The journal represents original scientific researches of scientists from the East-European region.
The Journal welcomes articles on different aspects of physical education, sports and health of students which cover scientific researches in the related fields, such as biomechanics, kinesiology, medicine, psychology, sociology, technologies of sports equipment, research in training, selection, physical efficiency, as well as health preservation and other interdisciplinary perspectives.

In general, the editors express hope that the journal “Physical Education of Students” contributes to information exchange to combine efforts of the researchers from the East-European region to solve common problems in health promotion of students, development of physical culture and sports in higher educational institutions.
Key title: Physical education of students

Abbreviated key title: Phys. educ. stud.

ISSN 2308-7250 (English ed. online)

Founders: Iermakov Sergii Sidorovich (Ukraine); (doctor of pedagogical sciences, professor, Department of Physical Education, Kharkov National Pedagogical University).


Address of editorial office:
P.O.Box 11135, Kharkov-68, 61068, Ukraine.
Tel. +38 099 430 69 22
e-mail: sportart@gmail.com

Frequency - 6 numbers in a year.

Journal is ratified Ministry of Education and Science of Ukraine (online):
physical education and sport - № 374, 13.03.2017;

Journal is reflected in databases:

1) Web of Science Core Collection
   [Emerging Sources Citation Index (ESCI)]
   http://ip-science.thomsonreuters.com/mjl

DOAJ (Directory of Open Access Journals)
   http://www.doaj.org

CABI (CAB Direct)
   http://www.cabdirect.org

WorldCat
   http://www.worldcat.org

SHERPA/RoMEO
   http://www.sherpa.ac.uk

Open Science Directory (EBSCO information services)
   http://www.openscience.directory.net

PBN (Polish Scholarly Bibliography)
   https://pbn.nauka.gov.pl/journals/42127

ERIH PLUS (The European Reference Index for the Humanities and the Social Sciences)
   https://dbh.nsd.uib.no

IndexCopernicus
   http://journals.indexcopernicus.com

Russian Science Citation Index
   http://elibrary.ru

Scilit - http://www.scilit.net

Academic Journals Database
   http://journaldatabase.org

ROAD - http://road.issn.org

2) BASE (Bielefeld Academic Search Engine)
   http://www.base-search.net

CORE
   http://core.kmi.open.ac.uk

DIIRJ (Directory Indexing of International Research Journals)
   http://drji.org/

Google Scholar
   http://scholar.google.com.ua

OAJI (Open Academic Journals Index)
   http://oaaji.net/journal-detail.html?number=770

WorldWideScience Alliance
   http://worldwidescience.org

Ulrich’s Periodicals Directory
   http://ulrichsweb.serialssolutions.com/login

V.I.Vernadskiy National Library of Ukraine
   http://www.nbuv.gov.ua

Library of the Russian State University of Physical Culture, Sport and Tourism
   http://lib.sportedu.ru/Press/FVS
Bobrytska V.I., Beseda N.A. Future specialists in physical culture and sports cardiovascular system functional condition evaluation ............................................................................................................................................... 232

Kaya M., Soyal M., Karakuş M. The effect of the leg and back strength of the serve and tennis players to the serve throwing speed and agility ............................................................................................................................................. 237

Lebedinskiy V.Y., Kolypsheva E.A., Kudryavtsev M.D., Sidorov L.K., Zukanov N.N., Doroshenko S. A., Kondratyuk T. A., Alshuvalii H. H. Dynamics of physical fitness changes in preschool children, schoolgirls and female students of Eastern Siberia (Russia) .................................................................................................................. 243

Lotfi Gh., Hatami F., Zivari F. Effect of model’s skill level and frequency of feedback on learning of complex serial aiming task ................................................................................................................................................... 252

Nalbant Ö., Özer K. Evaluation of the relationship between body composition and aerobic fitness in youth soccer players ................................................................................................................................................................ 258

Osipov A.Yu., Kudryavtsev M. D., Kopylov Yu.A., Kuzmin V.A., Panov E.V., Kramida I. E. The possibility of a significant increase in the level of motor activity in students with the use of the potential of computer technology ........................................................................................................................................ 265

Sharifi M., Hamedinia M.R., Hosseini-Kakhak S.A. The effect of an exhaustive aerobic, anaerobic and resistance exercise on serotonin, beta-endorphin and BDNF in students.......................................................................................................................... 272

Yilmaz A., Gurses V.V., Gulsen M. The effect of combined preconditioning strategies on isokinetic strength in well trained kickboxers ........................................................................................................................................... 278

Information: .................................................................................................................................................................................. 285
Future specialists in physical culture and sports cardiovascular system functional condition evaluation

Bobrytska V.I.1ABCD, Beseda N.A.2ABCD

1Department of Social Philosophy, the Philosophy of Education and Educational Policy, National Pedagogic Drahomanov University, Ukraine
2Department of Physical Education, Sport and Human Health, Poltava National Technical Yuri Kondratyuk University, Ukraine

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

Abstract

Purpose: to investigate and evaluate future specialists in physical education and sports cardiovascular system adaptive potential.

Material: 28 first (bachelor) level students aged 17-18, doing their degree in 017 “Physical Culture and Sports” (experimental group of 12 participants) and in 227 “Physical Therapy, Ergotherapy” (experimental group of 16 participants) from Poltava National Technical University specialism took part in the research. All the participants gave their written consent for participating in the research. Students’ cardiovascular adaptive potential was defined according to R. Baevsky methods.

Results: 71.3% of boys and 69.2% of girls showed high level of the body functionality. Adaptive mechanisms tension features revealed 28.4% of female students and 26.6% of male students. Persons with failure of adaptation have not been found.

Conclusions: The measurement of the cardiovascular system adaptive potential enables evaluating the level of students’ physical health condition. Consideration of students’ cardiovascular system adaptive potential indicators contributes to implementation of a differentiated approach to teaching Sports and Pedagogic disciplines. The above increases the quality of the occupational training of the future specialists in Physical Culture and Sports provided that their adaptive capacities are developed.

Keywords: adaptation, adaptive potential, specialists, Physical Culture, Sports, cardiovascular system, physical condition.

Introduction

The reform of the higher education system in Ukraine includes a number of transformations. They are aimed at changing the quality of education at higher education institutions (HEI). Given this educational process organization in contemporary HEI brings students a number of new requirements. Because the previous experience of the usual ways of performing educational activities, acquired by them earlier, becomes inadequate to the changed settings. Specifically, the difference in organization of the educational process in secondary schools and HEI creates a kind of a barrier. It needs to be addressed by the first-year students to actively engage in the new forms of activity. The main purpose is the goal being their professional and personal development along with health maintenance [1, p. 83]. We note the increase in demand for the level of competitiveness, adaptability and mobility of the future specialists with higher education in the modern labour market. This introduces a series of internal emotional contradictions. Consequently, leads to a complex convergence of subjective and objective factors affecting their physical condition, and therefore health. Ago the problem of student youth adaptation to the growing requirements to their professional training in modern HEIs is becoming increasingly important.

Domestic and foreign scientists’ investigations have reveal various aspects of the adaptation capabilities formation. In the publications of H. Bezverkhnia et al. [2] it has been proved that the adaptive potential of a person depends on their somatotype. T. Kutseryb et al. [3] associate the development of adaptation with the specifics of the one’s health. V. Bobrytska [4], investigates the influence of socio-psychological, didactic, professional and physiological aspects of the adaptation of future specialists with higher education on their health condition R. Baevsky [5], N. Bogdanovska [6] and others point out that the level of adaptation is related to the cardiovascular system condition.

First-year Bachelor’s degree students at the higher education are a focus group whose dynamics of health as an indicator of individual’s adaptive. This is because traditional forms of educational process organisation are combined with physical activity. The cycle of professional training of future specialists in Physical Culture and Sports includes a number of sports and pedagogical disciplines. This requires a lot of physical activity for students. It is known that “the effectiveness of exercising physically depends greatly on the degree of physical activity appropriateness to the health condition, physical development, functional abilities, age and individual characteristics of the body of persons engaged in physical culture” [7, p. 19]. In this context, the study of future specialists in Physical Culture and Sports adaptive potential, as compared to the specialists-to-be in the other spheres, is gaining paramount importance.

Physical condition of athletes and persons engaged in physical education is reviewed by are considered...
by many researchers [3, 8, 9]. Some scientists believe physical condition the features complex formedness of addressing the morpho-functional body condition [7, 10]. Some consider it as the ability of functional systems to mobilize the body reserve capacity when performing physical activity [5, 6]. Others are convinced that the is development of body resistance to adverse environmental factors [2].

Some compensation occurs for the impact of static and dynamic forms of training. This expected to contribute to the adaptive potential of the future specialists in Physical Culture and Sports, as compared to specialists in other areas. However, we assume that the inadequate taking into account specific of the physical load on the body of the first-year student may cause a reverse effect. For example, being an increase in the expression of negative physiological reactions of a body.

The intense physical activity can cause physical discomfort and psycho-emotional stress. Lead to disruptions in adaptation, that is, to the occurrence of disadaptational syndrome. This is accompanied by sleep disorders, fatigue, denial to further physical exercises, etc. Ago must be taken into account be paid to personal, age and gender peculiarities of the students when scheming the health and fitness process [7].

Hypothesis

We consider the cardiovascular system adaptive potential as one of the integral indicators of the boys and girls physical condition. Taking into account its indicators will promote the optimal choice of physical education means and methods. This will help to choose of rational motor regimes and the formation of student’s long-standing motivation to self-improvement. We are convinces that this will improve the quality of professional training of the future specialists in Physical Culture and Sports.

The objective of the research is to assess the health condition, including physical condition of the future specialists in Physical Culture and Sports, based on the cardiovascular system adaptive capacity measurement.

Material and Methods

Participants

There were 28 first (bachelor) level students aged 17-18 from Poltava National Technical University. Experimental group included 12 students of specialty 017 “Physical culture and sport”. Control group included 16 students of specialty 227 “Physical Therapy, Ergotherapy”. All participants gave written consent to participate in the study. The study was conducted during the period from September 2017 to March 2018. Both experimental and control groups were formed by the equivalent pairs method. The students of the experimental group (EG) were taught sports and pedagogical disciplines on the basis taking into account the indicators of the students’ cardiovascular system adaptive potential. The students of the control group (CG) were trained according to traditional system.

Research conduction

The cardiovascular system adaptive potential was measured according to R. Baevsky’s [5] method at rest and using limited physical activity load. Calculations were carried out using the following formula:

\[
APB, \text{ a.p.} = 0.011 \times HR + 0.014 \times BP_s + 0.008 \times AT_s + 0.014 \times A + 0.009 \times BW - 0.009 \times BL - 0.273
\] (1),

where APB is adaptive potential of the cardiovascular system of R. Baevsky; \( HR \) - heart rate, beats/min; \( BP_s \) - systolic blood pressure, mm Hg; \( AT_s \) - diastolic arterial pressure, mm Hg; \( BW \) - body weight, kg; \( BL \) - body length, cm; \( A \) - age, years; 0.27; 0.014; 0.011; 0.009; 0.008 – coefficients of the equation of multiple regression.

Evaluation of the results was performed with regard to the levels of adaptive capacity (R. Baevsky’s [5]), namely:

1. Satisfactory adaptation (APB figures were less than 2.1 a.p.).
2. The tension of adaptation mechanisms (from 2.11 to 3.2 a.p.).
3. Poor adaptation capacity (from 3.21 to 4.3 a.p.).
4. Disrupted adaptation (APB figure exceed 4.3 a.p.).

Statistical Analysis. Spearman correlation analysis was applied to reveal the difference between criteria of cardiovascular system adaptive potential of control and experimental students’ groups. Arithmetic mean determination enabled comparing the indicators obtained and estimate adaptive abilities level of researched groups participants in general. The IBM SPSS Statistics Base 20 program was used to analyze the statistics.

Results

While applying the above method, at the empirical stage of the experiment, we identified the students’ traditional parameters of the central hemodynamic. This is heart rate, systolic and diastolic blood pressure. We identified these metrics in the condition of relative restraint, after the dynamic and static loading. Was taken into account well the students length and weight of the body and the actual age. The calculations performed enabled defining the level of research participants’ cardiovascular system adaptive capacity of (Table 1).

Table 1. Average statistical figures and evaluation APB (X±m)

<table>
<thead>
<tr>
<th>Groups</th>
<th>APB (X±m)</th>
<th>Aged 17</th>
<th>Aged 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>1,89±0,03*</td>
<td>1,91±0,03*</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>2,01±0,04**</td>
<td>2,04±0,04**</td>
<td></td>
</tr>
</tbody>
</table>

Comment: APB – adaptive potential of Baevsky’s. The reliability of the difference between group figures: * - p<0,05, ** - p<0,01.

A comparative analysis of results indicates that CGs are characterized by higher values of APB than those for...
EG. Students aged 18 demonstrate higher rates of APB. The percentage-based distribution of participants with different APB grading is highlighted in Fig. 1.

The data in Fig. 1, 70.2 % of EG and 67.4 % of CG showed a high level of body functionality (APB≤2.1). These students are characterized by a high physical working capacity and ability to adapt easily to changing conditions of the external environment. Signs of adaptation mechanisms tension (APB 2.11-3.2) have revealed 21.3 % of people in EG and 20.9 % of CG. The percentage figures for unsatisfactory adaptation (APB 3.21-4.3) of EG and CG makes 8.5 % i 11.7 % respectively. Individuals (APB> 4.3) with disrupted adaptation were not found.

In order to monitor the experiment participant’s health condition in March 2018, the re-measurement of the cardiovascular system adaptive capacity of was performed in the study groups.

The dynamics of the results is presented at Fig. 2.

The indicators of a satisfactory level of adaptation among the EG students increased by 3.6%. The level of adaptation tension of this group increased by 2.8% due to the decrease of the level of unsatisfactory adaptation by 6.4%. Compared to the figures for EG, students of CG had 4.3% fewer people with satisfactory levels of adaptation and 7.3% more people with an unsatisfactory level of adaptation. The obtained results testify to the

optimal level of EG student’s cardiovascular activity. They confirm the expediency of assessing the physical condition of freshmen students. So, you need to take into account into account the results obtained in the process of future specialists in Physical Culture and Sports professional training.

Systolic blood pressure at the end of the experiment did not reveal significant difference according to standard deviation indices. He is122.46 ± 1.12 mm of mercury versus 125.8 ± 1.13 12 mm of mercury, i.e. t = 0.94. At the beginning of the experiment EG people diastolic blood pressure indicators made 76.1 ± 1.4 mm of mercury. At the end of it - 72.3 ± 1.2 mm of mercury, no significant differences in the indicators revealed (t = 0.97).

Apparently, the obtained results testify to the optimal level of the EG students’ cardiovascular activity. These results confirm the expediency of assessing the physical condition of freshmen students. It is advisable to consider this in the process of the future specialists in Physical Education and Sports professional training.

We had a conversation with the students. It has been found that concentration of the student’s attention on their own achievements encourages them to continually improve themselves. Due to this, there is an increase in motivation of the future specialists in Physical Culture and Sports professional growth. The reasoning of this

Fig. 1. Results of measuring the level of adaptive capabilities of the students at the beginning of the experiment, %.
Comment: APB – adaptive potential of Baevsky’s. EG – experimental group. CG – control group.

Fig. 2. The results of measurement of the adaptive capacity level of the future specialists of Physical Education and Sports after the experiment, %.
Comment: APB – adaptive potential of Baevsky’s. EG – experimental group. CG – control group.
idea is grounded in the inferences of V. Bobrytska [4]. The researcher notes “In order to meet their own needs being strategic life goals, the individual tries to work out a multi-purpose poly-motivational program of activity, letting the motives go through the filter of values being social attitude reinforced in the consciousness” [4, p. 127].

We can see, it is much easier for the students of the specialization 017 “Physical Culture and Sports” to mobilize their body adaptive. This is evident from the data for the students obtaining degree in the of 227 “Physical Therapy, Ergotherapy” specialization. This put the emphasis on the appropriateness of the pedagogical design and the scheming of a physical education and fitness process at a higher education institution. The purpose is to improve the level of physical condition and personal health of the students. You will find recommendations below suitable for optimizing the student youth motor activity, namely:
- performing not less than 60 minutes of physical activity every day and 12-15 hours a week;
- performing physical exercises from moderate to high intensity;
- relevance of physical activity to the body functional capabilities;
- aerobic exercises systematic performing (walking, jogging, swimming, cycling, etc.) [17, 18, 19].

Thus, the diversification of motor activity will contribute to achieving the optimal level of physical fitness of the future specialists in Physical Culture and Sports.

Discussion
The conducted research might be regarded as an addition to a number of scientific inferences [2, 7, 16] concerning the study of student youth physical condition. The information on the expediency of measuring the cardiovascular system adaptive capacity as an important indicator of the student’s level of physical condition is completed. It is justified that the level of cardiovascular system adaptive potential depends on the morphological and physiological features of boys and girls. This should be taken into account in the process the future specialists in Physical Education and Sports professional training.

While performing the experiment the data were validated [5, 11]. This showing that the number of people representing both genders with tensions in adaptation mechanisms increases as those people get older. We associate this with a decrease in motor activity and the level of students’ physical condition. In this regard, we recommend diversifying the types of motor activity, as well as intensifying the intensity and duration of physical activity. Due to this we recommend to diversify the physical activities types and increase intensiveness and time of physical exercises.

The obtained results of the study broaden the data about peculiarities of adaptation capabilities development [8, 17, 21]. It is proved that students’ positive motivation to self-improvement significantly mobilizes their functional capabilities. We would like to explain the fact with individuality of functional adaptive system developing. What are important, people with tensed adaptation mechanisms or its unsatisfactory level are able to reveal high functional capabilities under increased activity motivation. Such motivation can include needs and interests stimulating students to mastering necessary knowledge and skills aimed. They will be useful at their own body adaptive resources increase.

Percentage allocation analysis of gradation shows that in the main group there are more students with satisfactory cardiovascular system adaptation (73,8%). This is more than in the control group (69,5%). It proves the idea about influence of systematic physical exercises on improvement of the body adaptive processes.

Conclusions
1. Adaptive potential defining according to R. Baevsky’s enables evaluating the student’s cardiovascular system functional condition. It allows you to use it the results to control the physical loading influence.
2. Consideration of the student’s cardiovascular system adaptive potential indicators contributes to the implementation of a differentiated approach to teaching sports and pedagogical disciplines. It increases the quality of the future specialists in Physical Culture and Sports professional training in terms of developing their adaptive capacities.

Conflict of interest
The authors declare no conflict of interest.

References
1. Bobrytska VI. The process of adaptation at higher educational institution as a factor in the formation of a healthy lifestyle. Visnik Cherkas’kogo universitetu, 2002;43:83 – 88. (in Ukrainian)
7. Beseda NA. Health saving technologies in ensuring the quality of the educational process at higher educational
14. Bobrytska VI. Value-motivational aspects of the occupational adaptation of specialists with higher education. Problemi osviti, 2015;84:64-68. (in Ukrainian)
15. Bobrytska VI. Certain indicators of adaptation to the settings of gaining education at a higher school and the health of students. Formuvannia zdogovu spozuba zhitia students’koi molodi, 2003;1:40 – 42. (in Ukrainian)
20. Nazar PS, Shevchenko OO, Gusiev TP. Medical and biological foundations of physical culture and sports. Kiev: Olympic Literature; 2013. (in Ukrainian)

Information about the authors:

Bobrytska V.I.; DSc in Pedagogics, Professor; http://orcid.org/0000-0002-1742-0103; bobrytska@ukr.net; Department of Social Philosophy, the Philosophy of Education and Educational Policy, National Pedagogic Dragomanov University; 9, Pyrogova st., 01601 Kyiv, Ukraine.

