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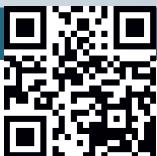
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DRAGI ČITAOCI,

ovaj, deseti broj Časopisa „Sportske nauke i zdravlje“, predstavlja na neki način mali jubilej, pet godina od izlaska prvog broja Časopisa. Kada počinjete, želite i da trajete, a to trajanje zavisi gotovo isključivo od Vas, autora radova! Hvala Vam na tome što ste svojim naučnim i stručnim radovima, omogućili trajanje našeg Časopisa. Vjerovali ste u Redakcioni odbor, vjerovali ste u Fakultete sportskih i zdravstvenih nauka, u Panevropski univerzitet „Apeiron“, da ćemo svi zajedno i sa recenzentima, stvoriti kvalitetan Časopis.

Od petog broja, Časopis izlazi na srpskom i engleskom jeziku. U kategorizaciji Ministarstva nauke i tehnologije Republike Srbije, Časopis je sa 27 bodova, vođeći nacionalni Časopis i nalazi se u sljedećim citatnim bazama: EBSO HOST, INDEX COPERNICUS, CITE FACTOR, SCHOLAR GOOGLE, DOI SRPSKA, CROSSREF I ROAD ISSN.

Ono što nam imponuje, to je povećanje broja zemalja iz kojih stižu radovi za Časopis, tako da je do sada bilo radova iz 12 država, sa 275 autora: Bugarska (2 autora), Crna Gora (12 autora), Grčka (3 autora), Hrvatska (5 autora), Indija (1 autor), Makedonija (6 autora), Njemačka (2 autora), Poljska (3 autora), Slovačka (9 autora), Slovenija (4 autora), Srbija (80 autora) i Bosna i Hercegovina (148 autora).

„Čovjek produžava svoje trajanje: djetetom, zasadenim drvetom, ili napisanom knjigom“, kako to kaže kineska narodna poslovica. U jednom od brojeva našeg Časopisa, naveli smo istu ovu poslovicu i evo, produžavamo svoje trajanje već punih 5 godina.

Želimo da uz Vašu pomoć, i dalje napredujemo i da stručna i naučna riječ bude vodilja razvoja, pre svega, sportskih i zdravstvenih nauka.

UREDNIŠTVO ČASOPISA

DEAR READERS,

This tenth Number of the Journal “Sport Sciences and Health” is, in a way, Anniversary Journal; it has been five years now since our first Journal was published. Once you start, you want that to live for long time, and it solely depends on you, your papers! Thank you for enabling the existence of our Journal by sending us your scientific and professional papers. You trusted that our Editorial Board, Faculty of Sport and Health Science, PanEuropean University Apeiron, so all of us together with our critics will create a quality Journal.

Journal has been published in Serbian and English since our fifth Number. On the list of the categorized journals of Ministry of Science and Technology of Republic of Srpska, Journal has been given 27 points, and is the leading national Journal and is on the following quoted basis: EBSO HOST, INDEX COPERNICUS, CITE FACTOR, SCHOLAR GOOGLE, DOI SRPSKA, CROSSREF I ROAD ISSN.

What makes it more impressive is the increased number of the countries of the authors' origin, so since now, we have published the papers from 12 countries, total of 275 authors: Bulgaria (2 authors), Montenegro (12 authors), Greece (3 authors), Croatia (5 authors), India (1 author), Macedonia (6 authors), Germany (2 authors), Poland (3 authors), Slovakia (9 authors), Slovenia (4 authors), Serbia (80 authors) i Bosnia and Herzegovina (148 authors).

“The man enlarges its duration with: a child, a planted tree or a written book”, Chinese national proverb says. In one Number of our Journal, we quoted the same proverb and well, here we are almost 5 years after that.

We wish our journal to live more with your help, we wish to improve ourselves and that the professional and scientific word is the leader of progress, above all, of sport and health science.

