination of univocal individual bent’s correspondence to motor functioning specifics and optimal medium is possible. Characteristic of medium can be measured rather accurately. Measurement of individual’s potentials for assessment of his compliance with medium is also relatively solved. At present time there is no unified passport, which would contain: physical condition, degree of individual’s bent to motor functioning specifics; his readiness for fulfillment of task with the set complexity and assessment of current condition.

As far as there is a demand in professional graph of every sport activity, it is necessary to make professional record of individual fitness for appropriate kind of physical functioning.

For this purpose characteristics of physical progressing as biological maturity indicator are required. Specificity of motor functioning is determined by shares of motor qualities. In this case shares’ correlation of motor qualities (motor abilities and motor attributes), which determine individual motor potentials, is required in professional graph. In the whole, available at present time works in the field of physical culture and sports theory permit to practically solve this problem [13].

Ergo-graphic analysis of motor functioning was rather difficult because there were no methodic for determination of potential energy level (or reserve). Assessment of only kinetic energy did not permit to build ergo-graph of movement completely. It eliminated its value in the whole. The reason was that any motor action bears static
tension and kinematic characteristics, reflecting traveling of body bio-kinematic links. The consumed kinetic energy is found rather simply, if to know the mass of body and its velocity. But consumption of potential energy for keeping body posture was difficult to be found. It made impossible to construct general picture of energy consumption, required for definite motor action.

This task became solvable owing to finding of regularity of force at unbending angle between appropriate bio-kinematic links of total kinematic chain of body. Determination of physical force indicators (static tension, kinematic of body links’ traveling) opened wider opportunities for researches in sports, especially in cyclic kinds.

Assessment of consumed potential energy for muscular tension permits to control individual’s current condition and determine his current fatigue (workability). Owing to video recording current workability can be registered without contact at any distance, feasible for visual control. The main idea of such control is that measurement of decelerating dynamic of bending angle (or unbending angle between bio-kinematic pair in plio-metric motor actions) characterizes the progress of current fatigue [14].

The worked out methods of composing individual characteristic of motor functioning qualitative structure became possible owing to implementation attribute semantic spaces in scientific research practice. In these spaces there is single measure of the used attributes’ comparison. The created on his base model characteristics of the best sportmen permit to purposefully select the closest by qualitative correspondence body structures of sportmen-beginners [7].

Computer modeling of movements’ kinematic permits to enter individual weight-height data, bio-kinematic links’ masses and their gravity centers. Such approach permits to reproduce technique of movements with complex coordination. It changes practice of sportsman’s technical training rather substantially.

The problem of current express control over organism’s functional state can be solved because there are many new methods of research. Of special importance are: modern methods of video recording; computer programs of video-records’ processing; the found laws of organism’s reactions to endured physical load.

Substantial contribution in physical training individualization and determination of different motor aptitude was made by comprehensive researches of human and animals organisms’ morphological and functional systems during all history of science.

Demands of social progress and differentiation of industry deepened knowledge in appropriate fields. It resulted in development specific terminology. Then, advanced branch lost need in further deepening of knowledge, because they exceeded the frames of social demands. Need in other field of knowledge developed in the same order, but gave birth to other terminology. It complicated understanding their similarities. With certain periodic character of differentiated knowledge spheres’ development there appeared demand in integration of their achievements. Such integration has certain limits of their generalization, but always substantially contributed in further deepening of knowledge. Just these periods of scientific knowledge development can be estimated as periods of synchronization of inter-conditioned researches and emersion of agreed scientific terminology [15].

Knowledge differentiation and integration processes have reproducible periodization at all levels of self-organization of inter-conditioned relations. It can be presented as frequency characteristic of the required process. The volume of fulfilled scientific knowledge differentiation and integration can be characterized as their amplitude oscillation in each of their development periods. With accumulation of knowledge certain volume and qualitative orientation there appears possibility to find the laws of this process progressing.

The most expressively this process was characterized by G. Bernal, who said that “In science more than in any other human institute it is necessary to study the past for understanding of the present and domination over the nature in the future” [20].

Of not less importance, in this respect, is necessary accumulation of knowledge about the past for understanding it in the present [16]. Such waves of knowledge integration can be noticed in every sphere of knowledge and their interdisciplinary combinations. Long lasted struggle between vitalist and mechanistic approaches to theory of development resulted in understanding unanimity of material world development laws and then in general.

In biological field of knowledge formation of system was based on purely anatomic classification principles. Further formation of this concept presented system as a complex of inter-conditioned relations, directed at receiving final result. Their opposition ended by combining. It permitted to regard the process of development as single morphological functional interaction, resulted in organic genesis in developing “autonomous system”. Theory about unclear multitudes permitted to finalize general theory of systems. In its turn it resulted in successful solution of many tasks. It permitted to find mechanisms, explaining restriction of developing systems’ complexity; reasons of emersion of functional activity differentiation; to solve the problem of paradox of development.

Conclusions

Appropriate video recording means, computers, software permitted to fulfill processing of received sport data more qualitatively. It permitted to find analytical regularities and to use video recording processing results in actual scientific researches. Such regularities are practical tool in organization of training process, control over competition performances and their further analysis.

Realization of such control implies corresponding training of coach personnel and certain logistic. Control of fatigue dynamic by change of bio-kinematic links’ movements makes possible to solve this task in real time. However, with complete presence of the above mentioned
opportunities a coach can not ensure fulfillment of all scope of possible work.

In modern training process there exists registration of sportsman’s individual features and his current condition. For this purpose specialist is required, who will analyze results of video records’ computer processing.

Solution of these tasks requires training specialists for ensuring scientific-technical maintenance of training and competition processes. It implies new specialization for ensuring scientific technical maintenance and control over dynamic of human functional state. Training of such specialists is dictated by need in monitoring of human current state in different branches of industrial functioning, medicine, sports and rehabilitation medicine.

Conflict of interests
The author declares that there is no conflict of interests.

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On health protection and health related physical culture trainings of first year students
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Abstract
Purpose: to assess health protection and health related physical culture trainings of first year students.
Material: in the research first year students (n=121; 86 boys and 35 girls of age 16 – 19 years, participated.
Results: components of students’ individual health were found. Situation with health related physical culture trainings, ensuring students’ sound health and optimal functional potentials of their organisms were determined. It was found that leading role shall be played by formation of health world vision values, knowledge about formation of practical skills in healthy life style. Motivation tendency for realization of intentions and practicing of health related physical culture trainings were found in students.
Conclusions: the received results prove students’ tendency to pay insufficient attention to individual health. It was found that health related physical culture trainings require modern renewal of education’s content, forms and methods of physical education. The basis of such trainings shall be health related orientation.

Keywords: questionnaire, students, health, program, functional.

Introduction
Students’ physical education in higher educational establishments is and efficient factor in personality oriented teaching, in formation positive motives for systemic physical exercises’ practicing, careful attitude to health. All these shall be the basis of youth’s life activity.

Results of domestic scientists’ works witness about the following: there is significant quantity of students with low health level [3, 4, 6, 7]; increasing of students’ quantity, who belong to special health groups [1, 5, 16, 33].

Scientists proved that great number of modern students have insufficient physical fitness [43] and poor somatic health. It is noted that insufficient motor functioning negatively influences on most of organism’s functions and facilitates emersion of vegetative vascular dystonia [12, 14, 34].

One of obstacles for physical exercises’ practicing is students’ unsatisfactory health and physical fitness. The following main negative factors influence on youth’s health: unsatisfactory organization of physical education in students’ teaching. Scientists say that worsening of school age children’s health is medical and pedagogic problem. The main task of comprehensive educational establishment shall be pupils’ health protection and strengthening; formation of their responsible attitude to own health [2, 8, 11, 35].

Only 5% of adolescents remain to be healthy by the moment of secondary education finishing. 40-50% of school-leavers have substantial morphological functional disorders; 40-60% - have chronic diseases. From 20% to 80% of adolescents have pathologies in two – five human life provisioning systems [9]. It is facilitated by the absence of proper pedagogic control over schoolchildren’s health [25].

Important components of sport and health related works among students are:

- Creation of healthy environment [19, 36, 37, 41];
- Substantiation of physical loads’ level [18, 22, 23];
- Correction of deviations in different aspects of students’ physical, psychic and social- moral health [17, 21, 29, 44];
- Influence of negative and harmful habits on students’ organisms [13, 15, 32];
- Development of personality’s components of healthy life style [31];
- Rising of health condition level and health at the cost of different modern training methods [31];
- Prevention from progressing of students’ harmful computer habits [30];
- Organization of proper pedagogic control over students’ health [24, 26, 27];
- Improvement of students’ general and special physical qualities by sport trainings [20, 28, 39, 40].

Health improvement or sustaining on proper level shall be the main purpose of physical education classes. Possibility to assess students’ health level is an important motivation factor for students’ health related physical culture trainings. That is why it is important that usage of pedagogic experiments would give them confident information about their health. It will permit to select appropriate individual correction means for increasing motivation for health related physical culture trainings (especially for students with little deviations in health).

The purpose of the research is to assess health protection and health related physical culture trainings of first year students.

Material and methods
Participants: in the research first year students (n=121; 86 boys and 35 girls of age 17 – 19 years, participated.
Organization of the research: students’ attitude to own health was studied with the help of special questionnaire. The questionnaire contained questions about conditions of study and rest, influence of sports and physical exercises practicing on health, formation of health protection...
environment in university, quality of physical education trainings and other.

Statistical analysis: we used the methods of transformation of questioning empiric data. With the help of logic meaningful procedures we revealed correlations of the studied variables.

Results

For health assessment the students were offered to answer a number of questions. The question “how your health influences on results of your studying?” we received the following answers: 58% of students understand importance of health for study progress; 38% think that health does not influence on study at all; 4% do not know how health influences on studying.

Students’ answers concerning role of health in their lives were as follows: 41% - health is the main thing in life; 48% - health is necessary condition of full fledged life activity; 6% - there are other important values; 5% want top live not thinking about health.

Students “determined the state of their health”. Their self assessment was: 47% consider their health to be good; 37% - satisfactory; 16% think that their health is unsatisfactory.

In the questionnaire there was such question: “After medical examination at the beginning of academic year, to what health group you were related?” The answers were as follows: main health group – 75%; special health group – 10%; group of therapeutic physical culture (TPC) – 15%.

Answering the question about possible influence of physical health on psychic self-feeling 43.5% noted that it influences; 56.5% think that health does not influence on psychic self-feeling.

Answering the question “is there dependence between study progress and physical health?” 48% of students understand the importance of physical health; 42% neglect health; 10% could not answer. Answers to question “which kinds of leisure do you prefer?” were: 78% prefer passive leisure (TV, internet). Physical exercises and sports are preferred by 22%. It should be noted that many students are oriented on passive leisure. Results of our questioning illustrate the results of other work [1]. The author found that the youth’s interest to physical activity is rather at high place in structure of interests. But in many cases this interest is passive and not realized in practice.

Stress-factors are poor sleep, hunger, thirst, excessive physical loads and immobility [10]. Students’ way of life was elucidated by their answers to question “how long your sleep lasts (day and night)”. Answers showed that 50% of students sleep 5-6 hours; 4% - less than 5 hours. In connection with deficit of sleep every second student is influenced by stress-factor. 46% of students pointed that their sleep lasts 7-8 hours.

Only 26% of students have normal eating – 3-4 times a day. More than half – 54% eat 2-3 times a day. 20% feel fatigue and stress because of eating 1-2 times a day.

Among reasons of lecturers’ missing students noted reduction of adaptation that manifests in morbidity: 24% are sick very rarely – once in several years; 36% - 1-2 times a year; 26 - once in semester. Extremely low adaptation level (diseases 1 time every month) was found in 14% of students.

It is known that strengthening of organism’s reserves is possible by three means: physical, hypoxic training and hardening. That is why students’ attitude to hardening for health improvement is rather interesting. 1% of students practice hardening constantly; 7% - sometimes; 92% do not practice hardening at all.