Beseda N.A.; (Corresponding author); PhD in Pedagogics; http://orcid.org/0000-0002-1454-1938; natabeseda78@gmail.com; Department of Physical Education, Sport and Human Health, Poltava National Technical Yuri Kondratyuk University; 24, Pershotravneva Avenue, 38011 Poltava, Ukraine.

Cite this article as: Bobrytska VI, Beseda NA. Future specialists in physical culture and sports cardiovascular system functional condition evaluation. Physical education of students, 2018;22(5):232–236. doi:10.15561/20755279.2018.0501

The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/deed.en).

Received: 20.06.2018
Accepted: 12.07.2018; Published: 30.09.2018
The effect of the leg and back strength of the serve and tennis players to the serve throwing speed and agility

Kaya M.1ABCDE, Soyal M.2ACDE, Karakuş M.1ABCDE

1Physical and Sport College, Erciyes University, Kayseri, Turkey
2Physical and Sport College, Istanbul Gelisim University, Istanbul, Turkey

Abstract

Purpose: The aim of this study was to examine the effect of leg and back strength on serve throwing speed and agility of 19-23 year old male tennis players who are studying at university.

Material: Twelve male tennis players, aged between 19 and 23, who were studying at university in Kayseri participated in the study voluntarily. Individuals who played tennis for at least 5 days per week participated in the study and leg and back strength measurements and their relation with the serve and agility were compared.

Results: In the study, leg strength test, back strength test, agility test and serve throwing speed tests were applied to the subjects. These tests reveal a significant relation between back strength and serve throwing speed (R=0.660, R2=0.435; p<0.050). When the t-test results on the significance of the regression coefficient are examined, it is seen that back strength level affects serve throwing speed and explains approximately 43% of the total variance. There is a significant relation between leg strength and serve throwing speed (R=0.586, R2=0.343; p<0.050). When the t-test results on the significance of the regression coefficient are examined, it is seen that leg strength level affects serve throwing speed and it explains approximately 34% of the total variance.

Conclusions: As a consequence, it has been revealed that leg strength and back strength in tennis players have a statistical relationship with agility and serve throwing speed. For this reason, it is considered necessary to apply training programs to improve leg and back strength in trainings.

Keywords: Tennis, Back Strength, Agility, Service Throwing speed.

Introduction

Tennis is a sports branch in which anaerobic metabolism is used intensively. Anaerobic power is defined as the work that can be created by using the ATP-CP energy source at a unit of time. During the competitions, the maximal heart rate of the players reaches 90% during the period of 2.5 - 3 hours. During this time all the strokes are made with explosive power, showing how important the anaerobic power is [1].

Tennis has the feature of an intermittent game which includes 10-20 sec pauses after a short but at a high tempo game [2]. Strength is a very important parameter for performance to be displayed in tennis. It can be seen as the statement of the performance amount that is displayed in a certain period of time. Lower extremity strength ensures both to catch the ball in the shortest time and to hit the ball harder during the match [3]. An effective serve throwing is highly important in tennis to display a successful performance. In the serve and volley, the player who throws the serve makes a move towards the net after throwing the serve and throws the returned ball by volley to the corner that the opponent cannot reach. Besides, one of the most important criteria in determining serve performance is the ball speed in serve throw [4]. The speed of the ball in serve throws depends on the fact that the interdependent factors are in a complex whole. Among these factors, the physical structure, strength, joint range of motion of the tennis player, and speed of the joints and racket during serve throw are very important [5]. Throw speed is directly related to the range of motion of the joints that create the throw strength because the agonist muscles responsible for the movement will stretch in accordance with the wide joint motion at the beginning of the movement. This will also increase the throwing speed [6, 7]. Agility is the coordination skill that allows the body and joints to remain in the right position in space during very fast direction changes during a series of motion [8]. Agility consists of two main components, psychological and physical, such as decision-making mechanisms and speed of direction change [9]. The speed of direction change is influenced by factors determining the quality of the lower extremity muscles, such as straight sprint, technical and reactive (elastic) strength, concentric muscle strength, and right-left leg strength imbalances [9, 10].

It is an indisputable fact that tennis should be supported by scientific studies in order to achieve international achievements.

Hypothesis: Service and volley tennis players with high leg and back strength have better service throw speed. Purpose: In this study, it is aimed to investigate the effect of leg and back strength of male tennis players on the serve throwing speed and agility.

Material and Method

Participants.

Forming Voluntary Groups:

Twelve male students aged between the ages of 19-23 who played tennis at university level voluntarily participated in the study. Participants consisted of individuals who had 5 days tennis activity per week. The volunteers were informed before participating in the study and confirmation forms were received.

Research Design.

Age, Height and Body Weight measurements: A measuring tape with the 0.01 cm degree of precision was used to measure the heights of the volunteers.
Measurements were obtained while the volunteers were barefoot. While the measurements were taken, the heads were upright position, soles were on the floor, knees were stiff, ankles were contiguous and bodies were upright position. The body weights were measured barefoot and with minimal clothes by using a bascule with 0.1 degree of precision.

**Leg Strength Test:**

Measuring leg strength: The measurement was made using the takei physical fitness test brand leg dynamometer. After warming up for five minutes, the subjects placed their feet on the dynamometer table as their knees were bent. They pulled the dynamometer bar vertically upward by using their legs at maximum rate as their arms were stretched, backs were straight and the bodies were slightly leaned forward. This pulling was repeated twice and the best value for each subject was recorded in kg [11].

**Back Strength:**

Measuring back strength: The measurement was made using the takei physical fitness test brand back dynamometer. After the volunteers placed their feet on the dynamometer table as their knees were stretched and as their arms were stretched, backs were straight and bodies were leaned forward slightly. They pulled the dynamometer bar that they gripped by their hand vertically upward at maximum rate. The pull was repeated twice and the best result was recorded in kg [11].

Measuring agility

T test was used to measure the agility. This test was applied to determine the speed in covering a distance by changing direction such as sprinting forward, drifting left and right and backward run [12].

Cone were placed so that the distance between them would be 4.57 m. The subjects started at cone A. They sprinted to cone B and touched it. They then run to cone C and D by side steps and touched them in turn. They shuffled back to cone B and completed the test by reaching cone A running backward. Volunteers’ test completion times were measured by a stopwatch. Each volunteer repeated the test twice and the best time was recorded as the volunteer’s score in sec [13, 14].

**Serve Throwing Speed:**

The speed of the ball during the serve was measured by a “Stalker solo 2” brand radar device with the ±0.8 km.h-1 degree of precision that can make the speed measurement of between 8-224 km.h-1. Measurements were taken 1.5 higher than the serve end line by the same person [15]. Measuring the Ball Speed in Serve Throw: All serves were thrown in a closed tennis court in order to control the effect of the air. The subjects warmed up until they reached the maximal serve speed level. 3 minutes after the subjects warmed up, test phase started and they were asked to throw 5 serves at maximal speed. In accordance with the tennis rules, it was required to throw the service to the serve point, the cross-court service box, with backhand. The serve was not recorded as a value in case of it was thrown to the net or out of the service box. All serves were thrown to the left service box for the right-handed players (from right) and to the right service box for the left-handed players (from left). All players were asked to use the flat service technique. For the data analysis, the fastest service (km/h) out of the 5 serves that the players threw at maximal speed was analyzed as the maximal service (Vmax) [5, 16].

**Sport Age:**

The time that the volunteers spent in tennis branch was recorded as year.

**Statistical Analysis:**

In this study, to obtain the statistical results, SPSS 24 package was used. The means and standard deviation of the measurements and tested variables of all subjects were calculated. Values under p<0.05 were accepted as statistically significant. Pearson correlation analysis was used to analyze the relation of the data, and simple regression analysis was used to analyze the effect levels of the related values.

**Results**

When Table 1 was reviewed, it was determined that the average age of the participants was 20.75±1.28 years, average height was 177.58±3.65 cm, average body weight was 75.41±5.26 kg, sport age average was 9.50±1.31 years and the average of Body Mass Index was 23.89±1.08.

When Table 2 was reviewed, it was found that the average of the back strength was 122.16±13.16, leg strength average was 112.33±13.51, agility average was 10.12±5.4 sec and serve throw speed average was 125.72±11.79 km/hour.

When Table 3 is reviewed, it is seen that there is a high level of positive relation between serve throw speed

![Fig. 1. T test used to measure the agility](image-url)
Table 1. The Demographic Characteristics of the Participants

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
<th>X±SD</th>
<th>minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Year)</td>
<td>12</td>
<td>20,75±1,28</td>
<td>19,00</td>
<td>23,00</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>12</td>
<td>177,58±3,65</td>
<td>172,00</td>
<td>185,00</td>
</tr>
<tr>
<td>Body Weight (kg)</td>
<td>12</td>
<td>75,41±5,26</td>
<td>69,00</td>
<td>90,00</td>
</tr>
<tr>
<td>Sport Age (Year)</td>
<td>12</td>
<td>9,50±1,31</td>
<td>8,00</td>
<td>12,00</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>12</td>
<td>23,89±1,08</td>
<td>22,78</td>
<td>26,30</td>
</tr>
</tbody>
</table>

Table 2. The average results of the participants’ selected motoric properties

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
<th>X±SD</th>
<th>minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back Strength</td>
<td>12</td>
<td>122,16±13,16</td>
<td>105,00</td>
<td>140,00</td>
</tr>
<tr>
<td>Leg Strength</td>
<td>12</td>
<td>112,33±13,51</td>
<td>85,00</td>
<td>132,00</td>
</tr>
<tr>
<td>Agility</td>
<td>12</td>
<td>10,12±,54</td>
<td>9,05</td>
<td>11,20</td>
</tr>
<tr>
<td>Serve Throw Speed</td>
<td>12</td>
<td>125,72±11,79</td>
<td>105,40</td>
<td>142,50</td>
</tr>
</tbody>
</table>

Table 3. The correlation analysis between the serve throw speed and other variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back Strength</td>
<td>r</td>
<td>p</td>
<td>r</td>
<td>p</td>
</tr>
<tr>
<td>Leg Strength</td>
<td>r</td>
<td>p</td>
<td>r</td>
<td>p</td>
</tr>
<tr>
<td>Agility</td>
<td>p</td>
<td>r</td>
<td>r</td>
<td>p</td>
</tr>
<tr>
<td>Serve Throw Speed</td>
<td>p</td>
<td>p</td>
<td>p</td>
<td>p</td>
</tr>
</tbody>
</table>

*p<0.05 **p<0.001

Table 4. Regression analysis regarding the prediction in serve throwing speed in tennis

<table>
<thead>
<tr>
<th>Variables</th>
<th>β</th>
<th>t</th>
<th>P</th>
<th>R</th>
<th>R²</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back Strength</td>
<td>.660</td>
<td>2,774</td>
<td>.020</td>
<td>.660</td>
<td>.435</td>
<td>7,698</td>
<td>.020</td>
</tr>
<tr>
<td>Constant</td>
<td>.586</td>
<td>2,285</td>
<td>.045</td>
<td>.586</td>
<td>.343</td>
<td>5,222</td>
<td>.045</td>
</tr>
</tbody>
</table>

P<0.05

and back strength (p<0.05, r=.863). A medium level of positive relation between serve throw speed and leg strength is determined (p<0.05, r=.586). There is no significant relation between serve throw speed and agility (p>0.05).

When the table is reviewed, it is seen that there is a significant relation between back strength and serve throw speed (R=.660, R²=.435; p<.050). When the results of the t-test regarding the significance of the regression coefficient are examined, it is found that the level of the back strength (t=2,774, p=.020) affects serve throw speed and it explains approximately 43% of the total variance. There is a significant relation between leg strength and serve throw speed (R=.586, R²=.343; p<.050). When the t-test results regarding the significance of the regression coefficient are examined, it is seen that leg strength level (t=2,285, p=.045) affects serve throw speed and it explains 34% of the total variance.

Discussion

In this study, which 12 male students aged 19-23 who played tennis at university level participated in voluntarily, it is aimed to display whether serve throw speed is statistically related to leg strength and back strength.

In the study, it was determined that the average height of the players was 177,58±3,65 cm, body weight average was 75,41±5,26 kg and body mass index average was 23,89±1,08 kg/m².

Houston et.al determined the body mass indexes as 22,1± 5,50 kg/m² in their study they conducted on tennis players [17]. Cohen et.al determined the body mass indexes as 22,3±7,40 kg/m² in their study on tennis players [16]. These results are similar to our study.

An efficient serve is a parameter related to the stature directly and workout age expresses the experience of serving [18]. Tall tennis players seems to be more advantages than the short ones since they meet the ball higher and they create a bigger angle. This angle means hitting the ball harder. Flat services need to be shot at least 254 cm high in order not to hook the net. Balls shot at 254 cm height can reach up to 179 km/h because of the vertical angle range [19]. For faster services, the ball and racket meeting point must be higher, which explains the relationship between service ball speed and height. A study was conducted on the serve speed according to the
anthropometric characteristics of the tennis players. It is stated in this study that there is a positive relation between the ages (r=0.60; p<0.01), statures (r=0.58; p<0.01) and body weights (r=0.47; p<0.05) of the male tennis players and the service speed [20]. In another study, a relation is found between the statures (p<0.01) and workout ages (p<0.05) of the tennis players and the speed of the ball in the serve. It is reported in this study that a significant relation is not found between the ball speed and age and body weights [5].

In our study, the relation between the serve throw speed and stature has not been studied, and it is recommended this comparison to be included in other studies.

In the study, the average of the back strength was found as 122,16±13,16 kg, leg strength average as 112,33±13,51 kg, agility as 10,12±,54 sec and the average of the serve throw speed as 125,72±11,79 km/hour. In addition, when the relation between leg strength and serve throw speed was examined, a statistically significance was detected between the values. As being special to the tennis serve, many parts of the human body is required optimal strength, flexibility, timing and coordination. The performance of the service therefore depends on the fact that many interdependent factors are within a complex whole. One of the most important of these factors is undoubtedly muscle strength and joint range of motion. Muscle strength at high speed, which is an integral part of tennis serve, needs to be transferred from the legs and the body to the arms at the appropriate level and time [5].

When the similar studies in the literature is viewed, it is found that Göral et.al determine the leg strength value as 155,7±7,27 kg and back strength value as 115,7±16,06 kg [21]. In another study conducted by Gelen et.al, the back strength of the major league players is determined as 143,1±12,5 kg and the minor league players’ as 131,1±12,5 kg. While the leg strength of the major league players is 185,1±9,6 kg, minor league players’ is 173,9±10,1 kg [22]. In the literature, although there are studies that accept there is a moderate to low level of relationship between ball speed and upper extremity isokinetic strength [16], in some studies it is stated that no relationship is found between the two [23]. In their study, Gelen and et.al state that there is a negative relationship between the ball speed in the serve throwing of tennis players and mesomorphic values (p<0.01). However, they found no relation between endomorphic and ectomorphic values [5]. A statistical significance is determined between the values when the relationship between leg strength and serve throw speed is examined according to the results of our study. This indicates that our study is supported by other studies in the literature. Besides, the finding of that there is a high level of positive relation between serve throw speed and back strength is again supported by other studies.

The overall structure of the tests analyzing the agility depends on the measurement of shuttle run speed on the horizontal plane. The scores measured in the tests applied to evaluate the agility characteristics should be independent from the maximal speed at flat sprint [9].

When the relation of the leg and back strengths with the agility is examined in our study, a statistical significance is not determined between the values. Since explosive strength is more effective in serve throwing, agility has the secondary level of importance.

In general, low or insignificant relations have been determined between agility and flat sprint, lower extremity strength and power in the studies [24, 25]. Hazir et.al reports in their study that relations between lower extremity strength measurements and agility tests have changeable values depending on the content of the agility test. They also reports that the relations between the scores obtained from average strength and agility in the 30 sec multiple jump test are not significant [10]. Similarly, in a study conducted formerly, no significant relation (r = -0.15) is determined between the strength values measured in the agility test containing 90° and 180° rotations and 15 sec multi jump test [9]. These results are parallel with our study.

Conclusions

It is determined that leg and back strengths of the tennis players participated in the study have a positive relationship with serve throw speed. Especially when the obtained results were evaluated, it was found that there was a positive and strong relationship between back strength and service speed and back strength had an effect of about 43% in the formation of service speed. With this result, there is an opinion that back strength plays an active role in a large part of the service throw. Looking at the components of the movement during the service throw speed, it is seen that the back muscles are the most active muscle group in the rotation of the arm and in the time until the moment of hitting the ball. This fact is thought to reveal the importance of back strength. It was also found that there was a positive and moderate relationship between leg strength and service rate and that leg strength had an effect of about 34% at the service throw speed. Especially since the balance is at the optimal level during the service throw, it is thought that foot strength is important during the rotation of the body during service. The lack of a relation between agility and service speed in the study may be attributed to the availability of a more stable state and a predictable movement chain especially during service, although agility has a great importance in the tennis branch.

As a consequence, it has been found that back and leg strength has an effect on service throwing speed in a positive way. It is believed that for a high speed of service throw, workouts to improve back and leg strength will contribute the performance. In further studies, it is thought that the application of different leg and back strength training programs, the inclusion of athletes in different training programs as experiment and control groups and the investigation of the effect of the different training programs on service throw speed will contribute to sports science and tennis branch.

Conflict of interest

The authors declare no conflict of interest.
References


4. Dangel, G. Tennis konditionstraining [Tennis condition training.] Sport Verlag, Deutschland; 1993. (In German)


Information about the authors:

Kaya M.; http://orcid.org/0000-0002-2438-2678; mustafakayaerciyes@gmail.com; Physical and Sport College, Erciyes University; Erciyes University, 38039 Kayseri, Turkey.

Soyal M.; http://orcid.org/0000-0001-6528-0275; mehmetsoyal3838@hotmail.com; Physical and Sport College, Istanbul Gelişim University; Cihangir Mahallesi Şehit Jandarma Komando Er Hakan Öner Sk. No:1 Avcilar/Istanbul, Turkey.

Karakuş M.; http://orcid.org/0000-0002-8910-4302; mblackkus@gmail.com; Physical and Sport College, Erciyes University; Erciyes University, 38039 Kayseri, Turkey.

Cite this article as: Kaya M, Soyal M, Karakuş M. The effect of the leg and back strength of the serve and tennis players to the serve throwing speed and agility. Physical education of students, 2018;22(5):237–242. doi:10.15561/20755279.2018.0502

The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/deed.en).

Received: 12.08.2018
Accepted: 12.09.2018; Published: 30.09.2018
Dynamics of physical fitness changes in preschool children, schoolgirls and female students of Eastern Siberia (Russia)

Lebedinskiy V.Y.1ABCDE, Koipysheva E.A.1ABCDE, Rybina L.D.1ABCDE, Kudryavtsev M.D.2,3,4,5ABCDE, Sidorov L.K.3,4,5ABCDE, Zukanov N.N.4ABCDE, Doroshenko S.A.2,5ABCDE, Kondratyuk T.A.3,5ABCDE, Alshuvaіli H.H.2,4ABCDE

1Department of Physical Culture, Irkutsk National Research Technical University, Russia
2Department of Physical Education, Reshetnev Siberian State University of Science and Technology, Russia
3Department of Physical Training, The Siberian Law Institute of the Ministry of Internal Affair of Russia, Russia
4Department of Theoretical Foundations of Physical Education, Krasnoyarsk State Pedagogical University of V.P. Astafyev, Russia
5Iraqi Football Association, Iraq

Abstract

Purpose: the analysis of physical fitness dynamics of the preschool children, schoolgirls and female students living in the region with an intense ecological situation.

