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DEVELOPMENT OF HOCKEY GAME AND MODEL FOR LEARNING PHYSICAL EDUCATION IN CHILDREN'S ELEMENTARY SCHOOL

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Summary: The purpose of this study is to develop tools and products for the hockey water pipe (PSA) game model in order to overcome the problem of limited facilities and infrastructure and improve students' movement coordination skills and increase the variety of small ball games. This research is a research and development (RnD) that refers to Sugiyono's (2013) theory which is product oriented. The results of this study have been found (1) the Hockey PSA game model can attract the attention of upper elementary school students to get to know the Hockey game (2) The Hockey PSA game model can add variety to the game for teachers who teach upper grade elementary school children (3) the game model PSA Hoki can express the imagination of upper elementary school students in the combination of modification of tools and games with the results of the affective aspects of the trial that is the aspect of students willing to play again obtained a percentage of 92.08% (very feasible). The conclusion of this research is the Hockey PSA game model can overcome the problem of limited facilities and infrastructure improve student movement coordination and increase the variety of small ball game material.

Keywords: modifications, hockey, games, physical education, learning, elementary school

Introduction

The little ball game is one of the subject matter that exists in the elementary school physical education learning process (Burhaein 2017b; Mustofa Mansur & Burhaein 2019). Based on the information and provisions in the references used in the 2013 curriculum in the Basic Competence (KD) section a physical education teacher at a high school can be individually developing their creativity in the learning process (Kemendikbud RI 2013). Creativity can be through games that refer to the concept of motion in games that use small ball media (Burhaein 2017a; Purnomo Tomoliyus & Burhaein 2019). The theory of motion in games carried out in physical education learning includes variations and combinations of basic motion patterns namely locomotor motion non-locomotor motion and manipulative motion.

Small ball game is a game which in its implementation uses a small ball. In addition to small balls most small ball games use tools to support them (Ardian Suharjana & Burhaein 2019; H. Hakim 2013). There are many kinds of small ball games including baseball rounders kippers roasted balls (Mustofa et al. 2019; Sintara & Sonchan 2015). One type of small ball game that is almost never taught in the physical education learning materials of upper class elementary schools is Hockey.

Hockey is one type of small ball game. Hockey is a game that is played between two teams each team using a crooked stick or stick to move the ball (Kaur 2018; Phytanza Burhaein Sukoco & Ghautama 2018). The goal of the Hockey game is to put the ball as much as possible into the opponent's goal and keep the goal in order not to concede the ball.

Researchers conducted observations and observations at elementary school (SD) Muhammadiyah Kregan Cangkringan. The introduction of the Hockey game was done to elementary school children but it did not continue due to damaged infrastructure and the modification of the hockey game model so elementary school children did not have any knowledge of the Hockey game. In addition limited facilities are the main cause of the introduction of Hockey material when learning upper-class physical education in elementary schools. In this regard the implementation of the game of Hockey sticks will become a very important part in the implementation of learning activities both Hockey sticks that are in accordance with the standards or modified Hockey sticks (Jerath & Long 2020; Pramantik & Burhaein 2019). Based on the identification results not all elementary schools in Sleman have a number of Hockey sticks which are adequate for implementing Hockey game learning.

Modification is an attempt to make the game of Hockey easier and more interesting to be played by students (A. Hakim Ambardini Nugroho & Burhaein 2018; Wibawa 2017). In addition modification is expected to change the notion that Hockey is dangerous and does not need to be taught in elementary school physical education. In field hockey the number of players is twenty-two (22) for 2 teams with a composition of 20 players and 2 goalkeepers then the size of the field used is 91.40 meters long and 55 meters wide (Ciavarro Dobson & Goodman 2008; Phytanza & Burhaein 2019). Researchers conducted interviews with a number of hockey game equipment traders and obtained the results of playing field hockey using a ball at a price of Rp. 200000 - and sticky wood (stick) the purchase price of each stick (stick) reaches Rp. 1000000 per stick and body protector for the goalkeeper whose prices reach tens of millions. This is one of the reasons behind the lack of introduction of the game of Hockey for elementary school children.

With games that are packaged creatively it will be fun for upper class students to play the game of Hockey and save on the costs needed. Furthermore physical activity can benefit the child and the child is better prepared to continue the next meeting with more complex material. For this reason the form of hockey game activities needs to be developed to meet students' needs for movement and which will support the process of growth and development as well.

Methods

Participant

The participants of this study were students of grade 6 SD Muhammadiyah Kergan in Cangkringan sub-district in Indonesia. The number of participants with a total of 25 students 13 boys and 12 girls with ages 12-14 (M = 13.5; SD = 1.49).

Research methods

This research is a type of development research (Research and Development). Steps for Using the Research and Development (R&D) Methods according to Sugiyono (Sugiyono 2014) are: 1. finding the potential problems; 2. data collection; 3. product design; 4. validity; 5. design revision; 6. product trials; 7. product revisions; 8. product trials; 9. product revisions; 10. mass product/ yield.

Instrument and Data collection technique

The instrument used in this study was the product of the validity of the material expert. The validity of the product is obtained from the results of filling out the questionnaire and evaluation sheet given to the validator. The questionnaire was based on the assessment needs. The type of data used in this study is quantitative and qualitative data. Quantitative data are scores obtained from questionnaires filled in by material experts media experts and students. While the qualitative data obtained from the results of the conversion of scores of quantitative data obtained by the assessment determining the quality of the game model.

Data analysis

Data analysis techniques are the ways how to find out the results of research conducted. Data analysis includes all the activities of clarifying, analyzing, using and drawing conclusions from all data collected in action. After the data is collected, the data will be processed. The data analysis technique used in this study is a quantitative analysis technique that is assessment using numbers.

Percentage is intended to find out the status of something that is presented and presented as a percentage. The calculation formula for eligibility according to Sugiyono (Sugiyono 2014) is as follows:

$$\textbf{Formula}: \frac{SH}{SK} \text{ x } 100\ \%$$

Information:

SH: Calculate Score

SK: Criterium Score or Ideal Score

The results of subsequent data calculations are made in the form of a percentage multiplied by 100 %. The results of the percentage obtained with the formula then include the feasibility of a hockey game model for physical education learning for upper grade elementary school children in this development research which is classified into five categories of eligibility that are not feasible, less feasible, decent enough, decent and very feasible.

Result

1. Material Expert Validation Data

Material experts who become validators in this research development are Dra. Sri Mawarti M.Pd. namely an expert lecturer in the field of hockey sports Faculty of Sports Science Yogyakarta State University. Researchers chose him as a material expert because his competence in the field of hockey games was very adequate. Material expert data retrieval was carried out in April 2017 obtained by providing initial media products and the book "Game Model of Hockey" along with assessment sheets in the form of questionnaires.

1) Suggestion

The validator gives advice in the revised section column "no. 11 which is meant for what kind of skilled?"

2) Comments

The general comments and suggestions column the validator as a material expert gives input to the hockey game product model that is "tools facilities and infrastructure can be used for fourth grade elementary school students in addition to game subjects".

Table 1

Data from Expert Material Evaluation Results

No.	Rated aspect	Score Obtained	Maximum Score	Percentage (%)	Category
1.	Theory	61	75	81%	Very decent
Total Score		61	75	81%	Very decent

Source: Primary data processing for 2017

In the validation of the percentage obtained 81 % thus it can be stated that according to the material expert at the stage of validation of the hockey game material that was developed from the aspect of the feasibility of the contents of the material get the category "Very Eligible".

2. Validation of Infrastructure (Sarpras) Expert

Infrastructure expert who became the validator in this research development was Dra. A.Erlina Listyarini M.Pd. He is an expert lecturer in sports facilities and infrastructure Faculty of Sports Science Yogyakarta State University. Researchers chose him as a material expert because of his competence in the field of facilities and infrastructure especially for playing hockey which was very adequate.

Material expert data retrieval was carried out in April 2017 obtained by providing initial media products and the book "Game Model of Hockey" along with assessment sheets in the form of questionnaires.

1) Suggestion

The validator provides advice in the revised section column "game rules (number of players) improved"

2) Comments

The general comments and suggestions column the validator as the material expert gives input to the hockey game product model namely "If the researcher still determines the number of participants the title must be changed but if it matches the title above then the number of players (participants) is replaced with the number of students there are. divided into 2 (two) teams (because of learning) ".

In the validation of the percentage obtained 81% it can be stated that according to the expert on facilities and infrastructure at the stage of validation of the facilities and infrastructure of hockey games developed from aspects of the feasibility of facilities and infrastructure get the category "Very Eligible".

Table 2

Data from Sarpras Expert Assessment Results

No.	Rated aspect	Score Obtained	Maximum Score	Percentage (%)	Category
1.	Sarpras	61	75	81%	Very decent
Total Score		61	75	81%	Very decent

Source: Primary data processing for 2017

3. **Data on Validation of Physical Education Learning Experts**

Physical education learning expert who is a validator in this research development is Ahmad Rithaudin M.Or. he is an expert lecturer in the field of learning Faculty of Sports Science Yogyakarta State University. Researchers chose him as a physical education learning because his competence in the field of facilities and infrastructure especially for hockey games was very adequate.

Data collection on physical education learning experts was carried out in April 2017 obtained by providing an initial media product and a "hockey game model" book along with an assessment sheet in the form of a questionnaire or questionnaire.

1) Suggestion

The validator provides advice in the revised section column "rules for using the tool?"

2) Comments

The general comments and suggestions column the validator as the material expert gives input to the hockey game product model that is "Although the rules for using equipment are not included in the rules but when practicing it is necessary to emphasize that in the game actually only one side is allowed to hit the ball".

4. **Physical Education Expert Validation Data Validation**

In the validation of the percentage obtained 86% thus it can be stated that according to the learning expert at the validation stage the physical education learning activities of hockey games developed from aspects of the feasibility of physical education learning get the category "Very Eligible".

Table 3

Data on Assessment of Physical Education Experts Assessment

No.	Rated aspect	Score Obtained	Maximum Score	Percentage (%)	Category
1.	Learning	65	75	86%	Very decent
Total Score		65	75	86%	Very decent

Source: Primary data processing for 2017

In the validation of the percentage obtained 86% thus it can be stated that according to the learning expert at the validation stage the physical education learning activities of hockey games developed from aspects of the feasibility of physical education learning get the category "Very Eligible".

5. Validation of Physical Education Practitioners

Physical education learning expert who is a validator in this research development is Alfia Safitri S.Pd. She is a physical education teacher at Muhammadiyah Kregan Cangkringan Elementary School. Researchers chose him as a physical education practitioner because he was a physical education teacher who would later use research products in the learning process.

Data collection on physical education learning experts was carried out in April 2017 obtained by providing an initial media product and a "hockey game model" book along with an assessment sheet in the form of a questionnaire.

1) Suggestion

The validator as a physical education practitioner does not give advice in the revised section column.

2) Comments

The general comments and suggestions column the validator as a physical education practitioner does not provide general comments and suggestions in the column. The validator gives a conclusion that this model is "feasible for use / small-scale trials without revision".

Table 4

Data on Physical Education Practitioner Assessment Results

No.	Rated aspect	Score Obtained	Maximum Score	Percentage (%)	Category
1.	Learning	65	75	86%	Very decent
Total Score		65	75	86%	Very decent

Source: Primary data processing for 2017

In the validation of the percentage obtained 86% thus it can be stated that according to physical education practitioners at the validation stage of physical education learning activities hockey games developed from aspects of physical education learning eligibility get the category "Very decent".

6. Testing of elementary students (small group trials)

Table 5

Results Data on Students or Respondents

No.	Rated aspect	Score Obtained	Maximum Score	Percentage (%)	Category
1.	Psychomotor	224	240	93.33	Very decent
2.	Cognitive	210	240	87.50	Very decent
3.	Affective	221	240	92.08	Very decent
Total Score		655	720	90.97	Very decent

Source: Primary data processing for 2017

The results of the questionnaire of elementary school students at an early age regarding hockey game media showed that for the assessment of psychomotor aspects 93.33% were categorized as "Very Eligible" cognitive aspects were 87.50% categorized as "Very Eligible" and affective aspects amounted to 92.08% which were categorized " Very Worthy ". The total assessment of the feasibility test of the hockey game training model according to high school elementary school student respondents was 90.97% categorized as "Very Eligible" which means that the model was very feasible to use so it did not need to proceed to large group trials.

Discussion

The research and development of this hockey game was designed and produced into an initial product in the form of learning activities of game materials on physical education subjects for upper elementary school children. Researchers develop this by presenting a hockey game model with a glimpse of the material and rules of the game. The process of developing this model through research and development procedures in several stages of planning production and evaluation. Then the product is developed by looking at the literature relating to game systems and hockey equipment modified using water pipes so that a new hockey game model is produced. The product goes through the next stage to be evaluated to experts through expert validation.

After the expert validation then the product needs to be tested on the participants of the upper class elementary school children. In the evaluation phase material experts facilities and infrastructure specialists physical education learning experts and physical education practitioners. The research phase was carried out by small group trials in this study as many as 24 students to test the final feasibility of the hockey game model developed by researchers.

This hockey game model is included in the "Very Eligible" criteria. This statement can be proven from the results of the "Very Eligible" assessment analysis from four experts including material experts, facilities and infrastructure experts, physical education learning experts and physical education practitioners. The results of the small group trial evaluation give the conclusion that the total data falls under the "Very Eligible" criteria. High school elementary students feel happy and enthusiastic about this product because high school elementary students are interested in learning and hope that this product can be disseminated to other high school elementary students.

The teacher and several parents of upper elementary school students welcomed the hockey game model. According to them the strengths of the game models are that they are still a new game for children, a unique game tool, a modified game system adapted for learning so that it makes primary school students interested and then has an impact on hockey game products as playing support to attract the attention of high school elementary students. The visual advantage with a bat from a modified water pipe and goalpost makes hockey games interesting and is loved by high-grade elementary school children (Jerath & Long 2020; Mustofa et al. 2019). High school students' interest in media Hockey games are motivations that can increase student interest during the play process related to increased student movement activities. This product also allows high school elementary students to provide a cognitive understanding of the basic game of hockey. This product is intended for upper elementary school students so they can play actively and independently because this product is easy to use because basically it has been technically modified for elementary school age children.

With the advantages of this product as for the weaknesses in this product include students who are comfortable playing using games without additional tools such as soccer and volleyball then need some time to adapt using sticks as a hockey ball beater. A small portion of students show difficulties at the beginning of learning then start smoothly during learning. Some of these weaknesses are expected to receive attention and further development efforts to obtain better product results. This fact will increasingly open up opportunities for further holding of further research with different aspects.

The test results can be described in the following discussion:

1. Testing of material experts

The results of the validation test through a questionnaire to material experts showed a level of relevance to the material level of 81 %. The results of the validation mean that the material in the hockey game model is very suitable for use in physical education learning in the field.

2. **Testing of facilities and infrastructure experts**

The results of the validation test through a questionnaire to the facilities and infrastructure experts the level of relevance to the material level was 81%. The results of the validation mean that the supporting infrastructure in the hockey game model is very suitable for use in physical education learning in the field.

3. **Testing of physical education learning experts**

Validation test results through a questionnaire to physical education learning the level of relevance into the learning level of 86 %. The results of the validation mean that the supporting infrastructure in the hockey game model is very suitable for use in physical education learning in the field.

4. **Testing of physical education practitioners**

The results of the validation test through a questionnaire to physical education practitioners the level of relevance into the category of 86 %. The results of the validation mean that the concept of the practice of movement activities in the hockey game model is very suitable for use in learning physical education in the field.

5. **Testing for elementary students (Small group trials)**

The results of the questionnaire of elementary school students at an early age regarding hockey game media showed that for the assessment of psychomotor aspects 93.33 % were categorized as "Very Eligible" cognitive aspects were 87.50 % categorized as "Very Eligible" and affective aspects amounted to 92.08 % which were categorized " Very Worthy ". The total assessment of the feasibility test of the hockey game training model according to high school elementary school student respondents was 90.97 % categorized as "Very Eligible" which means that the model was very feasible to use so it did not need to proceed to large group trials.

Conclussion

The results of the research into media development of the hockey game model are categorized as very appropriate to be used as learning media to provide an understanding of the game of hockey for elementary school children. This can be seen from the results of the assessment of material experts 81.00 % Infrastructure Specialists 81.00 % Physical Education

Specialist 86 % Physical Education Practitioners 86% and based on the results of field trials of 90.97 %.

The contributions of this study are: 1) For Physical Education teachers who support elementary school children in order to be able to utilize and apply this hockey game model as a variation in the delivery of material to attract and motivate high school students; 2) For schools where upper elementary school children learn in order to be able to use hockey games as an educational medium in introducing hockey sports; and 3) For upper elementary school students to be more motivated in playing and observing how to play this hockey game material. Suggestions for further research are expected to develop media models for hockey games more interesting and effective in learning and physical activity based on the shortcomings of this study.

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Conflict of Interest

The author states there is no conflict of interests.

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CAN THE REGULAR PHYSICAL LOAD CHANGE THE FUNCTIONAL STATE OF PUPILS IN ELEMENTARY SCHOOL?

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Summary: The functional status of the organism is a cluster of aerobic, cardiorespiratory and cardiovascular ability in co-operation with the muscular ability ensuring physiological activity of myocard and muscles in the form of regular dynamic and static active movement. Nowadays is observed an increasing lack of physical activity in the pediatric population, which is reflected in the increasing number of the civilization diseases. The aim of this work was to show the impact of regular dynamic activity on the functional status of the cardiovascular system and fitness in schoolable children (n = 100) using Ruffier's functional test. The values of the Ruffier index were monitored and compared in groups of girls (n = 25) and boys (n = 25) involved in regular school activity within subject „Physical education" in comparison with groups of children participating also in regular out-of-school physical activity (girls n = 25, boys n = 25) during 5 months. The most significant result ($p < 0.001$) was observed in functional status of children involved in both regular and after-school activity after 5 months. Presented work showed the significant impact of regular physical activities on circulatory system and muscular work of schoolable children.

Key words: children, load, physical load, cardiovascular system

Introduction

One of the conditions how to maintain health and healthy lifestyle is regular physical activity. The movement is a resource of expressing personality and communication, it is a complex of human behavior that includes all human movement activities (Pastucha et al. 2011). The physical activity is human manifestation including all activities performed by the skeletal muscle system with the interaction of all physiological functions. The movement is one of the basic demonstration between the body and the external environment as well as is a factor of a child's mental development (Hrabinec et al. 2017).

The functional ability of the organism (aerobic ability, cardiorespiratory or cardiovascular ability) is in cooperation with muscle ability, flexibility and body composition of the aerobic ability of the organism. It is defined as "the body's ability to receive and use oxygen efficiently mainly from physical activity". The content and form of physical activity is important for adaptation to individual variations - biological age, current health status, interests, functional fitness, gender, range of motion of the individual (Pokorný 2004). In the resting phase of the organism, a large part of the total blood flow leads to the digestive tract and kidneys. During exercise the arterioles dilate in the muscle fibers, reduce resistance and redirect more blood flow to the relevant organ systems and also reduce the relative flow to the digestive tract and kidneys, while the blood flow to the brain remains constant. During the physical activity of the body, the sympathetic nervous system is stimulated and the adrenaline is released, subsequently the rate and the contractility of heart increases. This results in an increase of ejecting volume of heart, cardiac output and a decrease in end-diastolic volume. During aerobic exercises, the heart and the heart wall thickness increases with the formation of eccentric hypertrophy, which allows greater ventricular filling and stronger contractions. Thus, a larger ejection volume can be achieved at rest (Labrosse 2018).

The physical load leads to complex of physiological processes allowing striated skeletal muscles to perform increased work performance, the higher muscle load puts higher demands on oxygen intake and on the cardiovascular system, e. g. by increasing of cardiac output, heart rate and heart rate volume. After regular intense and prolonged physical activity are observed physiological changes such as hyponatremia, activation of procoagulant and fibrinolytic mechanisms, oxidative stress. The adaptation of organism to physical regular load/exercise plays important role in suppression of oxidative stress effect, the other symptoms include the higher blood volume, triglycerides level decrease, the HDL cholesterol level increase and the blood pressure decrease after load. The degree and mode of adaptation action to physical load depends on the kind of physical activity as well as on the genetic predisposition of organism (Vančura & Radvanský 2007). The physical exercise is divided into several groups: static/dynamic, eccentric/concentric, isotonic/isometric, strenght/ endurance, light/heavy, continuous/ intermittent (intermittent by rest or very light load), force explosive/force endurance, of small muscle groups/of large muscle groups, postural muscles/phasic muscles

(Radvanský 2006). The physical load dividing into dynamic and static load influences the body adaptation way during exercise, but usually occurs the combination of these two types of physical load (Vančura &Radvanský 2007).

The dynamic load is characterized by cyclic alternating of muscle tension and relaxation resulting of isotonic muscle contraction (Štejfa 2007). According to the power resistance and speed of the active movement is the dynamic load divided into endurance, maximum, explosive and speed load (Zumr 2019). The response of organism to dynamic physical activity has three phases. The initial phase arises before physical activity, tachycardia is observed in the pre-start state of the organism. The accompanying phase is characterized by fast increase of heart rate followed by slower increase and then the heart rate stabilizes at the steady-state value, as long as the intensity of the physical activity does not exceed the level of the anaerobic power of organism. After physical exercise in the final state it showes a rapid heart rate decrease, later a slow decrease of the heart rate is observed (Jančík et al. 2006). During non-physiological dynamic activity is showed the significant increase of lung ventilation compared to oxygen consumption. This difference is related to metabolic acidosis, which is compensated by an increase of CO_2 excretion and a decrease in blood pCO_2. Oxygen consumption as a parameter of total energy production of the organism increases in conjunction with the physical exercise to a physiological maximum (maximum rate of oxygen consumption, VO_2 max.) (Javorka et al. 2014).

The isometric muscle contraction is typical for static load of organism, while the energy needed for performance of static work is converted to heat and the effectiveness of this static work is at zero level (Javorka et al. 2014). The continuous prolonged muscle contraction with superior power is causing muscle fatigue due to increased intramuscular pressure, which compresses the capillaries and narrows the blood supply to the muscles. Muscles obtain oxygen supply from myoglobin through anaerobic glycolysis to form lactic acid and its storage in the muscles is causing exhaustion and pain in the contracted muscle (Radvanský 2006). Muscle activity causes the increasing of lung ventilation via increased respiratory volume and respiratory rate (Javorka et al. 2014).

During short-time exercise is observed hyperglycemia, the blood glucose concentration is increased by 60 %, during long-term exercise is observed hypoglycemia as the response of depletion of the organism due to a general adaptation syndrome. Also the concentration of free fatty acids increases, but after intake of carbohydrate reach food remains physiological value of free fatty acids probably due to increased insulin release inhibiting lipolysis (Javorka et al.

2014). During muscle contraction is formed the heat, while the excessive amount of heat is dissipated by sweating (up to 1 liter of sweat per hour) (Vokurka 2012).

The autonomic nervous system modifies the changes caused by stimulating of the endocrine system activity in pre-start state of physical load and during prolonged exercise. The aerobic exercise stimulates the sympathetic nervous system as well as increases oxygen consumption, the stretching activates the parasympathetic nervous system during unchanged oxygen consumption. The activation of the sympathetic system releases adrenaline/epinephrine and noradrenaline/norepinephrine from the adrenal marrow and mobilizes glycogen and lipids stores and stimulates the production of cyclic adenosine monophosphate (cAMP) and heart function. The intensity of this regulatory process is demonstrated by the urinary excretion of vanilmandelic acid. The pituitary-adrenal neuroendocrine system is participating after the start of exercise by the regulation of secretion of adrenocorticotropic hormone (ACTH) from the anterior lobe of the pituitary gland, ACTH promotes the glucocorticoids secretion from the adrenal cortex. Glucocorticoids involves in the inhibition of glucose utilization in all tissues except the brain and heart, also have the lipolytic effect in adipose tissue and glycolytic effect of glucagon in the liver, what is beneficial for muscle work (Javorka et al. 2014).