Smoking is the main etiological factor of many heavy and fatal diseases of men and women. As per the data of World Health Protection organization 1.1 billion of people are tobacco-smokers [45]. The question “Do you smoke?” 56% answered “Yes”; 34% - sometimes. Only 10% of respondents answered “No”. We think that active propaganda of smoking harm and struggle with it can reduce the number of adult smokers as far as just school age and students’ age is the main source of adult smokers’ population.

Students’ alcohol drinking was studied by their following answers: “once a week and more often”, “sometimes”, “no”. Alcohol drinking once a week and oftener is intrinsic to 14% of students; “sometimes” – 82% of students and 4% do not drink alcohol at all.

In opinion of the most of students harmful habits are not the main reason of indifferent attitude to physical culture. However students’ dependence on harmful habits is evident. It underlines again the difference between verbal and real attitude to healthy life style values.

Students’ answers to the questionnaire’s questions permitted to find their understanding of demand in health related physical culture classes. For this purpose the students were offered to answer the question, concerning significance of physical culture in realization of life plans and health preservation.

Analysis of answers showed that health related physical culture trainings are significant for 49% of students; by signs of usefulness and prestige – for 51%. As it is known environmental conditions significantly influences on human attitude to different activities. That is why we interested how students assess conditions for health related physical culture training in places of their residence. The results showed that about 8% think that they are positive and 92% are not satisfied by environmental conditions. It can be considered to be one of reasons of their unwillingness to participate in health related trainings.

There was one more question: “Let’s assume that in the place of your residence there are proper conditions for health related physical culture trainings (in any convenient for you time). Will your attitude change?”

80% gave positive answer. Analysis of students’ answers to all questions showed that the students have positive motivational base for health related trainings.

Next question was “do you practice health related physical exercises?” Answers to this question permitted to determine individual interests, motives and orientations in health related physical culture trainings. 23.1% of students...
answer positively. Thus, students’ answers permitted to find results of formed in them positive motivation at the stage of desire realization; presence of targeted structure and realization plan. 71% of students practice physical exercises 1-3 times a week; 25.6% - 4-5 times a week; 2.7% - practice physical exercises 6-7 times a week.

Modern requirements to students’ health determine demand in comprehensive development of health protection and health related physical culture trainings of first year students. It shall be one of main directions for health related physical culture trainings. The fulfilled by us study proves and supplements the works of domestic scientists about insufficient level of students’ health and protection and health related physical culture trainings. The fulfilled by us study proves and supplements the works of domestic scientists about insufficient level of students’ health and formation of healthy life style.

**Discussions**

Modern requirements to students’ health determine demand in comprehensive development of health protection and health related physical culture trainings of first year students. It shall be one of main directions of physical education process. The fulfilled by us study proves and supplements the works of domestic scientists about insufficient level of students’ health and formation of healthy life style.

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Evaluation of skis of alpine skiing behavior on the snow

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Abstract

Purpose: The purpose of this study was to evaluate the behavior of the skis on snow depending on sex, type of ski and the level of training of the technical skier.

Material: In the research participated 57 skiers, generally of age 26 ± 8.62 years (34 males and 23 females) at the ski center of Parnassos (Greece). The evaluation of the ski behavior on snow came up via the scores on Test 1 to Test 5 in practice, to the rating scale from 0 to 10 respectively. The participants, after performing daily training with their skis completed the questionnaire. The questionnaire included the following elements: sex, height, weight, the type of skis and the type of TEST as: 1-2) behavior of skis in long and short turning radius, respectively, 3) grip of the ski edges in turn, 4) stability of ski riding, 5) usage of general muscle strength (fatigue).

Results: The correlation between the first four tests (Test 1-4) was significant at statistical significance level p <0.05, apart from test 5, which shows reduced physical fitness of the skier. Also the majority of skiers prefer parabolic skis (carving ski), although the racing skis were highly rated.

Conclusions: The widespread “carving skis” are skis with medium score in both of all five tests in comparison to the Race skis (carving ski), although the racing skis were highly rated. The correlation between the first four tests (Test 1-4) was significant at statistical significance level p <0.05, apart from test 5, which shows reduced physical fitness of the skier. Also the majority of skiers prefer parabolic skis (carving ski), although the racing skis were highly rated.

Keywords: alpine skiing, ski behavior, evaluation, test.

Introduction

In skiing, the downhill of the skier on the slopes is accomplished by using the skis. A good skier involves good technical training. The technical training in Alpine skiing is the grade of control of the ski from the skier during the course of descent, and the appropriate use of the baton. Depending on the way of descent, the technique of skiers classify in beginners, medium, advanced and athletes. For this reason in every ski resort there are shaped slopes for all levels of skiers from beginners to elite sportmen.

Each slope may differ in the difficulty of the descent. The difficulty is usually due to the slope to the horizon, the width and the quality of the snow that exists on the slope. The greater the slope and the smaller width, the more difficult it is considered. The quality of the snow is something which depends on various factors such as the temperature of the atmosphere and the snow, the moisture, the sunshine, the wind etc.

The Ski contests, like the ski equipment, are classified into 3 categories: Nordic ski, Alpine ski and Freestyle ski. The Nordic ski includes jumps from springboard (Jumping ski) and endurance (Cross country ski). The Alpine ski includes speed contests (DH & Super-G) and contests of «slalom» (GS & SL), while the Freestyle ski involves acrobatic contests (Mogul ski, Aerial ski, Cross ski & Half-pipe ski). The sample of this research is all skiers of the ski resort Center of Parnassos (Greece). The evaluation of the ski behavior on snow came up via the scores on Test 1 in the research participated 57 skiers, generally of age 26 ± 8.62 years (34 males and 23 females) at the ski center of Parnassos (Greece). The evaluation of the ski behavior on snow came up via the scores on Test 1 to Test 5 in practice, to the rating scale from 0 to 10 respectively. The participants, after performing daily training with their skis completed the questionnaire. The questionnaire included the following elements: sex, height, weight, the type of skis and the type of TEST as: 1-2) behavior of skis in long and short turning radius, respectively, 3) grip of the ski edges in turn, 4) stability of ski riding, 5) usage of general muscle strength (fatigue).

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In freestyle skis the construction is different than the carving ski. The differences are the followings: they are larger so they have bigger part of contact with the snow, they don’t have big side cut, which is something that doesn’t suit in short turns.

Literature Review

On the evaluation of the ski behavior on the snow by users of different levels there are not many reports. Specifically, the Daily mail ski and snowboard magazine (DMS & S) has dealt with this subject in the issues of [1, 2, 3, 4, 5, 6, 7]. The rating of the skis was done in the form of a questionnaire by professional athletes and ex-champions while tests were done at a specific slope in Italy. The skis were evaluated in the following 12 criteria (DMS & S ski test): Holding the edges, in short turning radius, in long turning radius, stability at speed development in the straight, high speed, low speed, passing over rough terrain, response of skis to the movements of skier, adaptability to different conditions, performance in slopes with brindle, response of skis in powder, and finally how flexible the skis are in the passages with “bumps”. Regarding the kind of the skis, in the issues of [5, 7], worked with the freestyle skis in the issue of [2] with the race skis, in issues of [1, 6] with the carving and in the issue of [3] with the cross skis.

On the evaluation of the ski behavior on the snow by
non-professionals worked on only the magazine [14, 15],
where a non-professional skier tested 13 different pairs of
skis and a team of experts marked them as follows: the
response of skis in the entry of turn, the adaption of skis to
changes made by the skier and at various turning radius.
In all these researches evaluated the same types of skis
different companies. There is a research that compares
different types of skis between them, such as racing and
touring skis for men and women [10, 11, 12], while for
teens and freestyle skis there are tests in the following
magazines: [10, 13].

**Purpose.** The purpose of this study was to evaluate the
behavior and the capabilities of skis on snow regarding:
sex, type of ski, the level of the skiers in relation to the
parameters - criteria (test).

**Cases.** The study was structured to answer the
following research questions:
a) Are the carving skis the most popular and the most
highly rated skis regarding the 5 criteria mentioned above?
b) Can the results of the evaluation of the skis
contribute to a better selection of skis from elite athletes
and even to recreational skiers?
c) Can the type of ski in relation to his behavior on the
snow be rated by non-professional skiers?

**Material and Methods**

**Participants.** The 57 tested were aged from 10 to 52
years (26.19 ± 8.62). The average height of males was
1.78 ± 0.08, while of females was 1.65 ± 0.05. Also the
body weight of males was 73.68 ± 10.44, while females
57.17 ± 8.76. Finally, the values of the body mass index
(BMI) of males were 23.19 ± 2.40, while females 20.90
± 2.92, where the mark of obesity for both sexes was
normal.

**Research Design.** For the study 57 skiers were selected
by random sampling in the ski center of Parnassos (Greece).
The results were analyzed in three different categories: 1)
sex (23 females and 34 males), 2) depending on the type
of skis (all - mountain, carving, cross, freestyle and race
ski), 3) according to the level of technical training: (12
athletes, 24 advanced, 11 medium and 10 beginners). The
evaluation of the behavior and ability of skis on the snow
was done via rating skis with 5 different criteria in the
evaluation scale of 0 to 10. The process of each test was
as follows: the tested, after performing the daily training
with his skis, completed the closed form questionnaire
with the following information: personal (sex, height,
weight), experience in skiing, type of ski equipment and
type of test. The test represented the following parameters
- criteria [9]:
1. Behavior of skis in big turning radius (TEST 1)
2. Behavior of skis in small turning radius (TEST 2)
3. Behavior of skis to the grip of edges in turn (TEST
3)
4. Behavior of skis in stability of riding (TEST 4)
5. Behavior of skis during fatigue of general muscle
strength (TEST 5)
The evaluation was to one mark with percent values in
accuracy.

**Statistical Analysis.** The statistical analysis was
performed using the statistical program Excel 2007 and
SPSS 20.

**Results**

**Evaluation according to sex**

Table 1 shows small deviations between males and
females, while the females are given a lower score in
the first four tests compared with the males. This means
that to them the first four tests were difficult. Also in the
fifth and final test, which refers to the fatigue of general
muscle strength seems that females reported higher score
(7.3 points), which means that they spent less muscle
energy than males (6.9 degrees). The above phenomenon
can be explained due to the power of gravity and inertia,
because running the downhill on sloping ground and not
on straight ground. The classic example is the results in
various Alpine ski races where female athletes were not
behind males [8]. The correlation coefficient between the
tests was important about males (r = 0,60-0,85) except
TEST 5 which shows the reduced fitness of the skier,
while about females there was correlation in all the tests
(r = 0 , 36-81) at significance level p <0.05.

**Evaluation depending on the type of ski**

The tested skiers prefer Carving skis (57.4%)
compared to the rest categories (Figure 1), although the
Race skis (24.1%) had the highest score in most of the
tests (Figure 2), while the other categories share the rest
percentage.

As for the results for each type of ski in the five
different tests, in the first test (the behavior of skis in the
long turning radius) we observe that predominate Race
skis (9.1 points) and Freestyle skis (9 points), while
Carving skis took low score (6.5 points).

In the second test (the behavior of the ski to short
radius turn) we observe that the Freestyle skis are rated
in turns with short radius with low score (5 points). The

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<th>FEMALES</th>
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<td>TEST 1</td>
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<td>TEST 5</td>
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Table 1. The results of tests in relation to sex.
Race skis are rated and in the second test with too high score (9.4 points), while the Carving skis in this test are in better position (6.6 points), because their construction helps to do turns with short radius. In the third test (grip of the skis edges in turn) we observe that the order of the score of skis in short turning radius (test 2) and of the grip of the ski edges in turn (test 3) are the same. In the fourth test (stability of skis in riding) dominated again the race skis (9.9 points) while freestyle skis are rated higher than the second and third test. In the fifth test the skis were rated according to the fatigue of general muscle strength that the skier felt in the downhill. In this category the cross skis rated too high (8.7 points) which is explained by their construction (with medium side cut) and they are used in stepped and unstepped tracks respectively (e.g. 50%-50%).