Material: In total were surveyed: 1580 preschool children (age 4-7 years), 3211 schoolgirls (age 7-17 years) and 5827 female students (age 17-21 years). It was applied physical fitness tests of various groups of Russia population.

Results: It was determined three essential periods of the main characteristics changes of physical fitness. The preschool age is characterized by the expressed gain of results. The lowest characteristics were revealed in senior age (after 17-18 years). Female students have relative stabilization value of these indicators.

Conclusions: it is necessary to change the content of the educational process of physical training in educational institutions of the region.

Keywords: preschool children, schoolgirls, female students, physical fitness.

Introduction

Increase in the level of physical fitness – is one of the most important tasks. They have to be solved in the course of physical training of younger generation in general [1] and also of preschool children [2], school pupils [3] and female students [4]. The health of each nation in many respects depends on the efficiency of its solving. Physical conditions of children [5] and young people considerably determine the level of their health [6]. It is extremely important to understand and to estimate correctly physical fitness of modern preschool children, schoolgirls and female students [7]. The factor of strengthening of the pedagogical orientation of physical training of students at the non-major universities is especially relevant now. Such universities don’t train future experts in physical culture and sport [8].

The physical fitness is the result of physical training to a certain kind of activity. This process is characterized by the level of development of the main quality for this activity (endurance, force, dexterity, flexibility, speed). The degree (high, average, low) of their mastering is also very important [9]. The process of assessment of this level has to be based on the comparison of testing results to standards. It is necessary to consider the dynamics of a gain of individual characteristics in each age group [10].

Pedagogically purposeful impact on the development of physical qualities is very important [11]. It is performed in indissoluble correlation with training in physical capacities. This process is directed at promoting the full display of physical qualities. Their progress is shown at different steps of age development. This role is especially essential to successful mastering motor skills. It is very important to add and to correct impact of physical work on the development of physical qualities [12]. The main content of the first initial training is a comprehensive physical education of preschool children. It is necessary to control children’s mastering of basic techniques of physical exercises performance [13].

Characteristics of children’s physical activity are collected on a basis of examination of homogeneous groups of children. Children live in a certain region. All this is the basis for calculation of their physical fitness standards. These standards can be considered the most important tool of primary control over a condition of physical health of the younger generation [14]. The objective assessment of physical fitness is very important. It is necessary to consider the regularities of preschool children develop in the motor sphere.

Many researchers have described differences in parameters of children physical fitness of different regions of Russian Federation (RF). It is theoretically proved the need of introduction, so-called large zone standards at the level of the big region (territory, area) [15]. It is supposed introduction of separate regional assessment standards at the city level.

Nowadays in Eastern Siberia region is applied only the all-Russian standards for assessment of children’s motor qualities. Irkutsk region (Irkutsk city) has been chosen as one of five basic platforms. Collecting and processing of materials for monitoring researches have been organized.
institutions high comprehensive schools (MOI HCS) and educational institutions (MPEI), in municipal educational teenagers and student's youth in the municipal preschool allow to increase the efficiency of their physical training. preschool children, schoolgirls, and female students will in the choice and receiving sports education [34]. It is very important a special approach to positive attitude formation towards own health [32] in sports activities [33]. It is necessary to consider in the training of future teachers conditions on the development of children motor abilities. These differences are defined also by ethnonational peculiarities of the population. These differences are defined also by ethnonational peculiarities of the population. It is also necessary to consider the influence of climatic conditions on the development of children motor abilities. It is necessary to consider in the training of future teachers physical culture [30]. The Australian researchers pay special attention to the study and creation of programs of physical training [31]. The youth has to demonstrate a special approach to positive attitude formation towards own health [32] in sports activities [33]. It is very important in the choice and receiving sports education [34]. Hypothesis. The research of the physical fitness of preschool children, schoolgirls, and female students will allow to increase the efficiency of their physical training. Research purpose. To study physical fitness of children, teenagers and student’s youth in the municipal preschool educational institutions (MPEI), in municipal educational institutions high comprehensive schools (MOI HCS) and in the higher educational institutions (HEI).

Material and methods
Participants: it was examined: 1580 preschool children at the age of 4–7 years (researches haven’t included the children with chronic diseases) (Irkutsk, Russia); 3211 schoolgirls at the age of 7–17 years (Irkutsk, Russia); 5827 female students at the age of 17–21 years (1–4 year of study) (Irkutsk, Russia).

Organization of a research. It was applied tests of physical fitness of various groups of Russia population [35]. Researches were performed two times per year: at the beginning (September) and at the end (May) of the academic year (from September 2004 to May 2007). For girls (age 4-7 years) four tests were applied: on flexibility (“seated forward bend” test); on speed (“30 m run” test); on force – it was measured the dynamic force of girdle of inferior extremity muscles (“standing long jump” test); on high-speed and power endurance of flexors of the back (“Sit-ups in 30 s” test) [36, 37, 38].

The following tests were performed by schoolgirls and female students: for assessment of high-speed endurance and dexterity connected with change of the direction of the motion and alternation of acceleration and braking (“shuttle run” test); for assessment of force and static endurance of muscles of the girdle of superior extremity (“bent suspension” test); for measurement of active flexibility of a backbone and bending in coxofemoral joints (“seated forward bend” test); for measurement of high-speed and power endurance of flexors of the back (“Sit-ups in 30 s” test); for determination of the general endurance (1 000 m run test – schoolgirls, 5 min run – female students); for speed assessment (run tests: 20 m run – female students and 30 m run – schoolgirls); for measurement of dynamic force of girdle of inferior extremity (“standing long jump” test) [36, 37, 38].

Statistical analysis. It was applied the software of Microsoft Excel 7.1 and "Statistica 6.1". The statistical significance of the average values of independent samples was estimated by Student’s t-test at p<0,05.

Results
It is possible to trace the data shown in this publication (according to performed monitoring researches) at the age from 4 to 21 year (tab. 1).

It was revealed the changes in physical fitness characteristics in girls and female students of various age stages according to the results of the performed research.

It was performed the analysis of characteristics change of high-speed and power of body muscle endurance in examined persons (tab. 1, fig. 1). They can conditionally be divided into 4 stages:
- the 1st stage – the expressed rise (4–7 years) of indicator values – up to 7,6 times a year at the age up to 7 years;
- the 2nd stage – a moderate gain (8–11 years) of indicator values– up to 0,8 times a year at the age up to 11 years;
- the 3rd stage – a low gain (11–17 years) – up to 0,5 times a year;
- the 4th stage – decrease in values of the studied
indicator to 1.1 time in a year (17–21 years).

The analysis of flexibility characteristics of a spinal column and bending in coxofemoral joints (fig. 2) shown that its changes proceed in five main stages:
- the 1st stage – from 4 to 6 years. There are no essential changes;
- the 2nd stage – the expressed rise (7–11 years) of indicator values up to 1.5 cm a year;
- the 3rd stage – from 11–13 years appears wavy changes of characteristics. By age 12 years (0.4 cm a year) there is an insignificant decrease in values. By age 13 years (0.2 cm a year) it increases again;
- the 4th stage – an intensive gain (14–18 years). At this stage, the minimum gain is in 15 years (to 0.2 cm a year), and maximum – is in 18 years (3.3 cm a year);
- the 5th stage – from 19 to 21 years. Characteristics of flexibility whether don’t change (19 years) or slightly increase up to 0.3 cm a year.

The dynamic force of muscles of the lower extremities (fig. 3) can also conditionally be subdivided into the 5th a stage:
- the 1st stage – from 4 to 6 years – intensive (up

Table 1. Physical fitness of preschool children, schoolgirls, and female students

<table>
<thead>
<tr>
<th>Test</th>
<th>Age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Sit-ups in 30 s (times)</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>±0.3</td>
</tr>
<tr>
<td>Seated forward bend (cm)</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>±0.4</td>
</tr>
<tr>
<td>Standing long jump (cm)</td>
<td>62.9</td>
</tr>
<tr>
<td></td>
<td>±1.2</td>
</tr>
<tr>
<td>Age (years)</td>
<td>10</td>
</tr>
<tr>
<td>Sit-ups in 30 s (times)</td>
<td>19.9*</td>
</tr>
<tr>
<td></td>
<td>±0.2</td>
</tr>
<tr>
<td>Seated forward bend (cm)</td>
<td>7.5**</td>
</tr>
<tr>
<td></td>
<td>±0.3</td>
</tr>
<tr>
<td>Standing long jump (cm)</td>
<td>135.4*</td>
</tr>
<tr>
<td></td>
<td>±0.9</td>
</tr>
<tr>
<td>Age (years)</td>
<td>16</td>
</tr>
<tr>
<td>Sit-ups in 30 s (times)</td>
<td>22.7</td>
</tr>
<tr>
<td></td>
<td>±0.2</td>
</tr>
<tr>
<td>Seated forward bend (cm)</td>
<td>11.2</td>
</tr>
<tr>
<td></td>
<td>±0.3</td>
</tr>
<tr>
<td>Standing long jump (cm)</td>
<td>169.1</td>
</tr>
<tr>
<td></td>
<td>±1.1</td>
</tr>
</tbody>
</table>

*P<0.001, ** P<0.01, *** P<0.05, in relation to the previous age.

Fig. 1. Results of performing the test “Sit-ups in 30 s”
to 16 cm a year) development of characteristics of this indicator;

- the 2nd stage – moderated (4–14 cm a year) development at the age of 7–12 years. It should be noted that at the age of 9–12 years it is more expressed (9–14 cm a year);

- the 3rd stage – a moderate gain (from 13–17 years);

- the 4th stage – the expressed decrease in indicator values (up to 15 cm a year by 18 years);

- the 5th stage – stabilization (19–21 years).

Earlier we determined 5 stages of motor qualities development (high-speed and power endurance of body muscles, the flexibility of a spinal column and bending in coxofemoral joints, the dynamic force of girdle of inferior extremity muscles). Their main changes can be divided into 3 stages: 1st stage (preschool age). He is characterized by the expressed gain of results. At the 2nd stage (8–16, 17 years) it is defined their moderate gain which becomes more active during the sensitive periods. At the 3rd stage (girls senior to 16, 17 years) is the insignificant gain of fitness or even its essential decrease.

It was considered the maximum and minimum values of the average level of their development in the construction of a diagram. According to the results of comparison the level of physical fitness of children from municipal preschool educational institutions (Irkutsk) [1] with children from other regions of Russian Federation [16] it was revealed: in the test “Standing long jump “ (fig. 4.) – regional values was worse only in 4 years girls; in other age categories they approach to the all-Russian standards, though remain at lower level. In 6 years girls from Irkutsk have little improvement of the low limits of values of these indicators in comparison with preschool children from other regions of Russian Federation.

In the test “Sit-ups in 30 s” (fig. 5) girls from Irkutsk have lower results, than their contemporary (Russian Federation) in 4–5 years. However in 6–7 years the upper limit of values of regional indicators accrues and comes nearer to all-Russian, and their lower limit – has values significantly below.

The Irkutsk preschool children demonstrated the worst results at the age of 4–5 years in the “30 m run” test (fig. 6). However in 6–7 years they improve values of this indicator to the level of their equals in age from other regions. In 6 years Irkutsk preschool children improve the upper limits of this indicator.

In school-age children of Irkutsk, the better results of speed testing (“30 m run”, fig. 7) were at all age.

---

**Fig. 2.** Results of performing the test “Seated forward bend”

**Fig. 3.** Results of performing the test “Standing long jump”
The test result on the assessment of the dynamic force of the girdle of inferior extremity muscles (“Standing long jump”, fig. 8) was almost identical in both compared groups. At the age of 7 and 8 years, it was slightly worse in Irkutsk schoolgirls.

In the test for determination of flexor muscle force (“Sit-ups in 30 s”, fig. 9) pupils of Irkutsk have higher results at all age groups.

The analysis of test results on the determination of the general endurance (“1000 m run”, fig. 10) has shown that girls of Irkutsk from 7 to 12 years only have better characteristic. Then their values become worse, and in 15–17 years advantage of results have Russians.

In considering and comparing of motor qualities characteristics in pupils of Irkutsk schools and the all-Russian standards it was revealed that they are almost equal in testing muscles dynamic force of the girdle of inferior extremity. In girls of Irkutsk at all age, it is better results of tests for speed assessment (“30 m run”). Besides, in 7–17 years they have a higher force of body flexor muscle (“Sit-ups in 30 s”).

Discussion
Experts support the necessity of carrying out monitoring and performance of physical fitness level assessment of children, teenagers, and youth of student’s age. Such researches have to be performed during preschool and elementary education at schools. It is important to include as active as possible the physical fitness monitoring in the general assessment of the social and public life of the educational institution. Thus our research is coordinated with other scientific work [28]. It is also agreed with other.
researches [26] in different regions of Russian Federation [27, 29]: monitoring implementation activities [14] of population physical health [18], physical development of children [2], teenagers [5], youth [4].

Improvement of physical training in school pupils [3] is directed to an increase in the level of their physical fitness [6]. Therefore this research doesn’t conflict with the general tendencies [6] in the physical training of preschool children [16] and school pupils [15].

The solution of the task of health passport development [19] is agreed with the general [9] and regional settings [7]. Global distribution of a hypodynamia [20] and overweight in young people does this research even more demanded and relevant [30]. In this case, the position of authors of the article coincides with the opinion of a number of foreign experts [21]. For example, in a question of studying and increase in physical activity [31] of preschool children [23], elementary-school age children [24], teenagers and students [25]. Experts make the offers in the general concept of the increase in level of youth health. It is implemented in training programs on physical training [30] among modern young people.

It was revealed some distinctions in comparison of regional standards of physical fitness with the all-Russian characteristics [16]. Perhaps, it is defined by population living conditions in Eastern Siberia [13].

It is possible to draw the following conclusions in comparison of regional standards of physical fitness
of preschool children from Irkutsk with all-Russian characteristics: Irkutsk girls seriously concede to contemporaries from other regions according to the key indicators. Especially these distinctions are expressed at the age of 4–5 years in the tests “Sit-ups in 30 s” and “Standing long jump”. However, from 6 to 7 years the borders of regional standards increase. Then they approach all-Russian, and according to speed value – coincide with them.

Our research of motor qualities of Irkutsk schoolgirls has allowed to draw the corresponding conclusions. It was revealed age features in the analysis of studying results of the motor qualities dynamics in girls and female students. Their intensive improvement is mainly in 9–11 years. Such tendency is characteristic for Irkutsk and of the Russian schoolgirls. In a number of characteristics, the advantage of all-Russian standards is defined only at the senior school age (15–17 years). The differences between the results of the compared groups are minimized at the younger age. It is revealed that extent of motor qualities development (limit of the average level) in them coincides with all-Russian standards according to the majority of the studied indicators. However, girls from Irkutsk have authentically higher values of high-speed and power endurance of body muscles.

In the meantime, for increasing in level of physical fitness of preschool children, schoolgirls and female students requires the development of qualitatively new approaches. It is important that these approaches corresponded to each age and social group at the level of a class or student’s group. Training to increase the physical fitness level have to take place according to educational programs in each concrete educational institution. It is especially important to consider age features of preschool children, schoolgirls, and female students.

Conclusions

Results of a research allow to develop criteria for evaluation of effective work of instructors and physical culture teachers in the creation of educational process. The received results are recommended to apply in teaching and educational activities at comprehensive and sports schools, on physical culture chairs of higher education institutions. The database of examination results and the developed standards of physical fitness of Irkutsk girls and female students from 4 years to 21 years could serve as a ground for further scientific research of physical fitness of various groups of the population.

Conflict of interests

The author declares that there is no conflict of interests.

References

1. Koipysheva EA, Rybina LD, Lebedinskiy VY. Physical condition and physical fitness of pre school age girls, schoolgirls and girl students of Irkutsk. Teoriia i praktika fizicheskoi kul’tury, 2016;4:41–43. (in Russian)
7. Lebedinskiy VY. Physical development of pre school age girls, school girls and girl students. Irkutsk: IRNITU Publ.; 2016. (in Russian)
18. Vinogradov PA. Functioning of Goskomport of Russia on population, children’s, adolescents’ and youth’s physical health monitoring. Moscow; 2002. (in Russian)


26. Tiapin AN, Shcherbakov VP, Golovkin IuV. Forms of the static reporting during physical fitness testing of pupils in educational institutions of Moscow. Moscow; 1998. (in Russian)


29. Indreev MKh. Scientific technological support of social-pedagogical design of monitoring system of division and health condition of different groups of the population of KBR. *Scientific conference “Physical Culture and Sport in Development of Health Promotion Technologies”*. Irkutsk; 2005. P. 125-128. (in Russian)


35. Lebedinskij Vl, Kolokol’cev MM, Maslova ES, Mel’nikova NS, Shporin EG. The health monitoring of educational processes entities in higher education institutions “Passport of health”. Irkutsk: Irkutsk State Technical University Publ.; 2008. (in Russian)

36. Liakh VI. *Physical culture. Test control. 10-11 forms*. Education; 2012. (in Russian)


Information about the authors:

Lebedinskiy V. Y.; http://orcid.org/0000-0002-5291-8775; lebedinskiy@istu.ru; Irkutsk National Research Technical University; 83 Lermontov St., 664074, Irkutsk, Russia.

Koipysheva E. A.; http://orcid.org/0000-0003-4058-5085; koip00@mail.ru; Irkutsk National Research Technical University; 83 Lermontov St., 664074, Irkutsk, Russia.

Rybina L. D.; http://orcid.org/0000-0003-3666-1946; rybina.liuda2016@yandex.ru; Irkutsk National Research Technical University; 83 Lermontov St., 664074, Irkutsk, Russia.

Kudryavtsev M. D. (Corresponding author); http://orcid.org/0000-0002-2432-1699; kumid@yandex.ru; Siberian Federal University; 79 Svobodny pr., Krasnoyarsk, 660041, Russia.; Reshetnev Siberian State University of Science and Technology; Office A-406, 31, Krasnoyarsky Rabochy Av., 660014, Krasnoyarsk, Russia; Krasnoyarsk State Pedagogical University of V.P.Astafyev; Ada Lebedeva Street, 89, Krasnoyarsk, 660049, Russia; The Siberian Law Institute of the Ministry of Internal Affair of Russia; Rokosovskia str., 20, Krasnoyarsk, 660131, Russia.

Sidorov L.K.; http://orcid.org/0000-0002-4337-8201; sidorovk@kspu.ru; Krasnoyarsk State Pedagogical University of V.P. Astafyev; Ada Lebedeva Street, 89, Krasnoyarsk, 660049, Russia.

Zukanov N. N.; http://orcid.org/0000-0003-4476-6772; Nikolai_Zukanov@mail.ru; The Siberian Law Institute of the Ministry of Internal Affair of Russia; Rokosovskia str., 20, Krasnoyarsk, 660131, Russia.

Doroshenko S. A.; http://orcid.org/0000-0002-8593-1685; trisha246@yandex.ru; Siberian Federal University; 79 Svobodny pr., Krasnoyarsk, 660041, Russia.

Kondratyuk T. A.; http://orcid.org/0000-0002-3770-6336; kondr1607@mail.ru; Krasnoyarsk State Pedagogical University of V.P. Astafyev; Ada Lebedeva Street, 89, Krasnoyarsk, 660049, Russia.

Alshuvali H. H.; http://orcid.org/0000-0001-5044-592X; hassoo.nhashim@yahoo.com; Siberian Federal University; 79 Svobodny pr., Krasnoyarsk, 660041, Russia.; Iraqi Football Association; Zayouna, Al-Shaab Stadium, Baghdad, Iraq.


The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/deed.en).