The stimulus/stressor is an action inducing the response/reaction. If stimuli and reactions are regularly repeated for a long time, the adaptation of organism arises. Adaptive changes include the heart and muscle hypertrophy by the transformation of muscle fibers II-A, an increase in the heart ejection volume and VO_2 max. Adaptation to physical activity takes place in a training process in improving of the functional state of the organism (Javorka et al. 2014).

Methods

The aim of this study was to determine the functional state of the cardiovascular system and condition in primary school students aged from 11 to 15 years through Ruffier's functional test by the Ruffier's index (Chuo et al. 2018) expressed, which is a value parameter of the cardiovascular system state as well as the condition of the organism during physical activity. Pupils (n = 100) were divided into 4 experimental groups according to gender and the number of regular physical activities for 5 months. The regular physical activity in all tested groups of children was physical education during the standard teaching process at elementary school. The subject – „Physical education“ took place twice a week (for an hour and a half per week). The experimental groups were divided into girls group (GPhE – girls with the subject Physical education, n = 25) and boys group (BPhE – boys with the subject Physical education, n = 25), whose regular physical activity consisted only of the „Physical education“ subject and into girls gruop (GPhEc – girls with the subject Physical education with the combination the other regular physical activity, n = 25) and boys group (BPhEc – boys with the subject Physical education with the combination the other regular physical activity, n = 25), whose regular physical activity consisted of the physical education with combination of other external sport activities at regular time, such as athletics, dance education, inline skating, floorball etc. The experiment was performed with consent of parents and/or legal representatives. Pupils from elementary school were in good health conditions without the presence of cardiovascular diseases or musculoskeletal disorders.

Measurement of heart rate values was performed in two samplings:

1. measurement - the period when the pupils/children started school after the 2 months of summer holidays (sampling 1: groups GPhE1 – GPhE in the sampling 1, GPhEc1 – GPhEc in the sampling 1, BPhE1 – BPhE in the sampling 1, BPhEc1 – BPhEc in the sampling 1).
2. measurement - the period when children were completed the regular physical activities during 5 months (sampling 2: groups GPhE2 – GPhE in the sampling 2, GPhEc2 – GPhEc in the sampling 2, BPhE2 – BPhE in the sampling 2, BPhEc2 – BPhEc in the sampling 2).

The results of measurements were obtained under the same conditions, on the same day and time. The Ruffier test was repeated in each pupil after 30 minutes during measurements 1 and 2 to obtain an average RI (Ruffier index) value. Based on Ruffier index was determined and compared the functional state of the organism of each pupil and the average functional state of the organism of children in all experimental groups (Baňárová et al. 2015). The statistical analysis of results as well as statistical significance of differences between all experimental groups was determined and compared by one-way ANOVA test and confirmed by Tukey post test (MiniTab, Czech Republic). Level of statistical significance 0.001 was expressed by p value ($p < 0.001$).

Results

Measurement 1

In the experimental group of girls GPhE1 were found after the measurement 1 two girls (8 %) with Ruffier index values in interval from 3.1 to 7.0 and according to evaluation of the functional state of the organism based on the Ruffier test index can be described this result as a good functional state of the organism. Ten girls (40 %) showed an average functional status, 12 girls (48 %) showed poor functional status, one girl (4 %) showed very poor functional condition. In the GPhEc1 experimental group was evaluated the good functional status of 13 girls (52 %) and the average functional status of 12 girls (48 %). In the experimental group BPhE1 was evaluated the functional status as good (n = 7; 28 %), average (n = 11; 44 %), poor (n = 5; 20 %) and very poor (n = 2 ; 8 %). The experimental group BPhEc1 contained 13 boys (52 %) with good and 12 (48 %) boys with moderate functional status of organism.

Measurement 2

The second measurement of this experiment started after 5 months of regular physical activity involving only physical education 2 times every week for 1 and a half hours in groups GPhE2 and BPhE2 as well as in groups GPhEc2 and BPhEc2 with the combination of regular physical education in adition to the other regular physical activity. The experimental group of schoolgirls GPhE2 showed the following functional status: good (n = 4; 16 %), moderate (n = 14; 56 %) and poor (n = 7; 28 %). In the experimental group GPhEc2 was found the good functional status in 21 girls (84 %) and the average functional status in 4 girls (16 %).

In the boys of experimental group BPhE2 was measured an average functional state of 20 pupils (80 %), good of 4 (16 %) and a poor of 1 (4 %). The BPhEc2 group achieved good functional status in 21 pupils (84 %) and average functional status in 4 pupils (16 %). The GPhE experimental group reached the average of the experimental group functional state in measurement 1 (GPhE1) and measurement 2 (GPhE2) as well as the decreasing average RI value results (Table 1) by 1.22 (10.63 %).

The GPhEc group improved the functional status in comparison with measurement 1 (GPhEc1) to measurement 2 (GPhEc2) from average to good functional status by reducing the RI value at 1.03 (14.27 %) (Table 1). The boys of experimental group BPhE demonstrated the average functional state in the measurement 1 (BPhE1) and measurement 2 (BPhE2), the average of RI value decreased by 0.77 (7.95 %). The change of the functional status was achieved in the BPhEc experimental boys group during the measurement 1 (BPhEc1) and measurement 2 (BPhEc2) from the average to good functional state (difference of the RI value: 0.82; 11.15 %) (Table 1).

However, the most significant difference of functional status was observed after 5 months (in measurement 2) of regular physical activity/load of the organism in the girls group GPhEc2 (6.22 ± 0, 91) compared to GPhE2 (10.20 ± 2.15) (Figure 1) and in the boys group BPhE2 (8.96 ± 1.55) compared to BPhEc2 (6.46 ± 0.98) at a significance level of $p < 0.001$ (Figure 2). This significant result indicates the fact that the dynamic regular physical activity of the organism is one of the factors influencing the improvement of the functional state of the organism and participates in increase of the individual condition of pupils regardless of gender. Based on the measurement 2 after 5 months of regular exercise in physical education in all four groups can be stated a positive effect of regular dynamic load as one of the factor influencing the condition and cardiovascular fitness especially in girls and boys who were engaged in free time regular physical activity/load.

Table 1
The average functional state expressed by RI ± SD (Ruffiers index ± standard deviation) in all experimental groups after measurement 1 and measurement 2

Experimental group	Measurement 1	Measurement 2
GPhE	11.42 ± 2.58	10.20 ± 2.52
GPhEc	7.25 ± 1.73	6,22 ± 0.92
BPhE	9.73 ± 3.25	8,96 ± 1.56
BPhEc	7.30 ± 1.78	6.48 ± 0.98

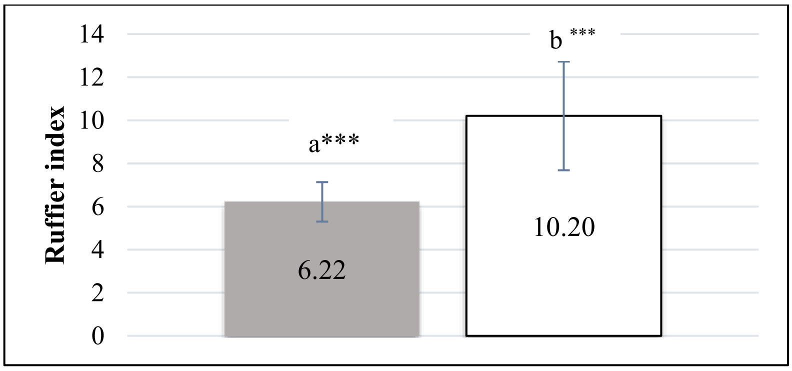

Figure 1
The comparison of average functional state in the girls experimental groups GPhEc2 (measurement 2; 6.22 ± 0.92) and GPhE2 (measurement 2; 10.20 ± 2.52); different letters (a^{***}, b^{***}) meant the significant effect pexpressed by value $p < 0,001$

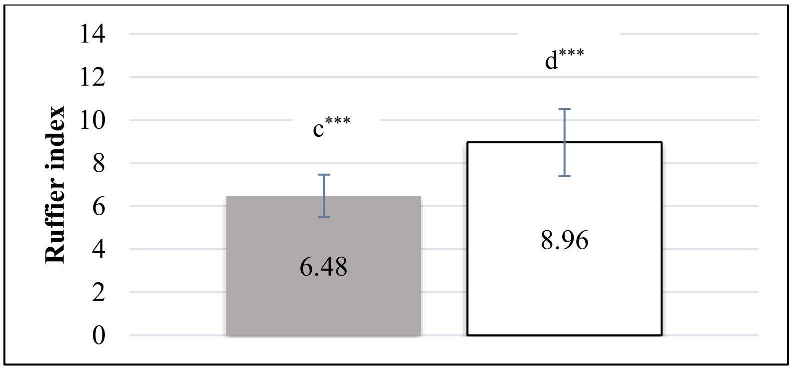

Figure 2
The comparison of average functional state in the boys experimental groups BPhEc2 (measurement 2; 6.48 ± 0.98) and BPhE2 (measurement 2; 8.96 ± 1.56); different letters (c^{***}, d^{***}) meant the significant effect expressed by value $p < 0,001$

Discussion

Nowadays, the physical inactivity is part of possible risk factors affecting a lot of health problems/disorders/metabolic diseases e. g. obesity, *diabetes mellitus*, hypertension, the reduction of muscle-sceletal mobility or psychosocial problems (Svobodová 2015). The adequate quantity and quality of movement/exercise/physical activity forms the essence of existence of maintained homeostasis in the body (Kusyn & Kusynova 2018). Aerobic activities have the greatest health benefits especially for the cardiovascular and respiratory systems (Sigmund & Sigmundova 2015). Aerobic fit organisms are able to receive more oxygen during exercise and load, increase muscle work, increase blood volume and the number of oxygen-saturated erythrocytes. The system of blood vessels expands and the possibility of fat storage in blood vessels is reduced (Červinková et al. 2000). If is the physical activity regular and prolonged, the heart and lungs function and oxygen transport is under adaptation of organism thereby ensuring the prevention of civilization diseases is often increased (Dvořáková & Engelthalteová 2017).

The child should have physical activity not only during the school education with regular intervals at the subject of „Physical education", but also during the free time as well as on holidays, e.g. on the two months lasting summer holiday is necessary to provide suitable regular physical activity/exercise (Škutová 2020). The combination of the lack of physical activity and unhealthy diet eating habits has a negative effect on the development of the cardiovascular system and musculoskeletal system. The results of the functional status in pupils of elementary school obtained from experiment showed a reduced condition in groups of children who have had less regular school physical activity as well as no activity during summer holidays. This can be caused by decreased physical activity and irregular eating. It is necessary to refer to the increased incidence of children with overweight and obesity, the formation of the vertebrogenic disorders, which has had gradual tentency as a consequence of insufficient physical activity (Marko & Bendíková 2019).

Tanha et al. (2011) found the increased risk of cardiovaclular system problems in healthy physically inactive children with an average age of 9.8 years. The level of physical activity was evaluated using resting heart rate, blood pressure and maximal oxygen absorption in the group of 223 children. The children physically more active showed a lower risk of occurence of cardiovascular diseases.

The appearance of overweight and obesity in 20 % of children aged from 11 to 15 years was observed in the Czech Republic (Kalman 2019). The following study showed this result:

64 % of children spent time without physical activity on summer holiday (Roubalová 2015). The physical activity is important in children with *diabetes mellitus* type I., e.g. the asymptomatic increase of carotid artery thickness was observed. Patients with *diabetes mellitus* type I have five times higher risk to die of cardiovascular and cerebrovascular disorders at the ages 20 – 39 years (Järvisalo et al. 2002). Herbst et al. (2007) observed the effect of regular physical activity on cardiovascular risk factors such as blood lipid concentration and blood pressure with the finding that one and more risk factors affect 69 % of pediatric patients with *diabetes mellitus* type I. However the increased physical activity in children diagnosed with *diabetes mellitus* type I is associated with decreased lipoprotein levels of plasma as well as diastolic blood pressure.

Dias et al. (2015) examined the effect of exercise on flow-mediated arterial dilatation (FMD) in overweight and obese children and adolescents and also examined the role of cardiorespiratory parameter (maximum oxygen consumption – VO_2max) in comparison to mean difference between vascular functions (by FMD) and VO_2max between exercise and rest time. The regular exercise improved cardiovascular function in overweight and obese children founding a significant improvement in FMD and VO_2max parameters. However, the occurence and effect of a one risk factor does not affect the insufficient activity of the cardiovascular system, but the permanent and prolonged action of risk factors (poor lifestyle, smoking, alcoholism, lack of exercise, metabolic diseases) leads to the functional state and condition disorders of organism in children but also in adolescents, e.g. by Baňárovej et al. (2016) based on the Ruffier functional test was classified a below-average value of cardiovascular condition in 39 % of young people under age of 25 years.

Conclusions

Physical education should not be the only way to exercise necessary to the healthy growth and development of school-age children. It is important to lead children to a healthy lifestyle, not only by consuming a healthy food, but especially in connection with sport activities.

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PLYOMETRIC EXERCISES IMPROVES MUSCULAR POWER AND DIGITAL ACHIEVEMENT IN HIGH JUMP AMONG STUDENTS

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Summary: The research aim was to identify the effect of using some plyometric exercises to improve muscular power (vertical jump) and digital achievement in high jump activity among third year's students. The researchers used an experimental method in conformity with research nature between pre-tests and post-tests for the sample research. The sample was formed by students belonging to the physical education and sports institute, University of Mostaganem (Algeria) of the academic year 2018/2019. 40 students were chosen and divided into two groups (experimental 21 students, control 19 students). The vertical jump test of stability and digital achievement test were used. After the treatment of the results by statistical means and through these results, it has been reached several conclusions from them. Plyometric exercises are important to develop vertical jump and digital achievement level in high jump [discussion significant difference ($p \leq 0.05$)] among students, and the best improvement of the experimental group based on plyometric exercises is marked comparing to the control group.

Keywords: plyometric exercises, muscular power, vertical jump, digital achievement, high jump

Introduction

Athletics games are considered among events that attracted attention in the area of research thing which led to the improvement in various training methods. As consequence there were improvements concerning records in run, jump and throwing competitions at different international levels. This kind of games depends on muscle strength at jump and throws competitions. The muscle strength is an important element to achieve any sort of physical performance. Its contribution varies according to the kind of performance and contributes to the appreciation of other physical elements as speed, endurance and agility. For that, it has occupied part in sport training programs and it's considered as an important determinant in achieving sport superiority at most of athletics games events.

A review of the published literature produces a common definition of plyometric exercise. (Fatouros et al. 2000), (Moore et al. 2005) report plyometric exercises as those that are characterized by a rapid deceleration of the body followed almost immediately by a rapid acceleration of the body in the opposite direction. It is this eccentric/concentric contraction pattern which is reported to evoke the elastic properties of the muscle fibers and connective tissue in a way that allows the muscle to store more elastic energy during the deceleration phase and release it during the acceleration period. Zabchi et al. (2016), Benzidane et al. (2015), Mokrani et al.(2015), Bensikaddour et al.(2015), Hamdi (2011) mentioned that plyometric training and plyometric exercises contribute in improving the achievement especially in activities that use explosive muscles contractions.

Bal et al. (2011) says that the concept of plyometric training program is divided into three ranks based on the volume and intensity. The plyometric exercise program has low, middle, and high, the low plyometric exercise prepares muscles and basic skills, namely power, strength, muscle endurance, and balance to turn into better and more complex skills, the middle plyometric exercise aims to give stimulus in order to improve fitness' components (Bal et al. 2011). And the high plyometric exercise aims to shape specific skills based on the particular sport. This plyometric training program is a conditioning method intensely. It is better for young silat fighters to start the training with low intensity then improve it later (Alptekin & Mavis 2013).

The research problem due to researchers field follow-upin the area of teaching students in athletics specialty at physical education and sports institutes, It's, also, noticed students weak performance in the jump as well as slower speed concerning the approximate sprint add to bad standing which require a height speed and strong fast while approaching. This is what students do suffer from in the high jump. This what let us to notice the reasons of digital achievement weakness in high jump due to the lack of using training methods without looking for means and methods which may fulfill sport superiority. For that, researchers suggested to know the effect of using some plyometric exercises on legs strength to realize the digital achievement in the high jump effectiveness among third year's students of sports and physical education, university of Mostaganem, Algeria.

Objective:

- Using plyometric exercises to develop muscular power (vertical jump) among students (third year) sports and physical education,
- Using plyometric exercises to develop the performance in the high jump of students (third year) during sports and physical education,
- To identify the differences between pre and post-tests for members of the research group.

Methods

Research Methodology: Researchers used experimental method reliving to the nature and the problematic of the research.

Research Society and Sample: Search community were selected from third-year LMD students physical education and sports, Institute of physical education and sports of Mostaganem (Algeria), 40 students ranging in age between 20 to 22 years of the academic year 2018/2019, 40 students were chosen from males and were divided into two groups as follows: Group one is the experimental group (21 students), and the second group is the control group (19 students). Knowing that (Table 1), all of them belong to the same level and the same specialization (athletics).

Table 1

Sample Specifications

Variables	Experimental group	Control group	T	Difference significances
	Mean±SD	Mean±SD		
Age (years)	21.82±4.16	21.12±4.28	0.52	No Significant
height [m]	1.72±0.35	1.73±0.48	0.07	
Weight [kg]	69.29±5.10	68.50±5.63	0.46	
BMI [kg/m^2]	23.48±3.87	22.83±3.90	0.52	
Vertical jump [cm]	39.33±5.07	37.73±5.34	0.96	
Achievement [m]	1.59± 0.22	1.55 ± 0.38	0.25	

T Tabular =1.69

Test 1: vertical jump to the top from stability "Sargent"

The purpose of the test: Measuring muscle power of the legs.

Tools: Chalk, measuring tape, wall.

Performance specifications: The student stands next to the wall and extends his arms to the top in order to determine the brand with chalk. Then he moves arms, bends forward and down, bends his knees and then jump towards the top to determine the second mark.

Recording: The distance is measured between the two brands in centimeters (Fig. 1).

Test 2: High Jump Test

The aim of the test: measurement of distance achievement for high jump Tools used: measurement band of distances, high jump track.

Performance description: each athlete was selected after controlling the approximate distance to the standing board. Three (03) attempts were given to every athlete recording the highest achievement. The distance was measured to the last trace left by the athlete (Fig. 2).

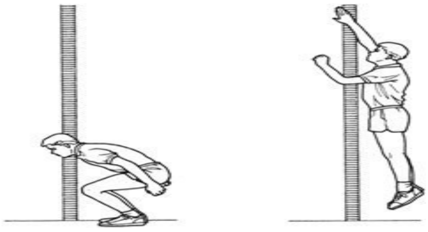

Figure 1

The vertical jump test

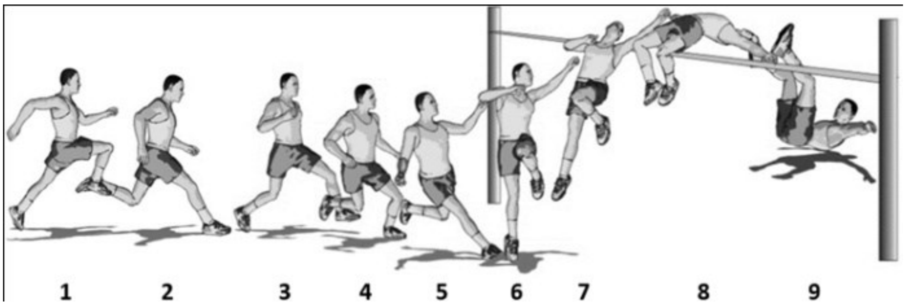

Figure 2

The high jump test

The Main Experience

Training sessions for research sample were held in the morning of each Monday and Wednesday. Set of plyometric exercises were prepared aiming to develop legs muscular strength for third year students of physical education and sports by using the necessary tools and means, was practiced 2 days per week for 6 weeks. Each session had its own procedural aim beginning from Feb. 04^{th}, 2019 to Mar. 13^{th}, 2019.

Data Analysis

The results are presented as the mean ± standard deviation (SD). The mean and standard deviation were calculated with the measured results, paired T-test was applied for mean difference test between groups. Statistical significant level was set at α = 0.05.

Table 2
The content of the program (plyometric exercises)

Weeks	Week 1	Week 2	Week 3
Exercises	- Double leg jump forward (2x10) - Double leg jump backward (2x10) - Pogo jump (2x10) - Double leg hop (2x10) - Power skipping (2x10)	- Double leg jump forward (3x8) - Pogo jump (3x8) - Zig Zag Double leg hops (3x8) - Double leg target jump (3x8) - Mini squat jump (3x8)	- Jump & turn 90° (4x8) - Knee tuck jump (3x8) - Single leg jump forward (3x8) - Alternating Leg Hops (3x8) - lateral box push-offs (3x8)
Intensity	70 – 80 %	70 – 80 %	80 – 90 %
Rest between exercises	15 – 25 s	15 – 25 s	30 – 40 s
Rest between sets	1 – 2 m	1 – 2 m	2 – 3 m
Weeks	**Week 4**	**Week 5**	**Week 6**
Exercises	- Single leg jump forward (3x8) - Knee tuck jump (3x8) - Alternating Leg Hops (3x8) - lateral box push-offs (4x8) - ball or bench taps (3x8) - Power skipping (4x8)	- Incremental vertical jump (3x6) - Single leg vertical jump (3x6) - Squat jump (3x6) - Scissor Jumps (3x6) - Pogo jump (3x6) - Power skipping (3x6)	-Single leg vertical jump (3x6) - Pogo jump (3x6) - Drop depth jump (6*3) - Jump & turn 180° (3x6) - double leg drop jump over a hurdle (3x6) - Power skipping (3x6)
Intensity	80 – 90 %	90 – 100 %	90 – 100 %
Rest between exercises	30 – 40 s	60 s	60 s
Rest between sets	2 – 3 m	3 – 4 m	3 – 4 m

Results

Viewing, analyzing the vertical jump test

Table 3
Comparisons between the pre-test and post-test results in the vertical jump

Statistical means Research Sample	N	Pre-test	Post test	T Calculated	T Tabulated	Difference significances
		Mean ± SD	Mean ± SD			
Control group	19	37.33± 5.34	42.19 ± 5.11	2.51*	1.73	Significant
Experimental group	21	39.33± 5.07	47.84± 4.61	3.43*	1.72	Significant

The results of table 3, after using the significance differences test, shows that the calculated T value for the control group amounted to 2.51 which is superior than tabulated T estimated to 1.73 at the degree of freedom 18 and the level of significance 0.05 which means the existence of statistical significance. Concerning the experimental group the calculated T value amounted to 3.43 which are superior than the value of tabulated T estimated to 1.72 at the degree of freedom 20 and significant level 0.05 that means the existence of statistical significance which means the existence of significant difference between averages in favor of the post-test.

Viewing, analyzing the high jump test

Table 4

Comparisons between the pre-test and post-test results of Achievement in high jump

Statistical means Research Sample	N	Pre-test	Post-test	T Calculated	T Tabulated	Difference significances
		Mean ± SD	Mean ± SD			
Control group	19	1.55 ± 0.38	1.62 ± 0.20	1.68	1.73	No Significant
Experimental group	21	1.59± 0.22	1.76 ± 0.17	3.72*	1.72	Significant

Through the statistical results mentioned in table 4, after using the measurement of statistical significance T student, we notice that the calculated T value for the control group amounted to 1.68 which is smaller than the tabulated T value estimated to 1.73 at the degree of freedom 18 and significant level 0.05 which means the existence of statistical significance. As for the experimental group the value of calculated T amounted to 3.72 which superior than tabulated T amounted to 1.72 at the degree of freedom 20 and significant level 0.05 that means the existence of statistical significance which means also the existence of significant difference between the pre and post calculated average in favor of the post-test.