The correlation coefficient (r) between the tests was important to the specific types of skis as: All-mountain (r = 0.91-0.98) and Carving (r = 0.38-0.77), in significance level p <0.05, while the feature of All-mountain skis was the following, that the four tests in relation with the test 5 had negative sign. This means that it required big fatigue of muscle strength (Test 5) in all four tests, which shows the reduced fitness of the skier.

The Race skis had significant correlation between the first four tests (r = 0.52-0.78), while they had any correlation with the test 5, which shows the reduced fitness of the skier. The Freestyle skis had significant correlation between all tests (r = 0.80-0.99), except for the first two tests, while Cross skis (Free race) had significant correlation only between TEST 1-3, TEST 1-4 TEST, TEST 2-5 and 3-4 (r = 0.91-0.98).

Evaluation according to the level of technical training

Regarding the effects of the level of technical training of skiers through the five different tests, as expected, the athletes dominate (Figure 3). It is remarkable that the beginner skiers had little fatigue of general muscle strength (Test 5) relating to the other categories of the skis. The correlation coefficient (r) between the tests was important to the specific types of skis as: All-mountain (r = 0.91-0.98) and Carving (r = 0.38-0.77), in significance level p <0.05, while the feature of All-mountain skis was the following, that the four tests in relation with the test 5 had negative sign. This means that it required big fatigue of muscle strength (Test 5) in all four tests, which shows the reduced fitness of the skier.

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level and to the correlation between the tests. The above fact in this case is explained on the one hand because of the good fitness of the beginner skiers, and on the other hand because of the correct selection of equipment with shorter skis.

The correlation coefficient between the tests was significant about athletes (r = 0.69-0.99) except for TEST 5 and between TESTS 1-5, which shows the reduced fitness of the skier. Also about beginners there was correlation at all tests (r = 0.60-0.89) except for between TEST 1-5, in statistical significance level p <0.05.

Discussion
From the analysis above and the five tests the following question is raised: why the majority of skiers prefer carving skis while race skis responds better in tests? The above phenomenon may be due to the construction (with a large side cut) and the heavy weight of the ski accessories such as “plate”, etc., while it should be noted that the race skis look like racing skis therefore they require better fitness by the skier. Also, the above phenomenon is explained by the vast publicity and Carving skis of that season marketing. The Carving ski is considered unreliable in terms of large radius, because of their construction (with a large side cut), as it is specialized for turns with short radius. Remarkable is that cross skis have stable rating and they are found at the first four tests in the second place, while the race skis were impressive because of the fact that they were top at the first four tests, while in the last one (test 5) high fatigue (tiredness) of muscle strength was necessary (6.8 degrees). This reflects on the reduced fitness of the skier. The Freestyle skis are rated as unreliable in turns with short radius (5 points), probably because of their construction (with small side cut). The differences in estimate between the all- mountain skis and carving skis were small as in all the above tests. Based on the tests above, it is recommended for beginner skiers, before they buy their new equipment, to test the skis through rentals with shorter skis from the usual options.

Conclusions
Based on these results we can conclude the followings: the skis descent can be classified regarding their behavior on the snow through the method suggested above (the practical part and the questionnaire). The results of the evaluation of the skis can contribute to a better choice of skis from elite athletes even to tourist skiers. The evaluation of the ski behavior on the snow was accomplished with high ratings by the females in all the tests, despite the small muscular strength compared to males (r = 0.36-0.81). The widespread and more published «carving skis” are the skis with a medium score to the 5 tests compared to the Race skis, which had a high score (r = 0.52-0.78), while they have no correlation with TEST 5 which shows the reduced fitness of the skier. Finally, as expected, the highest rating given by the athletes (r = 0.69-0.99) at statistical significance level p <0.05. For further research the correct selection of the skis in relation to the fitness of the skier, prevention and injuries are recommended.

Conflict of interests
The author declares that there is no conflict of interests.
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The mid – term effect of kinesio taping on peak power of quadriceps and hamstring muscles after anterior cruciate ligament reconstruction

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Abstract

Purpose: The aim of this study was to assess mid-term effect of Kinesio tape on peak power of quadriceps and hamstrings muscles after ACL reconstruction 24 hours after taping.

Material: Thirty six men who had undergone ACL reconstruction and completed physiotherapy periods (6 months) were assigned to no taping, placebo and taping groups. Peak power was tested before and 24 hours after taping by isokinetic dynamometry. Data was analyzed by SPSS software 19. ANOVA and post hoc test (LSD) were used for interpretive analysis.

Results: The results showed that the effect of Kinesio tape on peak power of quadriceps muscles at velocities of 180°/s and 300°/s was significant. In the hamstring muscles, significant effects were obtained at velocities of 60°/s, 180°/s & 300°/s.

Conclusions: Positive impacts of Kinesio tape on muscular peak power among athletes who had ACL reconstruction were observed. Regardless of psychological effect and reducing re – injury fear, Kinesio - tape causes to stabilize and increase effective range of motion of the knee, so it is recommended that in the explosive training, athletes who have ACL reconstruction should use tape to reduce the probability of re-injury and increase muscle power.

Keywords: sport biomechanics, knee ligaments, physical treatments, athletes.

Introduction

Rupture in ACL is very prevalent and its treatment is too costly and time-consuming [1]. Previous studies show that 80 to 250 thousand of ACL injuries occur yearly between ages 15 to 25 years [2]. Reconstruction of this ligament is the most common method of treatment for those who encounter with ACL tear. Special care and physiotherapy after surgical operation, together with the special exercise may help the athlete to return to competitions after some months [1]. The increased rate of ACL tears in youth athletes have been attributed to multiple factors including an increase in early sports specialization and competition, lack of free play and increased awareness of ACL injuries in children [3]. On the other hand, Quadriceps weakness persists after ACL reconstruction. Muscle atrophy and activation failure may contribute [4]. It has been mentioned that ACL reconstruction and injured limb decreased from 5% to 40% in strength of the quadriceps muscle [5, 6, 7]. It can be concluded that other factors (physical fitness) such as maximal power is affected by ACL reconstruction. So, Physiotherapist and sport therapists must plan and treat athletes to achieve all these factors in the shortest possible time and reach them to the peak level of their activity. Achieving to muscle maximal power factor is extremely important because it is infrastructure and basic foundation of athletes’ skills training. Maximal power factor is considered in rehabilitation programs from 6th month after reconstruction. Plyometric training is a specialized, high-intensity training method which aims to increase sport-specific explosive peak power and the rate of force development [8]. Plyometric training is applied as muscle peak power in rehabilitation protocols after the sixth month, because it’s not only increasing muscle peak power but also neuromuscular coordination. For prevention, rehabilitation and modulating some physiological processes of ACL injury, different methods and tools such as “Kinesio- Tape” were used [9, 10, 1, 11]. Taping is usually used to help recover from overuse and other injuries. Taping can support injuries at the muscle-tendon units by compressing and limiting movement and secure protective pads, dressings and splints [12]. KT gives support and stability to the joints and muscles without affecting circulation, range of motion and allows for the athletes to exercise with greater intensity [1]. Application of the tape allows the body to move normally, and reacts to the fascia via biomechanical or proprioceptive mechanisms [13]. Some of the researchers assumed that KT can facilitate and stimulate muscle function if its application starts at the origin of the muscle and ends at its insertion [12, 13, 14]. KT could stimulate the fascia and provide higher tension for facilitating the muscle contraction [12, 14]. Before starting explosive exercise such as plyometric exercise, evaluation of the femur’s muscles peak power can help to rehabilitator. Peak power of hamstring and quadriceps muscles can be considered as fair criteria and useful signal in the prevention of re-injury and promote a return to sport for injured athletes. Applying KT can help joint stability and increase the muscular power among athletes who underwent ACL reconstruction. Some studies have noted a positive effect of taping on explosive exercise and others have considered it ineffective [13, 15, 16]. Some
of the studies have researched the effect models of taping in different area of the body. The most recent systematic reviews have concluded that there is little quality evidence to recommend the usage of KT to prevent or treat musculoskeletal injuries \cite{17, 18} and regarding efficacy of KT applications to promote strength gains has recently been reviewed (19). Since previous studies have been conducted on healthy people and athletes and on the other hand, few studies about applying mid-term KT on peak power of the femur’s muscles have been done. So the aim of this study was studying mid-term effect (24 hours) of KT on peak power quadriceps and hamstring muscles among athletes who underwent ACL reconstruction.

**Material and Methods**

The method of this research was quasi experimental. Statistical population of present research included all of the athletes that had ACL reconstruction. The ACL surgery was performed by an orthopedic surgeon using a double-bundle method (allograft) followed by an effectively ACL reconstruction rehabilitation program that was performed about 6 months (see table 1). Inclusion criteria of the study were: (1) isolated ACL injuries; (2) unilateral arthroscopic ACL reconstruction; (3) age between 21 and 31 years; (4); regular attendance, missing no more than three sessions of ACL surgery rehabilitation in the first three months after ACL reconstruction. According to the aim of research, 36 men who had experienced ACL reconstruction randomly were divided into three groups: taping (N=12), non-taping (N=12) and placebo (N=12) groups. The instruments used were Siemens Isokinetic dynamometer (Iso 2 model, made in Italy), 3NS TEX (made by Korea) Kinesio tape, IKDCSKE form and SECA Scale (weight and height, made in Germany). Research procedure was explained verbally to the subjects. After adjusting isokinetic dynamometer for each subject, they performed 8 repetitions with a speed of 360°/s as a warm up set. The test protocols consisted of 2 repetitions in 3 sets with a speed of 300°/s, 2 repetitions in 3 sets with a speed of 180°/s and 2 repetitions in 3 sets with a speed of 60°/s. They rested 10 seconds between each set and 120 seconds between stages 1 to 3.

According to study of Kase et al (2003) Kinesio tape is applied for both “muscle facilitation” and “muscle inhibition” technique. KT applying from the muscle origin to insertion with stronger tension (50 to 75%) of its original length may enhance muscle contraction. On the contrary, muscle contraction may be reduced by applying KT from the muscle insertion to origin with weaker, tension (15 to 25%) of its original length. So, Three different quadriceps taping modes were applied (no taping, placebo taping and taping) for three groups. The Tex was used from origin to insertion of the quadriceps muscle (50% tension by length), around and below the patella bone as KT (experimental) group (Fig1). According to the study of Vithoulka et al (2010), for placebo group two levels Tex were applied transverse on quadriceps muscle. One of Tex 5 cm above the middle distance of the femur and the other one 5 cm below were applied (Fig 2). As mentioned three groups (no taping, placebo taping and taping) performed testing protocol before and 24 hours after taping in the same room and environmental circumstances such as light, noise, temperature and wet. By using SPSS 19 data was analyzed. Descriptive statistics was used for measurement of Average, Standard Deviation, variance and interpretive analysis was applied for frequency tables and ANOVA and post hoc test (LSD) within three groups.

**Results**

According to the table 3 in the hamstring muscles, significant effects were obtained at velocities of 60°/s, 180°/s & 300°/s. Furthermore, there were significant effects in the quadriceps muscles at velocities of 180°/s and 300°/s 48 hours after taping (P<0. 05).