Editorial

IMPROVING TEACHING AND LEARNING IN PHYSICAL EDUCATION: USING A DEVELOPMENTAL CONTINUUM AND ELIMINATING TRADITIONAL GRADING

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Abstract: Assessment methods and the ownership of learning in Physical Education remain, in most cases, as highly traditional practices which do not fully allow students to be active and enthusiastic participants in the process of learning physical skills and health related knowledge. This study focuses on the improvements of student accountability and ownership for learning in Physical Education classes when traditional grading is removed and a year-level-only curriculum is replaced with a developmental learning continuum. The context of this study is to identify the relationship between student motivation, interest in learning, and the accountability to reach set goals when grade rewards are replaced with clear descriptions of student performance and development along a schema of skills and knowledge in PE. The research of our project will determine that the modifications made to the process of teaching and learning has improved the learning experience of our test subjects. The study has proven that when traditional grading is removed and students have the opportunity for true differentiated learning, they demonstrate far more intrinsic motivation in their learning. The students have taken grater ownership over their development and have become more accountable for their own process of learning. To truly unlock the potential of each child, we educators need to support our students to be risk takers who are inquiring and reflective.

Keywords: developmental continuum, grading, ownership, accountability, physical education

INTRODUCTION

Assessment methods in physical education and in schools in general are entrenched in old philosophies and deep-rooted practices that have endured despite numerous movements of pedagogical change and call for reform (Anderson, 1998). Yet, teaching and learning have come far over time. In those rare progressive learning environments, the emphasis has shifted from rote memorization of facts and skill-drilling to student-centered environments which emphasize the whole-child and active learning (Kohn, 2008). With the above in mind, a greater focus on student accountability, learning ownership and individualized assessment methods, can occur. What has not changed is the use of “grading-systems” as rewards and motivators used to communicate performance feedback to students (Lowman, 1990). There is a belief within the academic world that grades should be done away with altogether (Miller, 2013). Part of this is due to the growing concern over the quality of assessments in schools (Zhang & Burry-Stock, 2003). As a result – some have turned to standards-based assessment which emphasizes that assessment methods and reporting are reliable; valid; inform performance; and guide teaching and learning (Hardegree, 2012).

As one researches a growing trend that is standards-based grading, it becomes apparent that a new paradigm shift is needed in physical education, one which would be the answer to the un-evolved nature of student performance assessments (Melograno, 2007). It also cannot be forgotten that grades should clearly reflect student achievement and performance of a culmination of work (O’Connor, 2007). Therefore, we would submit that the ideologies of assessment are at cross-roads. Nevertheless, un-informing methods of grading persist in schools and do little to indicate the connection between learning (skills/knowledge), the curricular goals (standards), and student feedback. Scrifflin (2008) confesses that when she was challenged to explain the qualitative difference between the letter grades (A-F), her answers were vague, unclear, and superficial. So remains a status quo that unfortunately emphasizes:

- grading as a rating/ranking system for parents and universities;
- the use extra-credit work or homework;
- a blurred connection between curricular goals with learning and student feedback;

- a de-valuing of student goal-setting and reflection;
- a reliance on old philosophies of student motivation and reward.

It is time for change, one class, one grade, and one school at a time. There is not a better place to begin the change, than in a performance-based discipline, such as physical education. This study will look to challenge the above points so that student feedback engages students in their learning.

METHOD – PROJECT IMPLEMENTATION

We began the pilot program by introducing the standards-based curriculum document and assessment methods into Grades 4-7 of our teaching responsibilities last school year. The process of execution occurred in the following steps:

1. We started by informing the parents and students of Grade 4-7 that they would be participating in a pilot project that featured standards-based assessment and learning. This occurred during the parent information evening during the first week of school. The students were then presented with their developmental continuum and were given online access (shared through Google Docs) to the necessary indicators. By creating a weighted equation, we ensured all stakeholders that it will still be possible to discern a number grade from a fully plotted schema. However, at no time, was this requested by any student.