Received: 12.05.2018
Accepted: 12.06.2018; Published: 30.09.2018
**Effect of model’s skill level and frequency of feedback on learning of complex serial aiming task**

Lotfi Gh, Hatami F, Zivari F

*Shahid Rajaee Teacher Training University, Tehran, Iran*

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

**Abstract**

**Purpose:** Modelling in observational learning and feedback are most important sources of information for learning of a new task. This study aimed to investigate the effect of model’s skill level and feedback frequency on learning of complex serial aiming task.

**Material:** 48 female students aged 19 to 25 years old were selected as sample; based on pre-test scores, they were divided into four groups of 12 subjects: expert model and 100% feedback, expert model and 50% feedback, novice model and 100% feedback, and novice model and 50% feedback). In acquisition phase, the groups performed 80 times the serial aiming task according to specific instructions. The immediate retention test was conducted 15 minutes after completion of acquisition phase and the delayed retention test was conducted 24 hours later.

**Results:** In acquisition stage, the results of analysis of variance with repeated measures showed that the expert model observation group had less spatial error and longer movement time. In immediate and delayed retention stages, the results of two-way analysis of variance showed that the expert model observation group had less spatial error and longer movement time. In delayed retention test, also, the main effect of feedback frequency on spatial error was significant. The 100% feedback group had less spatial error than 50% feedback group.

**Conclusions:** According to Fitz’s speed-accuracy trade-off law, the results are justified as following: since the expert model observers focus on error reduction and increased accuracy in executing complex tasks, their movement time gets longer. Also, the 100% feedback frequency in complex tasks leads to stronger memory consolidation.

**Keywords:** Model's skill level, Observational learning, Feedback Frequency, Serial Aiming Task, Complex Task.

**Introduction**

The learning, especially motor learning, plays a vital role in human life and accomplishment of tasks [1, 2]. The coaches and practitioners use different methods to train motor skills and transfer information to individuals [3]. Many coaches emphasize the display of motions as a means of transferring information to learners [4]. The modelling or observational learning is a process in which the individuals replicates the actions of others to obtain the necessary information of a skill [5]. Bandura showed that the observation provides an opportunity for performer to develop a cognitive representation for initial performance of skill [6]. It has been argued that the observation causes engagement in cognitive processes [7] and improves learner’s perceptual abilities [8]. In addition, the researchers suggest that the model display is more profitable in early stages of motor learning; in this period, the learners look for better ways to perform the skills [9].

There are two views on effectiveness of observational learning. According to Adams’s closed-loop theory, the motor model is selected and started through a memory trace; i.e. a motor program which is organized based on previous experiences. During movement, a comparison is made between perceptual trace and response and the sensory feedback is obtained from movements. Any symptom of error will be as a stimulus for conducting corrective action. According to Adams’ theory, the educational model should be presented in a correct way to develop a strong perceptual trace. Accordingly, the expert model should be used to develop a strong perceptual trace [10].

Considering Schmidt’s schema theory, however, when individuals provide an answer, they store information in four parts at their memory [11]. Instead of being explicitly stored, these four sources are stored implicitly and the learner obtains information in two generalized schemas: the recall schema which is responsible for initiation and implementation of movement and recognition schema which is responsible for assessing and correcting motor error. According to Schmidt, these two schemas are basis for learning and performing movements. According to Schmidt’s theory, both correct and incorrect answers (of novice) help learning; both play a role in development of schemas [12].

The video tutorials are one of the most commonly used modelling techniques in physical education. In all modelling methods, the model display by expert and novice individuals may be used; in expert modelling, the correct skill model is displayed. Landers and Landers [13] argued that according to general principle of skill display, the performer should perform the skill correctly. The expert model demonstrates desired features of skill and the learner may observe the desired performance and obtain information for learning of skill. The use of novice model is another strategy. Hebert and Landin [14] argued that the expert model would provide less information to observer about error in processing information; but, the involvement of individual in cognitive activities would facilitate learning. In this regard, research has shown that the combined use of both expert-novice models may lead to better learning outcomes than using any model individually [15-17].

Martens et al. [18], Hebert and Landin [14], and Want and Harris [19] showed that the observational learning is an effective factor in acquiring motor skills. Sabbaghi et al. [20] showed that the model gender does not impact on acquisition, retention, and transfer stages; the skill level of model is important. In general, several studies...
have shown the beneficial effect of using expert model. However, some research shows contradictory results. Pollock and Lee [21] compared observation of expert models through video and non-expert models; the results showed no significant difference in performance of groups. Shayan Noushabadi et al. [22] studied the dart throw skill learning and found that there was no difference between learning and expert modelling in any stages of learning.

The learning mostly occurs when individuals are in mutual relationship with coach. The relationship and feedback are intrinsically interconnected. The coach’s feedback is an essential element in the learning process to diagnose, correct, reinforce, and refine students’ perceptions of their skills and physical actions. The feedback is not only a way to determine the quality of education, it is but also a concept for development of education and performance. The term “feedback” refers to all information which is obtained from response during or after movement [23]. The knowledge of result (KR) is one of the most important categories of augmented feedback. The KR feedback is often provided as a verbal and final augmented feedback that informs the learner about outcome of movement and serves as a basis for correcting errors in subsequent trials. It is also a good guide to achieve an effective performance [24, 25]. Adams [26] states that the learning occurs when the learner uses KR to improve his or her next response. He also believes that if feedback is removed, the learner will only reinforce what has been learned from previous response with KR. Therefore, according to this view, it is expected that repetition of 100% KR will lead to better learning. In recent processing perspective, however, it is suggested that KR 100% or KR with high frequency will have destructive effect on motor learning; some of this KR will serve as a guide to response [27, 24].

In their research on children, Butki and Hoffman [28] found that the 100% feedback group had a better performance in acquisition test and 50% feedback group had a better performance in retention test. Chiviakovsksy et al. [29] conducted a study among normal children and showed that the children who received 100% feedback had better performance than those who received less feedback. Hemayattalab and Rashidi Rostami [30] studied the learning of a motor skill among individuals with cerebral palsy and found that the subjects who received 50% feedback had better performance at retention stage.

Therefore, the modelling in observational learning and feedback are most important sources of information for learning of a new task. The study of these two important variables involvement in learning of a complex task is the main objective of this research. Since the task information may be used by learner, the results of this study may be used to optimize the training of motor skills. These information resources also improve performance of motor skills, especially complex skills. The learner, through these resources, acquires necessary information to get close to performance of others. This may help teachers, coaches, and therapists to design a more effective training process.

Material and Methods

Participants: The sample consisted of 48 female students at Shahid Rajaee Teacher Training University in 2017-2018; they participated voluntarily in this study. Based on pre-test scores, they were homogeneously distributed in four groups of 12 subjects. The independent variables included model’s skill level (novice and expert) and feedback frequency (100% relative frequency, 50% relative frequency). The dependent variables included movement time and spatial error (pre-test, acquisition, immediate retention, and delayed retention).

Research Design: This was a quasi-experimental study; the data were collected in laboratory. The factorial design was used in this study. The research tools included demographic characteristics questionnaire, Edinburgh’s Handedness Inventory, and Serial Aiming Task Software.

After determining sample, Edinburgh’s Handedness Inventory and demographic characteristics Questionnaire were distributed among participants. It should be noted that the individuals were not familiar with intended task and they were all right-handed. First, the participants were provided with explanations about performing serial aiming task. In pre-test stage, the participants completed 10 complexes eight-part training exercises and their points were recorded. Then, the subjects were homogenously divided into four equal groups of 12 subjects (expert model and 100% feedback, expert model and 50% feedback, novice model and 100% feedback, novice model and 50% feedback). In acquisition stage, each group performed 80 trials with right hand (8 blocks of 10 trials). However, the expert model groups observed expert performer performance in 10 complex training trials and the novice model groups watched novice performer performance in 10 complex training trials. After observation, both groups performed desired training trials. The mean movement time and mean spatial error were provided as feedback to 100% feedback group after each training trial and 50% feedback group alternatively after each training trial. After completing each 40 trials, the participants rested for two minutes; during this period, they also watched the intended film. The immediate retention test was conducted 15 minutes after completion of acquisition session and the delayed retention test was conducted 24 hours later. In each stage, the participated conducted 10 complex trials.

Statistical Analysis: The descriptive (mean and standard deviation) and inferential statistics were used for analysing the data. The Levene’s Test was used to examine the equality of variances. The Shapiro- Wilk’s Test was used to examine the normality of data distribution. In pre-test, the one-way analysis of variance was used to compare the means. At acquisition stage, the mixed ANOVA with repeated measures was used to compare the means. At retention stages, the two-way analysis of variance was used to compare the means of groups.

Results

The demographic characteristics of participants including height, weight, and age are presented in table 1.
The Shapiro-Wilk’s Test showed that the distribution of data is normal in movement time and spatial error of complex serial aiming task at different measurement stages (P>.05).

The Levene’s Test confirmed the equality of variances for movement time and spatial error of complex task at different measurement stages (P>.05). The one-way ANOVA was used to evaluate the mean of pre-test movement times of groups before beginning of training. The results showed that there was no significant difference between groups (F (3,44) = 1.362, P =.267).

A. Movement time

The mean of movement time at performing a complex task in different measurement stages in shown in figure 1. At acquisition phase, 2 (model’s skill level) * 2 (feedback frequency) * 8 (training block) and analysis of variance with repeated measures were used to compare the mean of movement time. The results showed that none of interactive effects of studied factors was significant; at acquisition stage, the model’s skill level and feedback frequency had no significant impact on movement time at conducting complex serial aiming task (P>.05). However, the effect of model’s skill level was significant (F =18.24, P =.001, η² =.293). Comparing the means at acquisition stage, it was found that the groups that observed expert model had longer movement time than observers of novice model.

At immediate retention stage, the two-way analysis of variance was used to compare the mean of movement time. The results showed that the main effect of feedback frequency and interactive effect of model’s skill level * feedback frequency, was not significant; however, the main effect of model’s skill level was significant (F =15.82, P =.001, η² =.265). Comparing the means at immediate retention stage, it was found that the groups who observed expert model had a longer movement time than novice model observers.

At delayed retention stage, the two-way analysis of variance was used to compare the mean of movement time. The results showed that the main effect of feedback frequency and interactive effect of (model’s skill level * feedback frequency) was not significant; however, the main effect of model’s skill level was significant (F =20.9, P =.001, η² =.322). Comparing the means at delayed retention stage, it was found that the groups who observed expert model had a longer movement time than novice model observers.

B. Spatial error

The mean of spatial error at performing a complex task in different measurement stages in shown in figure 2. At acquisition stage, 2 (model’s skill level) * 2 (feedback frequency) * 8 (training block) and analysis of variance with repeated measures were used to compare the mean of spatial error. The results showed that none of interactive effects of studied factors was significant; at acquisition stage, the model’s skill level and feedback frequency had no significant impact on movement time at conducting complex serial aiming task (P>.05). However, the effect of model’s skill level was significant (F =18.24, P =.001, η² =.293). Comparing the means at acquisition stage, it was found that the groups that observed expert model had longer movement time than observers of novice model.

At immediate retention stage, the two-way analysis of variance was used to compare the mean of movement time. The results showed that the main effect of feedback frequency and interactive effect of model’s skill level * feedback frequency, was not significant; however, the main effect of model’s skill level was significant (F =15.82, P =.001, η² =.265). Comparing the means at immediate retention stage, it was found that the groups who observed expert model had a longer movement time than novice model observers.

At delayed retention stage, the two-way analysis of variance was used to compare the mean of movement time. The results showed that the main effect of feedback frequency and interactive effect of (model’s skill level * feedback frequency) was not significant; however, the main effect of model’s skill level was significant (F =20.9, P =.001, η² =.322). Comparing the means at delayed retention stage, it was found that the groups who observed expert model had a longer movement time than novice model observers.

Table 1: Demographic characteristics of participants including height, weight, and age

<table>
<thead>
<tr>
<th>Model’s skill level</th>
<th>KR Frequency</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>Age (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>expert</td>
<td>100%</td>
<td>166.25 ± 5.31</td>
<td>58 ± 9.195</td>
<td>22.17 ± 4.529</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>164 ± 5.721</td>
<td>63.75 ± 12.381</td>
<td>22.58 ± 2.275</td>
</tr>
<tr>
<td>novice</td>
<td>100%</td>
<td>166.17 ± 5.859</td>
<td>59.5 ± 8.618</td>
<td>21.67 ± 2.498</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>165.58 ± 3.942</td>
<td>60.83 ± 8.233</td>
<td>21.92 ± 1.379</td>
</tr>
</tbody>
</table>

Figure 1. Mean of movement time of complex task at different measurement stages
frequency had no significant impact on spatial error at conducting complex serial aiming task (P>.05). However, the effect of model’s skill level was significant (F = 32.313, P = .001, η² = .423). Comparing the means at acquisition stage, it was found that the groups that observed expert model had less spatial error than observers of novice model.

At immediate retention stage, the two-way analysis of variance was used to compare the mean of spatial error. The results showed that the main effect of feedback frequency and interactive effect of (model’s skill level * feedback frequency) was not significant; however, the main effect of model’s skill level was significant (F = 39.08, P = .001, η² = .47). Comparing the means at immediate retention stage, it was found that the groups who observed expert model had less spatial error than novice model observers.

At delayed retention stage, the two-way analysis of variance was used to compare the mean of spatial error. The results showed that the main effect of feedback frequency and interactive effect of (model’s skill level * feedback frequency) was not significant; however, the main effect of model’s skill level was significant (F = 30.61, P = .001, η² = .41). Comparing the means at delayed retention stage, it was found that the groups who observed expert model had less spatial error than novice model observers. Also, the main effect of feedback frequency was significant (F = 5.137, P = .028, η² = .105). Comparing the means at delayed retention test, it was found that the groups who received 100% feedback had less spatial error than those who received 50% feedback.

Discussion
This study examined the effect of model’s skill level and feedback frequency on learning of complex serial aiming task among right-handed and novice female students. At acquisition stage, the analysis of variance with repeated measures was used to compare the means. The results showed that the main effect of model’s skill level was significant. Comparing the means, it was found that the groups that observed expert model had less spatial error and longer movement time than observers of novice model. The results of two-way analysis of variance at immediate and delayed retention stages showed that the interaction of (model’s skill level * feedback frequency) had no significant impact on immediate and delayed retention of complex serial aiming task; however, the main effect of model’s skill level was significant at both stages. Comparing the means, it was found that the groups who observed expert model had less spatial error and longer movement time than novice model observers. At delayed retention stage, also, the main effect of feedback frequency was significant. The groups who received 100% feedback had less spatial error than those who received 50% feedback.

The findings of this study about model’s skill level are consistent with some previous studies. Hatami et al. [31] examined the effect of model’s skill level on performance and learning of simple volleyball service, Sabbaghi et al. [20] examined the effect of model’s skill level (with an emphasis on model and learner gender) on learning of a motor skill, Hatami et al. [32] studied the effect of model’s skill level on suppression of mu rhythm in three-step basketball shoot, Abdoli et al. [33] examined the effect of self-control observational exercise and model’s skill level on learning of Badminton’s long-distance service, and Hung [34] studied the effect of various displays on performing motor skills during video tutorials; they all showed that the individuals may learn motor skills through observation and the observation of expert model is better for learning. Also, it seems that the
individuals who observed expert model tried to increase their accuracy. According to Fitz’s speed-accuracy trade-off law, most of hand-held aiming skills require the individuals perform the skill with high speed and accuracy. The exchange between speed and accuracy is one of the most fundamental principles which is observed in performance; i.e. when the individuals emphasize speed, the accuracy decreases, and vice versa.

Shayan Noushabadi et al. [22] studied the effect of modelling interaction (expert model and self-modelling) and kind of feedback on performance and learning of dart throwing skill, Ghavami et al. [35] studied the effect of observing animation model, fixed images, and combined model on balance skill learning, Lotfi and Mohammadpour [36] studied the effect of three observational learning methods on acquisition and learning of archery skill, and Pollock and Lee [21] compared the effect of observing expert model through video and expert model; these all did not report any significant difference between performance of different groups. This result is inconsistent with findings of this study; this was mostly due to different types of task, participants’ training background, number of training sessions, and modelling type.

The findings of this study on effect of feedback frequency are consistent with findings of Aslankhani et al. [37], Shayan Noushabadi et al. [22], Nezakat alhosseini et al. [38], Mohammadi et al. [39], Rezaee et al. [40], Guadagnoli and Kohl [41], Patterson and Carter [42], Butki and Hoffman [28], and Chiviacowsky and Wulf [29]; all of these studies showed that the high frequency of feedback helps to learn motor skills. On the other hand, this finding is not consistent with results of Wrisberg and Wulf [43]; this inconsistency is due to using simple tasks in that study.

This finding supported Adams’ closed loop theory. Adams [26] states that the learning occurs when the learner uses KR to improve his or her next response. He also believes that if feedback is removed, the learner will only reinforce what has been learned from previous response with KR. Therefore, according to this view, it is expected that repetition of 100% KR will lead to better learning.

**Conclusions**

Regarding the fact that the model’s skill level has a significant effect on learning of complex serial aiming task, it is recommended that coaches and teachers use expert modelling in teaching complex motor tasks to novices. The use of expert model in tasks that require speed-accuracy exchange makes learners focus on increasing accuracy. Also, since 100% feedback frequency impacts on long-term memorization of complex serial aiming tasks (delayed retention), it is suggested to provide 100% feedback to novices in training and teaching complex motor tasks.

**Conflict of interest**

The authors declare no conflict of interest.
Evaluation of the relationship between body composition and aerobic fitness in youth soccer players

Nalbant Ö.1ABD, Özer K.2AC

1Coaching Education Department, Alanya Alaaddin Keykubat University, Turkey
2Coaching Education Department, Istanbul Gedik University, Turkey

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

Abstract

Purpose: The purpose of the study was to make an evaluation between aerobic fitness (VO2max) and body composition in youth soccer players.

Material: U19, U17, U16 and U15 age groups participated in the study. Twenty-eight U19 (average age 18,03±0,58), twenty-three U17 (average age 16,72±0,30), twenty-seven U16 (average age 15,79±0,23) and twenty-one U15 (average age 14,67±0,31) totally ninety-nine athletes voluntarily participated in the study. The subjects’ body weight and fat percentage were estimated by bioelectrical impedance. VO2max was determined by YOYO Intermittent Recovery test protocol. Shapiro-wilk test, independent t test, hierarchical regression and analysis of covariance were used to compare the relationships between aerobic fitness and body composition. Additionally, Pearson correlation coefficients were calculated to examine the relationships between variables. The level of significance for all statistics was set at p<0.05. SPSS 23 software was used to calculate the data. The total value of all estimators is f = 18,001 and p <0.0001.

Results: Although all variables were included in the model, the BMI was considered the greatest explanatory factor for fatness. Aerobic endurance was assessed in direct proportion to age, sit and reach test, crunch test, plank, and long jump test. As the distance increased, the fat ratio decreased (p <0.001), and the fat ratio decreased with the decrease in the T test (p <0.001).

Conclusions: In this study, it was determined that body fat ratio determined by BMI, body fat percentage decreased with increasing aerobic endurance, body fat ratio was negatively correlated with aerobic fitness and lean body ratio. It was also determined that aerobic fitness was positively correlated with age, sit and reach, crunch test, plank, standing long jump and T test.

Keywords: aerobic fitness, body composition, fat percentage, soccer, training, YOYO.

Introduction

Aerobic endurance is an important factor of success in sports achievements. And this status generally considered for determiner of cardio respiratory fitness. VO2max refers to the intensity of aerobic process, maximum capacity and consumption oxygen during exercise [1]. Aerobic fitness is the main factors that enhance human to doing daily jobs and also improve the ability to long time duration exercise [2]. Body composition is also a very important factor for many sports disciplines. Components such as muscle mass, stamina and speed are the effects of body composition on the athlete [3].