Table 1. ACL reconstruction rehabilitation programs

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Rehabilitation program</th>
<th>Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 4</td>
<td>Electrotherapy on Reducing pain, Inflammation, edema, achieving ROM and IKDCSKEF test</td>
<td>5 per weeks</td>
</tr>
<tr>
<td>5 to 8</td>
<td>Limiting hemarthrosis, pain and edema, obtaining full ROM and full weight bearing, gait training and IKDCSKEF test</td>
<td>3 per weeks</td>
</tr>
<tr>
<td>9 to 12</td>
<td>Neuromuscular, Core, balance, PNF stretching, proprioceptive exercises and IKDCSKEF test</td>
<td>2 or 3 per weeks</td>
</tr>
<tr>
<td>13 to 16</td>
<td>Running, agility and IKDCSKEF test</td>
<td>2 or 3 per weeks</td>
</tr>
<tr>
<td>17 to 20</td>
<td>Plyometrics, TRX exercises and IKDCSKEF test</td>
<td>2 per weeks</td>
</tr>
<tr>
<td>21 to 24</td>
<td>Access better, fair H/Q ratio and IKDCSKEF test</td>
<td>2 per weeks</td>
</tr>
<tr>
<td>25 to 28</td>
<td>Intermediate specific exercise in related sports functional and IKDCSKEF tests</td>
<td>3 per weeks</td>
</tr>
<tr>
<td>29 to 32</td>
<td>Advanced specific exercise in related sports functional and IKDCSKEF tests</td>
<td>3 or 4 per weeks</td>
</tr>
<tr>
<td>33 to 36</td>
<td>Return to sport by specific and skill tests</td>
<td></td>
</tr>
</tbody>
</table>
Discussion
In quadriceps and hamstring muscles there were significant effects at velocities of 180°/s and 300°/s 24 hours after taping. Of course in quadriceps muscle, significant effects were obtained at velocity of 300°/s in the placebo group. Studies have used the output strength or peak torque but limited studies have directly evaluated the peak power of the femur’s muscles among unhealthy athletes. However, peak power and torque in different angular velocities can be fair criteria for explosive movement of the femur’s muscles. It has been reported that peak power is generated at velocities of 60°/s & 180°/s. It also has been found that measurements of power can be useful in describing the types of deficits seen in some patient types. Isoifidou et al (2000) found that increase in angular velocity lead to increase in peak power of the femur’s muscles [20, 21]. Herington et al (2004) figured out that use of tape is ineffective [22]. It seems that difference in the mentioned results and present study may be due to tension, type or method of taping and samples (healthy ans injured). Takey et al (2007) obtained significant differences in peak power between left and right leg among elderly females and suggested that peak torque is representative of work and power and may be the only necessary parameter for isokinetic muscle performance testing of the extensor muscles of the knee in the elderly [23]. Fu et al (2008) found no significant difference in muscle power among the three conditions and believed that KT on the anterior thigh neither decreased nor increased muscle strength in healthy non-injured young athletes [24]. They examined the possible delayed (12 hours after taping) effects of KT on muscle strength in the quadriceps and hamstring when taping is applied to the anterior thigh of 14 healthy young athletes in taping and control groups while in this study muscular power was assessed in athletes (men) who had ACL reconstruction and significant effects of KT on peak power at velocities of 180°/s and 300°/s 24 hours after taping in the quadriceps and hamstring muscles was observed. The inconsistency in the above results and present study may be attributed to difference in tension (30% vs 50%), type, method and time of taping (12h vs 24 h), samples (healthy and injured) and groups. Vithuolk et al (2010) taped their samples (nonathletic female) in different manner. Of course their taping had significant effect on peak torque. Nelson (2011) obtained significant decrease in maximum power post- intervention, and no significant differences in the average power, or average

![Fig 1. The model of taping in the taping group.](image1)

![Fig 2. Model of taping in the placebo group](image2)

**Table 3. The mid – term effects (24 hours) of Kinesio Tape on peak power among groups**

<table>
<thead>
<tr>
<th>Muscles</th>
<th>Angular Velocities°/s</th>
<th>Group</th>
<th>Peak power Pre-test Mean (SD)</th>
<th>Post-test Mean (SD)</th>
<th>F</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quadriceps</td>
<td>60</td>
<td>No taping</td>
<td>151(38.63)</td>
<td>153.77 (41.12)</td>
<td>0.631</td>
<td>0.546</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taping</td>
<td>149.44 (90.82)</td>
<td>169.34 (55.05)</td>
<td>1.831</td>
<td>0.031*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placebo</td>
<td>150.31 (48.36)</td>
<td>152.01 (45.74)</td>
<td>1.276</td>
<td>0.243</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td>No taping</td>
<td>208.12 (42.89)</td>
<td>216.12 (87.65)</td>
<td>0.529</td>
<td>0.611</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taping</td>
<td>211.37 (79.84)</td>
<td>241.51 (88.09)</td>
<td>2.423</td>
<td>0.035*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placebo</td>
<td>210.65 (84.05)</td>
<td>216.07 (67.17)</td>
<td>0.059</td>
<td>0.955</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>No taping</td>
<td>355.22 (31.22)</td>
<td>368.1 (83.98)</td>
<td>0.483</td>
<td>0.642</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taping</td>
<td>357.12 (64.69)</td>
<td>408.07 (78.01)</td>
<td>2.384</td>
<td>0.041*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placebo</td>
<td>356.87 (156.76)</td>
<td>371.51 (91.04)</td>
<td>0.158</td>
<td>0.879</td>
</tr>
<tr>
<td>Hamstring</td>
<td>60</td>
<td>No taping</td>
<td>149.11 (31.89)</td>
<td>149.98 (39.04)</td>
<td>0.281</td>
<td>0.542</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taping</td>
<td>150.66 (42.05)</td>
<td>163.29 (41.01)</td>
<td>1.981</td>
<td>0.098</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placebo</td>
<td>152.77 (12.44)</td>
<td>157.4 (45.7)</td>
<td>1.100</td>
<td>0.088</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No taping</td>
<td>219.12 (52.01)</td>
<td>221.37 (44.53)</td>
<td>0.182</td>
<td>0.860</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td>Taping</td>
<td>226.62 (51.35)</td>
<td>282.05 (47.32)</td>
<td>4.037</td>
<td>0.005*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placebo</td>
<td>2187.5 (33.7)</td>
<td>228.87 (41.86)</td>
<td>0.366</td>
<td>0.059</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No taping</td>
<td>370 (56.05)</td>
<td>379.45 (77.05)</td>
<td>0.208</td>
<td>0.262</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taping</td>
<td>373.19 (79.2)</td>
<td>410.67 (87.87)</td>
<td>2.640</td>
<td>0.033*</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>Placebo</td>
<td>372.29 (55.02)</td>
<td>390.75 (86.09)</td>
<td>3.195</td>
<td>0.061</td>
</tr>
</tbody>
</table>
and maximum speed and cadence measurements [24]. Forty asymptomatic trained amateur cyclists performed two 1.5 km time trials pre- and post- KT application and Peak power of quadriceps muscles was studied by him while this study was performed on men who had ACL reconstruction and obtained significant effect (mid – time) of KT on power. Wong et al (2012) showed that despite of taping, work out of samples (14 healthy male and 16 healthy female) were decreased by using KT [26]. In fact, type and stretching of taping (tension) can cause decrease of work out and peak power among healthy people. They reported that decreasing of peak power in extension is visible and more than flexion while in this research the result indicated in quadriceps and hamstring muscles there were significant effects at velocities of 180°/s and 300°/s at the 24 hours after taping. Subjects of Wong et al (2012) were healthy that had more decrease in extension than flexion whiles our subjects were men who had ACL reconstruction. Wong et al (2012) studied the effect of taping on output peak power at velocities of 60, 120 and 180°/s while in the present study taping and its effect were studied at velocities of 60, 180 and 300°/s. They evaluated peak power on quadriceps muscles and obtained decrease in power while the present study investigated the effect KT on peak power of hamstring and quadriceps muscles and obtained increase in peak power. With respect to these results it can be concluded that taping (our model and 50% tension) can improve peak power before plyometric exercise in rehabilitation protocols. So using tape in rehabilitation phase and starting of explosive exercises is suggested for improving of functional muscles, increasing in peak torque and strength and prevention of re-injury. Wong et al (2012) tested before and immediately after taping while this study tested before and 24 hours after taping. Lumbrasso et al (2014) studied effect of KT (30% tension) application over hamstring on peak force among 36 physical therapy students (27) while our subjects were men who had ACL reconstruction and taped 50% tension. They found no immediate change of peak force in the hamstring group, however, two days later, peak force significantly increased that agrees with parts of the results of the present study. It has been figured out significant effects at 24 and 48 hours after taping compared with before taping in taping group [12]. They believed that using tape has a positive impact on explosive muscle performance and power in a vertical jump test that is compatible with the result of the present study. The isokinetic test (open chain exercise) involves one joint and segment, it limits the knee angular velocity and biarticular muscles (rectus femoris) are affected only by one joint (knee) since there is no simultaneous movement of adjacent joints. In contrast, the squat vertical jump test involves both legs, it is a closed chain exercise, the knee angular velocity is not limited and there is a transfer of energy from other joints so output power increases. However, according to reports of Nadali (2014), the positive effect of taping during the 24 and 48 hours after taping is effective on vertical jump or Sargent and results of the present study indicates increase of strength output of the femur’s muscles among athletes who had ACL reconstruction. So, taping can cause psychological positive effects, knee stability and adaptability (proprioceptive receptors) of the knee joint. Sera et al (2015) has not found significant differences in the variables assessed between KT and Micropore conditions or among testing sessions (pre, post, and 24h after) and no statistical significance for interaction between tape conditions and testing session [28]. They evaluated the effects of KT on knee extension force in soccer players while the present study tested the peak power of the femur’s muscles in athletes who had ACL reconstruction that agrees with the parts of the result of the present study. Guedes et al (2016) reported that there were no significant differences on time of taping at 24 and 48 hours and KT did not enhance knee extensor neuromuscular performance of healthy men at different muscle action velocities between 60 to 240°/s [29] but this study obtained significant effects of KT on muscular power in the quadriceps and hamstring muscles at velocities of 180°/s and 300°/s 24 hours after taping. It can be stated the difference in their results and present study may be due to tension (0% and 40% vs 50%), subjects (healthy vs Injured), type or method and time (duration) of taping. On the other hands, it has been verified that KT has positive effects in individual’s post-ACL reconstruction during returning to pre-injury activity level and/or sport [30].

**Conclusion**

It seems that the use of KT has a positive impact on peak power of quadriceps and hamstring muscles at the start of the powers’ program of the rehabilitation on unhealthy athletes who have ACL reconstruction. Apart from the psychological impact, taping by stabilizing the knee joint may result in significant impact. Use the proper tension of taping makes optimum traction to touch receptors, stimulating more skin deep motor neurons and thereby increase the torque and peak power of the femur’s muscles. Increasing stability in the joint of athletes can cause more daring and courage among athletes who have injury and can reach them to higher muscular peak power during plyometric exercises or explosive activity. Therefore, using mid – term taping (24 hours later) with the proper tension (50%) like model of the present study can be recommended (Mehregan model) in the start of the power’s program of the rehabilitation athletes who have ACL reconstruction. Other influences of KT among other injured athletes need to be addressed in further research efforts.

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**Conflict of interests**

The authors declare that there is no conflict of interests.
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Requirements for privatization of Iran pro league football clubs
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Abstract
Purpose: The purpose of this research was to determine the requirements for privatization of Iran Pro League (IPL) football clubs.

Material: A questionnaire was developed and distributed among a sample of IPL coaches, executives (senior executives from the Ministry of Youth Affairs and Sports and the Privatization Organization), and faculty members (public and private universities). Descriptive statistics and Kruskal-Wallis test were used for data analysis. Besides, AHP was used in Expert Choice software to weight and rank the items.

Results: The results showed that the most important factors were fighting corruption and rent-seeking during and after biddings (political), improving public perception of privatization of football clubs (sociocultural), increasing revenues from ticket sales (economic), transparency in laws regarding football club privatization (legal), and the changing structure and role of the government from exclusive ownership to oversight (structural).