2. Using the developmental standards schema, we placed each of our students on the continuum over the course of the first and second months of school. This occurred by using the indicators as performance exemplars while carrying out formative assessments. It should be noted that our project focused predominantly on formative assessments, goal setting and student reflection. The key to our new process is that students can move along their personalized continuum as they meet the expectations of a particular outcome.

3. As we prepared for our first parent conference, the students in the test group were required to choose one goal (outcome) that they would work towards. Each student needed to fill out a goal form, make a plan and describe the steps that they would take to accomplish the goal. For the first time at our school, students began to prepare to lead the upcoming conferences by presented to their parents their personal continuum document as well as their goals, successes, and areas for improvement.

4. In preparation for the reporting period in January, the students prepared a reflection or audio podcast which outlined the progress of their goal. Rather than receiving a number grade for the class, they met again with their teacher during the student led conference. Each student led the conference and presented their progress and shared their reflections related to their goal.

5. Within a week after of the grading period, the student met again with their teacher to choose a new goal or to identify the means to accomplish their previously chosen one.

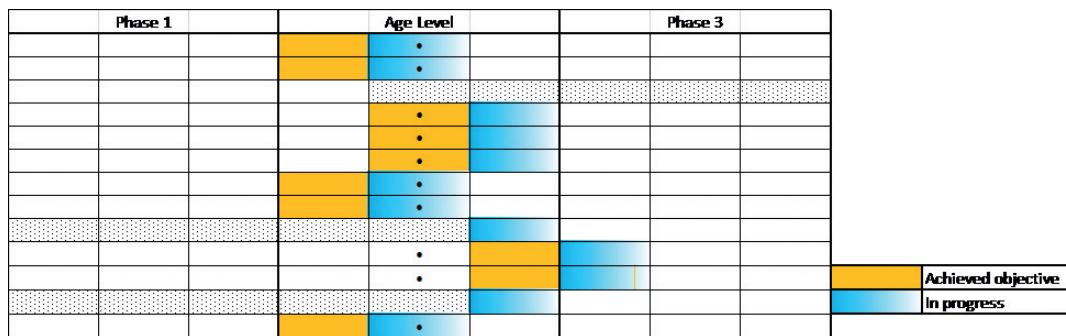
6. A final reporting conference took place at the beginning of June with the teacher, student, and parent. Here a short review of the student's progress occurred as well as a presentation, by the student, on his/her developments.

7. Before the student left the school for summer break, they discussed with their teacher their developments along the continuum during the year and where they would be starting after the summer holiday, so as to emphasize that learning had not ended at the conclusion of the calendar school year. Also, they were asked how the wanted to work on their goal over the summer. No documentation was required for any summer work.

8. It was essential for the project team to reflect on the project and plan for further implementation in the upcoming school year. Feedback was collected from the students, project members and the parents. Responses from questionnaires and interviews were overwhelmingly positive in favor of the pilot program.

OVERVIEW

All student grading has been done by using the new physical education continuum accompanied with the indicators of success (see Figure 1). Each student was placed on a working target for each of the 13 physical and personal developmental selectors (skills and knowledge standards). The following chart shows how a student could be placed on the Developmental Schema.

Figure 1. Assessment Overview

However, the standards placement can move horizontally and vertically along the continuum. In other words, a particular student might be placed with skills or knowledge in multiple grade levels, ultimately removing the importance or need for number grades. For example, a student might be an age-group higher in Dynamic Movements, but an age-group lower in Teamwork. In Tables 1-6 are shown some examples of student placement (without outcome descriptions).