Physical activity also has an impact on work capacity and body composition. It is known that the basal metabolic rate, VO2max, and hemodynamic responses to exercise are stronger than fat-free mass and total body mass [4]. Therefore, those participating in sports activities exhibit a higher level of physical activity than those who do not participate [5, 6].

On the other hand, low physical activity does not only lead to nonconformities in the physical structure, but at the same time immobility leads to diseases such as cholesterol, hypertension, diabetes and cardiovascular diseases in both adults and children [7]. In addition, children have a higher level of physical fitness at a better level than at a higher level.

From these views, it has not been found out that studies on body compositions and aerobics fitness of soccer players of different age groups. The aim of this study is to evaluate the relation between aerobic fitness and body composition in young soccer players.

Material and Methods

Participants

U19, U17, U16 and U15 age group soccer players participated in the study. Twenty-eight U19 (average age 18,03±0,58 year; height 178,12±5,29; weight 69,89±6,50; training experience 8,18±1,39), twenty-three U17 (average age 16,72±0,30; height 176,65±4,92; weight 65,94±6,11; training experience 6,74±1,51), twenty-seven U16 (average age 15,79±0,23; height 178,81±5,08; weight 68,01±7,24; training experience 4,74±1,32) and twenty-one U15 (average age 14,67±0,31; height 172,33±7,34; weight 60,76±8,73; training experience 3,95±1,20) totally ninety-nine athletes voluntarily participated in this study. The athletes were asked not to participate in a daily training program within 24 hours prior to testing. Testing was completed for all athletes in the same laboratory and field facilities. All athletes and parents were notified of the research procedures, requirements, benefits, and risks before giving informed consent and written informed consent was obtained from all the participants and their parents. Testing and measurements were made when entering the football season. The study
was conducted in a manner consistent with the institutional ethical requirements for human experimentation in accordance with the Declaration of Helsinki.

Measures

Measurements of Height and Body Weight

Body height and weight measurements were made using a digital scale (Seca 664, Hamburg, Germany) in bare feet and wearing only shorts. The body mass index (BMI) of each soccer player were calculated as weight in kg divided by weight in meters squared.

Assessment of Body Composition

In this study, a BC-418 8-contact electrode BIA system (Tanita Corp., Tokyo, Japan) was used to determine body composition. Body fat percentage and fat free mass were obtained by using this device.

Aerobic endurance tests (maximum oxygen uptake capacity (VO2max))

YO-Yo Intermittent Recovery test protocol

Yo-Yo Intermittent Recovery 1 (Yo-Yo Irt 1) is a field test and performs intermittent loads. This test was designed to measure aerobic capacity and the amount of VO2max used by athletes [8]. This test applied to footballers was made on the football ground. The test is a 20 + 5 m field athlete running at 8 km / h and the running speed is increasing. The rest period of the test is 10 seconds at 40m every time until the end of the test. The athletes move according to the signal sounds coming from the 20 m test run, and they complete the round by moving in and out. The + 5m distance in the test area is the resting interval that can be taken for 10s in each round. The test of the athlete who can not reach the area marked on the top twice shall be terminated. The number of rounds for which the athlete last ran is recorded in distance. This distance is used to calculate the VO2max value. The VO2max value of the athlete is calculated by the following formula.

\[ \text{VO}_{2\text{max}} = \frac{\text{distance (m) x 0.0084 + 36.4}}{\text{time (sec)}} \]

Sit and reach test: The athlete sat by his feet in front of the table for measurement. While he was in this position, he extended his body as far as possible, slowly pushed the table down and stopped at the end. The test is repeated twice and the best of both measurements was recorded [9].

Standing long jumping test: During testing in the beginning of a steel metric placed on a line of subjects ‘0’, the meter strip was centered between two feet. They wanted to jump the longest distance they could jump from the subjects. After the jump, the last points left of the subjects were determined and measured. In order for the measurements to be reliable, the subjects performed the test twice. The best measurement was recorded [10].

10 Meter and 30 meter speed test: Photocell is placed at the beginning and end of 10m and 30m tracks. Participants start a speed run 50 cm behind the start line. Two trials were conducted and the best score was recorded [11].

Crunch test: Lying on the back, the hands are consolidated on the hand. The knees were placed in a pulled position (with the knees at 90 degrees), with the bases fully grounded. Towards the top, the elbows had to come forward and the knees were touched at the end of the move. During the entire movement, it was noted that the hands were joined to the ensemble. At the beginning of the movement again the shoulders were at the mind. Within 30 seconds, this movement was tried to be repeated as many times as possible [12].

Sport-specific endurance plank test: Participants started the test by holding a basic plank position a prone bridge supported by the forearms and feet. Elbows were vertically below the shoulders with the forearms and fingers extending straight forward. The neck was kept neutral so that the body remained straight from the head to the heels. Participants were required to maintain the prone bridge in a good form. It should try to protect this position as much as possible. The result was recorded as time [13].

T-Test: The T-Test was administered using a version standardized from previous literature [14]. The units of measurement were changed from yards to meters, creating a 10 ×10 m course. The course procedure of having the participant touch each cone is not standardized in the literature; therefore, the task was eliminated. The directions adopted for this study were based on Miller et al. On the “go” command, the participant (1) ran or moved as quickly as possible forward to the center cone, (2) sidestepped to the right 5 m to the right cone, (3) sidestepped to the left 10 m to the far left cone, and then (1) sidestepped back to the right to the center cone. The participant then ran or moved backward as quickly as possible to cross the finish line. The raters began the stop watch on “go” and stopped when the participant broke the plane of the finish line. The time to complete each trial was recorded in seconds. Disqualification was determined if the participant failed to run the course as instructed, failed to reach the finish line or complete the course, moved any cones, did not keep his trunk and feet pointed forward at all times, or crossed his legs more than once when sidestepping. If a participant did not complete a trial successfully, a score of 0 was given [15].

Procedures

The athletes participate in training programs of 1.5-hour exercise in a day, 4 days per week done match during the season. The season was divided into three training parts, such as season preparatory period, preliminary competition period and competition period. All measurements were made in the preliminary competition period and between 8:00 and 12:00 a.m. in order to have similar chronobiological characteristics [16]. All measurements were performed by same researchers in morning times and American College of Sports Medicine Guidelines test procedures were followed [17].

Statistical Analysis

Before analysis, normality and equality of variance of the variables were assessed using a Shapiro-wilk test. The differences between age groups were determined using the Independent t test. Hierarchical Regression and analysis of covariance were used to compare the relationships between aerobic fitness and body composition. Additionally, Pearson correlation coefficients were calculated to
examine the relationships between variables. The level of significance for all statistics was set at $p<0.05$. SPSS 23, software was used to calculate the data.

**Results**

In our study, data on the performance of football players were obtained and the evaluations are shown in the following tables. The descriptive data (mean and standard deviation) of the measured variables including age, sport age, height, weight, BMI, %fat, sit and reach, shuttle, plank, standing long jump, 10 m speed, 30 m speed, t test, aerobic endurance and VO2max are shown in Table 1, and the results of statistical analysis and correlation of measured variables are shown in Table 6.

The dependent variable fat% description ratio of all arguments is adjusted $R^2 = 0.50$ (Table 2).

The total value of all predictors was found to be $f = 18,001$ and $p < 0.0001$ (Table 3).

Although all variables are included in the model, the BMI is considered to be the greatest predictor of fatness ratio (Table 4).

The aerobic endurance was found to be directly proportional to age, sit-up, crunch test, plank, and standing long jump test (Table 5).

**Discussion**

The determination of VO2max can be done by experienced personnel and high budgets in various laboratory environments. However, this is not appropriate for some applications [18]. For this reason, there are some tests that sports scientists can use and in which athletes can predict maximum oxygen uptake.

In this study, when all variables were included in the model, the finding that best explains the fatness ratio is the BMI. Goran et al. reported that maximal aerobic capacity was significantly lower in the obese children, as indicated by a higher HR and %VO2max; time to exhaustion was significantly lower in the obese children. Also said that FM does not have any effect on VO2max. Fatness and excess body weight do not necessarily imply a reduced ability to maximally consume oxygen, but excess fatness does have a detrimental effect on submaximal aerobic ca-

**Table 1. Test measurement results of the groups**

<table>
<thead>
<tr>
<th>Measurements</th>
<th>U19 (N=28) X±SD</th>
<th>U17 (N=23) X±SD</th>
<th>U16 (N=27) X±SD</th>
<th>U15 (N=21) X±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>18,03±0,5</td>
<td>16,72±0,3</td>
<td>15,79±0,2</td>
<td>14,67±0,3</td>
</tr>
<tr>
<td>Sports age</td>
<td>8,18±1,3</td>
<td>6,74±1,5</td>
<td>4,74±1,3</td>
<td>3,95±1,2</td>
</tr>
<tr>
<td>Height</td>
<td>178,12±5,2</td>
<td>176,65±4,9</td>
<td>178,81±5,0</td>
<td>172,33±7,3</td>
</tr>
<tr>
<td>Weight</td>
<td>69,89±6,5</td>
<td>65,94±6,1</td>
<td>68,01±7,2</td>
<td>60,76±8,7</td>
</tr>
<tr>
<td>BMI</td>
<td>22,03±1,8</td>
<td>21,11±1,7</td>
<td>21,25±1,8</td>
<td>20,37±1,7</td>
</tr>
<tr>
<td>%Fat</td>
<td>12,82±4,7</td>
<td>14,89±2,2</td>
<td>17,09±3,4</td>
<td>15,61±2,8</td>
</tr>
<tr>
<td>Sit and Reach</td>
<td>37,23±5,2</td>
<td>32,80±4,8</td>
<td>33,50±6,2</td>
<td>32,67±5,8</td>
</tr>
<tr>
<td>Crunch Test</td>
<td>51,31±7,4</td>
<td>49,75±8,6</td>
<td>45,50±5,1</td>
<td>48,89±5,5</td>
</tr>
<tr>
<td>Plank</td>
<td>131,28±7,8</td>
<td>177,17±5,2</td>
<td>167,94±5,3</td>
<td>184,83±5,7</td>
</tr>
<tr>
<td>Standing Long Jump</td>
<td>2,16±0,1</td>
<td>2,07±0,1</td>
<td>2,05±0,2</td>
<td>1,93±0,2</td>
</tr>
<tr>
<td>10 m Speed</td>
<td>1,76±0,1</td>
<td>1,71±0,1</td>
<td>1,71±0,1</td>
<td>1,89±0,0</td>
</tr>
<tr>
<td>30 m Speed</td>
<td>4,32±0,4</td>
<td>4,20±0,1</td>
<td>4,26±0,1</td>
<td>4,52±0,2</td>
</tr>
<tr>
<td>T test</td>
<td>9,26±0,4</td>
<td>7,90±0,2</td>
<td>9,14±0,6</td>
<td>9,03±0,3</td>
</tr>
<tr>
<td>Aerobic Endurance</td>
<td>1544,44±40,1</td>
<td>1366,67±40,8</td>
<td>1215,00±36,6</td>
<td>1184,44±38,9</td>
</tr>
<tr>
<td>VO2max</td>
<td>49,50±3,5</td>
<td>47,58±3,4</td>
<td>46,67±3,1</td>
<td>46,41±3,1</td>
</tr>
</tbody>
</table>

**Table 2. Regression model evaluation regression analysis for estimation of fat%**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.409a</td>
<td>.167</td>
<td>.155</td>
<td>3,4167</td>
</tr>
<tr>
<td>2</td>
<td>.654a</td>
<td>.427</td>
<td>.410</td>
<td>2,8554</td>
</tr>
<tr>
<td>3</td>
<td>.695a</td>
<td>.484</td>
<td>.460</td>
<td>2,7319</td>
</tr>
<tr>
<td>4</td>
<td>.728a</td>
<td>.529</td>
<td>.500</td>
<td>2,6282</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), age; b. Predictors: (Constant), age, bmi; c. Predictors: (Constant), age, bmi, Pla; d. Predictors: (Constant), age, bmi, Pla, End.
Thus, fatness and VO2max should be considered independent entities. Also, as the tests and measurements were made as they entered the football season, they were physically and conditionally ready, which confirmed the accuracy of the measurements made. Silvestre et al. reported also that soccer athletes who begin a season with a high level of fitness can maintain, and in some cases improve, body composition and physical performance. A correct combination of soccer-specific practices and strength and conditioning programs can maintain and develop physical performance. Nikolaidis also pointed out the relationship between BMI and fat ratio and mentioned the adverse effects of excessive weight on adolescent soccer players. For oil control, it also offers personalized work with proper training planning. Silva et al. reported that most of the findings from European football studies have the highest VO2max values of midfield players.

Another finding in the study is reduced body fat percentage as aerobic endurance increases. Denger and his colleagues conducted a study on girls and boys. Accord-

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>157,258</td>
<td>1</td>
<td>157,258</td>
<td>13,471</td>
<td>.000&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>1</td>
<td>Residual</td>
<td>782,155</td>
<td>67</td>
<td>11,674</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>939,413</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regression</td>
<td>401,299</td>
<td>2</td>
<td>200,649</td>
<td>24,610</td>
<td>.000&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>Residual</td>
<td>538,115</td>
<td>66</td>
<td>8,153</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>939,413</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regression</td>
<td>454,290</td>
<td>3</td>
<td>151,430</td>
<td>20,290</td>
<td>.000&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>Residual</td>
<td>485,123</td>
<td>65</td>
<td>7,463</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>939,413</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regression</td>
<td>497,344</td>
<td>4</td>
<td>124,336</td>
<td>18,001</td>
<td>.000&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>Residual</td>
<td>442,069</td>
<td>64</td>
<td>6,907</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>939,413</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: fat; b. Predictors: (Constant), age; c. Predictors: (Constant), age, bmi; d. Predictors: (Constant), age, bmi, Pla; e. Predictors: (Constant), age, bmi, Pla, End.

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>33,158</td>
<td>4,973</td>
</tr>
<tr>
<td>Age</td>
<td>-1,114</td>
<td>.303</td>
</tr>
<tr>
<td>(Constant)</td>
<td>17,885</td>
<td>5,007</td>
</tr>
<tr>
<td>2 Age</td>
<td>-1,629</td>
<td>.271</td>
</tr>
<tr>
<td>BMI</td>
<td>1,120</td>
<td>.205</td>
</tr>
<tr>
<td>(Constant)</td>
<td>22,191</td>
<td>5,056</td>
</tr>
<tr>
<td>3 Age</td>
<td>-1,669</td>
<td>.259</td>
</tr>
<tr>
<td>BMI</td>
<td>1,061</td>
<td>.197</td>
</tr>
<tr>
<td>Pla</td>
<td>.014</td>
<td>.005</td>
</tr>
<tr>
<td>(Constant)</td>
<td>23,115</td>
<td>4,878</td>
</tr>
<tr>
<td>Age</td>
<td>-1,345</td>
<td>.281</td>
</tr>
<tr>
<td>4 BMI</td>
<td>.885</td>
<td>.202</td>
</tr>
<tr>
<td>Pla</td>
<td>-.011</td>
<td>.005</td>
</tr>
<tr>
<td>End</td>
<td>-.002</td>
<td>.001</td>
</tr>
</tbody>
</table>

a. Dependent Variable: fat
ing to this study, boys with better aerobic endurance said that body fat ratios were better than girls [23]. In another study of Nikolaidis, the weight of footballers was similar to that of the general population, and the durability was inversely proportional to the body fat ratio [24]. Therefore, giving importance to body composition of soccer players will contribute to aerobics suitability. Overweight is also known to have negative effects on physical fitness. Minasian and colleagues found that females had a fat ratio of 24.73% and an aerobic fitness of 29.5 (ml/kg/min) and a male fat ratio of 19.32% and an aerobic fitness of 36.4 (ml/kg/min) in girls and boys. Results also revealed that there was a negative significant correlation between fat percent and aerobic fitness of boys (r = −0.81), and girls (r = −0.77) respectively [25]. This result reveals the conclusion we have determined between fat ratio and aerobic fitness.

The results of the study and other studies indicate that the fat ratio (% Fat) is negatively related to aerobic fitness and the lean body ratio (FFM) is positively associated with aerobic endurance. Reducing the fat percentage and increasing the lean body ratio is important to achieve high VO2max. The different study results clearly show that %Fat and FFM have not only an aerobic endurance but also a great effect on anaerobic and muscle strength [26, 27].

A significant relationship was found between aerobic fitness and age (r = 0.328, p < 0.01), fat% (r = -0.558, p < 0.01), sit and reach (r = 0.251, p < 0.01); crunch test (r=0.415; p<0.01); plank (r = 0.303, p<0.01); standing

---

**Table 5.** Relationship between aerobic endurance and some parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.328**</td>
<td>0.000</td>
</tr>
<tr>
<td>%Fat</td>
<td>-0.564**</td>
<td>0.000</td>
</tr>
<tr>
<td>Sit and Reach</td>
<td>0.251**</td>
<td>0.004</td>
</tr>
<tr>
<td>Crunch Test</td>
<td>0.415**</td>
<td>0.000</td>
</tr>
<tr>
<td>Plank</td>
<td>0.303**</td>
<td>0.000</td>
</tr>
<tr>
<td>Standing Long Jump</td>
<td>0.229**</td>
<td>0.008</td>
</tr>
<tr>
<td>Ttest</td>
<td>-0.336**</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).**

**Table 6.** The results of statistical analysis and correlation of measured variables

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2589.147</td>
<td>277.335</td>
<td></td>
<td>9.336</td>
</tr>
<tr>
<td>1</td>
<td>fat</td>
<td>-80.761</td>
<td>17.047</td>
<td>-0.564</td>
</tr>
</tbody>
</table>

**Figure 1.** Relationship graph between aerobic endurance and fat%.
long jump (r=0.229; p<0.01) and T Test (r = -0.336; p <0.01) (Table 5). This shows us that these parameters are directly proportional to aerobic fitness according to the results of these tests. Demirkan and colleagues found that the participant’s body fat percentage (FP), free fat mass (FFM) and basal metabolic rate (BMR) were calculated by bioelectrical impedance. Also, VO2max values were determined by the 12-minute walk study and multistage running tests (MST). According to the results obtained, boys and girls who have been trained have high VO2max values but boys have better values [28]. Czajkowska et al. conducted a study to evaluate the relationship between anthropometric and cardiovascular characteristics and aerobic capacity. They also noted that participants in the study also differed in physical activity levels according to resting and exercise conditions. When the relationship between physical activity and physiological characteristics was determined, it was found that VO2max value was an important factor [29]. Campos-Vazquez et al. reported that Maxvo2 and heart rate could be different, depending on the intensity of the soccer players loading in different seasons and weeks [30]. This is also an important information. On the contrary, Christopher and Emmanuel noted that the measurements did not show seasonal and temporal differences, and that differences existed according to positions [31].

Conclusions
In this study, it was determined that body fat ratio determined by BMI, body fat percentage decreased with increasing aerobic endurance, body fat ratio was negatively correlated with aerobic fitness and lean body ratio. It was also determined that aerobic fitness was positively correlated with age, sit and reach, crunch test, plank, standing long jump and T test.

Conflict of interest
The authors declare no conflict of interest.

References


Information about the authors:

Nalbant Ö.; http://orcid.org/0000-0002-2727-3522; ozgur.nalbant@alanya.edu.tr; Coaching Education Department, Alanya Alaaddin Keykubat University; Kestel Mahallesi Konya Çimento Caddesi No:80, 07400 Alanya/Antalya, Turkey.