Conclusions: Given the results of this research, the most important requirements for privatization of IPL football clubs include offering television broadcast rights, advertisement rights, and ticket sale rights to the clubs, and these and other factors discussed earlier are likely to accelerate privatization of football clubs.

Keywords: privatization, football clubs, requirements, coaches.

Introduction
One of the main challenges of governments is finding optimal ways of handling economic affairs. A major concern, especially in less developed countries, is the large size of the government and the extent to which it interferes in unnecessary activities. In most cases, this leads to higher costs, establishment of parallel institutions, and poor management, thus limiting economic activities by the people, reducing efficiency and productivity significantly, and disrupting the economic balance of the country [20]. Privatization is one of the most effective solutions commonly proposed by politicians and economics. Privatization of businesses in Iran was approved and initiated in 1991 based on the principles of the Iranian Constitution and the First Economic, Social, and Cultural Development Plan [27].

This process continued during the Second and Third Development Plans and was intensified during the Fourth Development Plan. In the sports sector, especially in football, there was a long-lasting assumption that clubs must be directly administered or indirectly supported by the public sector. However, the result was the failure of the government to run the costly business of sport clubs and provide quality services under a public economic system. Thus, the potential for the private sector purchasing and running clubs increased.

According to existing laws, government institutions must privatize the management of sport clubs, venues, and equipment [2]. Moreover, Iran’s poor sports infrastructure and lack of funds cannot respond to the growing needs of the society, further highlighting the importance of participation and investment by the private sector in sports development. Statistics show that despite the shortcoming of the government in developing sports infrastructure, the private sector has a low share in the ownership of indoor and outdoor sports facilities, amounting to 19.36% and 9.07% respectively [18]. Despite the propensity of the private sector to build sports facilities and develop sports infrastructure, it has been unable to invest in these areas for a variety of reasons, including high costs, insufficient support by the government, and lack of incentives and security for private-sector investment [1].

Data from other countries suggest a significant increase in private-sector participation in administering sports clubs and developing sports facilities. From 1995 to 2003, $4.70 billion was spent on building 24 new major arenas in the U.S. and Canada, of which only 39% was contributed from public sources. In a little over a decade, arena financing moved from being almost exclusively publicly subsidized to being primarily financed by franchise owners. The average cost of arenas in this most recent era was over $222 million. Thus, 39% of the average cost is $86 million, which in real dollar terms exceeds the contribution government was making in the early 1969–1984 eras when it was paying 100% of the cost [5].

The volume of private sector participation indicates accurate and strategic planning by governments and their success in sports industry privatization. However, certain requirements must be considered and met in moving from government monopoly to privatization. Various studies have examined the strengths, weaknesses, opportunities, and threats in privatization of sports clubs, especially regarding football. Some studies have identified government support and legal power to develop sports clubs [19] and successful attraction of private investors [21] as the strengths of private sector participation, while some others have noted lack of government support and incentives [22] and the high cost of using private sports complexes [15] as the weaknesses of privatization of sports industry. High risk of investing in the sports sector [15], economic instability [25] are shown to be some of the major threats for private-sector participation and sports development.
development. On the other hand, major opportunities include the potential for private-sector investment [21], political stability [22], and the increasing popularity of sports [14].

In one study of privatization in Iran, Korchian (2008) showed that privatization through competitive bidding is the best way of privatizing the sports industry and argued that this process is affected by a variety of institutional and organizational, socioeconomic, legal, and political factors [14]. Therefore, privatization in Iran is likely to expand only if there are no political barriers to its implementation and if it is in the economic interest of the government and profitable for investors. Some studies have also identified various environmental imperatives of privatization of the sports industry.

There is obviously a need to extensive research on privatization of sports as it is one of the hottest topics in Iran’s academia. Most studies carried out so far have focused on the sports industry as a whole, and to our knowledge there is no research on requirements for privatization of Iran Pro League football clubs. Therefore, the present research aims to describe the current condition of privatization of football teams, identify the factors that affect this process, and discuss the possible outcomes of privatizing the most popular sport in Iran.

The information includes the results of studies conducted in some other countries as well, since sports industry in these countries has undergone privatization and their experience will provide valuable insights and guidelines for research stakeholders. The results are expected to solve some of the problems the country faces in privatizing sports, especially football clubs.

Material and methods
Participants. The population consisted of the executives of the Ministry of Sports, managers and coaches of football clubs in Iran Pro League (IPL), and sports management experts. 56 individuals were selected from the population using purposive sampling and completed the questionnaire.

Research Design. A questionnaire was developed in two parts:
1. Demographic data (i.e. age, education, job, sporting experience, sport management experience)
2. Privatization Scale.

To construct the scale, first the relevant theories were studied and the literature was reviewed to extract key issues pertaining to requirements for privatization. Then, interviews were held with experts in the field of sports management with administrative experience, officials from Iran’s Privatization Organization, and members of Commission 44 of the Parliament. The questionnaire was then developed based on the views of experts about the requirements for privatization and was completed by the participants.

Statistical Analysis. Descriptive statistics were used for data analysis and the mean and standard deviation of the data were recorded. Moreover, the homogeneity and normal distribution of the data were examined using Levene’s test and Kolmogorov-Smirnov test. The results showed that despite their homogeneity of variance (p = 0.072), the data were not normally distributed (p = 0.01). Therefore, non-parametric tests were used for data analysis.

Binomial test was used to examine questionnaire items and identify the requirements for privatization of IPL football clubs. The items were rated on a 5-point Likert scale, with the rating of 3 being the threshold. That is, items with ratings equal or greater than 3 were the requirements for privatization in IPL. The analytical hierarchy process (AHP) was used to rank the requirements and Kruskal–Wallis one-way analysis of variance was used to examine differences between respondent groups. All the statistical analyses were performed in SPSS 22 at the 0.05 significance level.

Results

Table 1 provides the demographic data of the respondents (i.e. age, education, job, sporting experience, sport management experience).

The results of binomial test of privatization requirements showed that the observed p-value was greater than the expected p-value for three of the four factors and that these items were significant requirements for privatization in IPL:
- Changing structure and role of the government from exclusive ownership to oversight without any interference in club affairs
- Supporting private companies that volunteer to purchase IPL football clubs
- Reforming the structure of volunteer companies

The results showed that ‘establishing intermediaries between companies and the Ministry of Sports’ was not a significant requirement for privatization in IPL, as the observed p-value was less than the expected p-value (Table 2).

In terms of legal factors, the results of binomial test indicated that the observed p-value was greater than the expected p-value for three of the four factors and these items were significant requirements for privatization in IPL:
- Transparency of laws pertaining to privatization of football clubs
- Economic liberalization, including adoption of competitive economy and pricing reform
- Adequate legal support for investors

However, ‘new legislation and reform of existing laws pertaining to club ownership’ had a p-value less than the expected value and thus the null hypothesis was accepted (Table 2).

The results of binomial test showed that the observed p-value was greater than the expected p-value for three of the four economic factors and that these items were significant privatization requirements:
- Increasing club revenues from ticket sales
- Increasing revenues from television broadcast rights
- Increasing stability and security for the private sector
However, the results showed that ‘empowering the private sector’ was not a significant privatization requirement and the null hypothesis was accepted (Table 2).

As for sociocultural factors, the results of binomial test indicated that the observed p-value was greater than the expected p-value for two of the four factors and that these items were significant privatization requirements:

- Improving public perception of privatization of football clubs
- Promoting the culture of supporting football clubs by purchasing tickets and club promotional items.

However, for two sociocultural factors, i.e. ‘promoting the purchase of football club shares’ and ‘promoting the culture of profitability and competition in IPL’, the observed p-value was less than the expected p-value and thus these factors were not significant privatization requirements (Table 2).

The results of binomial test showed that for two of the five political factors the observed p-value was higher than the expected p-value and that these items were significant privatization requirements:

- Fighting corruption and rent-seeking during and after IPL biddings
- Serious attempts by the government and the parliament to develop and optimize sports infrastructure.

However, for the rest of the political factors, i.e. ‘separating decision-making and decision-taking institutions’, ‘protecting the property rights of companies or individuals that win the bids’, and ‘creating a platform and a system that encourages the establishment of new football clubs’, the observed p-value was less than the expected p-value and the null hypothesis was accepted (Table 2).

The results of Friedman test showed that some items are more important than the others (Table 3).

The results of Kruskal-Wallis one-way ANOVA showed that the mean ranks of privatization requirements are not equal and that some requirements are more important than the others. Therefore, Friedman test was used to rank these factors.

Based on the results of Friedman, the most important privatization requirements were the following: increasing club revenues from ticket sales, increasing revenues from television broadcast rights, and promoting the culture of supporting football clubs by purchasing tickets and promotional items. ‘Fighting corruption and rent-seeking during and after IPL biddings’, ‘transparency of laws pertaining to privatization of football clubs’, and ‘serious attempts by the government and the parliament to develop and optimize sports infrastructure’ were other major privatization requirements. However, factors such as ‘creating a platform and a system that encourages the establishment of new football clubs’, ‘protecting the property rights of companies or individuals that win the bids’, and ‘separating decision-making and decision-taking institutions’ were the least important factors.

<table>
<thead>
<tr>
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<th>Percentage</th>
<th>Cumulative Percentage</th>
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N = 56
Discussion
The purpose of this research was to identify and rank the requirements for privatization of football clubs in Iran Pro League (IPL). A questionnaire was developed with a variety of political, sociocultural, economic, legal, and structural items and was distributed among a sample of coaches, executives (senior executives from the Ministry of Youth Affairs and Sports and the Privatization Organization), and faculty members (public and private universities).

The results showed that among political requirements for privatization, ‘fighting corruption and rent-seeking during and after IPL biddings’ and ‘serious attempts by the government and the parliament to develop and optimize sports infrastructure’ were the most important factors, while ‘creating a platform and a system that encourages the establishment of new football clubs’ was the least important factor.
the establishment of new football clubs’, ‘protecting the property rights of companies or individuals that win the bids’, and ‘separating decision-making and decision-taking institutions’ were less important.

Among sociocultural factors, ‘improving public perception of privatization of football clubs’ and ‘promoting the culture of supporting football clubs by purchasing tickets and promotional items’ were more important than ‘promoting the purchase of football club shares’ and ‘promoting the culture of profitability and competition in IPL’. Among economic factors, ‘increasing club revenues from ticket sales’, ‘increasing revenues from television broadcast rights’, ‘increasing stability and security for the private sector in the business environment’ were more important than ‘empowering the private sector’. Among legal factors, ‘transparency of laws pertaining to privatization of football clubs’, ‘economic liberalization, including adoption of competitive economy and pricing reform’, and ‘adequate legal support for investors’ were more important than ‘new legislation and reform of existing laws pertaining to club ownership’.

Finally, among structural factors, ‘changing structure and role of the government from exclusive ownership to oversight without any interference in club affairs’, ‘supporting private companies that volunteer to purchase IPL football clubs’, ‘reforming the structure of volunteer companies’ were more important than ‘establishing intermediaries between companies and the Ministry of Sports’.

In ranking the privatization requirements by importance, ‘increasing club revenues from ticket sales’, ‘increasing revenues from television broadcast rights’, and ‘promoting the culture of supporting football clubs by purchasing tickets and promotional items’ were at the most important factors overall. This finding is consistent with the results of Rezayi et al. (2015) and Gharekhani et al. (2011). Rezayi et al. (2015) identified the interaction between people and television and purchase of promotional sports items as key factors in commercialization and ultimately privatization of football clubs [23, 10, 22]. Gharekhani et al. (2011) examined the most important economic barriers to privatization of football clubs in Iran and found that low ticket sale revenue and lack of payments for television broadcast rights and virtual advertising were major barriers to privatization [10].