Comparison of post-test results of research samples

Table 5

*Comparisons between experimental and control groups in Post-test (*p ≤ 0.05)*

Statistical means Tests	Control group	Experimental group	T Calculated	T Tabulated	Difference significances
	Mean ± SD	Mean ± SD			
Vertical jump (cm)	42.19 ± 5.11	47.84± 4.61	3.28*	2.04	Significant
Achievement (m)	1.62 ± 0.20	1.76 ± 0.17	2.33*		Significant

We do notice through Table 5, that the calculated T value amounted between 2.33 as smallest value and 3.28 as biggest value which is bigger than tabulated T estimated to 2.04 at the degree of freedom 38 and significant level 0.05 which confirms the presence of significant differences between these averages that means the differences have statistical significance.

Discussion

Through the Table 3, we notice improvement the vertical jump for the experimental group in comparison with the control group. This due to the use of plyometric exercises aiming at a rate of twice a week with specific intensities (70 % to 100 %), and includes a set of exercises such as (Double leg jump, Pogo jump, Power skipping, Zig-Zag Double leg hops, Squat jump…) to improve and develop legs power by activating voluntary muscles in work. This method leads to produce and output strength maximum to fulfill the best result, because leg strength is the primary source of power in many sports. According to Gambetta (2007) the legs can be seen as a functional unit of a closed kinetic chain without which an athlete cannot have speed, strength, power or suppleness to perform (Gambetta 2007). And plyometric training is an excellent method of developing body power and it is proved a very effective method for improving explosive strength. It offers rich variation of exercise and load structure any activity that activates that stretch reflex mechanism is Plyometric exercise (Henson 1994).

Also, the control group made some progress in the vertical jump test as a result of applying a group of jump exercises and during the practical lesson, which formed a kind of competition among students to achieve better results. Where she came in favor of the experimental group.

Where it leads to the development of muscular power and then leads to the production of high ability and fast dynamic performance. The use of plyometric exercises to develop legs muscles explosive power emphasizes to increase the push in advance due to the speed of the working muscles extension resulting from training and adapted to reduce the default time while executing the push in front of which increase the jump distance. Many studies (Holcomb et al.1996; Stojanović & Kostić 2002; Makaruk et al.2010; Kotzamanidis 2006; Ramirez-Campillo et al. 2014a; Sozbir 2016; Thakur et al 2016) mentioned that the use of training with plyometric exercises contribute to the improvement the explosive power for low parties after applying the jump test. The results agreed with the results obtained which confirm the effectiveness of the plyometric training method use to improve low parties (legs) explosive strength.

The results of Table 4 show also that the experimental group members had achieved the best results in post-test compared with control group members. This confirms the improvement of both experimental group levels due to proposed exercises included for the experimental sample in order to develop the digital achievement in high jump. The series of the performed plyometric exercises ranged in a set of different plyometric leaps confirmed their effective impact on the muscle system through relationship development between the maximum strength and the explosive strength for low parties. While the control sample made little progress that did not reach the level of statistical significance because the teacher was dependent on the skill side to a large extent at the expense of the physical aspect that plays an important role in achieving digital achievements in sports activities such as athletics competitions

Therefore, the researchers find that upgrading ability is essential and important to improve the digital achievement in the high jump. This coincides with (Essayed 2012) study which emphasizes on the application of physical exercises in adequate manner (redundancy, intensity and density). Malisoux (2006) that plyometric training contributes in the achievement improvement especially in the activities where muscle explosive contractions are used, and (Rahimi & Behpur 2005) who mentioned that the plyometric training in short term has a great effect to power muscle and upgrading development.

Through Table 5 we see that there are significant differences between the post measurements for each of the experimental group and the control group on the level of muscular power and achievement high jump event pilot for the experimental sample, and this result indicates that plyometric exercise was more effective in improving performance in the applied in the high jump tests compared to the traditional method, which relies on memorization and performance of the model with the control sample, with the application of the jump group exercises in the preparatory part. This confirms that the use of plyometric exercise in line with the characteristics of the game is an important principle for effective educational situation a principle taking account the individual differences among students, and given an additional motivation for learning as a result of the use of devices and tools to assist in education and training, which led to attract the attention of the learner, to know the material process, and provide opportunities for creativity shown by the student during the course of the lesson. This is in line with the study of Wong et al. (2010), Damon et al. (2010), Charag et al. (2011), Suhail (2014), Essam (2014), Benzidane et al. (2015), Thakur et al. (2016) showing that: Plyometric exercises increase muscular power and are most effective when designed to complement the specific movements required of the athletic activity. Bal et al (2011) assured that the plyometric exercise is designed to improve strength of particular muscle. Therefore plyometric exercise needs to be integrated in other supporting exercise programmes so that it has exercise variation, the key of safe and effective plyometric program is based on the developing age and level of fitness

Finally Through the presentation of the previous results found that the program prepared according to scientific controls has resulted in the development of the muscular power of the muscles of the legs as the use of methods of training and different in a scientific as well as the use of different Intensity and rest periods sufficient to restore the healing and the number of its replication fits with the intensity of exercise as well as the use of body weight at elevations varying has led to the development of the explosive power of the muscles of the legs and this, which led to the development aspects of physical, and reflected this development on the technical performance and this was confirmed that the plyometric exercises are aimed at the physical qualities associated with the type of sports activity development.

Conclusions

- The plyometric exercises have a positive impact on the development muscular power (vertical jump) among students.
- The plyometric exercises have a positive impact on the development of digital achievement in high jump among students.
- The existence of statistically significant differences between the experimental and control groups in the post measurement in favor of the experimental group.

Accordingly, we recommend the following:

- Attention to the physical aspect of students.
- Improving students' strength and muscular capacity.
- The use of plyometric exercises within the educational and training programs among students.
- Improving the digital achievement in the jumping competition activities.

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THE RESPONSE TO THE TRAINING LOAD IN THE AQUATIC ENVIRONMENT IN TERMS OF THE STIMULATION OF THE REFLECTIVE CAPABILITIES OF ELITE SYNCHRONIZED SWIMMERS

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Summary: The youngest swimming sport included in the Summer Olympic Games since 1984 is synchronized swimming. Since the synchronized swimming is still growing popularity and professionalization, it is important to search for ways to improve sports performance. There are few scientific studies focusing also on the biological and motor indicators of top athletes. The present study examined biological and motor variables of elite synchronized swimmers (SYN, N = 13) in ages of 16.5 ± 3.23 years and compare the frequency of Angiotensin Converting Enzyme (ACE) gene genotypes among elite female synchronized swimmers and the non-athletic control group (CON, N = 30) in ages of 16.0 ± 0.6 years. The motor variables were measured using Optojump system before and after water training session. All measurements were collected by trained data collection staff. The ACE I/D variation differences between groups were identified by Chi-Square test. The results of motor variables obtained were evaluated statistically using the Wilcoxon Signed-Rank Test. The strength of association between selected biological and motor variables was measured by Spearman's correlation. We provided evidence for significant differences of variation of the ACE I/D polymorphism between observed groups. A significant correlation among biological and motor parameters of SYN was demonstrated among the percentage of fat and the time of reflection ($p = 0.042$), the basal resting heart rate and the jump height ($p = 0.006$) and among the basal resting heart rate and the power ($p = 0.012$). The SYN significantly increased only their contact time in jumping ($p < 0.016$) after the training session. Based on the results we state that the effect of intervention in the stimulation of the reflective capabilities due to the training session in the aquatic environment was not confirmed in the study.

Key words: aquatic environment, training load, synchronized swimming, anthropometric characteristics, jump

Introduction

The youngest swimming sport included in the Summer Olympic Games since 1984 is synchronized swimming. Nowadays, the Olympic Games competitions in the discipline duet (two competitors) and discipline team events (eight competitors) (FINA 2017). Synchronized swimming according to the type of sports performance belongs to technical-aesthetic sports. Sport performance combines power, speed and endurance with precise synchronized movements and acrobatic movements (Ghiani et al. 2016). The aim of the athletic performance is accurate execution of conditioning-coordination movement-demanding movement with flawless technique. The athlete's effort is to perform a specific movement task as rationally as possible (Labudová 2011). Sports performance in synchronized swimming is realized in the water environment, therefore respecting and using its specific water laws is one of the basic prerequisites for the success of athletes. Homma (1994) states that almost half of the total duration of the competition routine for athletes is in dynamic apnea. The growing popularity and professionalization of synchronized swimming emphasize the importance of searching for ways to improve sports performance. There are few scientific studies focusing also on the biological and motor indicators of top athletes (Homma et al. 1999; Chatard et al. 1999; Yamamura et al. 1999, 2000; Alentejano et al. 2010; Rodriguez-Zamora et al. 2014). Systematic review of physiological parameters of athletes in the age category of juniors and seniors in the years 2006 to 2016 presented Ponciano et al. (2018). The protocols used analyses of physiological responses in synchronized swimmers during competitions or laboratory tests, lactate measurements, heart rate, rates of perceived exertion, VO_2 and lung volume. The authors recommend to carry out more measurements of physiological parameters in the conditions of competition. It can contribute to the expansion of knowledge about the conditionality of sport performance by the monitored parameters. They also attend to focus on men who have been competing in the World Championships in mixed duet since 2015. Several studies examined anthropometric parameters of top synchronized swimmers as body composition Poole et al (1981), Kirkendall et al. (1982), Moffat et al. (1982), Evans et al. (1985), Petkov et al. (1988), Labudová (2011), metabolism and nutrition D'alessandro et al. 2016 and Ghiani et al. (2016). Besides the training and nutrition, the genetic factors influence mostly the variance between individual athletes (Grznár et al. 2017).

Nowadays, more than 200 genetic variants are associated with physical performance (Eynon et al. 2011). The first described genetic polymorphism affecting sports performance was *ACE* gene polymorphism (Montgomery et al. 1998). Angiotensin Converting Enzyme (ACE) is a crucial part in Renin Angiotensin System and plays a central role in the regulation of blood pressure. It maintains the circulatory homeostasis. *ACE* gene polymorphism is located in the intron 16 and consists of either an insertion (I) allele or a deletion (D) allele leading to three genotypes: II, ID and DD. The I allele leads to lower ACE activity in serum and tissue. It is associated with a higher proportion of slow type I muscle fibers, higher efficiency of aerobic performance, better fatigue resistance, higher oxygenation of peripheral fibers during activity and more pronounced aerobic response to training (Shenoy et al. 2010). The D allele is associated with a higher percentage of fast muscle fibers type II b, which are essential for maximum strength performance in a short time (Zhang et al. 2003). In general, the frequency of genotype II is higher in athletes practicing high aerobic activity sports. The DD genotype is more frequent in strength and power athletes **(**Puthucheary et. al. 2011). Several studies deal with the comparison of monitored indicators with athletes related to sports (Zemková et al. 2009; Kyselovičová et al. 2016; Grznár et al. 2017). The area of the content of the training load in the aquatic environment and its response to the stimulation of selected motor abilities, as well as the genetic conditionality of performance in synchronized swimming is still less explored.

The aim of the study is to describe biological and motor variables of elite synchronized swimmers and accurate the knowledge about the response to the training load in the aquatic environment in terms of the stimulation of the reflective capabilities of elite synchronized swimmers.

Methods

Subjects

Thirteen elite female synchronized swimmers (SYN; age 16.54 ± 3.23 years) and thirty age-matching non-athletic control group (CON; age 16.0 ± 0.6 years) participated in the study. All subjects had competed at national and international level and they spent an average 20 ± 3,4 hours in training weekly. Additionally, one of them participated on Olympic Games in 2016, six of them had taken part in FINA World Championships and two of them are actually preparing on Qualification Tournament for OG 2021. The study was approved by the Ethics Committee of FPES CU in Bratislava.

Biological variables assessment

Body weight was measured to the nearest 0.1 kg using an electronic digital scale (model Omron BF511). Standing height, was measured to the nearest 0.5 cm. The head, shoulder blades, buttock and heels (without the shoes) were touching the wall, to which the tape was fixed (NHANES 2007). Body fat was measured by OMRON BF511 bioimpedance analysis. We established body mass index (BMI) before the training session. An integrated telemetric monitor was used for the measurement of baseline resting heart rate. The data were measured in the mornings of the same week, in a controlled environment with constant temperature. Subjects were asked to abstain from physical exercise the day before testing days and encouraged to rest the evening prior. Genomic DNA was extracted from the buccal swabs and standard protocol with Chelex (Bio-Rad). Genotypes were determined using regular PCR with primers: forward, CTGGAGACCACTCCCATCCTTTCT; reverse, GATGTGGCCATCACA TTCGTCAGA. PCR was performed in thermocycler (Biometra) for 30 cycles at denaturing temperature 95°C for 1 min, annealing temperature 58 °C for 45 s and extension temperature 72 °C for 45 s. PCR products were visualized using 2 % agarose gels stained with ethidium bromide. The sizes were 490 bp for I allele and 190 bp for D allele.

Motor variables assessment

The reflective capabilities as vertical jump height [cm] without upper limbs countermovement, the contact time [s] and the power of the vertical jump [W] was determined by Optojump system. The OptoJump system consists of two optical sensors (each 100 × 4 × 3 cm) based on photocells (transmitting and receiving rods, placed in parallel). The OproJump system detects time parameters with a frequency of 1 000 Hz and spatial parameters with an accuracy of 1cm. Each rod contains 96 LEDs (a light-emitting diodes), located 3mm from ground level at 1.04 cm intervals between them. The LEDs communicate via infrared transmission. The rods communicate continuously with light emitting diodes (LEDs). The rods acting as transmitting and receiving units for LED signals. Subjects had the task of jumping repeatedly, as high as possible for 10 s, with their hands on their hips. They were asked to have the shortest contact time with the pad and the highest jump during the jump test. The basic information was followed by a test demonstration (Amann et al. 2016). The motor tests were measured two times before and after training session in the same day. All pre- and post-measurements used the same techniques and identical equipment for all subjects.

Training session load in the water

The duration of the training session in the water was 90 min. The total swimming volume was 3 600 m. The swimming part was focused on the development of fitness skills. It accounted for approximately 2/3 of the total training volume (2 600 m). The special part was focused on the development and improvement of special motor abilities and skills of synchronized swimming. It accounted for approximately 1/3 of the total training volume (1 000 m). The training took place in a 50 m pool.

Statistical Analysis

Processing and evaluation of the collected data was completed using basic mathematical and statistical methods. The results obtained were evaluated statistically using the Wilcoxon Signed-Rank Test for dependent variables - to opinion of differences between average in group before and after training session. The Mann-Whitney U Test for independent variables was used to opinion the differences between averages of SYN and CON groups. The ACE I/D variation differences between groups were identified by Chi-Square test. Results are reported as means and standard deviations. Differences at the level of $p < 0.05$ were accepted as significant. Effect size (ES) were calculated and defined as follows: small r = 0.1- 0.29, medium r = 0.3 – 0.49 large r = 0.5 - 1 (Cohen 1992). The strength of association between two variables (selected biological and motor variables) was measured by Spearman's correlation, where the value r = 1 meant a perfect positive correlation and the value r = -1 meant a perfect negative correlation. The SPSS (version 23.0) statistical software package was used to analyze all data.

Results

Biological variables

As shown in Table 1, the synchronized swimmers showed significantly lower average of body weight, of BMI, of body fat percentage and of resting heart rate variables than CON, that are associated with the structure of sport performance of synchronized swimming.

Table 1

Biological variables of SYN and CON

	SYN	CON	
	Mean ± SD	**Mean ± SD**	**P value**
Body height [cm]	163.585 ± 2.931	164.1 ± 3.921	0.859
Body weight [kg]	53.408 ± 4.805	60.36 ± 6.9	0.004*
BMI [$kg.m^{-2}$]	19.908 ± 1.441	22.5 ± 1.2	< 0.001**
Body fat (%)	15.492 ± 3.157	23.18 ± 4.91	< 0.001**
Resting heart rate (bpm)	62.154 ± 10.542	69.25 ± 6.06	< 0.001**

** $p < 0.001$ between SYN and CON; *$p < 0.05$ between SYN and CON

The frequencies of *ACE* genotype in synchronized swimming group (SYN) as well as control group (CON) met HWE criterion. There were significant differences in genotype frequencies between SYN and CON groups (p=0.01) in *ACE* I/D.

Table 2

ACE I/D genotype distribution in synchronized swimmers and non-athletic controls

Group	ACE DD	ID	II	P value
SYN (n=13)	46.1%	15.4 %	38.5%	0.01
CON (n=30)	23.3%	56.7 %	20%	

*p < 0.05 between SYN and CON

Effects of intervention in motor variables

As shown in Table 3, the SYN significantly increased their contact time in jumping ($p < 0.016$, $r = 0.425$) after the training session. Height and power of jumps did not prove significant changes after the training session and show trivial effect size.

Table 3

Changes in motor variables of SYN

Dependent variables	Pre-Test Mean ± SD	Post-Test Mean ± SD	P value	ES r
Contact time [s]	0.21 ± 0.02	0.23 ± 0.03	0.016*	0.425
Jump height [cm]	21 ± 3.44	20.58 ± 3.93	0.959	0.009
Power [W.kg^{-1}]	29.49 ± 4.77	27.57 ± 5.09	0.056	0.338

ES – Effect Size; SD - Standard Deviation; *p < 0.05 between Pre-Test and Post-Test;

Based on the results, we state that a significant correlation among biological and motor parameters of SYN was demonstrated between the percentage of fat and time of reflection ($r = 0.571$, $p = 0.042$). The significant correlation was shown also among basal resting heart rate and jump height ($r = 0.718$, $p = 0.006$) and among basal resting heart rate and power ($r = 0.672$, $p = 0.012$). As we stated earlier, other measures of biological and motoric parameters of SYN showed no correlations among themselves (contact time correlating with body height: $r = 0.251$, $p = 0.408$, body weight: $r = 0.167$, $p = 0.585$, basal resting heart rate: $r = 0.163$, $p = 0.595$ and ACE: $r = 0.225$, $p = 0.461$; jump high correlating with body height: $r = 0.226$, $p = 0.459$, body weight: $r = 0.039$, $p = 0.899$, percentage of fat: $r = 0.11$, $p = 0.72$ and ACE: $r = 0.063$, $p = 0.839$; power correlating with body height: $r = 0.109$, $p = 0.723$, body weight: $r = 0.109$, $p = 0.723$, percentage of fat: $r = 0.091$, $p = 0.301$ and ACE: $r = 0.043$, $p = 0.888$).

Discussion

Accessible researches and studies indicated similar outcomes that aesthetic-technical sports prefer athletes who are taller with more body mass (Claessens et al. 1999; Monsma et al. 2005; Alessandra di Cagno et al. 2008; Kyselovičová et al. 2012; Chren 2015; Gerznár et al.

2019). These studies correspond with our results, where the synchronized swimmers showed significantly lower selected biologic variables than CON. We state that this fact is associated with the specific requirements of sports performance in synchronized swimming in terms of anthropometric and physiological variables (Evans et al. 1985; Petkov et al. 1988; Ponciano et al. 2017). Our results of SYN anthropometry parameters of body height, body weight and body are identical with previous studies (Homma et al. 1994; Yamamura et al. 2000; Peric et al. 2012; Rodriguez-Zamora et al. 2012). Moreover, authors investigated the possible link between levels of body fat and hydrostatic properties of synchronized swimmers because better buoyancy in the water can have positive influence on movements on and under the surface (Lundy 2011). In comparison to the findings of several studies we conclude that the physiological parameter - the basal resting heart rate, which indicates the adaptation to the training load, have the Slovak elite synchronized swimmers (62.15 ± 10.5 bpm) comparable values with foreign elite synchronized swimmers (Ponciano et al. 2018). One of the most observed gene polymorphisms associated with sport performance is ACE I/D gene polymorphism. In cardiac muscle *ACE* genotype variants influence the left ventricular mass changes in response to stimulus. In skeletal muscle, the D allele is associated with greater strength gains in response to training. DD genotype is more frequent in strength and power athletes **(**Puthucheary, et. al. 2011). Our results are in accordance with Nazarov et al. (2001) that found an excess of the D allele in short distance swimmers and of the I allele in middle distance swimmers. The frequency of genotypes II and ID is higher in athletes practicing sports requiring a high aerobic activity.

The results of several authors who have examined the effect of different types of training load on the stimulation of rebounding abilities of athletes on dry land are different. Romero-Franco and Jiménez-Reyes (2015) found that the vertical jump improved after warming up, but subsequently worsened after heavy plyometric training. On the other side Fortier et al. (2013) investigated that due to the short-duration isolated static stretching or combined with dynamic exercises, the acute effect did not occur before and after training in athletic sprinters. The area of the content of the training load in the aquatic environment and its response to the stimulation of selected motor abilities of performance in synchronized swimming is still insufficiently researched. We assume, that these findings are related to the external environment conditions where is the sport performance realized. The physical activity preformed on the land is influenced by gravity which is reduced in the aquatic environment (Rýzková et al. 2018). Even in our study, we did not find the significant effect of training load in the water in terms of the stimulation of the reflective capabilities of synchronized swimmers.

Conclusion

Every sport has specific requirements that can be considerably different to other sports. The sport of synchronized swimming requires low body weight associated with a lower percentage of body fat. In accordance with previous studies we conclude, that the biological characteristics and motor variables of the elite synchronized swimmers may play an important role during competition and can be considered as bases for success in this sport. We provided evidence for significant differences of variation of the ACE I/D polymorphism between observed groups. The response to the training load in the water in terms of the stimulation of the reflective capabilities of synchronized swimmers did not assume significant relations. This may be caused due to the specific environment, because on the land sport performance is influenced by gravity that is reduced in the aquatic environment.

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EFFECTS OF QUARANTINE DUE TO THE COVID-19 ON SLEEP DURATION AND QUALITY IN ALGERIANS

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Summary. This study tests the impact of COVID-19 on sleep of Algerian population before and during the COVID-19 quarantine by an estimated online survey, adapted from the PSQI Italian version. Including 1210 participants (age between 18-60 years old). The statistical analysis was carried out using SPSS version 22.0 software. Our results showed a significant change in sleeping quality during quarantine, the sleep timing markedly changed, we also noticed additional use of sleeping medications. Algerian scientists recommend to build public awareness and to provide necessary information regarding Algerian sleep quality, especially for Algerian adults.

Keywords: Quarantine, COVID-19, sleeping quality, Algerian population.

Introduction

From the end of December 2019 coronavirus disease 2019 (COVID-19) began to spread in central China (Zhu et al. 2020). As of March 4th 2020, more than 80 560 people had been diagnosed with COVID-19, and 3 010 patients had died from COVID-19 infection in China (Xiao, Zhang, Kong, Li & Yang 2020). Outside China the disease spread worldwide, nearly 13 570 patients were diagnosed with COVID-19 infection, and 270 patients had died from infection by this novel virus (Xiao et al. 2020). The outbreak of COVID-19 was recognized by the World Health Organization (WHO) as a Public Health Emergency of International Concern

(PHEIC) that endangers international public health (WHO -International Regulation(2005), 2007). The WHO has defined a PHEIC as an infectious disease with international spread, or an unusual, serious, or unexpected public health event that exceeds local health resources, or that requires immediate international action (WHO -International Regulation(2005, 2007).