Özer K.; (Corresponding author); http://orcid.org/0000-0001-9913-5084; ozgur.nalbant@alanya.edu.tr; Coaching Education Department, İstanbul Gedik University; Çamlık Mahallesi Nazende Sokak No: 2 Çamlık Spor Tesisleri Karşiği Kurtköy İstanbul, Turkey.


The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/deed.en).

Received: 27.07.2018
Accepted: 20.08.2018; Published: 30.09.2018
The possibility of a significant increase in the level of motor activity in students with the use of the potential of computer technology

Osipov A.Yu.1,4,5ABCDE, Kudryavtsev M. D.1,2,3,5ABCDE, Kopylov Yu.A.6ABCDE, Kuzmin V.A.1BCDE, Panov E.V.5BCDE

1Department of Physical Culture, Department of Valeology, Siberian Federal University, Russia
2Department of Physical Education, Reshetnev Siberian State University of Science and Technology, Russia
3Department of Theoretical Foundations of Physical Education, Krasnoyarsk State Pedagogical University named after V.P. Astafiev, Russia
4Department of Physical Culture, Professor V.F. Voino-Yasenetsky Krasnoyarsk State Medical University, Russia
5Department of Physical Training, The Siberian Law Institute of the Ministry of Internal Affairs of Russia, Russia
6Laboratory of Innovative Technologies, The Center of natural science of physical education, Russia

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

Abstract

Purpose: a significant increase in the level of everyday motor activity of students. It is intended to use the collection and exchange of data on the daily mobility of students in popular online networks and mobile applications. Identify the prospects for using social networks and mobile applications in the control and management of the body weight of students.

Material: The study involved students (n = 30, age 19-20 years). Admission to the group occurred by sending out invitations to social networks. The main criteria for selecting female students are the same age and absence of diseases. Also taken into account the indicators of the body weight of female students. It was used the following methods for assessing the level of physical condition of female students: control over the body weight (weighting), time parameters of recovery of the body after performing a test load (sample with 30 sit-ups). To evaluate the results of the studies, the Wilcoxon signed-rank test was used.

Results: multidirectional dynamics of changes in body weight data was detected among female students. In the control group, there was a slight increase in body weight. In the experimental group, a significant decrease in body weight was found. The recovery time significantly decreased by an average of 7±1 seconds (experimental group) and by 2±1 seconds (control group). The volume of daily motor activity of female students of both groups significantly increased. The students of the experimental group have higher rates of motor activity.

Conclusions: the possibilities of using social networks and mobile applications are shown to increase the daily motor activity of students and the possibility of correcting body weight.

Keywords: health, motor activity, students, social online networks, obesity prevention, mobile applications.

Introduction

Studies show that the level of physical activity and physical fitness of young people has a positive impact on the level of their academic performance [1]. This is typical for university students [2]. To maintain health and successful life, young people need at least 150 minutes of motor activity per week [3]. Scientists recognize that in recent years, the low level of everyday motor activity (MA) and a significant decrease in the proportion of maximum aerobic physical activity are the main problems for the health and well-being of modern youth [4]. It was revealed that a significant decrease in the level of MA is directly related to the enthusiasm of modern young people by the Internet [5], computer games and social networks [6]. The problem of the low level of everyday MA of youth is today relevant for countries around the world. For example, in China, only 3 out of 10 young people aged 15-16 years adhere to the recommended daily level of physical activity – 60 minutes per day or more. The remaining youth does not comply with these recommendations and is at risk of obesity. About 12% of young people already have this disease. This is a serious problem [7]. Effectively solve it, experts suggest starting a search for new, effective strategies for promoting and increasing the level of physical activity among young people: boys [8], children and adolescents [9]. Such strategies should be based on the individualization of the education of young people, taking into account their somatotype, functional parameters. Such strategies should be aimed at increasing of daily MA [10]. Maintaining the optimal level of students’ MA requires appropriate control of body weight. Such control is an effective way to prevent the development of obesity [11].

Analysis of the scientific literature shows that standardized programs of physical education of students are not able to solve the problem of deterioration of physical health [12]. Scientists note that educational institutions should provide a much wider range of physical education programs: schoolchildren [13] and students [14]. Modern students prefer a wider range of sports and fitness than the administration can offer them [15] and teachers [16]. It is known that modern young people consider: modern fitness, aerobics, dancing [17], functional training, athletic gymnastics [18]. Specialists note that educational systems in China [19] and Sweden [20] are gradually changing their direction. Instead of the methods of sports perfection, the methods of improving fitness are also used. Young people also consider it necessary to add interesting events to the educational process with the identification of the winner. The availability of a choice of physical activity programs will be especially important for female students. This is due to the fact that most girls...
have a lower base level of physical fitness compared to boys [21]. There is a number of data that the possibility of social communication and comparison of the results of exercise in online networks can significantly increase the level of daily MA of female students [22]. It is noted the advisability of introducing computer technologies in the process of physical education of modern youth [23]. Unfortunately, the integration of these technologies into student education programs is still at the stage of its development and needs additional research [24].

There is an increasing number of scientific studies suggesting the use in modern physical education of young people of modern computer technology [25]: Internet and video games [26]. Specialists note that informatization of the process of teaching students today is a necessary requirement of modern European [27] and world educational standards [28]. There are scientific studies proving that the use of various web applications increases the level of physical activity [29]. A number of scientists argue that the availability of social support from other users of social networks is an important condition for increasing the level of independent physical activity of each participant [30]. Other experts emphasize the rather low role of social support in online networks for increasing the level of MA of users [31]. In modern online networks, there are available platforms, through which effective medical and preventive effects on the lifestyle and movement activity of target populations are possible [32]. However, reviews of scientific literature show that there is no obvious evidence of the positive impact of social networks on the physical condition of people with chronic illness or obesity [33]. At the same time, scientists believe that additional research is needed to study the impact of social networking technologies on the health of users. It is necessary to prove the connection between theoretical reasoning and the analysis of the actual impact of social online networks on the health of users [34].

In some of the USA colleges and universities, scientists use mobile applications for smartphones [35]. It should be noted that teachers in Western Europe, Asia and North America make extensive use of information, communication and mobile technologies in the learning process [36]. Students have one of the most popular gadgets today, wrist monitors, showing the level of physical activity during the day. The use of such monitors by students allows young people to maintain a certain level of physical activity for a long time [37]. There are a number of studies on the prospects of using smartphones and mobile applications to improve the level of everyday MA [38] and manage their weight [39]. There are studies that prove the positive impact of mobile technology on the results of maintaining the user’s weight at the recommended level [40]. However, the positive effect of using mobile technologies and the Internet for most users is quite short-term – not more than a year [41]. Also, application developers should focus on the factors that contribute to the following: people getting involved in regular physical activity and fitness; adaptation of mobile applications for different population groups [42]. Many users in the future are disappointed in these applications because of the outdated design and lack of updates.

Further scientific research is needed to increase the effect of computer technology on body weight control and the prevention of obesity in young people. Scientists should focus their efforts on the best use of electronic devices and mobile applications to measure and collect data on the level of MA of users [43].

Hypothesis. The authors suggested that a significant increase in the level of students’ MA will be possible with the active use of popular in the youth social networking environment and other mobile applications for information exchange. According to the authors of the article, the daily exchange of data on their physical activity will contribute to a significant increase in the level of students’ MA. The authors of the article also planned to find additional evidence of allegations about the prospects of using online networks and mobile technologies in preventing obesity and correcting the body weight of young people.

Purpose of the study. Raising the level of daily MA of students by sharing information in popular among today’s young people social online networks and mobile applications. An additional goal is to confirm the hypothesis about the effectiveness of using mobile applications and online networks in monitoring and controlling the body weight of users of these applications.

Materials and methods.

Participants: The study involved students (n = 30, age 19-20 years). Admission to the group occurred by sending out invitations to social networks. The main criteria for the selection of girls: a similar age and the absence of diseases. Also taken into account the indicators of the body weight of female students. To maintain the purity of research, it was decided to recruit female students with a body weight of 48 to 56 kg. The students successfully passed a medical examination in the University clinic and had no contraindications for exercising. All the students gave their consent to participate in the research. As a result of the recruitment, the students were divided into 2 equal groups: group 1 (control group - n = 15), group 2 (experimental - n = 15). The average body weight of female students was just over 53.2 kg.

Organization of the study: Studies were conducted during the academic semester (September 2016 - February 2017). All the girls were offered daily to perform certain physical exercises for 30-45 minutes continuously. Students could perform 3 types of exercises for their personal choice: running (at least 4.5 km), swimming in the pool (continuously with different styles of at least 850 m), work on bikes (at least 8.5 km). It should be noted that the students of both groups performed daily exercises individually and at a convenient time for themselves. To increase the level of motivation of female students, the organizers decided to conduct research in the form of a contest with the identification of the winner group. The girls were given a condition – daily exercises should be performed by the whole group. The absence of any of the participants in the studies was recorded by the
coordinators. At the end of the research, the data on the performance of the exercises by the students were calculated to determine the winners of the competition. Exercise was recorded by the coordinators of the studies on the video. The video files of the control group sessions were recorded by the research coordinators to compile daily reports and analyze the information. The video files of the experimental group were recorded and daily uploaded to various popular among the students of the Institute of Oil and Gas SFU social online networks of the Russian-speaking Internet segment: VKontakte, Mail.ru, Odnoklassniki, Viber. Users of such files could write comments and post scores in online networks to participants of the experimental group for performing daily physical exercises. The main criteria for obtaining an assessment from users were the dynamics and intensity of the exercises by students.

In the course of the studies, the following parameters were also evaluated: the dynamics of changes in body weight values, the recovery time of the body of students after the test load (a one-stage test with 30 sit-ups). The girls were weighed every week. A sample with 30 sit-ups was conducted monthly. Also the total time of daily exercise for the students of both groups was taken into account during each month of research.

Statistical analysis: To evaluate the results of the studies, the authors used the Wilcoxon signed-rank test.

Results.
The evaluation of the results of the average changes in body weight of female students, showed multidirectional dynamics of changes in body weight values in groups. In the control group, an increase in the average body weight was found (from 53.26 ± 0.38 kg to 53.44 ± 0.34 kg). However, this increase was recognized by the authors as insignificant. In the experimental group, the average body weight of girls was reliably (P <0.01) decreased (from 53.41 ± 0.14 kg to 52.76 ± 0.12 kg). The indices of the recovery time of the female body after the test load was performed reliably (P <0.01) improved in both groups. In the control group, the recovery time was reduced (from 112 ± 1 seconds to 110 ± 1 seconds). In the experimental group, the recovery time of the pulse decreased on average from 113 ± 1 seconds to 105 ± 1 seconds.

In the course of the studies, a significant (P <0.05) increase in the number of female students of both groups was observed, which daily performed the proposed MA. In the control group, the number of students engaged in MA every day increased from 11.7 ± 0.1 to 12.0 ± 0.1. In the experimental group, the number of students engaged in MA every day increased from 12.2 ± 0.1 to 12.6 ± 0.1.

The main results of the studies are presented in Table 1.

Separately, it is worth considering the data on the level of daily MA of female students. From the beginning of the study, the indicators of the daily MA level were reliably (P <0.01) higher in group 2. Two months later, there was a significant decrease in the indicators of daily MA for both groups. Participants themselves noted that the decrease in the level of MA is caused by catarrhal and viral diseases (ARD, influenza, etc.). In December, there was an increase in daily MA in both groups: the level of daily MA in Group 2 was significantly higher (P <0.01). A significant decrease in the level of MA in groups was registered in January. The students explained the decline in the New Year holidays and the preparation and passing of the examination session. In February, the level of MA increases again in both groups: the level of daily MA of students of group 2 is much higher. Students of this group explain a higher level of MA by the presence of a large number of comments and evaluations of their activities in social online networks and mobile applications. The fact of assessing the level of MA of students gave extra motivation for doing physical exercises. The girls of the control group, in turn, noted a certain lack of motivation for daily MA activities. According to the students of Group 1, the lack of competitiveness and the opportunity to show their level of physical fitness to other participants played a significant role in the final results of the research.

The data for estimating the total time for performing physical exercises are shown in Fig. 1.

<table>
<thead>
<tr>
<th>Indices</th>
<th>group №1 (n=15)</th>
<th>group №2 (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>September</td>
<td>February</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>53.26±0.38</td>
<td>53.44±0.34</td>
</tr>
<tr>
<td>Recovery (sec)</td>
<td>112±1</td>
<td>110±1*</td>
</tr>
<tr>
<td>Daily MA (min)</td>
<td>351±1</td>
<td>362±1*</td>
</tr>
<tr>
<td>Engaged in activities (daily)</td>
<td>11.7±0.1</td>
<td>12.0±0.1**</td>
</tr>
</tbody>
</table>

Note * - P <0.01 - level of significance; ** - P <0.05 - level of significance.
Discussion.

To significantly increase the level of students’ MA, scientists recommend to use sports and fitness, popular in the youth environment. These types include fitness aerobics, dancing, athletic gymnastics [18]. It is believed that a high level of interest and motivation for exercising will increase the level of students’ MA [7]. However, the conducted studies prove the possibility of a significant increase in the level of daily MA of female students without using these species. Using student mobile applications and social online networks when performing monotonous and cyclic aerobic exercise can not reduce the level of motivation to increase MA.

To significantly increase the number of students (Internet users) facilitates the exchange of data on daily motor activity and the possibility of evaluating MA by other users. There is a low level of influence of social support for users of online networks on increases in motor activity [31]. However, the role of social support should not be underestimated. Girls of the experimental group note that it is the positive assessments and user comments that have influenced the increase in the level of daily physical activity. We found that the fulfillment of student physical exercises evaluated a significant number of users. This gave considerable motivation to the girls of the experimental group. It should be noted that experts do not deny the need for social support for users of mobile applications to increase the level of motor activity. It is about raising the level of social competition in online networks.

The research carried out by the authors confirms the hypothesis that mobile applications and social networks can be used to control and control the body weight of young people. During the period of studies in the experimental group, a significant (P <0.01) decrease in body weight parameters was revealed. The obtained results confirm the reports on the possibility of the positive influence of modern mobile technologies on maintaining the body weight of users at the recommended level [40].

Scientists say that modern conditions are characterized by a significant decrease in the level of physical activity of young people and the presence of a global threat of obesity. Therefore, any measures to increase the level of physical activity will be methodologically effective: there is no ideal tool for studying this health parameter [44, 45]. The importance of using the potential of computer technologies and social online networks to promote public health ideas [46] and disease prevention [47] is confirmed by scientific research.

Conclusions.

1. There has been a significant deterioration in the level of physical development and health of student youth. Therefore, new methods of increasing the level of everyday motor activity of students are needed among young people. Studies have revealed the possibility of a significant increase in the daily mobility of students: the collection and placement of information about everyday MA in social online networks and mobile applications.

2. The researches of the authors confirm scientific hypotheses about the prospects of using the Internet segments: social networks and mobile applications for effective body weight correction and obesity prevention in students. At the same time, development of all new online and mobile fitness applications is required. This is due to the fact that modern young people are experiencing a rapid loss of interest in independent exercise and sports.

Conflict of interest.

The authors of the article state that there is no conflict of interest.
References


4. Armstrong N. Young people are fit and active – Fact or fiction? Journal of Sport and Health Science, 2012; 1(3): 131–140. doi:10.1016/j.jshs.2012.05.003


32. Van Kessel G, Kavanagh M, Maher C. A qualitative study to examine feasibility and design of an online social networking intervention to increase physical activity in teenage girls. PLoS ONE, 2016; 11(3): e0150817. doi:10.1371/journal.pone.0150817


Information about the authors:

Osipov A.Yu.; http://orcid.org/0000-0002-2277-4467; Ale44132272@ya.ru; Siberian Federal University; 79 Svobodny pr., Krasnoyarsk, 660041, Russia. Professor V.F. Voino-Yasenetsky Krasnoyarsk State Medical University; P. Zeleznjak, 1, Krasnoyarsk, 660022, Russia. Siberian Law Institute of the Ministry of Internal Affair of Russia; Rokosovsky str., 20, Krasnoyarsk, 660131, Russia.

Kudryavtsev M.D.; (Corresponding author); http://orcid.org/0000-0002-2432-1699; kumid@yandex.ru; Siberian Federal University; 79 Svobodny pr., Krasnoyarsk, 660041, Russia. Krasnoyarsk State Pedagogical University named after V.P. Astafyev; Ady Lebedevoy Street, 89, Krasnoyarsk, 660049, Russia. The Siberian Law Institute of the Ministry of Internal Affair of Russia; Rokosovsky str., 20, Krasnoyarsk, 660131, Russia. Siberian State University of Science and Technology; Office A-406, 31, Krasnoyarsky Rabochy Av., 660014, Krasnoyarsk, Russia.

Kopylov Yu.A.; http://orcid.org/0000-0002-3825-0483; yuko.47@mail.ru; The Center of natural science of physical education; Semenovskaya embankment, 3/1, kor. 4 Moscow, 105094, Russia.

Kuzmin V.A.; http://orcid.org/0000-0002-4190-1628; atosn35@ mail.ru; Siberian Federal University, Siberian State Aerospace University; 79 Svobodny pr., Krasnoyarsk, 660041, Russia.

Panov E.V. http://orcid.org/0000-0002-2724-1854 pan_69@mail.ru; The Siberian Law Institute of the Ministry of Internal Affair of Russia; Rokosovsky str., 20, Krasnoyarsk, 660131, Russia.

Kramida I.E.; http://orcid.org/0000-0003-4256-2645; kramidai@mail.ru; Reshetnev Siberian State University of Science and Technology; Office A-406, 31, Krasnoyarsky Rabochy Av., 660014, Krasnoyarsk, Russia. Siberian Federal University; 79 Svobodny pr., Krasnoyarsk, 660041, Russia.

Cite this article as: Osipov AYu, Kudryavtsev MD, Kopylov YuA, Kuzmin VA, Panov EV, Kramida IE. The possibility of a significant increase in the level of motor activity in students with the use of the potential of computer technology. Physical education of students, 2018;22(5):265–271. doi:10.15561/20755279.2018.0506

The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/deed.en).

Received: 18.03.2018
Accepted: 20.04.2018; Published: 30.09.2018
The effect of an exhaustive aerobic, anaerobic and resistance exercise on serotonin, beta-endorphin and BDNF in students
Sharifi M., Hamedinia M.R., Hosseini-Kakhak S.A.

Department of Sport Physiology, Faculty of Sport Sciences, Hakim Sabzevari University, Sabzevar, Iran

Abstract
Purpose: Sport exercises play a major role in many hormonal factors which related to happiness in human. Therefore, the short-term effects of three anaerobic, aerobic and resistance exercises (BDNF) and hormones related to happiness such as serotonin and beta-endorphin has been studied in young men in this research.

Material: Thirty-two students (19 to 25 years old) who did not have regular physical activity were randomly divided into four groups, after the subjects were eaten the same breakfast, the blood of them were taken before and after the various short aerobic exercises (Exhaustive exercise with 70% of maximum heart rate) and anaerobic (Exhaustive exercise with maximum intensity) and exhaustive resistance exercise (with 8 stations); Control group did not practice any activity. Specific kits and ELISA method have been used to determine their values. Data were analyzed using ANOVA and ANCOVA method at a significant level of 5%.

Results: Beta-endorphins showed a significant increase in resistance and aerobic training sessions compared to control group. However, serotonin and BDNF had a significant intra-group change in the aerobic group.

Conclusions: It seems that aerobic exercises are the best practice for increasing some of the hormones associated with happiness.

Keywords: BDNF, Beta-endorphin, Serotonin, Aerobic Exercise, Anaerobic Exercise, Resistance Exercise.