Moreover, the results showed that ‘fighting corruption and rent-seeking during and after IPL biddings’, ‘transparency of laws pertaining to privatization of football clubs’, and ‘serious attempts by the government and the parliament to develop and optimize sports infrastructure’ were major privatization requirements. This is also consistent with past research findings. For instance, Sameti (2010) conducted a case study for reducing the economic activities of Iranian government and found

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Mean Rank</th>
<th>Rank</th>
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<td>3.59</td>
<td>8</td>
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<tr>
<td>Supporting private companies that volunteer to purchase IPL football clubs</td>
<td>4.08</td>
<td>7.88</td>
<td>7</td>
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<tr>
<td>Reforming the structure of volunteer companies</td>
<td>3.25</td>
<td>6.06</td>
<td>13</td>
</tr>
<tr>
<td>Establishing intermediaries between companies and the Ministry of Sports</td>
<td>2.93</td>
<td>5.36</td>
<td>14</td>
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<tr>
<td>Transparency of laws pertaining to privatization of football clubs</td>
<td>4.38</td>
<td>8.66</td>
<td>5</td>
</tr>
<tr>
<td>New legislation and reform of existing laws pertaining to club ownership</td>
<td>2.83</td>
<td>5.12</td>
<td>15</td>
</tr>
<tr>
<td>Economic liberalization, including adoption of competitive economy and pricing reform</td>
<td>3.51</td>
<td>6.13</td>
<td>12</td>
</tr>
<tr>
<td>Adequate legal support for investors</td>
<td>3.75</td>
<td>7.24</td>
<td>11</td>
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<tr>
<td>Empowering the private sector</td>
<td>2.73</td>
<td>4.88</td>
<td>16</td>
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<tr>
<td>Increasing club revenues from ticket sales</td>
<td>4.72</td>
<td>9.67</td>
<td>1</td>
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<td>Increasing revenues from television broadcast rights</td>
<td>4.69</td>
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<td>Increasing stability and security for the private sector in the business environment</td>
<td>3.83</td>
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<td>Improving public perception of privatization of football clubs</td>
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<td>Promoting the purchase of football club shares</td>
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<td>Promoting the culture of profitability and competition in IPL</td>
<td>2.39</td>
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<tr>
<td>Promoting the culture of supporting football clubs by purchasing tickets and promotional items</td>
<td>4.46</td>
<td>9.52</td>
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<tr>
<td>Separating decision-making and decision-taking institutions</td>
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<td>4.22</td>
<td>19</td>
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<tr>
<td>Protecting the property rights of companies or individuals that win the bids</td>
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<td>20</td>
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<td>Fighting corruption and rent-seeking during and after IPL biddings</td>
<td>4.41</td>
<td>8.69</td>
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<td>Serious attempts by the government and the parliament to develop and optimize sports infrastructure</td>
<td>4.14</td>
<td>8.23</td>
<td>6</td>
</tr>
<tr>
<td>Creating a platform and a system that encourages the establishment of new football clubs</td>
<td>1.74</td>
<td>4.06</td>
<td>21</td>
</tr>
</tbody>
</table>

Table 4. The results of Freidman test for ranking privatization requirements by their importance
that the sociocultural and political characteristics of any economy affect the speed of transition from public to private sector, and that the process of privatization has been very quick in societies with a history of democracy and with a proper legal foundation [24]. That is because in developed economies with effective legal systems, the responsibilities of agents are well-defined and all the legal aspects of transition are clear [24].

Korchian (2008) argued that there is the legal basis for privatization in Iran, but laws are excessively complex and are not properly implemented, which affect the transfer of capital from public to private sector [14]. Repeated reform in tax laws were also considered a major factor causing uncertainty in private-sector investment. Marduki (2006) showed that corruption and rent-seeking discourage investment in the private sector and contribute to uncertainty in the business environment [17]. Unless there is a serious drive for fighting corruption and rent-seeking in the government, the private sector will not be able to compete with the public sector and will head toward negative returns, thus deterring private companies from participating in the transfer from the public sector to the private sector.

Supporting private companies that volunteer to purchase IPL football clubs’, ‘changing structure and role of the government from exclusive ownership to oversight without any interference in club affairs’, and ‘improving public perception of privatization of football clubs’ were next in the ranking and important privatization requirements. This is also consistent with the results of past research. One of the primary principles for transferring the administration of certain public organizations to the private sector is to hand them over to powerful organizations to prevent the failure of privatization in early stages.

Iran’s Privatization Organization must support and incentivize private companies to purchase and run public companies and some government organizations (Bagherzadeh, 2002). Principle 44 of the Constitution requires a change in the role of the government from leadership to supervision over national economy and investment in the private sector (Abbasi, 2006). These requirements were highlighted in the present research in the context of privatizing football clubs. It has previously been documented that one of the main reasons for the departure of investors from Iran is opposition to capitalism by the government and a portion of the population.

As a result, incentives for private investment were suppressed by the fear of and frustration with social rejection. Public perception of privatization has been a significant disincentive for the private sector. Therefore, public attitude toward privatization must be improved and the culture of transferring power from the government to the private sector must be promoted in order to facilitate the process of privatization [2]. In this research, improving public perception of privatization of football clubs was identified as one of the key privatization requirements.

Overall, the results of the present research were consistent with past research on privatization requirements. In this research, increasing club revenues from ticket sales, increasing revenues from television broadcast rights, and promoting the culture of supporting football clubs by purchasing tickets and promotional items were found to be the most important requirements for privatization of football clubs in IPL. This was in line with the results of similar studies conducted in Iran. However, unlike previous studies, these factors were approved by sports management experts, Parliament members, Privatization Organization officials, and IPL managers and coaches, which add to the credibility of the findings. The results of this study can provide a crucial guideline for privatization of IPL clubs.

Conclusion

Based on the present findings, it can be argued that privatization of football clubs can be facilitated by giving television broadcast rights, advertisement revenues, and ticket sale revenues to the clubs, all of which are currently controlled by the government. These and other factors discussed in this research can accelerate the transfer of sports clubs from the public sector to the private sector.

Conflict of interests

The authors declare that there is no conflict of interests.

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13. Khahiri M. Comparison of IPL football clubs to EUFA standards and selected football clubs from Japan, South


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Means of optimal body mass control and obesity prophylaxis among students

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2Siberian State Aerospace University, Russia
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Abstract

Purpose: approaches to control over limits of students body mass range and obesity prophylaxis through their physical condition improvement are offered.

Material: in the research 100 boy students, divided into 2 equal groups (experimental and control) participated. Their age was – 19-20 years. In the research we used methodic of control over maximal admissible body mass. Strength was registered by quantity of chin ups. Endurance was assessed by time of 3000 meters’ distance run. Quickness was assessed by time of 100 meters’ distance run. Besides, we considered the quantity of missed physical culture lessons.

Results: it was found that for successful body weigh reduction students have to significantly increase everyday motor functioning. It was also found that insignificant quantity of missed physical culture lessons can not noticeably influence on students physical condition. At the end of the researches tests showed some increment of strength and quickness and confident increase of endurance in experimental group students.

Conclusions: implementation of compulsory body mass control methodic in students physical education will facilitated overcoming global threats for youth’s health: obesity and immobile way of life.

Keywords: health, motor functioning, students, body mass, obesity prophylaxis, physical culture.

Introduction

At present time significant progressing of young people’s obesity is registered throughout the world. It results from deficit of modern youth’s everyday physical activity. Immobile way of life and obesity growth in different age groups is rather serious problem in many developed countries [16]. Reduction of such negative tendency requires intensive efforts of medical workers, pedagogues and specialists in physical education [3].

Researches show that modern young people spend most of their time with computer instead of gyms [30, 32, 49]. Durable sitting at computer results in obesity and diseases of muscular skeletal apparatus [33, 49]. In modern health protection system there are two equal aims: increase of population’s physical activity and reduction of time, spent at computer [13].

For medical workers the fact that physical functioning is effective, accessible and cheap mean of fighting different diseases has become evident long ago. Risk of diseases can be easily prevented by physical exercises’ practicing [5, 24]. Warburton D. [51] points at direct linear connection between motor functioning and human physical health. Blair S. found significant reduction of cardio-vascular diseases, brain attacks, and cancer of colon risk as well as prolongation of life span. All these are facilitated by different motor functioning forms, including cardio-respiratory fitness practicing [6]. Review of scientific works shows that scientists agree in determination of physical activity’s leading role in health protection and improvement in all population strata [24, 27, 31]. However, it is necessary to admit that in modern scientific medium there are different views on ways of motor functioning intensification among students.

Some scientists offer to fight with students’ excessive weight by means of special diets in students’ eating in combination with physical culture and sports practicing [2]. In the opinion of L. Pescatello, reasonable combination of physical functioning and diets in students’ everyday life will give more positive results, comparing with bare diets and uncontrolled sports practicing [42]. Grygiel-Górniai B. confirms that usual eating and physical activity influence health of modern young people [19]. Unfortunately only professional diet specialists can select correct rational eating for great number of young people. Their consultations are rather expensive for most of students. Staff structure of educational establishments does not stipulate such specialists. That is why it is very difficult for young people to organize correct balanced eating. Scientists note young people’s uncontrolled and independent usage of different methodic for body mass reduction (diets, fasting, application of different medications), which are, sometimes, very dangerous for organism. In the opinion of B. Abalkhai, educational programs for youth shall contain information about correct and healthy eating, optimal body mass and dimensions, use of everyday physical activity, prophylaxis of clinical obesity [1]. In other works need in urgent use of educational preventive measures on formation of young...
people’s health culture and handsome body is noted [8, 45].

Specialists know that negative after effects of immobility can be removed by highly intensive trainings [28]. In the opinion of Bogdanis G., for this purpose, additional researches for finding optimal parameters of long, highly intensive trainings are required [9]. The author notes that it is necessary to more attentively regard the problems of such trainings safety. It will permit to exclude over-fatigue for different age groups of population and for students. In other studies it was shown that intensive physical loads strengthen students’ health and facilitate their academic progress [17, 34, 46]. In application of such trainings it should be remembered that there is deficit of operative, reliable and informative methodic for control and assessment of loads intensity at physical culture lessons [7, 25].

Scientific researches show that physical health and functional fitness of most of students are not optimal for this category of population [38, 39, 47]. Specialists attract attention to wide opportunities for health improvement of this age and social group. Plotnikoff R. points that students are ideal targets for intervention of healthy life style values. The author thinks that most of time students are embraced by observation of different profiles medical workers; they have opportunity to use material base of health related resources (stadiums, swimming pools, simulators’ halls); they are admitted to wide theoretical knowledge about health and ways of its strengthening [43]. It is even possible to create certain health medium on territory of educational establishments [36]. In L. Korn’s opinion for students’ health strengthening educational establishments shall use the following: accessible and healthy eating in canteens; practice great number of sport mass measures; apply effective screening systems. Besides, physical culture lessons shall be compulsory for young people to receive bachelor’s degree [26]. King K. notes that when creating programs for increasing students’ physical activity it is necessary to obligatory consider existing in students campuses conditions for sports and physical culture practicing [23]. The author thinks that one of serious problems in increasing students’ physical activity is difficulty of objective comparison of different researches’ results. Different specialists use in their works rather subjective indicators of young people’s physical activity. In other work it is noted that fitness coaches and medical workers have different points of view on healthy life style values’ implementation among students [12]. Substantial contradiction was found between declaration of constant affirmations about young people’s healthy life style and absence of specially developed programs for physical culture classes. Kudryavtsev M. thinks that such programs shall be based on application of modern means of students’ physical health improvement [29]. Such means can include cardio-power training, different martial arts, and fitness aerobic and so on. In other works successfullness of fitness training programs’ application in students’ physical education is proved [35, 40]. Some works show that students’ physical activity programs shall be built on the base of power trainings [20, 21, 50]. However there are significant contradictions in scientific medium concerning this idea. In L. Judge’s opinion, construction of programs for students’ physical activity shall be on the base of aerobic exercises [22]. The author affirms that easy admittance to sport facilities is an important step for higher fitness indicators of students. It should be admitted that admittance to sport facilities and their condition are not at proper level. It should be also noted that there are only a few programs on students’ physical activity propaganda and their effectiveness is insufficient. Foreign scientists also note rather modest effect of physical activity and sports propaganda among young people [4]. Daskapan A. notes that many young people have psychological, social and personal barriers, preventing from regular physical exercises’ practicing [14].