On March 11th, 2020, the WHO declared the COVID-19 outbreak a pandemic (Cucinotta & Vanelli 2020). Data from China have indicated that older adults, particularly those with serious underlying health conditions, are at higher risk for severe COVID-19 associated illness and death than are younger persons ('The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China' 2020). Although the majority of reported COVID-19 cases in China were mild (81 %), approximately 80 % of deaths occurred among adults aged ≥ 60 years; only one (0.1 %) death occurred in a person aged ≤ 19 years ('The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China' 2020). Sporadic cases have been imported to Europe, Africa and North and South America via returning travelers from China. In Algeria, the first case of COVID-19 was reported on February 25th, 2020, when an Italian national tested positive in Ouargla region in the south of the country (Madani, Boutebal, & Bryant 2020), a few days later, on March 1, 2020, two cases were reported in Blida region in the North of Algeria, following their contacts with two Algerian nationals who came from France for holidays, they were detected positive after their return to France, since then, a COVID-19 outbreak has started in this region (Blida) that form a cluster of more than 5,4 million inhabitants with the surrounding cities (Algiers, Boumerdes, Tipaza) (Algerian Ministry of Health 2020, ONSA 2020), now, the epidemic is spreading to other parts of the country, until March 22, 2020, the Algerian authorities have declared 200 confirmed cases with a fatality rate of 8,5 % (Algerian Ministry of Health 2020).

This pandemic showed the lack of preparation of several European countries and the slow nature of the decision-making processes. This situation was also noted in other countries of Africa including Algeria which took the decision to isolate the region of Blida, the most affected at the start of the epidemic, which was somewhat delayed, and which facilitated the spread of the virus country (Madani et al. 2020).

Other decisions have been taken by the Algerian government, for example also in the context of social distancing through the demobilization of 50 % of the workers, the closure of schools, higher education units, and other structures, before extending partial containment from 7:00 p.m. to 7:00 a.m. to all states in the country, while 9 states have had their confinement extended from 3:00 p.m. to 7:00 a.m. The state of Blida, epicenter of the Covid-19 epidemic, in other words the "Wuhan of Algeria", has also been kept, by government decision, in total confinement imposed since 23 March 2020 given the large number of cases recorded, and which continue at this time, since the strategies of containment and mitigation of the epidemic are based on the nature of the virus and its way of spreading (Fauci, Lane & Redfield 2020).

The current situation is likely to have negative effects on many factors that influence sleep quality. Most people are experiencing major changes in their routines, living with uncertainty, and with stress, insecurity about their health, and worries about the situation and its duration. Most working parents are having to combine their work with home-schooling, home administration and household errands. All these adjustments in turn may affect how many hours a day they can actually spend on sleep (Altena et al. 2020). Several studies have highlighted that sleep is vital for the immune system (Bryant, Trinder & Curtis 2004; Besedovsky, Lange & Born 2012). The National Sleep Foundation (NSF) reported that too much sleep will not necessarily prevent sickness but could instead adversely affect the immune system. On the other hand, sleep loss and sleep deprivation impair immune function, since the release of cytokines, a protein that targets infection and inflammation, will decrease (Bryant et al. 2004). Moreover, the infection-fighting antibodies and cells are reduced during periods when humans do not get enough sleep (Bryant et al. 2004). Thus, sleep influences the immune system through the action of centrally produced cytokines which are regulated during sleep. Therefore, it is recommended to get enough sleep each night to fight off infectious diseases. The recommended duration of sleep depends on gender, age and physical activity, with the optimal recommended sleep duration being usually between 7 and 9 hours of sleep per night in adults (Hirshkowitz et al. 2015). Sleep deprivation has been linked with an increased risk of injury the day after (Luke et al. 2011). In that regard, recent literature has shown the positive impact of napping for physical performance and oxidative stress in athletes (Romdhani et al. 2019). Therefore, athletes are encouraged to put a high priority on their sleep pattern, and if necessary, complement night sleep with naps when necessary.

Current evidence supports the general recommendation for obtaining 7 or more hours of sleep per night on a regular basis to promote optimal health among adults aged 18 to 60 years. Individual variability in sleep need is influenced by genetic, behavioral, medical, and environmental factors. A clearer understanding of the precise biological mechanisms underlying sleep need continues to require further scientific investigation (Watson et al. 2015). For this reason, the aim of our study was to show the coronavirus impact on sleep quality, among the Algeria population before and during the COVID-19 quarantine, through an online adapted of the PSQI the Italian version (Curcio et al. 2013).

Methods

Design Study

This research was carried out by team N°04 of the laboratory OPAPS of the Abdelahamid Ibn Badis Mostaganem University, under the number W0890404. The present study is a quick, large cross-sectional online survey conducted by using a social Medias.

Data collection

Participants answered the questionnaires anonymously on the Internet from June 01, 2020, to June 07, 2020. The electronic survey was designed and edited by 04 academic Researchers in physical education from different Algerian universities: University of Ahmed ben Yahia el wancharissiTissemsilt; University of Ghardaïa, and University of Abdelhamid ibn badis Mostaganem, following with a structured literature review. The survey was uploaded and shared online on the Google platform. A link to the electronic survey was distributed via a different way: invitation via e-mails, Facebook™. whatsApp™ and Twitter™.

Sampling

A short questionnaire collected information on some demographic and COVID-19 related information. Standardized questionnaires to evaluate sleep quality and sleep duration were administered. The online survey was anonymous and not attributable to the identity of the participants. 1210 Algerian participants between (18 – 60 years old), were included under this study and grouped basically on their (Gender; Age; Family situation; Educational level; Sports and Health). All the characteristics of the participants are reported in Table 1. Sleep quality during the past month was appraised with a six-question. These questions were adopted from the Pittsburgh Sleep Quality Index. Sleep duration was appraised using one question "During the past month, how many hours of sleep did you usually get each night? This may be quite different to the number of hours you spent in bed. (Enter total number of hours sleep per night)."

Statistical Analysis

This study adopts qualitative and quantitative contents analysis as methodological techniques for interpretation and analysis. All data were analyzed using SPSS 22.0 for Windows Hence. Statistical descriptions were made using the mean, standard deviation for continuous variables, and percentage for categorical variables. Independent-sample *t*-test to compare between sleep duration before home confinement and during home confinement.

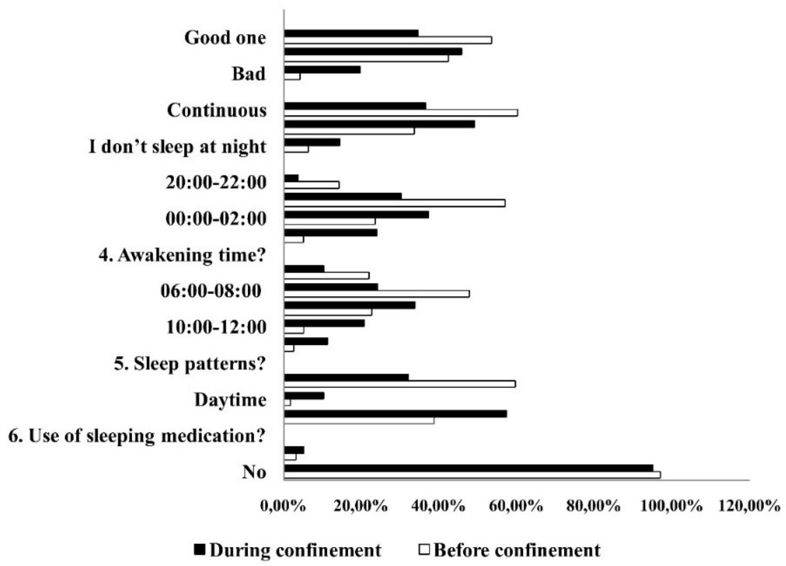
Results

Descriptive Analysis

The characteristics of participants are shown in table 1. In sum, 1210 individuals completed the questionnaires, 991 (81.9 %) were male, and 219 (18.1 %) were female. Age range: (18 – 60 years old). The most represented age range was 18 – 30 years 689 (56.94 %). Family situation Most of the participants were unmarried 750 (61.98 %). Educational level Most of the participants were University education 1001 (82.72 %). Sports: Most of the participants were athletes - 873 (72.14 %). Health: Most of the participants were non-patients - 992 (81.98 %).

Table. 1
Demographic characteristics of study sample

Variable	**Sample**		
		n	**%**
Participants	Total	1 210	100
Gender	Male	991	81,9
	Female	219	18,1
Age	18-30yearsold	689	56,94
	31-45yearsold	455	37,60
	46-60yearsold	66	4,95
Family situation	Unmarried	750	61,98
	Married	447	36,94
	Divorced	13	1,07
Educationallevel	There is no	7	0,57
	Primaryeducation	2	0,16
	Basic or intermediateeducation	34	2,80
	High school	166	31,71
	Universityeducation	1 001	82,72
Sports	Athlete	873	72,14
	Non-athlete	337	27,85
	Non- patient	992	81,98



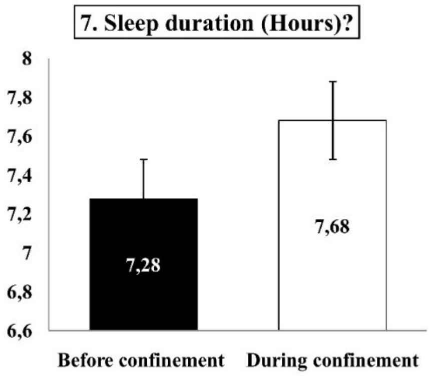


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Figure 1

Show the results of the sleep questionnaire recorded before and during home confinement

Table 2 presents the differences in sleep Quality and sleep duration recorded before and during home confinement in the Algerians population, Considering Sleep Quality assessed by the PSQI, the Italian version (Curcio et al. 2013). By relying on the number **(n)** and percentage **(%).**

Table. 2

Results of the sleep questionnaire recorded before and during home confinement

Questions	Before confinement		During confinement		Δ in %
	n	%	n	%	
Question. 01.					**Sleep quality?**
Good one	647	53.5 %	418	34.5 %	19.00 %
Medium	512	42.3 %	554	45.8 %	-3.50 %
Bad	51	4.2 %	238	19.7 %	-15.50 %
Question. 02.					**Sleep nature?**
Continuous	728	60.2 %	442	36.5 %	23.70 %
Intermittent	407	33.6 %	594	49.1 %	-15.50 %
I don't sleep at night	75	6.2 %	174	14.4 %	-8.20 %
Question. 03.					**Sleep onset time?**
20:00-22:00	171	14.13 %	44	3.64 %	10.50 %
22:00-00:00	689	56.94 %	365	30.17 %	26.78 %
00:00-02:00	284	23.47 %	450	37.19 %	-13.72 %
After 02:00	60	4.96 %	289	23.88 %	-18.93 %
Question. 04.					**Awakening time?**
04:00-06:00	266	21.98 %	125	10.33 %	11.65 %
06:00-08:00	578	47.77 %	290	23.97 %	23.80 %
08:00-10:00	274	22.64 %	408	33.72 %	-11.07 %
10:00-12:00	62	5.12 %	251	20.74 %	-15.62 %
After 12:00	30	2.48 %	136	11.24 %	-8.76 %
Question. 05.					**Sleep patterns?**
Night	721	59.6 %	394	32.6 %	27.00 %
Daytime	21	01.7 %	123	10.2 %	-8.50 %
Scattered between night and day	468	38.7 %	693	57.3 %	-18.60 %
Question. 06.					**Use of Sleeping Medication?**
Yes	37	3.1 %	62	5.1 %	02.00 %
No	1 173	96.9 %	1 148	94.9 %	-02.00 %

Question. 07.							**Sleep Duration (Hours)?**
	X	**SD**	**X**	**SD**	**%**	**T test**	**Sig P<0.05**
	7.28	1.59	7.68	2.07	5.49 %	7.41	.000*

Discussion

The measurements taken by the Algerian authorities to prevent the spread of the Covid-19 epidemic, including the demand for home isolation, have influenced the lifestyle of Algerians because they spend most of their time at home. Sleep is a physiological state that needs its integrity to allow the living organism to recuperate normally (Muzet 2007), sleep is necessary for health as its loss or restriction is associated with multiple detrimental consequences (Imeri & Opp 2009). Good sleep quality is necessary for good health (Imeri & Opp 2009). Studies have reported an association between the poor sleep quality and high risk of falls, infections, or the cold virus as a consequence of a reduction of the immune response

(Prather, Janicki-Deverts, Hall & Cohen 2015). The results of our study showed that 19 % of the respondents experienced a change in their sleep quality, from good sleep to bad and medium sleep. 4 % recorded intermittent sleep and 14% did not sleep in night during this quarantine. We explain this change by the high level of stress, This stress is reinforced by the fear of being contaminated, of dying and/or contaminating loved ones (increased perceived stress), by isolation, feelings of loneliness, possible intra-family tensions (decreased perceived social support), loss of routines and means of action (decreased perceived control) (Guichard et al. 2020). Higher perceived stress is associated with poor sleep quality (Tworoger, Davis, Vitiello, Lentz & McTiernan 2005; Burgard & Ailshire 2009). The decrease in physical activity during this quarantine also influenced sleep quality (Mendelson et al. 2016), recent research has shown that activity levels during the day also affect sleep during the following night; low levels of activity (whether due to, e.g., depression or confinement) affect sleep negatively (Altena et al. 2020), Potter et al confirm that the physical activity during the day (but not late at night) improves sleep quality (Potter et al. 2016)

A lack of regular social interaction can indeed enhance stress and negatively affect sleep quality (Xiao et al. 2020). Another factor that influences the quality of sleep is the increase in time spent in bed (Guichard et al. 2020) Reduced sleep quality negatively affects life satisfaction, health status, social, and emotional domains (Casagrande, Favieri, Tambelli & Forte 2020). The present study demonstrated that more than half of Algerians (56.94 %) sleeps in the second third of the night before the quarantine, otherwise the sleep onset schedule is shifted to the last third of the night during the quarantine. These shift controversies Islamic laws, where the god in the Noble Qur'an (Quran.com 2016), (Quran "ElNour", verset 58 Page 357), and the Prophet Muhammed in Sunnah recommend sleeping the first third of the night. We think the quarantine delayed the Algerians' chronotype, which Individuals with an early chronotype naturally sleep earlier in the 24-hour day cycle, while those with a late chronotype sleep later (Gariépy, Doré, Whitehead & Elgar 2019). Chronotype refers to the natural preference in the timing of daily patterns of activities, such as eating, exercising, and sleeping, that is controlled by the biological circadian rhythm (Adan et al. 2012). This late sleep is due to excessive exposure to artificial light (Guichard et al. 2020), consumption of stimulants in the evening, environmental factors that fragment sleep such as noise, light, temperature etc...

We also record a shift in waking hours, this shift is estimated to be more than 4 hours, or 23.80 % of respondents shift their waking hours after 10:00,except that 32.6 % of respondents who maintain their sleep habits (at night), on the other hand, we register 10.2 % who change their sleep from night to day, and 57.3 % who have a sleep dispersed between day and night, we see that this shift is due to late sleep, and without strict onset hours for school and businesses (Xiao et al. 2020). This sleep cycle disorganization may induce negative effects, or lack of sleep is associated with many diseases, including infection, and with increased mortality (Heslop, Smith, Metcalfe, Macleod, & Hart 2002). Most of our sample does not take medication to sleep, except 5.1% who take it, this result is very beneficial for the Algerian population, short sleep duration is associated with impaired immune and metabolic function (Ganz 2012), obesity, cardiovascular disease (CVD) and other chronic diseases, and increased mortality (Imeri & Opp 2009), Algerians retained their sleep duration 7.28 hours before confinement and 7.68 hours during confinement, but we record significant difference .000 in sleep duration in favor of sleep during confinement, this duration is consistent with National Sleep Foundation which shows that adequate sleep duration (i.e., 7 to 8 hours in 24 hours) are necessary for good health

Limitations and scope of the study

According to the results of the present study, our recommendations are to encourage those studies, which interact with lifestyle, health and wellbeing of the citizens. Not only during the COVID-19 pandemic but also in everyday citizens lifestyles. There was support by national data based on records and compared the lifestyle among of Algerian citizens.

Conclusion

During the corona virus pandemic, people around the world are facing a unique and difficult situation. Our data suggests negative changes in sleep (quality and duration) behaviors in Algerians population especially during the confinement imposed by Covid-19 pandemic. A group of researchers has referred to recommendations and scientific methods related to the quality and duration of sleep, which would allow regulate the biological clock to sleep, especially in the current circumstances and related to home confinement imposed by COVID-19, including: to maintain positive quality and duration sleep-related behaviors such obtaining 7 or more hours of sleep per night on a regular basis to promote optimal health among adults aged 18 to 60 years (Watson et al. 2015), to try exercising regularly, preferably in daylight, to try to get natural daylight during the day, particularly in the morning, and if not possible, have your home brightly lit in the daytime by opening curtains and blinds, or having lights on; to try to have dim light during the evening, with it even darker at night, to try to avoid using prescription sleeping medications if you can, their effectiveness is questionable and they can have some side-effects if taken for longer time (Curcio et al. 2013). Sleep necessity still require further scientific investigation. This recommendation creates a foundation to raise awareness and improve understanding of sleep effects on health and educating the public and healthcare providers on the importance of adequate sleep quality and duration for health. In the end the researchers advised to promote research in the role of sleep in health and well-being.

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SUBJECTIVE PERCEPTION OF LIFE QUALITY AMONG MEN WITH PHYSICAL DISABILITIES WITH DIFFERENT SPORT PARTICIPATION LEVEL

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Summary: The objective of the study was to analyse subjective perception of the quality of life (QOL) among men with physical disabilities with different sport participation level throughout quality of life indicators/domains satisfaction and overall QOL. Three groups of men with physical disabilities (n = 130) categorised by the level of sport participation were recruited for the study: elite athletes (n=26), recreational athletes (n = 45) and non-athletes (n = 59). The Subjective Quality of Life Analysis questionnaire and the WHOQOL User Manual were used as a primary research method. The highest subjective perception of life quality declares men elite athletes and the lowest non-athletes. Elite athletes are significantly more satisfied in their lives with domains Physical health/level of independence and Environment, indicators Sleep, Work, Leisure activities, Safety and overall QOL than non-athletes. No significant differences were found in subjective perception of life quality between men recreational athletes and non-athletes.

Key words: quality of life, indicators and domains, men, physical disability, elite and recreational athletes, non-athletes.

Introduction

The quality of life (QOL) construct has increasingly become a focus for psychological research. According to World health organisation approach QOL is “the individual’s perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns. It is a broad-ranging concept affected in a complex way by the person's physical health, psychological state, level of independence, social relationships, and their relationship to salient features in their environment" (WHOQOL Group 1995). This definition emphasizes not only the subjective nature of QOL, but also its cultural and environmental context as well as personal goals and values. At the same time, personal identity formation implies identification with specific values and choice of life goals and, moreover, this process is deeply rooted in socio-cultural context (Oleś 2016).

Physical disability affects the satisfaction with health, the ability of independent functioning, ability to work and earn for a living, the ability to have and raise children, and achieving partnerships (Bakula et al. 2011; Bendíková & Dobay, 2018). Own body image, self-concept and self-esteem can be significantly altered as a result of a disability (Janeković 2003). All these factors may contribute to a lower QOL for people with disabilities. Some studies have shown poor QOL for people with physical disability (Dijkers 1997). Others have shown disabled people to be more satisfied in some aspects of life, while less satisfied in others than people without disabilities (Post et al. 1998).

Participation in sports, whether competitive or non-competitive, is one way for people with disabilities to increase their QOL. Crnković & Rukavina (2013) argue that impact of kinetic activities of persons with disabilities is manifested through positive effect on motoric and functional capabilities, morphological characteristics, psychological, sociological and cognitive features and contributes to greater independence of people with disabilities, which is a predictor to better QOL. Some other studies have argued that people with physical disabilities who participate in sports and recreational activities improve self-confidence, self-esteem, and QOL, as well as performance of activities of daily living (Jackson & Davis 1983; Slater & Meade 2004; Ginis, Jorgensen & Stapleton 2012; Bendíková et al., 2018). Reviews of adults with various disabilities have described the physical, psychological, social, and economic benefits of participation in sports and recreational activities (Klapwijk 1987; Shephard 1991; Hutzler & Bar-Eli 1993; Richter, Gaebler-Spira & Mushett 1996; Vanderstraeten & Oomen 2010).

Many other scientific papers suggest that participation in sports and recreational activities is beneficial to people with disabilities (Gioia et al. 2006; Rimmer et al. 2010; Nemček 2017; Marko & Bendíková, 2019). Tasiemski et al. (2005) performed a very large questionnaire-based study, including almost 1 000 participants, in which about half were physically active or participated in organized sports. The participants were all wheelchair users. Those who participated in sports had a higher level of life satisfaction, along with a decreased depression and anxiety level. The overall conclusion was that the participants were satisfied with life in general, especially in social domains, but with the lowest satisfaction in sexual life and vocational situation. Another study presents, that people with spinal cord injury who participate actively in sports display increased community integration, life satisfaction, employment, and extraversion, as well as decreased levels of anxiety and depression (Sahlin & Lexell 2015).

Aim of the study

The objective of the study was to analyse subjective perception of the quality of life among men with physical disabilities with different sport participation level throughout quality of life indicators/domains satisfaction and overall quality of life. Concretely; this study had deepened the knowledge by the subjective quality of life comparison among men elite athletes, recreational athletes and non-athletes with physical disabilities.

Methods

Participants and procedure

Three groups of men with physical disabilities (PDs; n = 130) categorised by the level of sport participation were recruited for the study: elite athletes (n = 26; mean age 24.4 ± 1.9 years), recreational athletes (n = 45; mean age 27.1 ± 2.2 years) and non-athletes (n = 59; mean age 29.3 ± 1.7 years). Men with PDs included individuals with following disabilities: 28.5 % cerebral palsy, 28.2 % amputees, 18.8 % progressive muscular dystrophy, 17.9 % spine cord injury (quadriplegia and paraplegia), 5.3 % sclerosis multiplex and 1.3 % myelomeningocele. Most of the elite athletes competed in boccia Paralympic sports discipline. Participants were contacted through representatives of national regular/sport organisations/associations all around Slovakia unifying people with special needs. Some questionnaires were sent electronically by representatives of the organisations and some were passed out at the different meetings organised by national organisations. All data were collected for two years period (2018 – 2019). All participants with PDs agreed participate in the study and gave their written informed consent. The Ethics Committee of the Faculty of Physical Education and Sports, Comenius University in Bratislava (ref. no. 10/2019) had approved this research.

The Subjective Quality of Life Analysis (S.QUA.L.A) and The World Health Organisation Quality Of Life (WHOQOL)

S.QUA.L.A. is a multidimensional instrument. This multidimensional self-assessment method was created by Mathieu Zannotti in 1992 (Zannotti & Pringuey 1992). This scale includes 23 quality of life indicators (indicators). It covers traditional areas (food, family relation etc)., and more abstract aspects of life (politic, justice, freedom, truth, beauty and art, love). We used second part of S.QUA.L.A. where for each indicator, participants were asked to evaluate their degree of satisfaction using the 5-point rating scale. Score 1 (high satisfaction) meant the highest satisfaction and in the same time the highest level and score 5 (total disappointment) expressed the absolute insignificance of the indicator in men life. The lower mean point score meant higher satisfaction with indicator. We unified all 23 indicators into four quality of life domains (domains) following WHOQOL (WHO 1998): Physical Health and the Level of Independence (PH/LI); Psychological Health and Spirituality (PH/S); Social Relationships (SR) and Environment (E) domain. Overall QOL (OQOL) was calculated by summarizing all indicators. In this study a Slovak version of the S.QUA.L.A. was used (Nemček et al. 2011).

Data analyses

The program IBM SPSS Statistics version 23.0 was used for data processing. Quantitative variables are presented as mean and standard deviation (± SD). The Kolmogorov-Smirnov test was used to evaluate data normality, Kruskal Wallis test was used to assess differences in subjective perception of life quality among three groups of people with PDs according to their sport participation level and non-parametric Mann Whitney *U*-test between two independent samples. In the current study, only one measurement has been made and three main groups of people with PDs formed the study. The significance level was set at $\alpha \leq 0.05$ (*) and $\alpha \leq 0.01$ (**).