Table 1. Operating far above grade level = 7 (on scale 1-7, where 7 is the best grade)

Physical Education: Phase 3 (Grades 6-8)		
Physical Development		
Stage 1: Skills/Knowledge	Stage 2: Skills/Knowledge	Stage 3: Skills/Knowledge
3.1.1	3.2.1	3.3.1
3.1.2	3.2.2	3.3.2
3.1.3	3.2.3	3.3.3
3.1.4	3.2.4	3.3.4

Table 2. Operating above grade level = 6 (on scale 1-7, where 7 is the best grade)

Physical Education: Phase 3 (Grades 6-8)		
Personal Development		
Stage 1: Skills/Knowledge	Stage 2: Skills/Knowledge	Stage 3: Skills/Knowledge
3.1.1	3.2.1	3.3.1
3.1.2	3.2.2	3.3.2
3.1.3	3.2.3	3.3.3
3.1.4	3.2.4	3.3.4

Table 3. Operating slightly above grade level = 5 (on scale 1-7, where 7 is the best grade)

Physical Education: Phase 3 (Grades 6-8)		
Skill Development		
Stage 1: Skills/Knowledge	Stage 2: Skills/Knowledge	Stage 3: Skills/Knowledge
3.1.1	3.2.1	3.3.1
3.1.2	3.2.2	3.3.2
3.1.3	3.2.3	3.3.3
3.1.4	3.2.4	3.3.4

Table 4. Operating at grade level (best fit) = 4 (on scale 1-7, where 7 is the best grade)

Physical Education: Phase 3 (Grades 6-8)		
Behavioral Development		
Stage 1: Skills/Knowledge	Stage 2: Skills/Knowledge	Stage 3: Skills/Knowledge
3.1.1	3.2.1	3.3.1
3.1.2	3.2.2	3.3.2
3.1.3	3.2.3	3.3.3
3.1.4	3.2.4	3.3.4

Table 5. Operating below grade level = 3 (on scale 1-7, where 7 is the best grade)

Physical Education: Phase 3 (Grades 6-8)		
Personal Development		
Stage 1: Skills/Knowledge	Stage 2: Skills/Knowledge	Stage 3: Skills/Knowledge
3.1.1	3.2.1	3.3.1
3.1.2	3.2.2	3.3.2
3.1.3	3.2.3	3.3.3
3.1.4	3.2.4	3.3.4

Table 6. Operating far below grade level = 6 (on scale 1-7, where 7 is the best grade)

Physical Education: Phase 3 (Grades 6-8)		
Physical Development		
Stage 1: Skills/Knowledge	Stage 2: Skills/Knowledge	Stage 3: Skills/Knowledge
3.1.1	3.2.1	3.3.1
3.1.2	3.2.2	3.3.2
3.1.3	3.2.3	3.3.3
3.1.4	3.2.4	3.3.4

While there has been some resistance to this change from some PE staff members, we strongly believe that the new teaching and learning process in our department greatly improves student motivation, ownership of learning, and reflective knowledge. To help reduce the trepidation of such a significant change, we have held professional development sessions to all PE staff and have lowered the initial requirements to “place” and assess students on the developmental continuum. So far this school year, our department is using the developmental continuum, as well as no grading, across all levels.

We have offered a plan of action to increase the amount of other disciplines that could participate in this shift to standards-based assessment. The Drama Department has already voiced interest in joining this shift in paradigm as well as Humanities which has implemented a developmental continuum this year. Yet, the PE department remains the only discipline so far that has removed traditional form of grading. It should be emphasized that while this project has been incredibly successful, this is not a simple and easy remedy to improve teaching and learning. To effectively implement our model of teaching and learning, there is a large amount of required curriculum writing to organize standards and indicators so that they have vertical and horizontal alignment. We have simplified and reworked a process of implementation offered by Marzano (1996).

OUTCOMES

From our project we collected qualitative data from over 320 students ranged in age from 9-13 years of age. Only a very small percentage of these students (1%) felt that they preferred to receive “grades”. It is interesting to note that all of these students were those that were very high achievers in physical education and were used to receiving “top grades”. Yet, all students found much greater intrinsic motivation from having clear developmental goals and receiving effective feedback on their learning.