In our research we did not use methodic of students’ body mass index (BMI) determination. It is connected with the fact that such methodic are rather subjective in assessment of optimal body mass and requires serious additional tests [10, 15, 41, 44].

Analysis of literature data shows that there are many points of view on solution of problem of students’ physical health worsening. Such researches are often inconsistent and contradictory. That is why it is offered to concentrate efforts on solution of immobile way of life problem among young people and obesity prophylaxis.

Hypothesis: the author assumed that solution of problem of young people’s excessive weight and obesity would be facilitated by including one more criterion in list of compulsory physical culture control tests: range of optimal body mass of students. The author thinks that control over limits of students’ weight categories will permit to substantially increase everyday motor functioning of young people and their physical health. Application of this methodic contains an element of scientific novelty: analysis of scientific literature did not show any works, devote to control over weight categories’ limits in students.

The purpose of the research: is to improve students’ physical condition and health; prophylaxis of obesity emersion and progressing in students at the cost of control over weight range limits of students’ body mass.

Material and methods

Participants: in the research 100 boy students, divided into 2 equal groups (experimental and control) participated. Their age was – 19-20 years. Selection of the participants was conducted, considering their body mass indicators. Weight range of all tested students was 78.4 – 84.5 kg. Mean body mass of the tested was 82.3 kg. All students – participants in the research gave their consent for participation in experiment.

Organization of the research: the researches took one academic year. For achievement of the set target experimental group students were offered to control body mass range during all experiment alongside with regular attendance of physical culture lessons. Maximal deviation
from actual body mass was admitted in the range from 1 to 1.3 kg. Control group students were not limited in control over their body mass. For them main condition was regular attendance of physical culture lessons. Before experiment at physical culture lessons all students were trained by traditional program. This program envisaged principles of main sport games’ techniques (basketball, volleyball, football) and general physical training [48]. All students were offered to attend trainings by corrected physical education program during experiment. Specialists recommend to significantly intensifying young people’s motor activity at the cost of aerobic physical exercises [4, 13, 16, 35]. Training program for the tested included: principles of hiking tourism and sport orientation; skiing; health related run; physical exercises for training main physical qualities. The main idea of the used exercises was increasing of movements’ quantity of the tested.

In the course of experiment all students passed a number of tests for general physical fitness, which permitted to rather objectively assess their physical condition. Strength level was assessed by quantity of chin ups; endurance – by time of 3000 meters’ distance run. Quickness was estimated by time of 100 meters’ distance run. Besides, we considered total quantity of missed physical culture lessons.

Statistical analysis: was carried out with the help of SPSS20 program. Student’s t-criterion was used for checking of mean values of two interconnected samples.

Results
Before experiment body mass indicators of experimental and control groups students were not confidently different. Weight range of control group students was 78.6 – 84.5 kg. Mean body mass was 82.2 kg. Weight range of experimental group students was 78.4 – 84.3 kg, with mean body mass value – 82.4 kg. At the end of experiment weight indicators of experimental and control groups students were confidently different. In control group body weight confidently (p<0.05) increased (in average from 82.2 to 85.7 kg). Weight range of control group students was 82.4 – 88.6 kg. In experimental group, mean body mass value insignificantly reduced, comparing with the beginning of experiment (from 82.4 to 81.1 kg). Weight range of these students was 77.5 – 82.2 kg. It should be noted that 7 students from experimental group exceeded admissible maximal-minimal deviations from body mass (5 persons exceeded maximum and 2 – significantly reduced body mass). These students were excluded from further participation in the researches. But it did not influence significantly on results of the researches as far as quantity of the tested was rather big.

Results of control tests at the beginning of the researches sowed no confident prevalence of any physical quality in different groups. Students of experimental and control groups demonstrated approximately equal, rather moderate physical potential. At the end of the researches experimental group students confidently (p<0.05) increased their endurance and insignificantly increased strength and quickness. In control group we found confident (p<0.05) reduction of quickness and endurance and insignificant reduction of strength indicators. These results are given in table 1.

Discussion
From results of our research it is evident that most students’ everyday physical functioning and eating are not sufficient for maintaining optimal body mass. Control group students demonstrated significant (in average by 3.5 kg) body mass increase during academic year. With it these students attended physical culture lessons regularly. The program of these lessons contained prevailing quantity of aerobic exercises. Many specialists recommend such exercises for prevention from immobility and obesity in young people [22, 35, 40, 42]. The quantity of missed lessons in average was составляет 3±3 lessons in two semesters. Total quantity of physical culture lessons in

Table 1. Results of students’ body mass studies

<table>
<thead>
<tr>
<th>Physical qualities</th>
<th>Before experiment</th>
<th>After experiment</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Control group</td>
<td>Experimental group</td>
</tr>
<tr>
<td></td>
<td>Experimental group</td>
<td></td>
</tr>
<tr>
<td>Strength (chin ups, quantity)</td>
<td>10±4</td>
<td>9±4</td>
</tr>
<tr>
<td>Quickness (100 meters’ run, sec.)</td>
<td>13±0.8</td>
<td>14±0.2</td>
</tr>
<tr>
<td>Endurance (3000 meters’ run, min.)</td>
<td>13.26</td>
<td>13.41</td>
</tr>
<tr>
<td>Body mass, kg</td>
<td>82.2</td>
<td>82.4</td>
</tr>
<tr>
<td>Missed lessons</td>
<td>-</td>
<td>3±3</td>
</tr>
</tbody>
</table>
| Notes: * - p<0.05 – significance level.
academic year is 36. Such quantity of missed lessons can not influence significantly on students’ general physical fitness. Therefore for obesity prophylaxis in modern students only physical culture lessons are quite insufficient. Additional, regular and durable physical exercises’ practicing in free time is required. Insufficient physical functioning negatively influenced these students’ physical condition. At the end of the research we found in them certain weakening of strength and significant reduction of quickness and endurance.

Most of experimental group students succeeded in keeping the set body mass parameters: only 7 persons (from n=50) exceeded the recommended maximal-minimal limits of weight range (their own weight, which was at the beginning of experiment, by ±1.3 kg). For achievement of proper results students had to significantly intensify their everyday motor functioning. Students noted that besides academic physical culture lessons the started to attend additional trainings in sport clubs and circles (in average 2 additional trainings a week) and increased the scope of their everyday motor functioning (morning exercises, morning and evening runs, walking and etc.). Increase of motor functioning significantly influenced on students’ physical fitness level. At the end of the research control tests showed certain increment in strength and quickness and confident increase of endurance in experimental group. Correctness of such approach is proved also in other works [44, 47].

Experimental group students noted that they had to significantly expand their knowledge about healthy eating dietology and weight correction. All students mentioned that they regularly read scientific literature on such topics and tried to correct their everyday eating basing on acquired information. Students also noted that their usual eating regime and food significantly changed. The students changed the quantity and time of eating, increasing the quantity of eating periods (up to 5-6 a day). The students reduced calorific capacity and the volume of taken food. They started to drink 1.5-3 liters of purified water everyday, use vitamin complexes. Fulfillment of this condition students had to significantly increase motor functioning intensification. In our research it was determined that for successful implementation of compulsory control over body mass limits of weight range (their own weight, which was at the beginning of experiment, by ±1.3 kg). For achievement of proper results students had to significantly intensify their everyday motor functioning. Students noted that besides academic physical culture lessons the started to attend additional trainings in sport clubs and circles (in average 2 additional trainings a week) and increased the scope of their everyday motor functioning (morning exercises, morning and evening runs, walking and etc.). Increase of motor functioning significantly influenced on students’ physical fitness level. At the end of the research control tests showed certain increment in strength and quickness and confident increase of endurance in experimental group. Correctness of such approach is proved also in other works [44, 47].

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Prognostication of successfulness in arm-wrestling on the base of morphological functional indicators’ analysis

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Abstract
Purpose: to work out methodic of arm wrestling successfulness prognostication by morphological functional indicators and substantiate it.
Material: 189 sportmen (of age 21.62 ± 0.85 years) were tested. We fulfilled goniometric testing of arms’ joints (n=27) and hand dynamometry (n=50). Characteristics of physiological tremor were studied (n=29). Strength of forearm’s muscles was determined (n=33) as well as the strength of hand fingers’ extensors separately (n=50). Prognostication was realized with the help of sequential procedure by Wald’s methodic, with calculation of prognostic coefficients and their informative potential.
Results: prognostic table, containing functional state indicators of arm-wrestlers. It contained 18 criteria. The criteria illustrate power, goniometric and functional indicators. Informative potential varied within 64.70 – 6.33. The sense of prognosis is assessment of results and determination of appropriate prognostic coefficient. Besides, prognosis implies summing up of these coefficients for achievement of one of prognostic thresholds. The value of these thresholds was determined at level of ± 13, that corresponds to 95% (p<0.05) probability. Achievement of threshold + 13 and more means sportman’s successfulness higher level. In case of lower threshold achievement successfulness probability is low.
Conclusions: the conducted researches permitted to work out methodic of arm wrestling successfulness prognostication by morphological functional indicators and substantiate it. The offered methodic is based on sequential analysis by Wald and is a simple, informative and objective tool of arm-wrestlers’ condition control.
Keywords: arm-wrestling, morphological functional, indicators, prognosis.

Introduction
The problem of sportsmen’s successfulness prognostic is one of central in sports. The study of sportmanship levels, determination of correlations between them permit to optimize selection of promising sportmen and prognosticate their competition functioning.

The basis of prognosis includes different indicators, characterizing sportmen’s condition. For example, Baláš J. et al. [23] found that arms’ strength and endurance are the most informative indicators for prognostication of mountaineers’ successfulness. Dummer G.M. et al. proved prognostic significance of arms’ strength for successfulness in swimming [25]. Analogous studies were fulfilled in golf [39]. Klimczyk M. et al. studied correlations between efficiency and physical parameters of pole vaulting jumpers [33]. The authors proved possibility of prognosis with the help of determination of correlations between the studied indicators.

Aksutin V.V., Korobeynikov GV. offered to study special workability and psycho-physiological state for prognostication elite boxers’ successfulness [21]. Brezhliev A.M. et al. offered to predict volleyball players’ game fitness on the base of information about their competition functioning. It permitted to receive information about weak and strong sides of training and correct the training process [2]. This approach is based on assessment of volleyball players’ technical efficiency in games. The authors proved purposefulness of Kohonen nets’ application, which shall be adjusted by results of two previous games and predicted estimation of next game.

Latyshev S.V. regarded prognostication in free style wrestling [8]. The author notes that prognostication of wrestler’s successfulness is possible only by comparing his results with appropriate model characteristics at every training stage [8]. Formation of model pictures shall be realized in several directions. It implies modeling of wrestler’s fitness in certain age stage of selection. With it, informative parameters are: health state, fitness indicators, sport result and its dynamic.

Kudriashova T.I. et al. used analysis of correlations between load indicators in shot put. The authors constructed linear regression model of efficiency prognostication [7]. The data of other research permitted to predict results in 600 meters’ run on the base of the following indicators: physical condition and physical fitness of girls; parameters of cardio-vascular and central nervous system’s functional potentials [15]. Pomazan A.A. used results of anthropometric data correlation analysis and indicators of 4-6 years’ age children’s physical abilities [13]. The author found the most informative indicators for determination of promising for sports children [13].

Yavorskaya T.Ye. predicted efficiency in sports by a number of statistic methodic (regression, vector, matrix, dispersion and factorial analysis, theory of multi-dimensional linear regression in Euclid space) [19]. By the data of other work efficiency prognostication in long and super long distances run shall be fulfilled, basing on aerobic and anaerobic metabolism indicators [6].