Results

The analyses of the indicators' mean point scores of the Physical health/ Level of independence (PH/LI) domain shows that elite athletes with PDs are the most satisfied in their lives with sleep, recreational athletes and non-athletes present the highest satisfaction with food (Table 1). All evaluated groups of men with PDs according to their sport participation level are the most dissatisfied with physical well-being among all assessed indicators of the domain PH/LI. Significant differences in satisfaction within three groups of people with PDs according to their sport participation level was shown in indicators sleep (Chi = 7.005, p = 0.030) and work/study (Chi = 7.005, p = 0.030) (Table 1). Subsequent pair comparison revealed significantly the highest satisfaction with sleep indicator in the group of elite athletes compare recreational athletes (U = 385, p = 0.011) and non-athletes (U = 542, p = 0.029) (Figure 1). Pair comparison further revealed significantly higher satisfaction with work/study indicator in the group of elite athletes compare non-athletes (U = 448, p = 0.018) (Figure 1).

Table 1

Differences in subjective perception of life quality within three samples

Indicators/domains Overall QOL	**Elite athletes N = 26**	**Recreational athletes N = 45**	**Non-athletes N = 59**	**Kruskal Wallis Test**	
				Chi-square	***p***
Physical wellbeing	2.577±0.902	2.511±0.944	2.797±0.886	3.189	0.203
Sleep	1.808±0.749	2.444±1.013	2.310±0.959	7.005*	0.030
Self-care	2.120±0.927	2.273±0.845	2.414±0.750	3.576	0.167
Rest in leisure	2.192±0.801	2.133±1.013	2.339±0.939	2.413	0.299
Work/Study	2.167±1.090	2.425±1.196	2.746±1.058	5.867*	0.053
Food	1.961±0.528	2.067±0.939	2.118±0.892	0.290	0.865
Physical health/ Level of independence	**2.129±0.485**	**2.302±0.670**	**2.446±0.602**	**5.364**	**0.068**
Psychological wellbeing	2.077±0.744	2.178±0.886	2.203±0.886	0.552	0.759
Love	2.577±1.137	2.465±1.221	2.483±1.127	0.295	0.863
Religion	2.538±0.948	2.477±0.999	2.754±1.005	2.145	0.342
Justice	3.440±0.768	3.568±0.974	3.464±0.873	0.710	0.701
Beauty and art	2.462±0.582	2.512±0.869	2.554±0.807	0.832	0.660
Truth	2.615±0.803	3.000±1.069	2.965±0.981	2.552	0.279
Psychological health/ Spirituality	**2.608±0.457**	**2.692±0.610**	**2.719±0.531**	**1.113**	**0.573**
Family relations	1.846±0.881	2.023±1.023	2.051±1.024	0.564	0.754
Relations with others	1.885±0.816	2.067±0.751	2.085±0.772	1.570	0.456
Children	2.000±0.707	2.304±1.105	2.117±0.913	0.397	0.820
Sexual life	3.040±1.136	2.850±1.312	2.981±1.212	0.547	0.761
Social relations	**2.234±0.593**	**2.265±0.717**	**2.325±0.719**	**0.356**	**0.837**
Home environment	1.692±0.618	2.156±0.878	2.068±0.907	4.630	0.099
Political situation	4.167±0.816	3.841±1.010	3.897±1.003	1.479	0.477
Leisure activities	1.461±0.582	2.267±1.053	2.586±1.009	23.69**	0.000
Safety	2.154±0.834	2.489±0.895	2.759±1.014	6.780*	0.034
Freedom	2.461±0.948	2.682±0.983	2.732±0.981	1.255	0.534
Finances	2.708±1.160	3.067±1.053	3.000±1.169	1.662	0.436
Environment	**2.391±0.531**	**2.737±0.573**	**2.830±0.667**	**7.776***	**0.020**
Overall QOL	**2.335±0.388**	**2.539±0.546**	**2.643±0.503**	**6.606***	**0.037**

Note: Lower mean score indicates higher satisfaction with indicator/domain/Overall QOL level; Chi-Square = Kruskal Wallis Test statistics; *p*=statistical significance (*p*-values *≤.05, **≤.01)

The highest satisfaction with PH/LI domain shows the group of elite athletes with PDs achieving the lowest mean point score (2.129 ± 0.485 points) and the highest dissatisfaction with this domain declare men non-athletes with PDs achieving the highest mean point score (2.446 ± 0.602 points). Even no significant differences were found in satisfaction with domain PH/LI among three groups of men with PDs according to their sport participation level (Table 1), subsequent pair comparison revealed significantly higher satisfaction with PH/LI domain in the group of elite athletes compare non-athletes (U = 549, p = 0.037) (Figure 1).

The analyses of the indicators' mean point scores of the Psychological health/ Spirituality (PH/S) domain shows that all assessed groups of men with PDs according to their sport participation level are the most satisfied in their lives with psychological well-being and the most dissatisfied with justice (Table 1). Achieved mean point score of PH/S domain further show the highest satisfaction with this domain in the group of elite athletes with PDs achieving the lowest mean point score (2.608 ± 0.457 point) and the highest dissatisfaction in the group of men non-athletes with PDs achieving the highest mean point score (2.719 ± 0.531 points). No significant differences were found in satisfaction with indicators of the PH/S domain nor with PH/S domain among three nor two groups of men with PDs according to their sport participation level (Table 1).

The analyses of the indicators' mean point scores of the Social relations (SR) domain shows that all assessed groups of men with PDs according to their sport participation level are the most satisfied in their lives with family relations and the most dissatisfied with sexual life (Table 1). Achieved mean point score of SR domain further show the highest satisfaction with this domain in the group of elite athletes with PDs (2.234 ± 0.593 point) and the highest dissatisfaction in the group of men non-athletes with PDs (2.325 ± 0.719 points). No significant differences were found in satisfaction with indicators of the SR domain nor with SR domain among three nor two groups of men with PDs according to their sport participation level (Table 1).

The analyses of the indicators' mean point scores of the Environment (E) domain shows that elite athletes with PDs are the most satisfied in their lives with leisure activities, recreational athletes and non-athletes present the highest satisfaction with home environment (Table 1). All evaluated groups of men with PDs according to their sport participation level are the most dissatisfied with political situation among all assessed indicators of the domain E. Significant differences in satisfaction within three groups of men with PDs according to their sport participation level was shown in indicators leisure activities (Chi = 23.69, p = 0.000) and safety (Chi = 6.780, p = 0.034) (Table 1). Pair comparison revealed significantly the highest satisfaction with leisure activities indicator declared by the group of elite athletes compare recreational athletes (U = 321, p = 0.001) and non-athletes (U = 276, p = 0.000) (Figure 2). Pair comparison further revealed significantly higher satisfaction with safety indicator in the group of elite athletes compare non-athletes (U = 507, p = 0.011) (Figure 2). Even in the indicator home environment was not shown significant differences among three samples of men with PDs according to their sport participation level, subsequent pair comparison revealed significantly higher satisfaction with this indicator in the group of men elite athletes compare men recreational athletes with PDs (U = 420, p = 0.029) (Figure 2). Significant differences among three samples of men with PDs is displayed in the E domain (Chi = 7.776, p = 0.020) (Table 1), where the most satisfied with this domain from all evaluated samples are elite athletes compare recreational athletes (U = 378, p = 0.013) and non-athletes (U = 498, p = 0.010) (Figure 2).

The analyses of the mean point scores of Overall quality of life (OQOL) show the highest OQOL in the group of men elite athletes with PDs (2.335 ± 0.388 points) and the lowest in the group of non-athletes (2.643 ± 0.503 points). These differences in the level of OQOL among three samples of men with PDs according to sport participation level were statistically significant (Chi = 6.606, p = 0.037) (Table 1). Subsequent pair comparison revealed significant differences only between elite athletes with PDs and non-athletes, where men elite athletes presented significantly higher OQOL compare men non-athletes with PDs (U = 494, p = 0.009). No significant differences in OQOL were present between elite and recreational men athletes with PDs nor between men recreational athletes and men non-athletes with PDs.

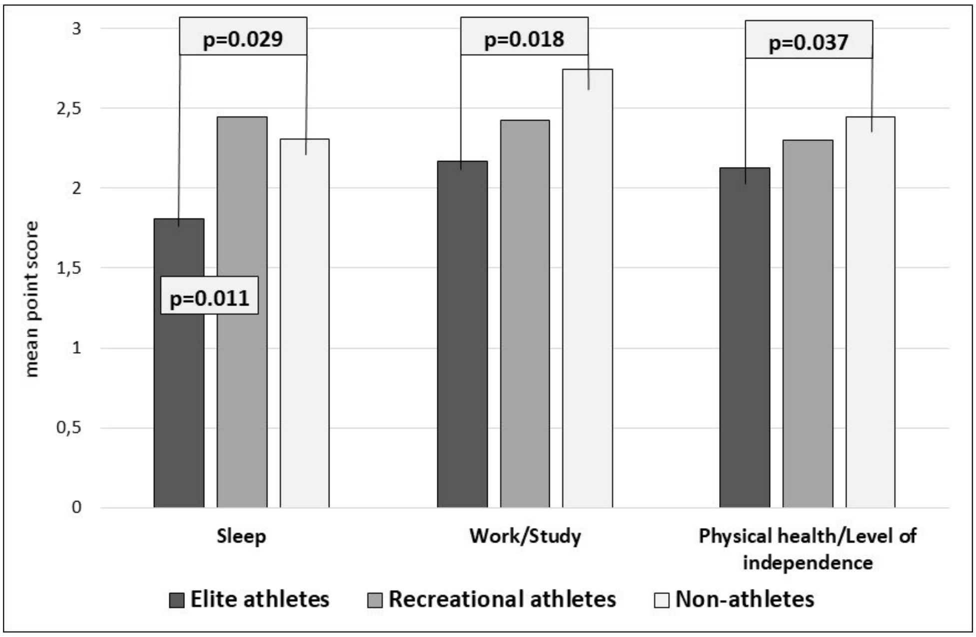

Figure 1
Differences in satisfaction with indicators of the PH/LI domain between two samples

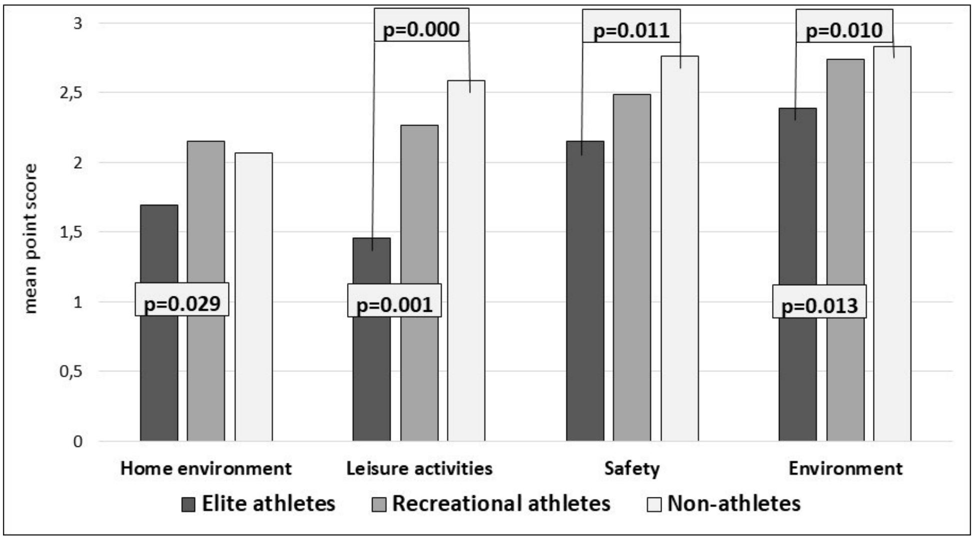

Figure 2

Differences in satisfaction with indicators of the E domain between two samples

Discussion

Individuals with higher levels of athletic competence show more enhanced self-concept and subjective perception of life quality (Kye & Park, 2014). The objective of the present study was to analyse subjective perception of the quality of life among men with physical disabilities with different sport participation level throughout quality of life indicators/domains satisfaction and overall quality of life. Concretely; this study had deepened the knowledge by the subjective quality of life comparison among men elite athletes, recreational athletes and non-athletes with physical disabilities. Results of many scientific papers confirmed, that elite athletes declare greater subjective perception of life quality than non-elite athletes (Marsh et al. 1997; Nemček, Kraček & Peráčková 2017) and non-athletes (Mahoney 1989; Kamal et al. 1995). The results of the present study corresponding with the results of above-mentioned studies, when elite men athletes with PDs show higher level of subjective perception of life quality than recreational athletes and non-athletes. Concretely elite athletes present significantly higher satisfaction with two domains (Physical health/level of independence and Environment) and four indicators (sleep, work, leisure activities and safety) than non-athletes and significantly higher satisfaction with one domain (Environment) and three indicators (sleep, home environment and leisure activities) than men recreational athletes with PDs. Surprisingly, no significant differences were found in satisfaction with indicators/domains nor overall QOL between men recreational athletes with PDs and men non-athletes with PDs. In accordance of the results of Crnković & Rukavina (2013), the effect of engagement in sports has significant positive correlation in all life domains of people with disabilities, regardless of the category to which they belong.

Position of sport plays a significant role in life quality of people with disabilities. The results of Nemček & Mókušová (2020) study revealed the highest position of sport among other life domains in elite and recreational deaf and hard of hearing athletes compare deaf and hard of hearing non-athletes. Another investigation of subjective perception of life quality among people with disabilities presented significantly higher level of overall quality of life (Nemček 2016a) as well as higher life satisfaction (Nemček 2016b) in the group of people with PDs, who participated in sport at elite and recreational level comparing inactive group of respondents with PDs. Related to these investigations, the results of the present study revealed significantly higher subjective perception of life quality through the overall QOL in men elite athletes with PDs than men non-athletes with PDs, but as we already above-mentioned, no significant differences were found in overall QOL between men elite and recreational athletes with PDs, nor between men recreational and non-athletes with PDs in this study.

Even many studies show the highest level of subjective perception of life quality in the group of elite athletes, no significant differences were reported in domains satisfaction nor in overall QOL between male and female elite athletes (Nemček 2020). Similarly, King et al.'s (1993) study showed the lack of difference in subjective perception of life quality scores between disabled and healthy individuals and based on their results suggested that clinical care approach not to be determined assuming that disabled people have lower subjective perception of life quality level.

Conclusion

Differences in subjective perception of life quality among three groups of men with PDs according to their sport participation level are significant. On the basis of the present study's results, the highest subjective perception of life quality declares men elite athletes and the lowest subjective perception of life quality men non-athletes. According to quality of life indicators/domains satisfaction and overall quality of life: (1) men elite athletes present significantly higher satisfaction in their lives with life domains Physical health/level of independence and Environment and indicators Sleep, Work, Leisure activities and Safety compare non-athletes; (2) men elite athletes further present significantly higher satisfaction in their lives with domain Environment and life indicators Sleep, Home environment and Leisure activities compare men recreational athletes with PDs; (3) and men elite athletes also presented significantly higher overall QOL compare men non-athletes with PDs. No significant differences were found in subjective perception of life quality between men recreational athletes with PDs and men non-athletes.

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CHANGES IN THE START REACTION TIMES IN THE 200 m RUN AT THE WORLD CHAMPIONSHIPS AFTER THE TIGHTENING OF FALSE START RULE

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Summary: Reaction time is an important component of the structure of sports performance in sprint disciplines. In our observation, we focused on the men's and women's 200 metres discipline at the World Championships (WCH) in two periods. The first in 1999-2009 and the second in 2011-2019. This division was conditioned by the change in the false start rule, which states that any competitor who makes a false start, except in multicontest, will be disqualified (valid since 1st January 2010). This change affected the speed of the sprinter's reaction. The monitored group were finalists of the 200 m runs at the WCH, a total of 11 events. We used basic mathematical-statistical characteristics and assessed changes in reaction times using parametric paired and parametric unpaired t-test and Wilcoxon test. We compared reaction time in the heats and the finals. We found that at some WCH, worse reaction times were achieved in the finals of both categories compared with the heats. By comparing the reaction speed in the heats with the reaction speed in the men's finals, we recorded this statistically significant difference in the first period ($p < 0.01$) and after tightening the rule at the level of $p < 0.10$. In the women's group, this difference was not statistically significant in any period. The percentage of the reaction speed in the final time of the 200 m run was 0.76 – 0.86 % in the men's group and 0.74 – 0.78 % in the women's group. The analysis of the results from the WCH in athletics confirmed the importance of reaction speed in the 200 m run.

Keywords: World Athletics Championships, reaction time, men's and women's 200 m running, heats, finals, IAAF (WA)

Introduction

The structure of sports performance is a complex, versatile and variable system. It is necessary to take into consideration the interconnections and relationships between individual parts instead of studying them as separate factors (Koštial 1984). The author emphasised that there is a specific hierarchy (the genesis of the structure) between the individual factors of the whole. Short distances are characterised by maximum load intensity in order to cover a given distance in the shortest possible time. As reaction time is a necessary part of these disciplines, Kampmiller & Koštial (1986), Sedláček (1992) have already included the ability to react in the first factor level in the structure of youth sports performance in the 100 m run (14.2 % share in total performance). In addition, among the limiting factors of achieving performance in athletic sprint disciplines belongs the maximum running speed and the ability to maintain it during performance at speed – referred to as endurance in speed (Kampmiller & Koštial, 1986). Unlike these authors, Choutka (1976) classified reaction speed in relation to sports performance into the second-factor level. The speed of response is influenced by several factors: age, gender, physiological and psychological abilities, fatigue, warm-up, athletic age, intelligence, anticipation (Schweitzer 2001; Luchies et al. 2002; Barral & Debu 2004; Van der Berg and Neely 2006; Kohen et al. 2008; Zemková 2011; Hodgkins 2013). The study by Adam et al. (1999) considered the hypothesis that men and women use other information processing strategies to create responses to given tasks. This fact was also confirmed by Brosnan, Hayes & Harrison (2016), who found significant differences in the reaction speed of elite athletes. Based on this, they recommended different limits to determine the violation of the response speed rule. Instead of the current 0.100 s for both categories, they recommend a limit of 0.115 s for men and 0.119 s for women.

The results are in favour of men, who achieved a much faster reaction time than women in a selective, compatible, and incompatible task that required a verbal response. Its significant position can be easily demonstrated with a sprint at 100 m. As the author Ozolin (1986) and Kuchen (1978) state, if we theoretically imagine two athletes with a difference in the start reaction of 20 ms, it would be reflected as a 20 cm distance in the finish, which is at the current differences in performance often the length difference between the first and fifth competitor. Although the share of reaction time in sports performance is getting smaller with increasing running distance, it is important to realise that the result is often decided by hundredths of seconds (Delalija & Babić 2008). Their research was also focused on reaction time as the first factor in the time sequence of the sprint. The sample included 250 women and 360 men from the 2004 Olympic Games in Athens. The research aimed to determine the effect of reaction time on the result of the sprint. The authors statistically proved a significant correlation between the reaction time and the achieved performance in the women's 100 m hurdles and the men's 100 m and 110 m hurdles. At 200 m, a significant linear increase in the mean reaction time was demonstrated at start (Baumann 1980; Babic & Delalija 2009). The authors Locatelli and Arsac (1995) stated that this is mainly due to the fact that the 200 m runners are aware of the small share of the reaction time in their final performance. We believe that a factor such as reaction speed must be approached as responsibly and with sufficient emphasis as the development of other skills. The speed of the reaction could also be influenced by the rules of athletics about start in short distances (rule no. 162). Changes in the number of false starts and tightening of the criteria for excluding an athlete could have affected the speed of the sprinter's reaction. The 2009 rule (effective from 1 January 2010) stipulated that the reaction rate should not be below 0.100 s. Since then, any competitor who makes a false start (except for multicontest) will be disqualified. After taking the final start position, the competitor must not start moving before the gun is fired. If in the opinion of the starter or a deputy – starter assistant, the athlete begins the movement earlier, it is considered a false start (IAAF Rules of Athletics 2018 - 2019).

This paper aimed to compare the reaction times at the start of men and women finalists of the 200 m World Championships in the years 1999 to 2019. The criterion for comparing the speed of reaction in the monitored groups (1999-2009, resp. 2011-2019) was the rule tightening on the exclusion of an athlete at the start.

Hypotheses

H1 We assume a statistically significant improvement of the start reactions in the final runs at individual WCH in comparison with the heats in the group of men and women in the whole monitored period.

H2 We assume, due to the rule change of a false start, we will find a statistically significant deterioration of the start reactions in the WCH at the period of 2011-2019 in comparison with the period of 1999-2009 at the heats and the finals of men and women.

H3 We assume statistically significantly better values of start reactions of men and women in the finals in comparison with the heats at the WCH in the first and second period, as well.

Tasks

1. Find and evaluate start reaction data from the official website of the IAAF (WA - World Athletics) from the WCH 1999-2019.
2. Analyse, compare, and statistically prove changes in start reactions in individual disciplines.

Methods

Participants

We researched men and women sprinters in the 200 m runs, who took part in the finals at the WCH in Athletics in the years 1999-2019. The group consisted of 348 athletes (176 men and 172 women).

Procedure

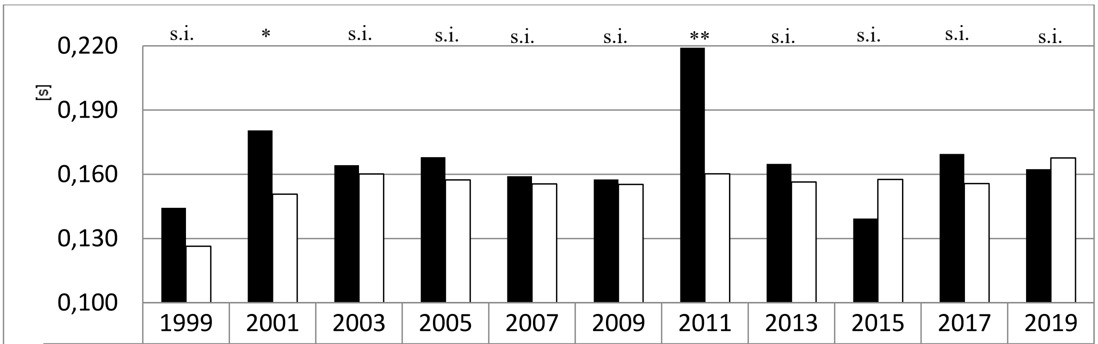
We obtained the values of the start reactions of sprinters from the mentioned period from the official website of the IAAF (WA). We calculated their percentage share of performance.

Statistical analysis

In the calculations, we used the basic statistical characteristics (Tab. 1): arithmetic mean (x), standard deviation (s), minimum value (x_{min}), maximum value (x_{max}) and variation range (v_r). We determined the statistical significance of changes (heats vs finals at individual WCH) using the Wilcoxon t-test. We used parametric paired and parametric unpaired t-test to compare the differences in the reaction speed in the monitored periods. The normality of the distribution was assessed by the Shapiro-Wilk test.

Results

The first hypothesis was the assumption that in each observed period, both men and women achieve faster start reactions in the final runs compared to the heats (Fig. 1, Fig. 2).