Using this new system of assessment and feedback our students have become accountable and individually aware of their performance levels and the specific goal (standard) that is the focus of any assessment or lesson activity. Further, the assessments, which are often performance videos, clearly demonstrate if a student has reached the goal expectations of performance exemplars. The highlight of these innovations is that all students have been allowed to actively move along their own personal developmental continuum. This standards schema has allowed each student to access outcomes from stages that are parallel to their age group. This means that true individualized assessment occurred in our project lessons and that the administrative use of grading had become obsolete and completely unnecessary. The students that have participated in our project did not ask for performance grades or need them for motivation. Rather, they found a genuine interest in developing their abilities and matching their skills to exemplars provided by other students who demonstrated high-level performance.

Yet, the amount of effort it has required for the PE Department staff to “place” students on their individual continuum has caused some logistical challenges. Additionally, new participants were not used to the idea of being responsible for formative assessments of individual students at all times. But moving away from traditional norms of pedagogy and embracing full-scale change is never easy. Teachers are now required to constantly make anecdotal observations of their students’ progress while referring to individual electronic schema documents.

Individualized developmental continuum documents have clearly given formative observations, more value, greater validity, and stronger reliability in relation to the learning outcomes. Importantly, our study has proven that when traditional grading is removed and students have the opportunity for true differentiated learning – via the developmental continuum – they demonstrate far more intrinsic motivation in their learning. The students have taken greater ownership over their development and have become more accountable for their own process of learning. All of these changes in teaching and learning have occurred while retaining a dynamic classroom where students are engaged, active, and having fun.

DISCUSSION

Current assessment and reporting practices, in regard to old philosophies and traditions, bring up serious questions about the authentic value learning and assessments are in PE classes (Melograno, 2007). Opportunities that offer authentic learning experiences for students ensure a positive “effect” in their thinking and perceptions of their own learning. A simple way to describe effective constructive learning opportunities are those that emphasize investigation and curiosity, yet do not punish students for taking risks or failing. Being unaware of learning tasks and unable to reflect on specific learning goals, a learner can acquire feelings of confusion, stress, dispiritedness and frustration (Kort & Reilly, n.d.). A concrete connection between assessments and learning goals is not reflected in reward systems that are vague and limited in meaning. Marzano, Pickering, and Pollock (2001) believe that it is crucial for students to do work that has closely linked curriculum objectives so that they can make connections between the assessments, the course work, and the learning standards.

It appears, from our research, that offering rewards does not inspire learners to take risks, investigate solutions, and be intrinsically motivated in their own goal-setting. Pink (2009) performed human research to identify the connection between rewards and motivation. He found that there was largely a negative connection between rewards as motivators. While his study is more focused on business, there is a human truth to his findings. If we make a parallel between the monetary rewards of business to the informing rewards (letter or number grades) in schools, it could be suggested that, at a human level, these reward systems are similar. Based on all that we have stated above, how can the expectations of a school’s mission and vision be met while the assessment continues to implement evaluation methods that are non-standardized, vague, outdated, uninspiring, and misinforming? The simple answer is: they cannot. This has led to our study which, in our belief, provides an effective innovation in assessment methods. It offers greater ownership to the students in their learning, while presenting opportunities for goal-based reflection and real

understandings of individual developmental success (Hardegree, 2012). In practical terms, our project is the abolishment of assessment rewards that rank student achievement – in relation to learning standards – on a linear scale. No more A's, B's, C's, percentages, or numbers. We have eliminated ad-hoc physical activities that fill time and have done away with reward-based reporting methods that communicate (or miscommunicate!) student rankings.

While this project, at first thought, seems like an overwhelming and potentially impossible undertaking, it is not so complex. No matter how strong a school's reluctance and resistance to this project might be, the status quo simply does not equate to the expectations of progressive pedagogy. And while we, as educators, further pull old beliefs and doctrines along with us, we fail to be innovative in our pedagogy and ultimately, fail to do what schools should: develop inquisitive learners that are reflective, independent, and self-motivated.