In other research mathematical models for
prognostication of 9-16 years’ Judo wrestlers’ successness with accuracy up to 81% were offered [17]. As foundation the authors took anthropometric and psycho-physiological parameters. Shyan V.N. and Shamardin V.N. worked out prognostication technology for badminton players’ achievements [18]. For the worked out analytical models of sportsmen the authors used functional, pedagogic and psycho-physiological criteria. They offered integral criterion, for prospects’ assessment by 9-points’ scale. Zaporozhanov V. et al. proved possibility of metrical calculation method for determination control testing results’ reliability, which are used for diagnostic of psycho-physical suitability and sportsmanship’s prognostication [5]. The authors calculated metrical assessments of measurements’ reliability (stability, concordance and informative potential of control data) for current diagnostic of sport potentials of the tested.

Bobrovnik V.I. worked out system for assessment and prognostication of qualified light athletes’ physical condition. Such approach stipulates complex of pedagogic tests, estimation tables, assessment of functional state of vegetative, nervous and cardio vascular systems as well as external respiratory system [1]. The received results permitted to find criteria of main organism systems’ physical fitness functional state, which influence on high sport results achievement.

Gaskov A.V. et al. determined importance of general and special physical fitness indicators for successness in boxing [26]. The built by them models differed, depending on sportsmen’s training stage. In other researches ways for training optimization on the base of models for sport future prediction are described [24, 28, 29]. In such cases registration of sportsmen’s morphological functional indicators is very important [35]. Popov Th. I. et al. developed prognosis of successness before cadets’ summer training period. The basis of this prognosis was the results of psychological-professional selection, physical and simulators’ training complex analysis [14]. Importance of complex assessment was stressed: as far as any of criteria does not give confident prognosis separately. Golets V.A. et al. substantiated possibilities of many-factorial express-diagnostic application for predicting reaction to physical load [4]. The found correlations between parameters permit to determine the persons of “risk group” and prevent from undesirable after effects of physical training.

Thus, the available data witness about possibility to prognosticate successness in sports on the base of morphological functional data. Such data are informative, accessible, and financially profitable. Mathematical methods, used in statistic, are the tools of prognostication. However, in arm wrestling this problem has not been solved finally. The existing situation conditions demand in working out complex prognostication methodic for arm wrestling successness, based on registration of morphological functional indicators.

The purpose of the present work is to work out methodic of arm wrestling successness prognostication by morphological functional indicators and substantiate it.

Material and methods

Participants: as main material 189 sportsmen (of age 21.62 ± 0.85 years) were tested. We fulfilled goniometric testing of arms’ joints (n=27) and hand dynamometry (n=50). Characteristics of physiological tremor were studied (n=29). Strength of forearm’s muscles was determined (n=33) as well as the strength of hand fingers’ extensors separately (n=50).

Organization of the research: the scheme of the research stipulated division of participants into two groups: experimental group (sportsmen from 1st category to master of sports) and control group (sportsmen of mass categories and students, training for recreation) [9-12, 36]. Prognostication was realized with the help of sequential procedure by Wald’s methodic, with calculation of prognostic coefficients and their informative potential [22]. Mean values of morphological functional indicators were taken as bordering values. Then, probability of less or higher indicators’ values in respect to mean values was determined. After that prognostic coefficients and information potential of the studied attributes were calculated.

In compliance with requirements of the methodic attributes shall be located in table in order of their information potential decreasing. Informational potential less than 5.0 was considered insignificant. Indicators with such or less value were not entered in the table. In case of equal informational potential the order of their location was determined randomly.

Statistical analysis: analysis of the received data was fulfilled with the help of licensed electronic tables Excel and calculation indicators of descriptive statistic [22]. Prognostic coefficients were calculated be the following formula:

\[
PC = 10 \times \log \left( \frac{p(D_1/S)}{p(D_2/S)} \right)
\]

(1),

Where PC is prognostic coefficient, \( p(D_1/S) \) – probability of attribute presence, \( p(D_2/S) \) – probability of attribute absence.

Coefficient 10 is introduced for PC to have the form of a whole number to make prognostic procedure easier.

Informational potential was calculated by the formula of Kulbak:

\[
I = PC - 1/2 \times [p(D_1/S) - p(D_2/S)]
\]

(2),

Where I - is informational potential of attribute. Other legend is the same as in the previous formula.

Results

The worked out prognostic table contains indicators, reflecting sportsmen’s functional state. Considering probabilities of distinctions and informational potential
of the registered indicators the table contains 18 criteria. These criteria illustrate power, goniometric and functional indicators (see table 1). Coefficients are dimensionless values and it permits to compare them and use for sportsmen’s condition prognostication.

The highest quantity of the used attributes (12) is goniometric ones and reflects amplitude of arm joints’ movements. Still 5 criteria illustrate relative strength of forearm’s and fingers’ muscles. 1 attribute characterizes tremor. Introduction of relative strength indices in prognostication procedure was conditioned by sportsmen’s different weight categories. Power indicators directly depend on body mass. That is why application of absolute indicators for prognostication would be incorrect. Informational potential of the indicators varied within the range from 64.70 to 6.33. For five goniometric indicators it was equal (10.46).

The table permits to prognosticate sportsmen’s successfulness on the base of methodic and tests. The prognosis itself implies: assessment of results; determination of appropriate prognostic coefficient; summing up of these coefficients. Such approach permits to reach one of prognostication thresholds. In compliance with commonly accepted approaches thresholds’ value was taken at level ± 13. It corresponds to probability of 95% (p<0.05). Reaching ± 13 (or more) threshold means high successfullness of sportsman. In case of reaching analogous negative threshold successfullness probability would be low and sportsman is not promising. If prognostication procedure resulted in reaching no thresholds, prognosis is considered to be indefinite. In such case additional tests are required for receiving additional information.

The offered methodic is of universal character and can be used at different stages of assessment of sportsman’s functional state. All criteria are well controlled and can change in the process of optimally built training. Thus, the offered methodic can be used for successfullness prognostication at stage of preparation for competitions, for current control and assessment of training loads’ adequacy.

Discussion

In context of present work solution of prognostication task implies choice of one from two available variants: if sportsman’s fitness level is high or insufficient for success. The procedure of prognostication task’s solution shall consider sportsmen’s functional state and graduate the used methodic depending on their informational significance. Advantages of the used methodic (as per Wald) include: possibility of application with different character of attributes’ distribution in the tested groups; absence of demand in indicators’ calculation (error of mean value and mean square deviation); easiness and feasibility.

Selection of adequate and informative indicators is an important pre-condition of prognostication. Parola F., Musso E. note certain problems’ existence in assessment of sportsmen’s competition functioning [34]. They are: finding effective criteria for physical fitness assessment owing to specific aspects of arm wrestling. Voronkov A.V. et al. say that the most important physical qualities in arm wrestling are: speed-power abilities; maximal power; power endurance. Importance of strength and speed for victory in arm wrestling is underlined also in other work [38]. The received by us results prove it: power indicators are characterized by high informational potential.

Table 1. Prognostication of arm wrestlers' successfulness

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Prognostic coefficients</th>
<th>Information potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence</td>
<td>Absence</td>
<td></td>
</tr>
<tr>
<td>Relative strength of right hand’s moving aside more than 18.75%</td>
<td>4</td>
<td>-3</td>
</tr>
<tr>
<td>Bending of right shoulder joint more than 159°</td>
<td>2</td>
<td>-3</td>
</tr>
<tr>
<td>Relative strength of right arm’s pronation more than 36%</td>
<td>2</td>
<td>-1</td>
</tr>
<tr>
<td>Unbending of left elbow joint more than 21°</td>
<td>1</td>
<td>-3</td>
</tr>
<tr>
<td>Relative strength of right hand middle finger more than 36%</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>Bending of left wrist joint more than 66°</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>Moving of left shoulder joint more than 25°</td>
<td>1</td>
<td>-2</td>
</tr>
<tr>
<td>Bending of right wrist joint more than 69°</td>
<td>1</td>
<td>-2</td>
</tr>
<tr>
<td>Bending of left shoulder joint more than 160°</td>
<td>3</td>
<td>-2</td>
</tr>
<tr>
<td>Relative strength of left hand moving aside more than 17.5%</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Time of right arm’s tremor less than 23 seconds</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Right wrist joint’s moving aside more than 42°</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Right elbow joint bending more than 127°</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Right elbow joints unbending more than 21°</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Right shoulder joint moving aside more than 149°</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Left shoulder joint moving aside more than 148°</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Left elbow joint bending more than 129°</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>Relative strength of left hand middle finger more than 36.25%</td>
<td>2</td>
<td>-2</td>
</tr>
</tbody>
</table>
The provided data witness about importance of movements’ amplitude in arms’ joints for prognostication in arm wrestling: most of attributes in tables are goniometric. The correctness of this assumption is proved in other research [27]. Analysis of typical for arm wrestling fracture of shoulder bone showed that this trauma is a result of external forces’ impact: bending torque, axial pressing and twisting. Thus, just these movements shall be regarded as the main in this kind of sports and be studied for prognostication.

As it has already been noted successfulness in arm wrestling depends on complex of criteria and indicators. Such approach was realized when creating selection methods for arm wrestling [16]. The methodic implies determination of special power endurance, hand’s strength, arms’ strength and quickness of reaction. It is very close to criteria used by us. However, with similarity of criteria there is a difference in the applied methods. The first quality is assessed by maximal quantity of hands with bar bell bending (the weight of barbell is half of the weight of the tested). Hand’s strength is assessed traditionally with hand dynamometry, while arm’s’ strength – by time of hanging on bent arms. Quickness of reaction is registered in tapping test. Result is received as total sum of points in compliance with specially worked out scales. On the base of these scales sportsman’s suitability for arm wrestling is assessed. In our opinion substantial disadvantage of this methodic is absence of consideration of parameters’ informational potential.

Optimality of exactly Wald’s methodic for prognostication can be proved by presence of analogous works. In the process of substantiation and creation of model for arm wrestlers’ functional state monitoring we worked out prognostication scale for prospects assessment in this kind of sports [37]. It included physical condition indices (relation of hand dynamometry to body mass; relation of forearm and shoulder arm lengths), biochemical indicators (relation of diene conjugates to the restored glutathione), bio-physical indicators (specific weight of electrically negative cells of buccal epithelium) and physiological indicators (results of “relay race test”). Application of indices permits to pass to relative indicators, i.e. to standardize prognostication procedure. Determination of the mentioned tests permits to assess sportsmen’s prospects in arm wrestling. However, this methodic requires special equipment, chemical agents and tools. It substantially weakens its feasibility and increases the cost of assessment. If to exclude bio-chemical [30-32] and bio-physical tests it will negatively reflect on its informative potential.

Akpinar S. C et al. worked out successfulness prognostication on example of participants of Turkey arm wrestling national championship [20]. The authors used morphological and functional indicators for prognostication. As successfulness predictors they noted arms’ strength, time of hearing reaction, length and circumference of forearm. Such approach and received results also coincide with our data. But these authors did not consider joints’ functional state, strength of separate fingers and forearm muscles. The authors did not use hand’s fine coordination. It substantially weakens prognostication effectiveness.

Thus, analysis of literature data permits to conclude that choice of morphological functional indicators and tools for prognostication was correct.

**Conclusions**

The fulfilled researches permitted to work out scheme of sportsmen’s successfulness prognostication with the help of morphological functional indicators and substantiate it. The offered methodic is based on sequential analysis by Wald and is a simple, informative and objective tool for control over sportsmen’s condition. For determination of indicators to be used simple and accessible equipment is sufficient (pronometer, dynamometer, weights) that permits to speak about feasibility and financial viability of such prognostication method.

**Conflict of interests**

The authors declare that there is no conflict of interests.

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