Introduction
Sport is one of the most prevalent conditions for challenging the human physiological systems. A more contemporary label which has been often applied to these exercises induced changes, is the “runner’s high.” The runner’s high has been described subjectively as pure happiness, elation, a feeling of unity with one’s self and/ or nature, endless peacefulness, inner harmony, boundless energy, and a reduction in pain sensation [1]. Up to date, Brain-Derived Neurotrophic Factor (BDNF), a member of the neurotrophin family which is promoting neuronal survival and proliferation, has been described as one of the best potential candidate molecules that plays a role in exercise-induced antidepressant effects [2]. In general, this neurotrophic factor has been found in the brain and peripheral nerves and it plays an important role in protection and production of neurons [3]. Sport activity has been shown to increase the secretion of BDNF in protein and mRNA levels of a Mice hippocampus and it provides evidence to claim that sport activity has a potential to increase neurotrophins in humans [4]. There is contradictory information about the impact of endurance and strength of training on BDNF values. Probably, these three training methods can affect the synthesis and BDNF release. However, it is not clear that this system will respond to the anaerobic and circuit strength exercises. Besides, no research has yet investigated the effects of various training methods on this system during a training period.

Serotonin or 5-hydroxytryptamine is a monoamine neurotransmitter that plays a significant role in regulating the neuro-hormonal system, modifying the mood, appetite, joy, sleep, physiological activities, and effective cognitive activities in learning and memory [5]. Serotonin has been synthesized in an enzyme pathway from the tryptophan amino acid. This mediator has also been known as the hormone of happiness. The density of tryptophan in the brain and hence the synthesis rate of 5-hydroxytryptophan depends on the density of free tryptophan in plasma and the density of large non-polar amino acids that pass through the blood to the brain via transfer mechanisms that are similar to tryptophan [6]. The results of various studies have showed that aerobic exercises such as jogging, running, cycling and swimming seemed to affect serotonin secretion in humans significantly [7]. The exact mechanism of this function is still unclear, but it is clear that aerobic exercise has been improved individuals’ mood as a result of increase in serotonin level [7]. Information on acute changes at serotonin levels is still unclear because of exercising. [8]. Researches on strength training suggest that there is no change in serotonin levels in most cases [9, 10]. The level of serotonin depends on the intensity and duration of the exercise, the exercise protocol and the elapsed time after the last training session that samples were taken [11]. Endorphins or hormones of happiness have been released in every physical activity; endorphin is secreted by the anterior pituitary gland in response to exercise; physical and psychological stress [12]. The most important of all hormones related to happiness that is beta-endorphin and it is released in the blood. Beta-endorphin has been released from hypothalamic neurons in the spinal cord and brain, and from the pituitary gland. The behavioral effect of beta-endorphin has been determined by brain growth function and possibly by hypothalamic neurons, which are the largest source of beta-endorphin [12]. Various research results show that different aerobic, anaerobic, and strength training will result in serum beta-endorphins increase [13, 14]. Various studies have shown that beta-endorphin responds differently to the intensity of exercises and it depends on the various features of both aspects, i.e. individuals (e.g., health status, preparation level), and type of exercise [15]. Researches on exercise training and its effect on endorphin density
have contradictory results. Therefore a research that has been conducted on various types of training programs and their effects on endorphin density in plasma can provide valuable information to the researchers.

The results of most short-term studies of beta-endorphins show that higher-intensity exercises have been increased the amount of β-endorphin in proportion to pre-exercise state, the results of this type of research on serotonin levels appear to be influenced by the training program and the results are different according to training method, and regarding BDNF the results are contradictory that is mostly related to training method and the specimens. Therefore, further research is needed to investigate the features of hormone responses which are related to happiness, such as serotonin, beta-endorphin, and BDNF, in relation to the physical activity, and especially in relation to relevant and important factors such as duration and intensity of the physical activity, type of the activity, gender, and weight of the participated specimens in the study that can have a significant effect on research results. Therefore, the purpose of this study is to evaluate the short-term effects of three anaerobic, aerobic and strength training methods on serotonin, beta-endogenous and BDNF hormones in young men.

**Material and Methods**

**Participants.**

The study population included boy students aged 19-25 in Babol who did not regularly participate in sports activities. 32 of the participants were volunteers. The inclusion criteria were age range of 19-25, the willingness to participate in the study, no smoking, no use of notorious or mood enhancing supplements, physical and mental health and no diseases in specimens' medical history. Exclusion criteria were non-compliance with the training protocol and inability to collect the information sought by the researchers.

**Research Design.**

The present research is semi-experimental. The research and methodology and possible dangers during the training were described to the specimens in one session, and then the informed consent was taken from all the specimens. All ethical principles were followed during the training process; code of ethics for this study was obtained from Sabzevar University of Medical Sciences under the following number (IR.MEDSAB.REC.1395.127); specimens randomly divided into four groups of aerobic, anaerobic, strength training and control groups. The height, weight and the fat percentage of the specimens were collected in the first session. One hour after having breakfast, that was identical for all (included juice and breakfast cake with 250 cal), all specimens according to the classified groups performed in a training session (anaerobic, aerobic, or strength training). 5Cc of blood were taken in two phases of before and after short-term activity from the cephalic vein of the right arm in the resting position, then immediately poured into the test tubes that contained EDTA (anti-coagulation agent) and centrifuged for 3 minutes at 10,000rpm and the isolated plasma was stored at -20° C till the variables were measured.

Each set consists of 30, 60 and 90 meters running, respectively.

**Statistical Analysis.**

Analyses of serotonin, β-endorphin and BDNF hormone densities were measured by ELISA method. To measure β-endorphin, serotonin and BDNF, plasma density ELISA was used; it is produced by EASTBIOPHARM Company in China, with a sensitivity of 2.59ng/l, 1.22ng/ml, and 0.01ng/ml. Finally, all data were analyzed using SPSS software version 20. Shapiro-Wilk test was used to determine the normality of the data. After assuring the data were normal, ANCOVA, ANOVA and dependent t-test were used to compare the data. Alpha is assumed 0.05.

**Results**

According to the Shapiro-Wilk test, it was found that all variables data in the research groups are of normal distribution. Table 4 shows the anthropometric characteristics of the subjects. One session of anaerobic exercise, aerobic exercise and strength training had no significant effect on serotonin and plasma BDNF levels in proportion to the control group and there was no

<table>
<thead>
<tr>
<th>Table 1. Aerobic exercise program for one session</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of exercise</strong></td>
</tr>
<tr>
<td>Running</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2. Anaerobic exercise program for one session</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of exercise</strong></td>
</tr>
<tr>
<td>Running</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3. A strength circuit training program for one session</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of exercise</strong></td>
</tr>
<tr>
<td>Resistance</td>
</tr>
</tbody>
</table>
significant difference between the groups in this regard. However, one aerobic exercise session has significantly increased plasma beta-endorphin in proportion to control group. One anaerobic exercise session had no significant effect on the same index. Nevertheless, intra-group changes were significant in this group. In the aerobic group, a significant change was observed in serotonin and BDNF level in pre-exercise group (Table 5).

**Discussion**

One session of anaerobic, aerobic and strength training had no significant effect on serotonin and plasma BDNF and there was no significant difference between the groups in this regard. However, one session of aerobic exercise has significantly increased plasma beta-endorphin in proportion to the control group, while one session of anaerobic exercise did not apply the same effect in proportion to the control group. Nevertheless aerobic exercises led to a significant increase in intra-group serotonin and BDNF compared to the pre-exercise state.

In the present study, one session of aerobic and strength training has significantly increased plasma beta-endorphin in proportion to control group; while one anaerobic exercise session had no significant effect on the same index. In various studies that have investigated the effect of short-term strength training on beta-endorphin, it was observed that these exercises led to an increase in the serum beta-endorphin levels [13, 14] that is consistent with the same study results. Variation in beta-endorphin levels during strength training may be related to the exercise protocol (intensity, repetition, and breaks between the sets) [13].

Multiple research results have showed that various short-term aerobic exercises by professional and amateur individuals with an intensity of 90-60% of maximum oxygen would result in a significant increase in the plasma beta-endorphins levels [16] that are consistent with aerobic exercise results that are in the present study. The beta-endorphin secretion depends on the intensity and volume of both aerobic and anaerobic exercise [17]. In the present study, the intensity of exercise was at maximum but since the duration of the exercise was optional and depended on the physical capacity of the individuals until exhaustion, therefore, they did not finish the exercise at the same time. On the other hand, Bandar et al. (2007) have stated that duration of the exercise has been more effective in beta-endorphin secretion than intensity of the exercise [18], consistent with Bandar et al., since in the present study, anaerobic exercises were performed at maximum intensity, they were done in shorter time frame than aerobic exercises; and on the contrary, since aerobic exercises were done with less intensity, they were performed in longer time frame than anaerobic exercises. Therefore, these anaerobic exercises did not increase β-endorphins. De Luigi et al. (2003) have showed that

---

**Table 4. Anthropometric characteristics of subjects**

<table>
<thead>
<tr>
<th>Group/Parameter</th>
<th>Height (cm)</th>
<th>Age (year)</th>
<th>Fat Body percentage</th>
<th>Weight(Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>181.12±2.79</td>
<td>21±1.19</td>
<td>20.51±6.81</td>
<td>78.87±11.88</td>
</tr>
<tr>
<td>Anaerobic group</td>
<td>182.12±7.92</td>
<td>21.12±1.72</td>
<td>17.62±7.14</td>
<td>72.88±20.27</td>
</tr>
<tr>
<td>Aerobic group</td>
<td>179±7.17</td>
<td>20.27±1.4</td>
<td>15.64±6.04</td>
<td>68.25±12.89</td>
</tr>
<tr>
<td>Resistance group</td>
<td>180±11.2</td>
<td>20.12±1.55</td>
<td>22.67±6.15</td>
<td>85.11±22.29</td>
</tr>
</tbody>
</table>

**Table 5. Statistics related to the happiness mediators**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>Before Exercises</th>
<th>After Exercises</th>
<th>P of Intergroup</th>
<th>P of Out of group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serotonin (ng/ml)</td>
<td>Control group</td>
<td>82.48±7.21</td>
<td>86.84±15.81</td>
<td>0.04</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>Anaerobic group</td>
<td>83.14±21.67</td>
<td>95.74±28.53</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aerobic group</td>
<td>64.43±14.24</td>
<td>78.09±24.07</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resistance group</td>
<td>61.06±23.92</td>
<td>70.22±23.47</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>Beta-Endorphin (ng/L)</td>
<td>Control group</td>
<td>141.08±67.86</td>
<td>142.08±77.86</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anaerobic group</td>
<td>157.47±91.50</td>
<td>175.47±91.50</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aerobic group</td>
<td>195.66±104.5</td>
<td>237.81±105.54</td>
<td>0.007</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>Resistance group</td>
<td>245.26±99.31</td>
<td>276.39±103.21</td>
<td>0.008</td>
<td></td>
</tr>
<tr>
<td>Resistance group</td>
<td>Control group</td>
<td>1.25±0.39</td>
<td>1.24±0.35</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anaerobic group</td>
<td>1.08±0.31</td>
<td>1.53±0.95</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aerobic group</td>
<td>1.23±0.15</td>
<td>1.38±0.31</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resistance group</td>
<td>0.97±0.52</td>
<td>1.17±0.44</td>
<td>0.21</td>
<td></td>
</tr>
</tbody>
</table>
an anaerobic exercise session on 18 male athletes did not increase serum beta-endorphin level [19], and it is consistent with the same study results. Octdalen et al. (2001) have stated that physical activity causes acidosis and as a result reduces blood PH in the body. This will activate the hypothalamus-pituitary axis and will result in the secretion of corticolibin. Corticolibin has been directly poured from the hypothalamus into the pituitary gland and corticotrophin and ACTH have been released by the pituitary. The beta-endorphin secretion from the anterior pituitary is associated with ACTH secretion, thereby increasing the production and secretion of beta-endorphins from the pituitary [20]. Moreover, by binding to receptors, beta-endorphin keeps potassium channels open and calcium channels close, that leading to hypoglycemia, and this phenomenon provides the conditions for beta-endorphin production [21]. On the other hand, the physical activity in hypoxic condition increases beta-endorphin secretion [22].

The present study has showed that three training groups during one sedation session could not result in a significant increase in serotonin level compared to the control group; although aerobic exercises will led to significant intra-group changes. Zhao et al. (2015) have showed that aerobic exercise with an intensity of 65-70% of maximum heart rate did not significantly increase serotonin [23] that is consistent with the results of the same study. Shaykh al-Islam and Salavati (2011) in a study on young men have showed that accession of acute strength training with a small-to-large muscle training protocol led to a significant increase in serotonin, that is not consistent with the present study results; however, the large-to-small training protocol did not result in a significant increase in serotonin that is consistent with the present study results [24]. In the present study, one movement has been considered for the upper trunk and one movement for the lower trunk, respectively. Sharifi et al. (2012) have showed that a training session with Bruce instructions up to fatigue limit resulted in a significant increase in serotonin levels immediately after exercise that is not consistent with the results of the present study [7]. To justify the differences, we can assert that serotonin levels depend on the exercise intensity, duration, protocol, and the elapsed time after the last training session that samples have been taken [11]. As stated, in this study, the plasma levels of BDNF has been increased after three training methods but that was not significant in any of the groups compared to the control group, although there was a significant intra-group difference which has been observed in aerobic exercises. Curie et al. (2010) in a study on 16 young men have showed that strength training session did not significantly change plasma BDNF density; he suggested that the type of exercise program could be a determinant factor of BDNF change in blood circulation [25]. Of course, the results are consistent with the same study results. Several studies that examined short-term moderate-intensity training have showed that this type of exercise will led to an increase in instability in serum BDNF levels that does not have significant implications [26], and it is consistent with the results of the present study. Different results of studies that examine the effect of training can be attributed to the type, duration, and intensity of the training [25]. Peko et al. (2014) have observed that epinephrine has been increased in endurance exercises and intense periodic training; however, epinephrine increase is retained for one hour after endurance, while the same was not observed in the periodic training group. Regarding the maintenance of epinephrine increase for an hour after endurance exercise and cortisol increase in response to severe periodic training, it can be argued that endurance exercises is more proper to increase BDNF than intense periodic training. [27]. BDNF levels are expected to increase regarding the use of muscles in strength training to produce maximum force. [25]. This viewpoint has been supported by reports that BDNF expression is increased in response to skeletal muscle contraction. [28]. It has been suggested that the sources of BDNF are the neurons between the skeletal muscles [25]. On the other hand, Matthias et al. (2009) have showed that although BDNF is produced by muscle, it cannot be transmitted to the bloodstream [29]. It seems in strength training, this is one of the main reasons for the absence of significant increase. On the other hand, Hinen et al. (2015) have argued that BDNF levels were adjusted during aerobic exercise by age, gender, and genetics [30] that could justify these differences in aerobic exercise.

Conclusions
The results of this study have been shown that the increase of internal factors leads to euphoria and feeling of happiness in human beings that seems to be different according to the type of exercise. Factors such as beta-endorphin have been significantly increased after acute strength training and aerobic exercise sessions, while serotonin and BDNF did not significantly increase. Aerobic exercises seem to be the best type of exercise in increasing some hormones which are relevant to joy. With aerobic, anaerobic, and strength training, you can increase joy with respect to the duration and intensity of the exercise but this behavior is not influenced by some hormones alone and many factors affect this behavior.

Acknowledgments
I announce my appreciation to those who helped us in conduction of this research, especially the Physical Education Department of Babol Azad University.

Ethical Approval
All ethical principles were observed during the training process. Code of ethics for this study was obtained from Sabzevar University of Medical Sciences under the following number of IR.MEDSAB.REC.1395.127.

Conflict of Interests
No conflicts of interest have been stated by the authors.
References


276
Information about the authors:

Sharifi M.; Graduated Ph.D. in Sport Physiology; (Corresponding author); http://orcid.org/0000-0002-6605-0241; sharifi.moslem@yahoo.com; Department of Sport Physiology, Faculty of Sport Sciences, Hakim Sabzevari University; Sabzevar, Khorasan Razavi Province, Iran.

Hamedinia M.R.; Professor; https://orcid.org/0000-0002-0973-0435; mrhamedi1350@gmail.com; Department of Sport Physiology, Faculty of Sport Sciences, Hakim Sabzevari University; Sabzevar, Khorasan Razavi Province, Iran.

Hosseini-Kakhak S.A.; Associate Professor; http://orcid.org/0000-0002-7510-2445; sa.hosseini@hsu.ac.ir; Department of Sport Physiology, Faculty of Sport Sciences, Hakim Sabzevari University; Sabzevar, Khorasan Razavi Province, Iran.


The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/deed.en).

Received: 08.08.2018
Accepted: 03.09.2018; Published: 30.09.2018
The effect of combined preconditioning strategies on isokinetic strength in well trained kickboxers

Yilmaz A.1ABCDE, Gurses V.V.2ABD, Gulsen M.3ABC

1Department of Sports Sciences, Baskent University, Ankara, Turkey
2Department of Coaching Education, School of Physical Education and Sports, Kastamonu University, Kastamonu, Turkey
3Vocational School of Health, Baskent University, Ankara, Turkey

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

Abstract

The use of preconditioning strategies (PconSt) alone has a positive impact on performance. However, it is thought that there will be more impact on the performance of the combined preconditioning strategies, and this is the first work to prove it. This study was to examine the effect of combined preconditioning strategies on isokinetic strength in well-trained kickboxers.

Material:

The following preconditioning strategies were combined: morning resistance exercise (MRE), ischemic preconditioning (IP), active warm-up (AW-U), hormonal preconditioning (HP) and post-activation potentiation (PAP). Fifteen well-trained male kickboxers (age: 22.38 ± 4.01years, height: 182.23 ± 1.05cm, body mass: 77.67 ± 8.01kg) volunteered for this study. Peak isokinetic knee extension and flexion moment were determined at 60°/s, 180°/s and 240°/s bilaterally. All participants performed the pre-test and then were randomly divided into Sham and PconSt groups on separate days. For the PconSt group, MRE, IP, AW-U, HP and PAP were implemented sequentially before test.

Results:

The findings indicated significant increase in strength after combined training in the PconSt groups for right leg flexion at 180°/s flexion (p < 0.05). The average percentage strength difference between sham and PconSt groups was 4.12 ± 8.95%.

Conclusions:

This study showed that a combined preconditioning strategy increased isokinetic strength.

Keywords: isokinetic, post-activation, potentiation, ischemic, preconditioning, hormonal.

Introduction

Increasing performance in sports science applications requires implementation of acute training. Exercises known as preconditioning strategies target acute positive effects and are implemented into a basic training routine within the pre-performance period. Examples of preconditioning strategies include morning resistance exercise (MRE), ischemic preconditioning (IP), active warm-up (AW-U), hormonal preconditioning (HP), and post-activation potentiation (PAP) [1] and whole-body vibration (WBV) [2]. Recently, studies have reported that preconditioning strategies have been used to increase athletic performance effectively, especially with respect to muscular strength, power output [1] and sprint performance development [2]. However, to date, no study has examined the effect of combining these strategies. Kilduff et al. [1] stated that performance in short-duration, high-intensity sports could be augmented by implementing single or multiple acute exercise strategies.

MRE is a preconditioning strategy in which exercises are performed 4–6 hours before the event. The aims of MRE include decreased reflex inhibition, increased central nervous system activation, reduced anxiety and improved psychological preparedness. An example MRE routine may comprise 3–6 sets of 5–6 repetitions of exercises such as squats, bench press [3], or backward overhead shot throw [4].

IP is a strategy in which blood flow to blood vessels and tissues is restricted for short periods and is accepted as a method of increasing the ischemic tolerance of tissues [5]. In addition, there are studies that relate IP to improved sports performance. Studies have shown that IP increases the number of muscle channels that are sensitive to intramuscular adenosine triphosphate [6], the number of potassium channels and adenosine levels [7].