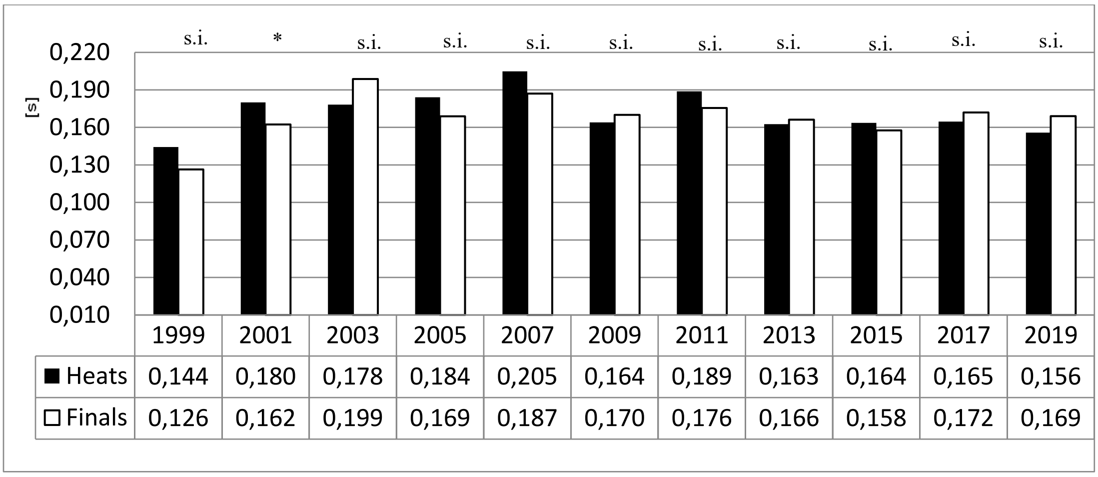
	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017	2019
■ Heats	0,144	0,181	0,164	0,168	0,159	0,158	0,219	0,165	0,139	0,170	0,162
□ Finals	0,126	0,151	0,160	0,157	0,156	0,155	0,160	0,156	0,158	0,156	0,168

Legend: * p < 0,05; ** p < 0,01; s.i. – statistically insignificant

Figure 1

Comparison of the average values of men's start reactions (n = 8) in the 200 m run from 1999 to 2019 at the World Athletics Championships

Figure 1 shows that men achieved, on average, faster start reactions in the finals at almost all WCH. In 2001 ($p < 0.05$) and 2011 ($p < 0.01$) the changes were statistically significant. In contrast, during 2015 and 2019, there was a deterioration in the speed of reaction in the finals (by 12.02 % and 3.57 %, respectively).



Legend: * p < 0,05; s.i. – statistically insignificant

Figure 2

Comparison of the average values of women's start reactions (n = 8) in the 200 m run from 1999 to 2019 at the World Athletics Championships.

In Fig. 2, it can be seen that the women achieved an improvement in the mean start reactions in 6 WCH. We recorded a deterioration in the average start reactions in the finals at five WCH, in 2003, 2009, 2013, 2017 and 2019. The average value of the improvement of the start reaction was 9.16 %. The average deterioration in the reaction rate was 5.51 %. Based on these results, we can state that we did not confirm H1.

In H2, we assumed that due to the change in the rule of the false start, we would find a statistically significant deterioration of the start reactions in the WCH during the second period (2011-2019) compared to the first (1999-2009) in the heats and finals of men and women. Table 1 shows the basic statistical characteristics of the observed periods, and Table 2 shows their statistical significance of differences.

Table 1

Basic statistical characteristics of men (M) and women (W) in heats and the finals in the 200 m run at the World Championships 1999-2019

Category and period	**X**	**Me**	**s**	x_{min}	x_{max}	v_r
M heats 1999-2009 (n=48)	0,162	0,159	0,023	0,124	0,229	0,105
M finals 1999-2009 (n=48)	0,151	0,156	0,016	0,124	0,186	0,062
M heats 2011-2019 (n=40)	0,175	0,165	0,039	0,128	0,314	0,186
M finals 2011-2019 (n=40)	0,160	0,161	0,018	0,119	0,198	0,079
W heats 1999-2009 (n=46)	0,178	0,169	0,04	0,133	0,367	0,234
W finals 1999-2009 (n=46)	0,174	0,172	0,039	0,124	0,277	0,153
W heats 2011-2019 (n=40)	0,167	0,161	0,023	0,136	0,238	0,102
W finals 2011-2019 (n=40)	0,168	0,162	0,021	0,138	0,228	0,09

Legend: Me – median, x – arithmetic mean, s – standard deviation, x_{min} – minimum value, x_{max} – maximum value, v_r – variation range, M – men, W – women

Table 2

Statistical significance of differences in reaction times in heats and the finals of the 200 m men's and women's run at the World Championships in Athletics

Period	1999-2009	t-test	2011-2019	1999-2009	t-test	2011-2019
M	Heats	s.i.	Heats	Finals	s.i.	Finals
W	Heats	s.i.	Heats	Finals	s.i.	Finals

Legend: s.i. – statistically insignificant, M – men, W – women

In the heats, men's reaction time in the second period was 0.175 s, which was a deterioration of 5.56 % compared to the first period (0.162 s). There was a similar trend in the final runs. In the years 2011-2019, the reaction rate deteriorated to 0.160 s (i.e. by 5.96 %) compared to the years 1999-2009, in which the average reaction rate time was 0.151 s. However, this deterioration was not statistically significant either in the heats or in the finals. In the women's group, we found an improvement in average times by 6.18 % (0.178 s and 0.167 s, respectively). In the final, there was an improvement of 3.45 % (0.174 s and 0.168 s, respectively). However, even these differences were not statistically significant. We state that we did not confirm H2.

In H3, we assumed that in the monitored periods (1999-2009, respectively 2011-2019), both men and women would achieve faster start reactions in the finals than in the heats. Table 3 shows that in the first period, this difference was statistically significant in men at the level of $p < 0.01$ and after tightening the rule at the level of $p < 0.10$. In women, this difference was not statistically significant in any period.

Table 3

Statistical significance of differences in reaction times in heats and in the finals of the World Championships in Athletics

Period	1999-2009				2011-2019		
M (n=48)	Heats	p <0,01	Finals	M (n=48)	Heats	p <0,10	Finals
W (n=46)	Heats	s.i.	Finals	W (n=46)	Heats	s.i.	Finals

Legend: s.i. – statistically insignificant, M – men, W – women

The importance of the reaction speed is confirmed by its percentage share in the final time of sprinters in the 200 m run (Table 4).

Table 4

Reaction times and their percentage share of the achieved performance in the 200 m run in the period 1999-2009 and 2011-2019

Period	Men				Women			
	Heats		Finals		Heats		Finals	
	RT [s]	% share	RT [s]	% share	RT [s]	% share	RT [s]	% share
1999-2009	0,162	0,79	0,151	0,76	0,178	0,78	0,174	0,77
2011-2019	0,175	0,86	0,160	0,79	0,167	0,74	0,168	0,75

Legend: RT – reaction time

Discussion

The first hypothesis about the improvement of start reactions in the final runs was not confirmed. Men at two WCH (2015, 2019) and women at five WCH (2003, 2009, 2013, 2017, 2019) achieved worse reaction times in the finals than in the heats.

In the second hypothesis, we assumed statistically significant differences in the reaction speed in the heats and the finals in the first (1999-2009) and the second (2011-2019) period. Our assumption was not confirmed in any of the groups. We did not confirm the third hypothesis about better reaction times in the finals in each period and both categories.

Among men, we showed a statistically significant improvement in the reaction speed in the finals in the first and second periods, but not in women. By tightening the rule of exclusion of the sprinter in the event of a false start, the statistical significance was reduced from $p < 0.01$ to $p < 0.10$. Our results confirmed the conclusions of Pilianidis, Mantzouranis & Kasabalis (2012), who noted a deterioration in the reaction speed of top sprinters following the introduction of the new rule on a false start. Similar results were presented by Haugen, Shalfawi & Tønnessen (2013). However, women did not confirm this trend. The reaction speed in the second period was higher in the heats (0.178 and 0.167 s, respectively) and the finals (0.174 s and 0.168 s, respectively) than before the rule tightening. These results confirmed the conclusions of Englert & Bertrams (2014), who stated that reaction skills could be improved through regular and systematic training, so it is necessary to monitor and pay attention to the reaction time in the training process. In a sample of 37 runners, the authors showed that the strength of self-control of athletes influences the value of reaction time. The result depends on the level of difficulty of the tasks performed by the athlete before the start. The fact that the reaction speed often decides the overall ranking is also proven by several data from the WCH in the 200 m run (Helsinki, 2005). Bronze runner Arron (FRA) and the second in the order Boone-Smith (USA) had the same final time in the finals (22.31 s). Arron's reaction time was 0.184, which was the second slowest reaction time in the finals. Smith won a silver medal with a reaction time of 0.161 s. At the WCH in Moscow (2013), the silver runner Ahouré (FRA) and the bronze Okagbare (Nigeria) reached the same time in the final run (22.32 s). Thanks to good reaction time, Okagbare (0.154 s) matched the faster runner in 2_{nd} place, Ahouré, who had a reaction time of 0.180 s. A similar situation occurred in the men's running finals in Beijing (2015). Fourth in the final run, Edward (Panama) and third Jobodwana (JAR) reached the same time 19.87 s. The placement was again determined by the reaction time, which Edward had 0.170 s and Jobodwana 0.154 s. Barral & Debu, (2004) and Hodgkins (2013) found that men have faster start reaction compared to women. We confirmed this conclusion in our investigation in three comparisons. We found the opposite trend - a better reaction time for women - in the period after the rule was tightened. In the heats, women had a faster reaction time (0.167 s) than men (0.175 s). During this period, in the final runs, the reaction speed was in favour of men (0.160 s and 0.168 s, respectively).

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ANAEROBIC FITNESS TESTING IN CROSSFIT

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Summary: CrossFit is one of the sports disciplines where endurance play a significant role in the performance. For testing anaerobic fitness it is important to choose the means that are part of the exercise and have a good transfer to the sport. A sample of competitive crossfitters (n = 12) underwent stress tests on the assault air bike (AB) (60 s) and Wingate. In addition to the performance parameters (Wmax, Wmean, W/kg, cal), lactate values after exercise (1st, 5th, 10th and 15th minute) were monitored. The results showed significant differences in both the absolute values of lactate and the development of the lactate curve ($\alpha = 0.05$). The correlation of the selected variables showed a significant relationship between the average Watts value and the calories traveled (0.894). Testing anaerobic fitness with AB appears to be a suitable variant for CrossFit, as well as monitoring the development of lactate curve. Due to the original design of the study, it is necessary to verify the results.

Keywords: performance, Wingate, assault air bike, lactate, VLamax, conditioning

Introduction

CrossFit is a worldwide phenomenon, which gradually evolved in a performance, respectively racing form. The races are organized at a local and international level and require a long-term and specific training. Therefore, it is necessary to analyze individual aspects and transfer the results to the training practice (Feito et al. 2018; Schlegel et al. 2020).

By its nature, CrossFit ranks among relatively short and highly intensive sport disciplines. Most of the load usually lasts between 5 – 20 minutes and consists of various modalities including not only the traditional endurance sports (running or rowing), but also exercises with bodyweight or external load. The level of load is evidenced by heart rate values, lactate levels or elevated creatine kinase parameters (Dexheimer et al. 2019). A good level of aerobic and anaerobic fitness is important for the mentioned endurance performance. Both components are involved in the outcome and their ratio must be in good balance (Butcher et al. 2015). Therefore, attention should also be paid to the level of anaerobic metabolism.

Testing anaerobic fitness represents a very short load at maximum intensity, which is mainly dependent on the energy substrates creatine phosphate, glycogen (Medbø & Tabata 1993). The duration of the tests ranges from 30 to 60s and parameters, such as a lactate level and course, peak power, mean power, fatigue index, or VO_2max are monitored (Noorhof et al. 2013). The level of these parameters is also dependent on strength, muscle fiber ratio or lactate metabolism. The monitoring of the blood lactate levels is a good feedback for evaluating the intensity of indoor stress (Brooks 2018).

A very common means is to use the Wingate test (Wingate), which uses a bicycle treadmill with a gradual increase in resistance. It is a valid and reliable device that is applied in various sports disciplines (Murawska-Cialowicz 2015). However, it uses only the lower half of the body and therefore its informative value may in some cases be limiting. In CrossFit, the upper body is also heavily involved, which is why it is tested. Assault air bike (AB) is a special free-wheeled wheel that allows you to engage the pull and push forces of the upper limbs. The load is therefore more complex with a likely overlap in the use of energy resources and a physiological response. It is also a commonly used training and racing device.

The aim of this research was to determine whether AB is a suitable means for testing anaerobic fitness in performance crossfitters and further compare the results with the Wingate test. Thus, a standardized and a non-standardized anaerobic fitness test were compared.

Methods

Study design

The participants underwent two stress tests to assess the level of anaerobic fitness. First, the AB test, then the Wingate test; the interval between tests was a week. In both tests it is necessary to work with the maximum effort to which individuals were motivated. The testing included a measurement of the lactate development after loading; performance values from both devices were also monitored. The tests were then compared in terms of the lactate curve and the measured parameters.

Participants

12 men (age 28.1 years, height 183.3 cm, weight 86.9) participated in the research. They were competitive crossfitters with experience with CrossFit for at least 2 years and with participation in competitions at least at the regional level. All of them were currently in a similar

stage of preparation without a significant variation in the training regimen or specific development of anaerobic fitness. The average number of training units was 6 and their content contained strength, weightlifting, gymnastic and conditioning parts. They all had experience with AB and the method of loading in tests. Two days prior to the test, they should only have a light training intensity. None of the participants had a significant low/high-carbohydrate diet. 48 hours before the test, carbohydrate intake should not be increased. The dietary supplements supporting the exercise have been banned.

Table 1

Description of the research sample

	Mean	SD	Minimum	Maximum	Median
Age	28.1	5.3	20	34	31
Height	183.3	5.7	174	193	182.5
Weight	86.9	9.8	73	107.5	84

SD – standard deviation

Testing

The same protocol was set for both tests. The test experienced a warm-up phase (5 minutes) on a bicycle or AB. The heating was done at light intensity to avoid a subsequent lactate increase and a significant increase in respiratory rate/depth. The targeted breathing techniques were also not allowed. This was followed by a 3 min passive pause and the first lactate collection. On instruction the participant took the test, where he was strongly motivated by the researchers in the limit performance from the beginning. The test was followed by a passive sitting position, in which he had to endure until the end of the test, any further movement was prohibited. The lactate collection after the exercise was performed at 1, 5, 10 and 15 minutes.

Wingate test

This is a 30s test on a Wattbike (Monark exercise AB, Sweden). The principle is isokinetic cycle sprint by 7.5% of the weight of the tested person. Peak power (Wmax), mean power (Wmean) and W/kg (maximum weight index) were monitored.

Assault air bike test

It is a special bike, where it is also possible to work with free arms that allow pushing and pulling upper body. The arms and pedals are mechanically dependent on each other and have the same frequency. The machine cannot adjust the difficulty, which increases as speed increases on the principle of an aerodynamic brake (resistance is created by flywheel). Here, the calories traveled (a separate unit of measure whose value is derived from the output force in watts) were monitored. The participants worked for 60s with maximum effort, right from the start.

Lactate

The enzymatic-amperometric method for the determination of lactate in fresh capillary blood (Lactate scout, EKF diagnostics) was used. The sample was taken from the earlobe.

Analyses of data

Using TIBCO Statistics, Desktop version, a t-test was applied between the measured lactate values after loading on AB and Wingate. Furthermore, the correlation analysis (Spearman coefficient) was used to determine the relationship between selected variables that were obtained from both tests.

Results

Table 2 shows selected values from the AB and Wingate stress tests. The results of Wmax, where the average was 1268, 8 Watts, reveal that they were the athletes with very good strength abilities of the lower limbs. Greater dispersion was recorded in calories traveled, values ranged from 34 – 57.

Table 2

Description of the performance values on AB and Wingate

	Mean	SD	Minimum	Maximum	Median
Wmax	1268.8	130.2	1045.0	1467.0	1264.5
Wmean	771.5	55.9	700.0	873.0	755.5
W/kg	14.6	1.1	13.4	16.9	14.3
Cal (AB)	43.9	7.2	34.0	57.0	41.5

Wmax - the maximum achieved value of Watts (Wingate); Wmean – average value of Watts (Wingate); W/kg - index of maximum power in terms of mass (Wingate); cal - calories traveled (AB)

The athletes achieved high levels of lactate during the tests (Table 3). During the first minutes there was a rapid increase, which reached a maximum in the 5th minute (Wingate), respectively in the 10th minute (AB). The development of the lactate curve of all participants is shown in Fig. 1 below. It is evident that after the loading on AB, lactate accumulated for a longer time, reached higher values and also decreased more slowly. Even after 15 minutes the average value was 15.7 compared to Wingate with 11.4. In addition, the lactate values at Wingate showed greater variance at 10 and 15 minutes. The figure also shows the course of changes in the lactate levels based on average values (AB - black, Wingate - blue). The curve shows a similar course, but is significantly different at the end.

Table 3

Average lactate values in minutes

	0	1	5	10	15
AB	1.78	11.65	14.46	15.98	15.68
SD	0.52	2.56	1.66	0.92	1.19
Wingate	1.75	10.30	14.09	13.16	11.10
SD	0.38	2.92	1.67	1.87	2.48

SD – standard deviation

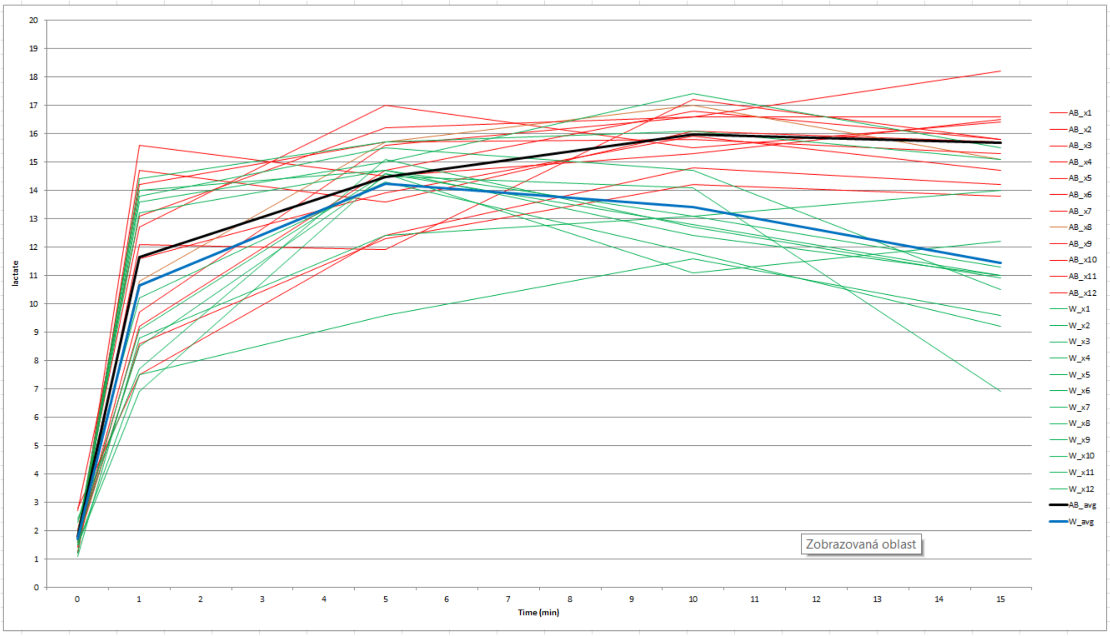

Figure 1

Lactate curve after Wingate and AB

Table 4

T-test for the average AB and Wingate values per minute

	Mean AB	Mean W	t - value	df	p	Valid N AB	Valid N W	SD AB	SD W	F-ratio variances	Variances
AB1 vs W1	11.65	10.64	0.90	22.00	0.38	12.00	12.00	2.56	2.92	1.30	0.67
AB5 vs W5	14.46	14.23	0.34	22.00	0.73	12.00	12.00	1.66	1.67	1.01	0.99
AB10 vs W10	15.98	13.41	4.28	22.00	0.00	12.00	12.00	0.92	1.87	4.16	0.03
AB15 vs W15	15.68	11.43	5.34	22.00	0.00	12.00	12.00	1.19	2.48	4.34	0.02

W – Wingate; AB – assault air bike; SD – standard deviation; mean AB – lactate average value for AB; MeanW – lactate average value for Wingate

A comparison of the lactate values in individual minutes is given in Table 4. A statistically significant difference can be observed at 10 and 15 minutes. Conversely, at 1 and 5 minutes it was not confirmed although the values for AB were higher.

Furthermore, the development of the lactate curve was analyzed and the increase, respectively the decrease in average values (Table 5). Although lactate increased by 555.2 % for Wingate and 611.9 % for AB between the 1st and 2nd measurements, the statistical significance was not confirmed. Similarly, between the 2nd and 3rd measurements, when there was an increase (28.8 % for AB, 41.3 % for Wingate). A statistically significant difference can be observed in the development between the 3rd and 4th measurement (absolute deviation of 16.6%) and also between the 4th and 5th measurement.

Table 5
Assessment of a different development of the lactate curve

	Mean AB (%)	Mean W (%)	t - value	df	p	Valid N AB	Valid N W	SD AB	SD W	F-ratio variances	Variances
AB 0-1 vs W 0-1	9.87 (611.9)	8.93 (555.20)	0.80	22.00	0.44	12.00	12.00	2.76	2.98	1.16	0.80
AB 1-5 vs W 1-5	2.81 (28.80)	3.58 (41.30)	-0.75	22.00	0.46	12.00	12.00	2.53	2.52	1.01	0.99
AB 5-10 vs W 5-10	1.53 (11.70)	-0.82 (-4.90)	3.25	22.00	0.00	12.00	12.00	1.65	1.87	1.29	0.68
AB 10-15 vs W 10-15	-0.31 (-1.80)	-1.98 (-14.40)	2.39	22.00	0.03	12.00	12.00	1.07	2.17	4.10	0.03

W – Wingate; AB – assault air bike; SD – standard deviation; mean AB – lactate average value for AB; MeanW – lactate average value for Wingate

A correlation analysis was performed to assess the relationship between the selected variables (Table 6). The expected strong relationship (α = 0.01) was shown between weight and Wmax (0.713) and also with Wmean (0.683). Neither age nor height showed a strong relationship with any of the selected variables. Calories traveled had a strong correlation with Wmean (0.894). Other statistically significant relationships were not shown.

Table 6
Correlation analysis of the selected variables

	Age	height	weight	Wmax	W_mean	W/kg	cal
Age	1	0.442	0.558	0.536	0.420	-0.116	0.471
height	0.442	1	0.224	0.172	-0.035	-0.090	0.094
weight	0.558	0.224	1	0.713**	0.683*	-0.473	0.519
Wmax	0.536	0.172	0.713**	1	0.568	0.268	0.474
W_mean	0.420	-0.035	0.683*	0.568	1	-0.310	0.894**
W/kg	-0.116	-0.090	-0.473	0.268	-0.310	1	-0.204
cal	0.471	0.094	0.519	0.474	0.894**	-0.204	1

Wmax - the maximum achieved value of Watts; Wmean – average value of Watts; W/kg - index of maximum power in terms of mass; cal - calories traveled

Discussion

The use of Wingate for testing the anaerobic endurance is common in sports training (Noordhof et al. 2013). In CrossFit, it has been used several times, but as a potential predictor of the CrossFit performance (Butcher et al. 2015). For some workout of the day (WOD), Wmax or Wmean may be related to the end result (Dexheimer et al. 2019), but this cannot be broadly claimed (see Bellar et al. 2015, Martínez-Gómez et al. 2019).

The absolute achievements (Wmax, Wmean) in Wingate are relatively high and comparable, for example, with hockey players (Lau et al. 2001). In this research, the participants reached higher values compared to the tested CrossFit samples (Feito et al. 2018 or Butcher et al. 2015). The overall performance level of the group seems to be a significant factor. These were the athletes who have competing experience at least on a local level. In such a case, it is possible to assume high strength abilities not only of the lower limbs (Serafini et al. 2018) and thus a high power production on the bicycle simulator.

This was the first known study to test the load using AB and therefore, no comparable studies can be referred to. Ozkaya et al. (2013) dealt with the use of an elliptical trainer, which also engages the upper and lower half of the body, but it is different from AB. As with this research, the treadmill showed higher physiological values than the Wingate. In most WODs the whole body is involved, and therefore, all the large muscle groups (Feito et al. 2018). AB also requires the use of upper body pushing and pulling forces, as demonstrated by the lactate accumulation that was higher than that of Wingate or equally long stress tests (Carey & Richardson 2003; Carter et al. 2005; Miladi et al. 2011).