Preconditioning strategies are usually implemented using two warm-up techniques. In the first method, the passive warm-up technique, hot packs, saunas, warm water, or heated clothes are used to increase the core or muscle temperature of an individual who is not moving. In the second method, AW-U, exercise leads to a temperature increase. AW-U results in higher cardiovascular and metabolic responses than passive warm-up [8]. In addition, AW-U is used more commonly and results in positive performance increases [9].

In HP, the trainer motivates the athletes using feedback and a video display [5]. The effects of HP are explained by a hormonal shift that develops in connection to an increase in motivation and confidence. This increase in testosterone level in turn provides improvements in strength performance [2].

Another strategy, PAP, is a dynamic method used to increase top power output. Alternatively, PAP may result in additional muscle contraction at the moment of voluntary maximal contraction; this is achieved by repeating contractions at 75–100% of the maximum [11]. While the rationale behind PAP involves deception of the neural system [22], an increase in motor neuron stimulation speed could be theorized based on an increase in the Ca2+ sensitivity of actin-myosin filaments [12, 13] and an increase in light chain phosphorylation [10, 14].
assessing strength performance gains after implementing combined preconditioning strategies. These devices must be designed to measure the speed of movement, which was difficult to determine before isokinetic dynamometers became available [14]. Isokinetic dynamometers are used in evaluating neuromuscular functions and can be used to provide a significant increase in strength performance [15]. Isokinetic movement involves contraction at a constant rate throughout the range of motion; this contraction is at peak moment for each angle of movement. Maximum isokinetic power is the highest moment value (rotation moment) that an individual can perform during a certain speed of contraction [13]. Evaluation of muscle power is accepted as the main function of these isokinetic dynamometers; they also provide data on moment, work and endurance (i.e., the dynamic performance of muscle) [14].

Previous studies have evaluated individual preconditioning strategies using various protocols and varying results were obtained [1-9]. However, studies evaluating a combination of preconditioning strategies have not been published. It is thought that using a combination of preconditioning strategies will amplify the effect of these strategies on performance. In this context, the purpose of this study is to examine the effect of combined preconditioning strategies on isokinetic strength in well-trained kickboxers. There are two main hypotheses in this study. First, the combined preconditioning strategies will affect isokinetic muscle strength. Second, there will be post-performance differences between the PconSt group and the Sham control group.

Material and methods

Participants. Fifteen well-trained male kickboxers (age: 22.38 ± 4.01 years, height: 180.01 ± 1.05 cm, body weight: 77.9 ± 8.01 kg) volunteered to participate in this study. Table 1 shows the participants’ mean age, weight, height, body mass, fat percentage, resting systolic and diastolic blood pressure and IP cuff pressure (systolic blood pressure [SBP] + 50 mmHg). The athletes participated in weekly micro cycles consisting of 10–12 training for 20 weeks as training for a national championship. None of the participants reported chronic diseases or regular use of medicines. All participants refrained from alcohol, caffeine and additional nutritional training supplements for 24 hours before all experimental testing. Before the study, participants were informed of the study details and signed consent documents. This study was approved by the Baskent University Institutional Review Board and Ethics Committee (Project No.: KA14/301) and supported by the Baskent University Research Fund.

Design. A single-blind crossover randomized control trial was performed. The study design is shown in Fig1. After pre-test prevention; the fifteen participants were divided into randomly Sham and PconSt groups. Anthropometric measurements of participants and a familiarization session were carried out on the first day. The one repetition maximum (1RM) for each participant was assessed by using the same protocol [13] and used for normalization and pretest strength testing was performed the next day. Participants performed the Sham and PconSt protocols on two different days with at least 72 hours and the most 96 hours between measurements to provide adequate recovery and avoid an extended IP effect.

Height and weight were measured using an electronic scale (Seca 707, Hamburg, Germany). Fat-free mass and body mass index were measured by bioelectrical impedance analysis (BIA) (Tanita SC 330, Tokyo, Japan). IP was implemented using a leg cuff (Erka, Bad Tölz, Germany). Heart rate and arterial oxygen pressure were determined with a pulse oximeter (Beurer PO30, Ulm, Germany). Muscle strength measurements for knee flexor and extensor muscles were assessed using a computed isokinetic dynamometer (Cybex 770 Norm, Lumex Inc., Rankokoma, NY, USA) at angular velocities of 60°/s, 180°/s and 240°/s. Blood pressure (BP) measurements were also taken at baseline. Preconditioning strategy application for the PconSt group was implemented in the order given below (Fig 2).

Morning resistance exercise (MRE). MRE was implemented in the PconSt trial 6 hours before strength testing, similar to the method used by Cook et al, [3] The

<table>
<thead>
<tr>
<th>Table 1. Subject characteristics and resting blood pressure.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Age (y)</td>
</tr>
<tr>
<td>Weight (kg)</td>
</tr>
<tr>
<td>Height (cm)</td>
</tr>
<tr>
<td>BMI</td>
</tr>
<tr>
<td>O₂sat (%)</td>
</tr>
</tbody>
</table>

Values are mean ± SD; n = 15; O₂sat (%) = percentage of oxygen saturation, SBP = systolic blood pressure, IP = ischemic preconditioning.
PconSt trial performed 10 repetitions at 50% of 1RM squat in warm-up, then three repetitions at 70% of 1RM squat followed by three repetitions at 90% of 1RM squat. Ninety seconds of rest was provided between sets; three sets were performed in total, including the warm-up. The MRE protocol for the sham group was not applied in a weighted environment to avoid performance increases associated with body-weight resistance.

Ischemic preconditioning (IP). IP was carried out 50 minutes before the isokinetic measurements in a similar way to that described by Crisafulli et al. [21] IP was implemented using a leg cuff pressure of 50 mmHg higher than the participant’s systolic blood pressure. After inflating the leg cuff, the circulation of the foot artery (metatarsal artery) was checked to confirm complete interruption. IP implementation was performed separately for each leg during three 5-minute intervals in a supine position. Oxygen saturation, heart rate and blood pressure were checked continuously. In the sham group, IP implementation was performed for a single 5-minute period at a standard 20-mmHg cuff pressure. After inflating the leg cuff, the circulation of the metatarsal artery was checked for reductions [22, 24].

Active warm up (AW-U). Athletes performed a 10-minute AW-U on a treadmill at 9 km/h following the IP session. Then, three sets of maximal jumping were performed over 10 seconds. In the sham group, athletes performed a classical warm-up consisting of 10 minutes of running and 5 minutes of dynamic stretching [23].

Hormonal preconditioning (HP). In the PconSt trial, verbal warnings and feedback were provided separately for each athlete by their trainers over a 4-minute period and athletes watched 5-minutes of their own kickboxing match videos [16]. In the sham group, trainers discussed tactical factors only and avoided motivational speech.
Post-activation potential (PAP). The PAP protocol was performed 10 minutes before the isokinetic test. The protocol composed of three sets of three repetitions at 75% of 1RM half squat with a 2 minutes rest between each set [20, 25]. In the sham group, participants performed one set of three squat repetitions without any extra load. Ambient temperature was kept at 22°C during the measurements.

Assessment of muscle strength: Muscle strength measurements were carried out using a computed isokinetic dynamometer. The dynamometer was calibrated by a technical service before testing began. Athletes were fixed with dynamometer belts around the upper body, waist and legs. Joint axis locations were aligned with dynamometer axes and fixed close to the expected maximum moment angle for active and passive conditions. All athletes performed 10 minutes of AW-U and 5 minutes dynamic stretching. They performed three repetitions on the same day for familiarization. Five repetitions were carried out at each angular velocity on the test day. Two minutes of rest were provided between sets. Isokinetic strength measurements were implemented bilaterally [14] at angular velocities of 60°/s, 180°/s and 240°/s. All isokinetic measurements were taken by the same researcher. Gravity correction techniques were applied and strong verbal feedback was used during all isokinetic tests. Peak isokinetic strength measurements for both extension and flexion at angular velocities of 60°/s, 180°/s and 240°/s were recorded automatically by the dynamometer [28].

Statistical Analyses. Statistical analyses were performed using SPSS 18.0 software (SPSS Inc., Chicago, IL, USA). All data are represented as mean ± SD and statistical significance was defined as p < 0.05. A two way analysis of variance (ANOVA) (time × groups) was used to analyze the significance of strength values. Statistical power was calculated using G*Power computer software. With 15 participants and a crossover design, the study power was determined as 83%.

Results

According to isokinetic testing results, a statistically significant difference was determined between pretest and PconSt group flexion strength of the right leg at the 180°/s angular velocity (RL180°F) (p < 0.05) (pretest mean ± SD: 83.7 ± 28.6 Nm, PconSt mean ± SD: 111.5 ± 33.8 Nm). Right leg strength values increases from pretest results ranged from 5.0% to 24.93% and the statistically significant increase in strength for the RL180°F group was calculated as 24.93%. No significant differences of RL180°F changes between sham and PconSt groups were observed. In addition, statistically significant differences were found between the left leg pre- and PconSt values at 240°/s extension angular velocity (LL240°E) (pretest mean ± SD: 136.7 ± 39.1 Nm; PconSt mean ± SD: 162.7 ± 33.0 Nm), 180°/s flexion angular velocity (LL180°F) (pretest mean ± SD: 71.6 ± 31.8 Nm; PconSt mean ± SD: 98.2 ± 22.1 Nm) and 240°/s flexion angular velocity (LL240°F) (pretest mean ± SD: 69.8 ± 26.5 Nm; PconSt mean ± SD: 94.6 ± 19.2 Nm). These results are represented graphically in fig 3a and 3b. Left leg strength increases from pretest results ranged from 8.96% to 27.09% and the statistically significant increase in strength was calculated as 15.98% for the LL240°E group, 27.09% for the LL180°F group and 26.22% for the LL240°F group. Furthermore, significant difference of left leg flexion strength at 240°/s angular velocity (LL240°F) between sham and PconSt group (PconSt mean ± SD: 110.0 ± 9.8 Nm; sham mean ± SD: 94.6 ± 19.2 Nm) was observed. Statistically significant performance increase of 13.9% was observed in the PconSt group for LL240°F. According to the two way analysis, there were no statistically significant differences at other angular velocities for either the left or the right leg between pre and PconSt values. In addition, statistically significant differences were determined between sham and PconSt groups for left leg extension strength at 60°/s angular velocity (LL60°E) (PconSt mean ± SD: 201.8 ± 16.9 Nm; sham mean ± SD: 186.0 ± 24.4 Nm), left leg flexion strength at 60°/s angular velocity (LL60°F) (PconSt mean ± SD: 126.2 ± 21.9 Nm; sham mean ± SD: 103.8 ± 22.6 Nm). Statistically significant performance increases of 7.4% and 17.7% were observed in the PconSt group for the LL60°E, LL60°F, respectively. No statistically significant differences were determined between sham and PconSt group at other angular velocities for either the left or the right leg. A comparison of the results for the PconSt and sham groups is shown in fig 3c and 3d.

Discussion

This study examined the effects of combined preconditioning strategies on isokinetic strength in well-trained kickboxers. The main finding of this study was that acute combined preconditioning strategies may enhance the strength performance of these athletes. To our knowledge, this is the first study in which multiple, sequenced applications were performed before the event at different time intervals. A sham protocol was used to minimize the effect of psychological factors; statistically significant differences between the PconSt group and sham group are shown in Fig 3c and 3d. Differences in strength performance between the PconSt and Sham groups ranged between −11.38% and 17.75% for different angular velocities; the average difference was 4.12 ± 8.95%. Because there is no comparable study on combined preconditioning strategies, the current results were compared with previous studies of individual preconditioning strategies, including those on MRE, IP, AW-U, HP and PAP [3-11]. Most of the studies on individual preconditioning strategies have not reported an increased or decreased performance percentage. However, in a meta-analysis study, it was reported that 78% of the articles analyzed found that various warm-up applications improved athletic performance [6]. In addition, a study of MRE performed 6 hours before the event showed increased pitching performance; these results match those of the current study. The same study also reported that jumping exercises with an additional 2% body-weight load performed and increased active
and squat jumping performance [16]. In another study on MRE, hormone levels and the performance effect of power exercise performed in the morning or in the afternoon were investigated; the study concluded that strength exercise performed in the morning increased afternoon performance [6]. Tillin and Bishop reported that 87% of 1RM chest press (3 sets of 3repetitions) provided an increase in upper-body power output [18]. IP with a 220-mmHg cuff pressure applied to 13 participants exercising at a medium level (4×5 minutes ischemia application) increased 5-km running times by 5% [26]. Similarly, 3×5 minutes double-leg IP (220-mmHg cuff pressure)
increased the maximum oxygen capacity and power output of 15 elite cyclists by 3% and 2.6%, respectively [27]. In another study performed on 12 amateur male cyclists, 5 minutes of ischemia was implemented on both legs with a 220-mmHg cuff pressure. Although the power output value for the IP group was 290 W compared with 278 W for the sham group, a statistically significant difference was not determined (p>0.05); the study concluded that IP did not provide performance increases in sub maximal exercise volume or level of fatigue [19]. Applications that aim to increase performance in connection with cortisol and testosterone level are called HP or hormonal preconditioning [16]. Increases in hormone levels result from positive feedback provided by trainers and from watching motivational videos. In a previous study, the effects of motivational videos and coach feedback on cortisol and testosterone hormone levels were evaluated; the application of these preconditioning activities resulted in maximal free testosterone levels and performance increases [3].

In another study performed on eight recreationally trained male participants, the effects of isokinetic short muscle contraction on jump performance were analyzed. The study reported that different preconditioning protocols did not result in statistically significant differences in jump performance. PAP depends upon maximal voluntary contraction and increase of muscle power principles. The effect of PAP is affected by factors such as size of applied muscle, fibril type in muscle, fast and slow twitch fibril percentage, maximal contraction volume and sub maximal contraction volume [16].

This study has several limitations. Because there are no previous studies of multiple preconditioning strategies, the completion of the sequential preconditioning strategy protocols took longer than expected, especially with challenges that occurred during the measurements. Another limitation was the difficulty of taking blood samples to detect metabolic changes. Overcrowding at the hospital where testing took place, the athletes training to compete in the national championship and the time-intensive application of sequential preconditioning strategies made it difficult to assess testosterone and cortisol levels. A third limitation of this study was the lack of blinding; the sham group realized which testing protocol they were performing.

In the current study, left leg isokinetic strength parameters (at pre-and PconSt and between tests) showed statistically significant differences. It is thought that the reason for these differences was that the left leg was non-dominant in all except one of the participants.

The current study showed that preconditioning strategies have a placebo effect, as demonstrated by the statistically significant difference between pre-test and PconSt results for the sham group. However, the statistically significant difference between the PconSt and sham groups after the experiment demonstrates the necessity for sham groups in similar studies on preconditioning strategies. It also shows that the PconSt group benefited from the actual application of combined preconditioning strategies. Consequently, the findings of this study show that combined preconditioning strategies can increase strength performance.

**Conclusion**

This study showed that a combined preconditioning strategy increased isokinetic strength. Therefore, the systematic combination of preconditioning strategies may provide performance improvements, specifically in strength.

**Highlights**

The application of preconditioning strategies in a systematic manner provides performance increases, specifically in strength. The results, therefore, show that if coaches and trainers implement this combined protocol prior to an event, they may be able to increase athletic performance in the athletes. This combined preconditioning technique could be used in kickboxing, boxing, some branches of track and field, swimming and many other sports in which anaerobic performance plays a large role.

**Acknowledgments**

The authors would like to thank the athletes who took part in this investigation and their coaches for their enthusiastic participation.

**Conflict of interest**

The authors declare that they have no Conflicts of interest concerning this article.

**References**


6. Clevidence MW, Mowery RE, Kushnick MR. The effects of ischemic preconditioning on aerobic and anaerobic variables
9. Bishop D. Warm up II: Performance changes following active warm up and how to structure the warm up. Sports Medicine, 2003;33: 483–498.

Information about the authors:
Yilmaz A. (Corresponding author); http://orcid.org/0000-0002-4520-0220; atakan@baskent.edu.tr; Department of Sports Sciences, Baskent University; Baglica Kampı, Eskişehir Yolu 20. Km., 06810 Etimesgut/Ankara, Turkey.
Gurses VV.; http://orcid.org/0000-0002-6249-3504; vgurses@kastamonu.edu.tr; Department of Coaching Education, School of Physical Education and Sports, Kastamonu University; Cebrail Mahallesi, Alptekin Sok. No:5, 37200 Kastamonu Merkez/Kastamonu, Turkey.
Gulsen M.; http://orcid.org/0000-0002-8826-8524; mgulsen81@hotmail.com; Vocational School of Health, Baskent University; Bağlica Kampüsü, Eskişehir Yolu 20. Km., 06810 Etimesgut/Ankara, Turkey.

The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive
This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/deed.en).
Received: 31.07.2018
Accepted: 20.08.2018; Published: 30.09.2018
SUBMISSION OF MANUSCRIPTS
(For more detailed information see http://www.sportedu.org.ua/index.php/PES/pages/view/trebovaniya-e)

Structure of article:
- title of an article;
- surname, full first name and patronymic;
- full name of organization (place of work or study);
- annotation in three language (Russian, Ukrainian, English). The scope of the annotation is to be 800-1000 symbols. Annotation must contain translate of surname, full first name and patronymic of authors, in Ukrainian (Russian) and English. Structure of annotation: aim, material, result. For authors from Russia, the translation in the Ukrainian language makes editorial board.
- Key words for the three languages: (1-2 lines of words. Do not use word combinations).
- Introduction (statement of a problem; analysis of the last researches and publications of this theme; to single out the open problem in the research article).
- Connection of the article with important scientific programs or practical tasks.
- Aim, tasks, material and methods.
- Results of the research (description of the main research material with full substantiation of the derived scientific results).
- Findings.
- Perspectives of future researches in this direction.
- Bibliographic references (more than 20) should be making up according to standard form.

REVIEW PROCEDURE FOR MANUSCRIPTS (For more detailed information see http://www.sportedu.org.ua/index.php/PES/pages/view/recenzirovaniye-e)
All manuscripts submitted for publication must go through the review process.

TREATMENT OF MANUSCRIPTS (For more detailed information see http://www.sportedu.org.ua/index.php/PES/pages/view/rassmotreniye-e)
Manuscripts are assessed by the Editorial Board within 1 month.
The Journal will acknowledge receipt of a manuscript within 2 days.

EDITORIAL ETHICS (For more detailed information see http://www.sportedu.org.ua/index.php/PES/pages/view/ethics-e)
The journal is committed to a high standard of editorial ethics.
Editorial board is used the principles of ethics of scientific publications upon recommendations of International Committee of Medical Journal Editors.
Conflicts of interests of persons who have direct or indirect relation to the publication of an article or any information that the article consist are settled according to the law of Ukraine in the field of intellectual property.

CONTACT INFORMATION
box 11135, Kharkov-68, 61068, Ukraine
phone. +38 099 430 69 22
http://www.sportpedu.org.ua
e-mail: sportart@gmail.com

Information:
Sponsors, Partners, Sponsorship:
• Olympic Academy of Ukraine
• Ukrainian Academy of Sciences.

SCIENTIFIC EDITION (journal)
Physical Education of Students, 2018;5
Editorial to the publisher department KSPU:
certificate DK №860 20.03.2002.

designer - lermakov S.
editing - Yermakova T.
administrator of sites - lermakov S.
designer cover - Bogoslavets A.

passed for printing 30.09.2018
Format A4.
PRINTHOUSE (B02 № 248 750, 13.09.2007).
61002, Kharkov, Girshman, 16a.