The correlation results show that AB and Wingate cannot be fully substitutable. AB was used with calories traveled, showing a high correlation (.871) with Wmean only. In addition to the maximum power output, both values also reflect strength endurance and work efficiency in a short maximum load - anaerobic work capacity. This includes not only the physiological aspects - the involvement of muscle fibers, the proportion of aerobic and anaerobic metabolism, the ability of glycolysis, lactate production (Brooks et al. 2018), but also the mental readiness to perform the limit performance. However, due to the high levels of lactate achieved (15.98 for AB and 14.2 for Wingate), both intensities and excessive activation of anaerobic metabolism appeared to be maximal in both tests.

The Wingate values, such as Wmax, fatigue index or W/kg are not very significant for the CrossFit performance. These variables can, of course, show when retesting the physiological changes that occurred during the training (Murawska-Cialowicz et al. 2015). Because of the nature of CrossFit, Wmean is more important because the load takes a longer time and more in the context of strength endurance than the maximum power output (Butcher et al. 2015). The calories traveled can therefore substitute for Wmean.

The lactate curve showed deviations after the stress tests. Already in the first measurement the values differed by 0.7. This is probably due to the involvement of more muscles and thus a slightly higher total lactate production (Noordhof et al. 2013). At 5 minutes the difference between the values decreased to 0.3, which is probably due to the organism's limit capacity to accumulate excessive amounts of lactate in the body. It appears that it will not be possible to achieve significant differences in lactate levels in the tests during the first minutes due to the physiological limitations mentioned (Özturk et al. 1998). At the 10th minute, the lactate curve developed in reverse and this was confirmed statistically ($\alpha = 0.01$). In AB, the amount of lactate increased further and reached its maximum, unlike Wingate, where it has already decreased. This is due to the more complex load at AB and probably also due to the length of load, although even tests lasting 45-90s do not always show such a course (Carter et al. 2005, Miladi et al. 2011). With Wingate, it is possible that the peak could be reached between 5 and 10 minutes (see Özturk et al. 1998). The high accumulation of lactate in AB had an effect on the further course, when there was only a small decrease compared to Wingate, where the decrease was already marked (to 11.4). In Wingate, it is possible to observe the earlier peak of the lactate curve and also the steeper decrease of the lactate level.

The Crossfitters achieved high lactate absolute values in Wingate, which are higher than in similar studies (Spierer et al. 2004; Miladi et al. 2011). The reason could be a higher proportion of type I muscle fibers, which are the primary producer of lactate. It is typical of the CrossFit that athletes must possess very good strength and dynamic-strength abilities associated with the Olympic weightlifting (Schlegel et al. 2020), which confirms this premise. For AB the values were even higher and the onset was steeper. Therefore, it would be better to approach VLamax (maximum rate of energy production using the glycolytic system). High lactate levels are one indicator of good levels of the anaerobic system (Vandewalle et al. 1987). This is an important feedback with respect to the training process.

The stress tests for anaerobic fitness testing usually range from 30 to 60s. The 60s load is sufficient for the maximum lactate production and at the same time, the aerobic processes are not so strongly involved (Green & Dawson 1993; Medbø & Tabata 1993; Carter et al. 2005). In the case of CrossFit, it is important to achieve VLamax when testing anaerobic fitness and therefore, a longer loading time seems more appropriate. Unlike a short Wingate load, a more anaerobic work capacity is projected to an AB performance of 1 minute, which is more important for the CrossFit performance. Therefore, the calories traveled will be a valuable indicator of the ability. The test time chosen therefore seems appropriate. Although the proportion of aerobic metabolism can reach as much as several tens of percent in the second half of the test (Medbø & Tabata 1989), it is nevertheless an optimal means for testing anaerobic fitness.

In the protocol a passive way of rest after the exercise was chosen. The method of rest after the exercise has a significant effect on the subsequent development of the lactate curve (Spierer et al. 2004; Ghorbani et al. 2015). The active method significantly reduces the rate of lactate degradation (Miladi et al. 2011). The passive rest clearly slows the transfer of lactate into oxidative fibers and other muscles. It is degraded primarily through glycolytic muscle fibers and metabolized through the liver (Brooks 2018). Especially in AB it was clear that the decline is very slow and even after 15 minutes was high (15.7). The steeper decline in recovery phase is due to better lactate clearance (Martin et al. 1998), which is a physiological component that is also involved in the CrossFit performance. This represents a relatively short load of usually 5 – 20 minutes of high intensity (Dexheimer et al. 2019). For testing purposes, an active way of rest could also be used, where the other processes mentioned above would be significantly affected by the process, but the development of these processes may also be a training goal.

Wingate is very often used across different sports (Butcher et al. 2015). As a result, it is also used for comparison with other anaerobic tests, as in the case of this research. Comparisons of unequal load lengths are reported by Carey & Richardson (2003) or Nebelsick-Gullett et al. (1988) using 60 s interval, similarly to Maud & Schulz (1989) with a load of 40 s on cycle ergometer. Wingate is also compared with specific tests that are close to the sport discipline. Tharp et al. (2013) monitored the load during the Wingate and the 600-yard run, where the average times were 119.7 s. Another example is the study by Sands et al. (2004), in which a comparison was made with the Bosco anaerobic test lasting 60 s.

The selected tests are not fully substitutable and identical results were not expected (due to the loading time, different amount of muscles involved, different devices). The purpose was to compare a standardized and non-standardized anaerobic fitness test. It seems that AB could be a suitable tool for testing this endurance in CrossFit and, due to its nature, is more suitable than Wingate. This is an original study, therefore it is necessary to confirm the results and conclusions regarding AB. A variant of shorter test time is offered for future research.

Conclusion

The CrossFit performance is influenced by both aerobic and anaerobic fitness, which must be matched in the context of training load and specific development. Both systems should therefore be included in fitness testing. For the purposes of CrossFit, it is advisable to use resources such as ABs they are part of the sporting discipline. Compared to Wingate, Wmean and calories have been shown to be related to the anaerobic work capacity that is important for CrossFit. After the AB test, the participants had higher lactate levels and, depending on the higher accumulation, there was also a different development of the lactate curve in the passive resting phase. The all-out AB stress test is not standardized, but it can be a good mean of testing anaerobic fitness when adhering to the test protocol. Testing the lactate level and the lactate curve in conjunction with the calories traveled seems to be a suitable mean for analyzing the current readiness of the anaerobic system.

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TYPES OF CLASSROOM CHAIR STRETCH EXERCISES AND THEIR FEASIBILITY AND POTENTIAL TO STRUCTURE THE RECOMMEND CLASSROOM-BASED PHYSICAL ACTIVITY BREAK PRIMARY PROGRAMS

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Summary: This pilot study tests the significance of a classroom chair stretch exercises types and their feasibility and potential to structure the optional classrooms Based Physical Activity Break Primary Programs (ABC-PA). **Materials and methods.** To achieve this goal**,** we proposed two chair stretch exercises ABC-PA programs, one with sit-to-stand chair exercises and other without sit-to-stand chair exercises. Applied for 4-weeks among 90 children, five grade levels, 45 in each division during the academic years 2017-2018. Controlled by components of Fitness Gram health-related physical fitness, before and after 4-weeks of the research project to establish the superiority of the two models proposed. **Results.** To admit study ABC-PA protocols, and statistics performed. Our outcomes confirmed sit-to-stand as the recommended exercise to structure the optional classroom-based physical activity breaks routine intervention. **Conclusions.** We approved the sit-to-stand as a powerful chair exercise able to enhance cardiovascular endurance, muscle strength, muscular endurance, flexibility, maintenance of body composition and reduction of prolonged class daily time sittings. More efficacy are the sit-downs noticed in this study as prolonged static stretch able to improve static flexibility but without changes in classrooms sedentary routine .

Keywords: classroom, children, chair exercise, breaks based physical activity intervention,

Introduction

Research indicates that prolonged sitting daily classroom is sedentary behaviour with defective biological consequences associated with chronic extended periods of muscular limbs inactivity (Mohammed 2018). Authenticated by population health-based studies as one of the several significant public health problems within the 21st century (Izet 2018). At significantly elevated risk for the decrease of energy consumption of the musculoskeletal system amounts of multi-joint immobility. Comment by Farzane et al. (2018) in the case of the workplace via the replacement of sitting by standing as one of several recommendations to reduce sedentary time and increase everyday energy expenditure to control weight gain in the long term (Farzane et al. 2018). Estimated by Uraiwan et al. (2015) to be done after every 2-hour of prolonged sittings. The opposite of physical medicine and rehabilitation studies that recommended its employment to be done after every 20 or 30 minutes long sitting. Break programs studies as real health-related fitness guidelines command to avoid physical inactivity costs of (6 – 8 h) lengthened sit-in classrooms daily hours (Virginia et al. 2016). Recently, pilot trial primary school studies challenged within classroom routine teachers to include sit-stand desks or 5 min bursts break of moderate-intensity physical activity per day (Amanda et al. 2017). It was pointed as exemplary strategies for routine classroom conditions leading to the recommended health-related fitness (Chin et al. 2012).

Australian teachers advised through classroom interventions, no longer than 5 min and without interspace or set-up in the classroom, according to (Agata et al. 2018). Practices used by Algerians primary school teachers through sit-downs were shown as ideal class guidelines aspects of respectable teaching discipline and successful learning behaviour, according to Mohammed et al. 2017.

To support the above teachers' recommendations as complexities this strategy should be integrated into the daily routine class schools. The contrary of work conditions studies commanding dynamic sitting as optional practice being used to help people moving more at the workplace (Koepp et al. 2016). Amanda et al. (2019) claimed minor changes in terms of frequency and intensity to improve classroom Based Physical Activity Break Programs. Encouraging future research to address these issues (Agata et al. 2018). The case of this experimental study was focused testing the significance of the stretch chair exercises types on the efficacy of classrooms Based Physical Activity Break Primary Programs. It was examined by the present study under two approaches with and without a set-up, among 90 children, five grade levels, 45 in each division, during the academic years (2017 – 2018). Figure 1, 2 as content and Figure 3 show us the time practises and standing at the classroom. Assessed by components of Fitness Gram health-related physical fitness,it was applied before and after 4-weeks of the research project to determine the superiority of the two models proposed.

Methods

This experimental study attends to test the significance of chair-type exercises on the efficacy of classrooms Based Physical Activity Break Primary Programs. Research was done by the following 2 models of ABC-PA: Group with 3 min Sit-downs Static Stretching Chair Exercises (ABC-PA-Sit-Downs) versus Group with 3 min sit-to-stand mixed Chair exercises (ABC-PA-Sit-to-Stand). Examination was done before and after the realisation of two proposed programs with components of Fitness Gram battery tests, as the most comprehensive and informative program that can drive meaningful behaviour change and set up children for a healthy future (Krause et al. 2014). It was applied during four weeks following the recommended classroom video-based physical activities (content and rhyme) planned for each class, including after each hour of classroom lessons. Total time work was 18 min per day and 72 min during the achievement of experience. The particular role of the teachers, who voluntarily accepted to participate in this experience was limited in application of recommended classroom video-based physical activity, because of time applications and the encouragements of their students for decent engagement.

Participants

The research group participated in the stud were approximately from 10 to 11 years of age ($\bar{X}$ = 10.5, SD = 0.57, minimum=10.' maximum=11). Table 1. shows general characteristics in the pre-test.

Table 1

General characteristics of the participants in the pre-test according to FitnessGram test battery

Variables ABC-PA	**Total n = 90**	**ABC-PA-Sit-to-Stand**	**ABC-PA-Sit-Downs**	**T**	**P≤0.05**
Age (years)	10.5 ± 0.57	10.1 ±0.92	10.5 ±0.46	0.46	0.76
Body height (cm)	142 ± 4.22	143.1 ±4.09	142.2 ±4.27	0.55	0.83
Body weight (kg)	35.44±3.66	35.48 ±4.32	34.9 ±0.78	1.02	0.75
Male	40	20	20		
Female	50	25	25		
Grade level	All class 5 grade level				
Aerobic capacity	41.28±4.66	42.45 ± 4.05	41.25 ± 3.92	1.22	0.71
Body composition	22.55±1.55	21.88 ± 2.45	22.23 ± 1.85	1.47	0.44
Muscular strength upper	2.42 ± 2.35	2.44 ± 3.42	2.84 ± 2.52	0.88	0.45
Muscular strength lower body	11.22±2.55	12.41 ± 3.02	11.74 ± 2.52	1.22	0.56
Endurance Abdominals	8.88 ± 3.33	7.89 ± 2.98	8.22 ± 5.45	0.98	0.64
flexibility lower back and hamstring muscles	14.55±2.58	13.99 ± 2.78	14.37 ± 4.88	0.42	0.58

ABC-PA-Sit-Downs: Group with 3 min ABC-PA with static stretching chair exercises/ ABC-PA-Sit-to-Stand Groups with 3 min ABC-PA with Sit-to-Stand mixed dynamic exercises separated by static stretching exercise.

The test battery consisted of Fitness Gram identified as an essential battery to assess three general components of health-related physical fitness (Cooper Institute for Aerobics Research, 2017).

- **Aerobic capacity:** based on a reduced Cooper test. The child run or walks around a marked rectangle measuring 9 × 18 m (the size of a volleyball field) for 6 minutes. Both running and walking are allowed. The test item score is the distance covered in 6 minutes (measured in meters).
- **Body composition:** based on Body mass index (calculated from height and weight).
- **Muscular strength upper and lower body, abdominal endurance, and trunk flexibility**:

✓ **Muscular strength of upper body**: based on pushing a medicine ball (1 kg) with two hands as far as possible. The starting position is with the feet parallel to each other and shoulder-width apart, with the ball held against the chest. The test item score (better of two attempts) is the distance achieved (measured in meters).

✓ **Muscular strength of lower body**: based on Vertical Jump Test the student high wall, such as the outside of a building and leaps vertically as high as possible using both arms and legs to assist in projecting the body upwards.

✓ **Flexibility**: based on sit and reach test as the common measure of flexibility and accurately measures the flexibility of the lower back and hamstring muscles. The score is recorded to the nearest centimetre or half inch as the distance reached by the hand.

✓ **Abdominal endurance**: we based on Abdominal Curl-Sit Up endurance tests usually conducted over one minute and measure the maximum number of correctly performed sit-ups in that time.

Children were tested individually. Each test item was explained and demonstrated before the child started. Tested before and after the realisation of the program applied under video sequences, sit in Figures 1 and 2 as content and Figure 3 as time practised. For the progress of students, based on one more repetition for each exercise per week.

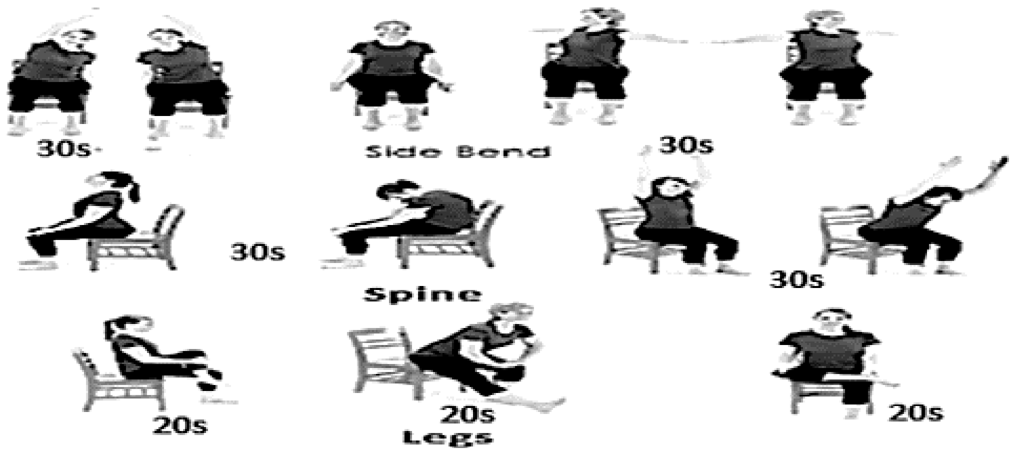

Figure 1
Present the ABC-PA-Sit-Downs

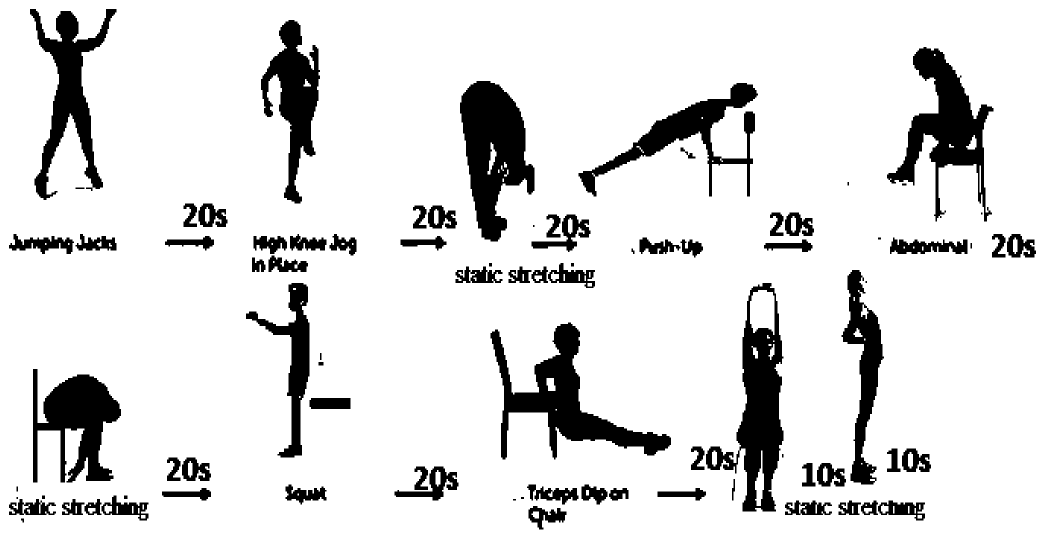

Figure 2
Present the ABC-PA-Sit-to-Stand

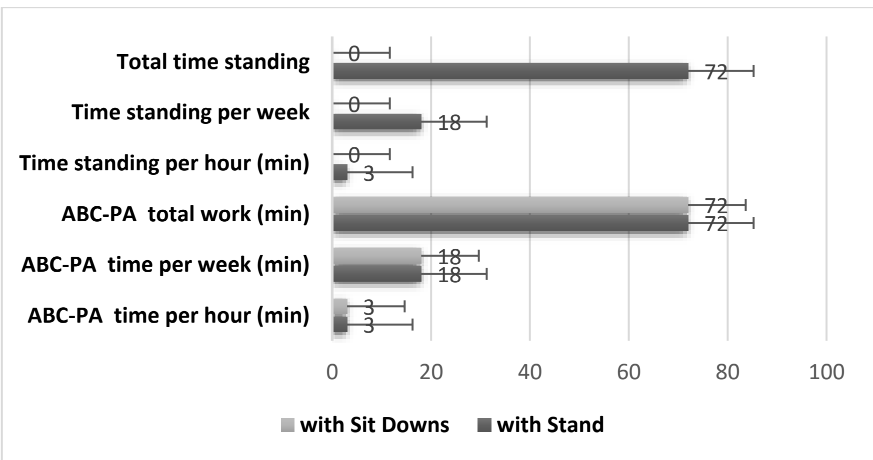

Figure 3
Present the ABC-PA time practises and their differences in time standing desks

All statistical analyses were performed with SPSS, version 16.0.1, * and consisted of Pearson correlation, and the independent T-test, set at p-value 0.05.

Results

Our samples are homogeneous in all pre-test practised, set in Table 1. , confirmed by the insignificance of independent T-test. The opposite of post-test, where all results are in the benefits of model 3 min ABC-PA-Sit-to-Stand, listed in Table 2.

Table 2
Present the post-test health-related fitness component results of samples in the FitnessGram test battery

Variables	**ABC-PA-Sit-to-Stand**	**ABC-PA-Sit-Downs**	**T**	**P≤0.05**
Aerobic capacity	43.68± 2.08	42.69± 1.12	3.55	0.00
Body composition	21.22 ± 0.88	22.08 ± 0.44	2.22	0.02
Muscular strength upper body	3.02 ± 1.75	2.52 ± 1.66	2.92	0.00
Muscular strength lower body	17.75 ± 2.43	13.02 ± 1.22	4.89	0.00
Endurance Abdominals	12.58 ± 4.48	8.99 ± 1.78	4.84	0.00
Flexibility of the lower back and hamstring muscles	16.95 ± 2.88	16.89 ± 1.65	1.09	0.52
ABC-PA-SSCE: Group with 3 min ABC-PA with static stretching chair exercises/ ABC-PA-DSCE Groups with 3 min ABC-PA with dynamic stretching standing chair exercises.				

FitnessGram test batteries were disclosed in the interests of ABC-PA-Sit-to-Stand in all components tested (Cooper Institute for Aerobics Research, 2017). Except for the flexibility of the low back and hamstring muscles compared to group ABC-PA-Sit-Downs. Evidence was strengthened by the Isokinetic and Exercise Science researchers. The core stability training is not generating sufficient stimulus to improve power and strength dependent performance skills, such as sprint, agility and cardinal components in conditioning programs (Sever et al. 2018). It was confirmed in this study by components of the FitnessGram test battery in the comforts of ABC-PA-sit-to-stand. It was report as a significant energetic exercise able to improve physical everyday fitness and reducing total sitting classroom time compete to ABC-PA-Sit-Downs (Figure 3). Mark et al. agreed that significant short break from sitting to standing, highly increase general fitness goals and weight loss (Mark et al. 2004). Porcari et al. (2015) proclaimed these benefits can improve functional range of motion and mobility in sports or activities for daily living (Porcari et al. 2015). Kevin et al. (2019) showed that through the potency of active exercises joined with static stretch as more optional than static stretch exercises improves the movement time of the upper extremities, body overall coordination and dynamic flexibility improvement. It was inspected as these routine integrated into the warm-up improved gain in max work capacity and recovery, improvements in strength, flexibility, and respiratory muscle endurance functionality (Kevin et al. 2019).

Table 3
Present the Pearson correlation post-test between Fitness Gram test and sample results (Cooper Institute for Aerobics Research, 2017)

Pearson Correlation		**ABC-PA-Sit-to-Stand**	**ABC-PA-Sit-Downs**
Aerobic capacity	N=90	0.84^{**}	-0.82^{**}
Body composition		0.54^{**}	-0.72^{**}
Muscular strength upper body		0.78^{**}	-0.75^{**}
Muscular strength lower body		0.84^{**}	-0.82^{**}
Endurance Abdominals		0.81^{**}	-0.84^{**}
Flexibility of the low back and hamstring muscles		0.87^{**}	0.86^{**}
P≤0.05**. Correlation is significant at the 0.01 level (2-tailed)			
ABC-PA-SSCE: Group with 3 min ABC-PA with static stretching chair exercises/ ABC-PA-DSCE Groups with 3 min ABC-PA with dynamic stretching standing chair exercises.			

Discussion

The primary objective of this study was analysing the effects of stretch chair exercises with and without Sit-to-Stand on potency of classroom-based physical activity intervention programs. Advised in this pilot Algerian study under two chair-based exercise modalities. It was expected to enable physical activity to be prioritised during the school day (James et al. 2011). While without a set-up into their interventions and no longer than 5 min, according to Australian teachers (Agata et al. 2018). Practices recommended by Algerian teachers through sit-downs were found as ideal classroom settings aspects of good discipline pedagogical and successful learning behaviour (Mohammed 2017). The model in this study ABC-PA-Sit-Downs combined static stretching chair exercises. The ABC-PA-Sit-to-Stand was composed of dynamic standing exercises. This study modifications were estimated in terms of frequency and intensity to test their feasibility and fidelity. Amanda et al. (2019) confirmed essential guidance to structure recommend classroom-based physical activity intervention programs. Based on independent t-test, all results are in the interests of Sit-to-Stand as potency classroom-based chair physical activity compared to ABC-PA-Sit-Downs. This study confirms sit to stand as the more energetic chair exercise able to enhance the components included in the FitnessGram test battery.

Evidence indicated by strength and conditioning trainers claimed advantages of dynamic exercises and high-volume upper extremity plyometric activities (Nebojša and Špela 2020). Multi-joint activities request step-ups and sit-to-stand (Olaf et al. 2016) to improve body movement that results in energy expenditure, aerobic or oxygen-requiring energy systems, muscle strength, flexibility, balance, coordination, and cardiorespiratory endurance (Bania et al. 2016).

As it is interpret in this study, requested chair-based exercises energy expenditure is able to break physical classroom routine programs (Alicia and Laura 2018). The components of Fitness Gram battery tests cerfies the potency of step-ups and sit-to-stand, not Static Stretching Chair Exercises to enhances the five essential motor abilities as endurance, flexibility, coordination, strength, and speed (Feng et al. 2018). Nancy and June (2005) revealed significant amount works performance necessitated within static post-workout exercise stations. They meaningfully improve suitable strength, necessary flexibility and aerobic and anaerobic power (Mohammed 2019). Step-ups and sit-to-stand are valuable explosive movements combined with static stretch to increase recovery time. Records of this study showes the recommended combination to enhance the energy expenditure relative to demanded heart rate. by Koepp et al. (2016) documented the surpluses 20 – 30 % of energy expenditure. Especially under sedentary behaviour in which energy expenditure is less than1.5 METS (Frank 2009). The case of ABC-PA-Sit-Downs, found in this study serves to increase static flexibility and range of motion (Heneghan et al. 2017; Andreas & Felix 2017). In this study it is recommended to include it into post-workout to speed recovery, decrease soreness and increasing muscle length (Fleck & Kraemer 2014) especially within ABC-PA-Sit-to-Stand.

This unique employment of chair-based classroom physical activity was recognised in this study, as extended static stretching. Strength training studies reported an optimal combination that can be used before the performance to facilitate the range of motion and succeeding performance (John 2013). Strength Trainers pointed adequate warm-up session to improve muscle compliance and enhance muscle force development, in comparison to warm-up that consists solely of static stretching (Bram 2016). Sciences of physical therapy through the efficacy of dynamic sitting exercises pointed that it hepls to prevent and decrease the lumbar range of movement in both back flexion and extension following a 2-hour prolonged sitting (Uraiwan et al. 2015). Farzane et al. (2018) suggested to decrease sedentary time and increase the daily energy expenditure to prevent weight gain in the long term (Farzane et al. 2018). This study recommend to implement more energetic classroom-based physical activity intervention programs.

Conclusion

This study affirms Sit-to-Stand within the school classroom as a required exercise to structure the optional active break routine classroom programs. In this study we claimed that with an adequate intensity and frequency, it is able to improve overall fitness, tone muscle and strengthen global body posture. In the interests of ABC-PA-Sit-to-Stand was approved and mix both work resistance limb exercises, to enhance schooling-health-related fitness components compared to ABC-PA-stretch sit-downs. It is recommended in this study to prolong stretch aimed to gain flexibility, but not to boost post-work cardiorespiratory fitness energy expenditure. It is requested in classroom-based physical activity intervention program to reduce the impacts of waking behaviour characterised by an energy expenditure of ≤1.5 METs.

Acknowledgements

As specialists in physical education and sport, we recommend Sit-to-Stand to be practised in classroom breaking activity programs. This study admitted one of several recommendations to raise cardiorespiratory fitness, energy expenditure and reducing the total daily chair sedentary time compared to ABC-PA-stretch sit-downs. The prolonged passive stretch should be primarily assessed after intensive break activity or at the end of active break program to gain in static flexibility, relaxation, the reduction of the client's stress level and muscle soreness.

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COMPARISON OF TWO TESTS TO DETERMINE THE MAXIMAL AEROBIC SPEED

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Summary: The aims of this study were (a): to compare maximal physiological responses (maximal heart rate: HRmax and blood lactate concentration: [La^-]) and maximal aerobic speed (MAS) achieved during a gold standard test (T-VAM) to those during a new test entitled: the 150-50 Intermittent Test (150-50_{IT}), and (b): to test the reliability of the 150-50_{IT}. Eighteen middle-distance runners performed, in a random order, the T-VAM and the 150-50_{IT}. Moreover, the runners performed a second 150-50_{IT} (retest). The results of this study showed that the MAS obtained during 150-50_{IT} were significantly higher than the MAS during the T-VAM (19.1 ± 0.9 vs. 17.9 ± 0.9 $km.h^{-1}$, $p < 0.001$). There was also significant higher values in HRmax (193 ± 4 vs. 191 ± 2 bpm, $p = 0.011$), [La^-] (11.4 ± 0.4 vs. 11.0 ± 0.5 $mmol.L^{-1}$, $p = 0.039$) during the 150-50_{IT}. Nevertheless, significant correlations were noted for MAS ($r = 0.71$, $p = 0.001$) and HRmax ($r = 0.63$, $p = 0.007$). MAS obtained during the first 150-50_{IT} and the retest were not significantly different ($p = 0.76$) and were significantly correlated ($r = 0.94$, $p < 0.001$, intraclass correlation coefficient = 0.93 and coefficient of variation = 6.8 %). In conclusion, the 150-50_{IT} is highly reproducible, but the maximal physiological responses derived from both tests cannot be interchangeable in the design of training programs.

Key words: Maximal aerobic velocity, intermittent test, validity, reliability, runner.

Introduction

Different physiological parameters, such as maximal oxygen uptake (VO_2max) or even energy cost, are used to predict running performance potential in middle-distance runners (di Prampero et al. 1986). However, these physiological indicators require expensive (gas analyzer) and not always available tools, as well as technical expertise to interpret the results (Coquart et al. 2017). On the other hand, mathematically, the maximal aerobic speed (MAS in $m.min^{-1}$ or $km.h^{-1}$) corresponds to the division of the maximum oxygen uptake ($mL.kg^{-1}.min^{-1}$) by the energy cost ($mL.kg^{-1}.m^{-1}$). Consequently, MAS is considered as an important indicator for predicting the performance of middle-distance runners (Lacour et al. 1991; Billat et al. 2001), and a great tool to set the training loads (Los Arcos et al, 2019). Moreover, MAS could be assessed from field tests. Consequently, several original investigations have provided evidence of the relevance of MAS as a measure of aerobic fitness (Berryman et al. 2018) and the realism leads coaches to opt for field tests (Saddek 2016; Benhammou et al. 2019). Léger and Boucher (1980) were the first authors to propose a maximum field test called the University of Montreal track test (UM-TT). Subsequently, various protocols followed. The Vameval test (T-VAM) is a modified version of the UM-TT initially used to evaluate the MAS for athletes (Cazorla 1990). During this test, athletes run continuously, with a speed that increases steadily (in steps) over time. The MAS reached at the end of this test is obtained through an effort different from that executed during the training sessions of runners, which often involve intermittent exercises (rather than exercises where the intensity is maintained at a constant level). Indeed, the modern training for middle-distance runners is based on intermittent exercises (Vuorimaa et al. 2008). For this reason, a particular attention was paid to incremental intermittent testing during the last years to assess MAS (Bangsbo et al. 2008; Carminatti et al. 2013; Castagna et al. 2014). In order to remain in this logic, a new intermittent field test adapted to these requirements and entitled: the 150-50 Intermittent Test ($150\text{-}50_{IT}$) has been developed. This test consists of repeated 150m distance runs alternated with 50m of active recovery performed until exhaustion.

Considering the importance of continuous incremental field tests to assess runners endurance performance, a test that includes intermittent runs appeared necessary (Buchheit 2008). In addition, it is also necessary that the type of muscle work performed during the test should be as close as possible to that performed by the athlete during the exercise of his discipline (Manouvrier et al. 2016). It would thus seem preferable that the MAS determination test should be consistent with the actual efforts that produce the middle-distance runners in the field, and that it can be used as a reference for intermittent training sessions.

Therefore, the aims of this study are: (a) to compare the maximal physiological responses and MAS achieved during a continuous gold standard test (T-VAM) to those during the $150/50_{IT}$, and (b) to examine the reliability of the $150/50_{IT}$ from test-retest procedure. We hypothesis that the $150/50_{IT}$ is a valid and reliable test.

Methods

Participants

Eighteen (22.6 ± 3.2 yrs, 67.7 ± 2.8 kg, 177 ± 4 cm, 21.8 ± 0.8 kg.m^{-2}) trained (4 training session per week) male middle-distance runners participated in this study. All were familiar with the intermittent exercises as part of their training program. All participants were notified of the research procedures and gave their written consent. The protocol was approved by ethics committee of the Institute of Physical Education and sports at the University Abdelhamid Ibn Badis, Mostaganem, Algeria, and was performed according to the Helsinki Declaration.

Study design and procedures

After being informed of the purpose of this study, all the subjects performed successively three maximum tests sessions, separated each by 3 days, in random order:

- T-VAM (the gold standard test) in order to determine the reference MAS,
- $150\text{-}50_{IT}$ in order to compare the results to T-VAM and test the validity of $150\text{-}50_{IT}$,
- A second $150\text{-}50_{IT}$ to analyze the test-retest reliability.

All testing sessions were conducted at the same time of day, and under the same environmental conditions (temperature: 20 – 23°C and the wind speed on the track inferior to 2 m.s^{-1}). Maximal heart rate (HRmax) was recorded using a heart rate monitor (Polar S610i, Polar Electro Oy, Kempele, Finland). Fingertip blood sample was taken three minutes after the end of each test to measure the concentration of blood lactate [La^{-}] by the Lactate Pro LT-1710 (Arkray®, Kyoto, Japan).

T-VAM consists to follow race speed controlled by audio beeps on a prerecorded file. Cones were placed every 20 m along the track as a reference. The speed at the first stage was set at 8.5 km.h^{-1} and increases by 0.5 km.h^{-1} every minute until exhaustion. Participants had to reach cone on each beep and adjusted their running speed. The test ended when the subject no longer capable of following the imposed rhythm of speed, for 3 consecutive occasions (delay on three consecutive cones). The MAS corresponds to the speed at the last completed stage (Cazorla 1990).

The 150-50 Intermittent Test ($150\text{-}50_{IT}$**)**

The 150-50IT is a field running test, which consisted of repeated 150m distance runs performed until exhaustion, alternated with 50m of active recovery (150-50). It takes place on a 400m athletics track (150/50 = 200 × 2 = 400m). The speed is imposed by an audio beep (designed at the 150-50IT) at regular intervals. At each beep, the athlete should be at one of the cone level placed on the track every 30-m. The test starts at a speed of 8 km.h^{-1}. The speed is increased by 0.5 km.h^{-1} every 200m, which corresponds to the successful overcoming of a level (Table 1). Subjects were instructed to reach as many stages as possible and incomplete stage is not considered. Finally, it should be noted that the total distance of 200 m for each stage (150 m run alternated with 50m of active recovery to allow an adaptation of the speed) was chosen because it been demonstrated that performance over a distance of 200 m can be used to predict performance in middle-distance runners (Brandon 1995).

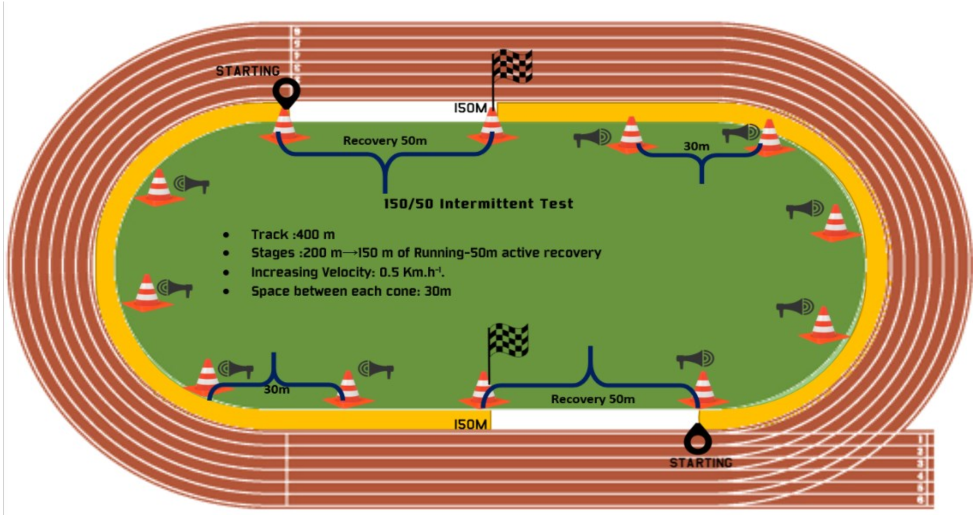

Figure 1
Material organization of the 150/50 intermittent test

Table1
The correspondence table of the 150-50IT

Stage	Speed km.h^{-1}	**30 m**	**60 m**	**90 m**	**120 m**	**150 m**	**R**	**D**
01	**8**	00:13,500	00:27,900	00:40,500	00:54,900	01:07,500	45''	150
02	**8.5**	00:12,705	00:26,258	00:38,117	00:51,670	01:03,529	45''	300
03	**9**	00:12,000	00:24,800	00:36,000	00:48,800	01:00,000	45''	450
04	**9.5**	00:11,368	00:23,494	00:34,105	00:46,231	00:56,842	45''	600
05	**10**	00:10,800	00:22,320	00:32,400	00:43,920	00:54,000	45''	750
06	**10.5**	00:10,285	00:21,257	00:30,857	00:41,828	00:51,428	45''	900
07	**11**	00:09,818	00:20,290	00:29,454	00:39,927	00:49,090	45''	1050
08	**11.5**	00:09,391	00:19,408	00:28,173	00:38,191	00:46,956	45''	1200
09	**12**	00:09,000	00:18,600	00:27,000	00:36,600	00:45,000	45''	1350
10	**12.5**	00:08,640	00:17,856	00:25,920	00:35,136	00:43,200	45''	1500
11	**13**	00:08,307	00:17,169	00:24,923	00:33,784	00:41,538	45''	1650
12	**13.5**	00:08,000	00:16,533	00:24,000	00:32,533	00:40,000	45''	1800
13	**14**	00:07,714	00:15,942	00:23,142	00:31,371	00:38,571	45''	1950

14	**14.5**	00:07,448	00:15,393	00:22,344	00:30,289	00:37,241	45’’	2100
15	**15**	00:07,200	00:14,880	00:21,600	00:29,280	00:36,000	45’’	2250
16	**15.5**	00:06,967	00:14,400	00:20,903	00:28,335	00:34,838	45’’	2300
17	**16**	00:06,750	00:13,950	00:20,250	00:27,450	00:33,750	45’’	2450
18	**16.5**	00:06,545	00:13,527	00:19,636	00:26,618	00:32,727	45’’	2600
19	**17**	00:06,352	00:13,129	00:19,058	00:25,835	00:31,764	45’’	2750
20	**17.5**	00:06,171	00:12,754	00:18,514	00:25,097	00:30,857	45’’	2900
21	**18**	00:06,000	00:12,400	00:18,000	00:24,400	00:30,000	45’’	3150
22	**18.5**	00:05,837	00:12,064	00:17,513	00:23,740	00:29,189	45’’	3300
23	**19**	00:05,684	00:11,747	00:17,052	00:23,115	00:28,421	45’’	3450
24	**19.5**	00:05,538	00:11,446	00:16,615	00:22,523	00:27,692	45’’	3600
25	**20**	00:05,400	00:11,160	00:16,200	00:21,960	00:27,000	45’’	3750
26	**20.5**	00:05,268	00:10,887	00:15,804	00:21,424	00:26,341	45’’	3900
27	**21**	00:05,142	00:10,628	00:15,428	00:20,914	00:25,714	45’’	4050
28	**21.5**	00:05,023	00:10,381	00:15,069	00:20,427	00:25,116	45’’	4200
29	**22**	00:04,909	00:10,145	00:14,727	00:19,963	00:24,545	45’’	4350
30	**22.5**	00:04,800	00:09,920	00:14,400	00:19,520	00:24,000	45’’	4500
31	**23**	00:04,695	00:09,704	00:14,086	00:19,095	00:23,478	45’’	4650
32	**23.5**	00:04,595	00:09,497	00:13,787	00:18,689	00:22,978	45’’	4800
33	**24**	00:04,500	00:09,300	00:13,500	00:18,300	00:22,500	45’’	4950
34	**24.5**	00:04,408	00:09,110	00:13,224	00:17,926	00:22,040	45’’	5100
35	**25**	00:04,320	00:08,928	00:12,960	00:17,568	00:21,600	45’’	5250

D: distance traveled (m). R: recovery.

Statistical analysis

The results are presented as mean ± standard deviation (SD). Normality of data was checked using the Shapiro–Wilk test. Student´s t-test for paired sample was used to compare the differences between the T-VAM and the first $150\text{-}50_{IT}$. The relationships between measurements were checked using Pearson correlation coefficient (r). The reproducibility was assessed by the coefficient of variation (CV), the intraclass correlation coefcient (ICC), and Bland and Altman plots. The level of statistical significance was set at $p < 0.05$. All statistical analyses were performed using SPSS for Windows 23.0 (SPSS Inc., IBM, Chicago, USA).

Results

MAS and maximal physiological responses (HRmax and $[La^-]$) during T-VAM and the first $150\text{-}50_{IT}$ are presented in Table 2. The average for MAS obtained during the T-VAM was lower than that measured using $150\text{-}50_{IT}$ ($p < 0.001$), despite a high correlation coefficient ($r = 0.71$; $p = 0.001$).

Regarding the results of HRmax, there was a significant difference between both tests ($p = 0.011$, Table 2). Nevertheless, these data were significantly correlated ($r = 0.63$, $p = 0.007$). The values of $[La^-]$ found during $150\text{-}50_{IT}$ are higher than those recorded during T-VAM ($p = 0.039$) and no significant correlation was noted between the both tests ($p = 0.467$).

Table 2
Physiological characteristics and performance for both tests

Variables	$150\text{-}50_{IT}$	T-VAM	Correlation of Pearson	
MAS (km.h⁻¹)	19.1 ± 0.9*	17.9 ± 0.9	p = 0.001	r = 0.71
HRmax (bpm)	193 ± 4*	191 ± 2	p = 0.007	r = 0.63
[La⁻] (mmol.L⁻¹)	11,4 ± 0,4*	11,0 ± 0,5	p = 0.467	r = 0,22

*:Significant difference between T-VAM and $150\text{-}50_{IT}$ ($p < 0.05$).

Finally, MAS obtained during the first $150\text{-}50_{IT}$ and the retest were not significantly different (19.1 ± 0.9 km.h^{-1} vs. 19.4 ± 1.6 km.h^{-1}, p = 0.76). Moreover, the correlation coefficient, coefficient of variation and intraclass correlation coefficient were of 0.94, 6.8 and 0.93, respectively. Figure 2 reports the Bland and Altman plot. Significant agreement was found between test-retest without systematic bias (0.20 km.h^{-1}) with low agreement limits (-1.58-1.41 km.h^{-1}).

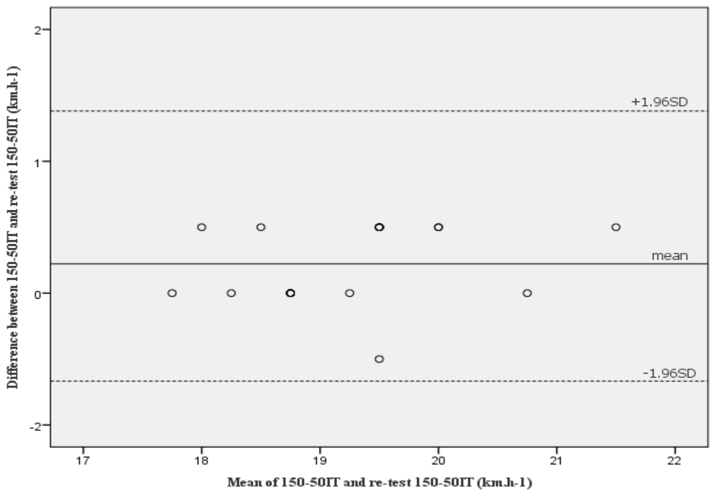

Figure 2
Bland-Altman plot of test-retest reproducibility

Discussions

The main aim of this study was to compare the MAS achieved during a continuous gold standard test (T-VAM) to those during the $150/50_{IT}$, and to check that the maximal physiological responses derived from both tests could be used interchangeably. Moreover, test-retest reliability of $150/50_{IT}$ was also studied. The major finding in the present study indicates that the MAS measured on T-VAM is significantly different of MAS achieved on the $150/50_{IT}$, and the maximal physiological responses (HRmax and [La$^-$]) derived from both tests are not interchangeable. Nevertheless, the 150/50$_{IT}$ was reliable.

The parameters (MAS, HRmax and [La$^-$]) reached at the end of T-VAM and 150/50$_{IT}$ were significantly different. There was a difference between the MAS obtained in the two tests ranging between 1.5 km.h^{-1} and 3 km.h^{-1} a difference of 9 to 15%. However, MAS obtained during both tests were significantly correlated (r = 0.71, p < 0.05). The present results can be compared with previous studies comparing intermittent vs. continuous incremental field tests (Aziz at al. 2005; Dupont et al. 2010; Benhammou, 2020). Similar to our observations, authors (Schnitzler et al, 2010; Los Arcos et al. 2019) have previously reported significant differences between MAS obtained from a T-VAM and intermittent tests, but all these authors have noted a significant correlation with high correlation coefficients (r > 0.67). Thus, although the MAS are significantly different, the significant correlations (like those obtained in other studies: Schnitzler et al. 2010 and Los Arcos et al. 2019) seem to suggest the convergent validity of 150/50$_{IT}$.

The HRmax were different between T-VAM and 150/50$_{IT}$ (Table 2), but wearing a heart rate monitor during the two tests allows to obtain a maximal HR close to the theoretical maximum (FCmax = 220 - age) (Nes et al. 2013) for all subjects. Our results contrast, however, with those reported by Dupont et al. (2010) who found similar values comparing the UM-TT (192.3 ± 8.0 bpm) and Yo-Yo intermittent recovery test (191.4 ± 7.8 bpm). The 150/50$_{IT}$ also allows establishing an individual curve of the relationship between running speed and HR. There is an increase and then a slower stabilization or evolution of the heart rate, and then a slight decrease during the recovery ranges that allows observing the quality of the recovery of the athlete. This is the additional interest of the intermittent form of 150/50$_{IT}$, even if further studies need to be conducted.

The [La$^-$] is one of the most frequently used biological parameters in sports biology (Petibois et al. 2001; Adel et al. 2019). A significant difference was noted between the two tests for [La$^-$]. The results of this work show that 150/50$_{IT}$ causes a greater accumulation of lactate (+0.4 mmol.L^{-1}) in comparison with VAM-T. These values at the end of the 150/50$_{IT}$ allowed to confirm the major contribution of anaerobic metabolism (with higher speed during the last stages in comparison with the VAM-T). These results are in agreement with previous studies showing a major anaerobic participation during intermittent exercise (Buchheit et al. 2009).

The $150/50_{IT}$ was found to have a high level of reliability in all studied parameters. The CV and ICC were within the acceptable ranges outlined by Hopkins et al. (2001). Therefore, the $150/50_{IT}$ must be considered as reliable.

Conclusion

Based on the present findings, the $150/50_{IT}$ it is highly reproducible but it overestimates the MAS, HRmax and [La^-]. These physiological indices derived from $150/50_{IT}$ and T-VAM cannot be interchangeable when designing training programs. Future studies should be conducted to examine the validity of the $150/50_{IT}$.

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