So, how do we change our thinking about something that is so deeply ingrained in our education systems? The answer is simpler than one might have thought. If we assume that our teaching is authentic and all activities and assessments are driven by the curriculum outcomes and standards then this process of innovation is nearly complete. We simply need to leave out the final step, the granting of penalties and rewards. Thus, this is what we have undertaken during our project. We facilitate a process of goal-setting and reflection in terms of personalized learning standards on a developmental continuum. We are able to do this because we have implemented new curricula that have clear learning outcomes which are used individually for each student. These can stand alone as indicators of skill or knowledge development. When planning or creating assignments, we re-shape the assessments so that they clearly indicate either, yes, the student has demonstrated the ability to perform the given task, or no, there remains areas for needed growth. For our project we have done away with the “shades of gray”, the mysterious numbers which represent performance, that blur the clarity of a student's understanding for their own learning and achievement.

Airasián (1994) suggest that heads of school and principals will fret over this change because, administratively, schools need letter and number grades to inform about student rankings, graduation standing, and appropriateness for promotion to the next grade level. We would question how the above idea justifies using a negatively reinforcing means (grades) to motivate student learning. Let the external exams inform the parents about which university their child will enroll. Allow the students to move along their schema at their own pace. Give the teachers the ability to motivate students with success rather than punishing them with normed comparisons. The idea is not so “out of the box”. There is a growing following of standards-based assessment that is gaining steam. Educators are becoming more aware that this rewards system need to change. Yet, they are also aware of the depth at which grading has rooted itself into universities, public school curricula and teaching practice. Parents will want the numbers because they grew up with them. They will also want them so they can compare their children with their neighbor's children. Teachers will resist because of the effectiveness of grading on student motivation.

CONCLUSION – MOVING FORWARD

It would be a challenge to find many teachers who do not want the best for their students. That being said, the most effective (and obvious) way to recruit believers for this innovation is by reminding about the “Why” of learning in schools. We have opened up discussions to our staff and other teachers about grading and have shared our research findings on current innovations in assessment. We have spoken about how traditional forms of pedagogy use grades as rewards and how the status quo devalues the ownership and accountability of student learning. As Lund (1992) suggests, “Assessment and accountability need to be applied to the instructional task system as part of an effective physical education program”. We have done this delicately, as our school (and many others) is entrenched in the use of grading and the overvaluing of collected data from internal assessments. Questioning the validity of these practices offended some and even angered others, as it has brought up questions about the effectiveness of their teaching practice. However, there is a “fail-safe mechanism” built into this assessment model. Specifically, that if a number grade is required, it can be easily and more accurately discerned from each student's developmental continuum. And ultimately, our findings have shown that students are more involved, engaged, and satisfied with the processes of our pilot project.

This innovation has offered teachers a more authentic way of evaluating and motivating students. By implementing this ourselves, we have been able to demonstrate the program “in action”, which has alleviated some initial resistance from the pundits. The culture of assessment overall, needs to change. Motivating learning through grading adds fear, stress, and reluctance to the learner. To truly unlock the potential of each child, we educators need to

support our students to be risk takers who are inquiring and reflective. Punitive rewards do serve an administrative purpose: to rank students within their year-group, supply parents (and students) with basic feedback, as well as placing students into various learning environments. However, a standards-based assessment can supply number grades if needed as well as provide an authentic and meaningful learning experience for the students. The status quo of grading does not clearly indicate a student's specific achievement in relation to the curriculum standards. Most importantly, they de-motivate students while instilling negative connotations to learning. It is time for a paradigm shift. Still, we do not propose change overnight, rather, with commitment, persistence, and a significant amount of work.

Authorship statement

The authors have contributed equally.

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Appendix A

Indicators of Success – descriptions of skill/knowledge development

Indicators of Success:

Phase 3 – Stage 1 – Physical Development

3.1.2 repeat learned dynamic movement skills to improve movement patterns

Indication of Benchmark Achievement

The student is able to...

- a. detect and analyze errors in dynamic movement skills
- b. work independently or with a partner to practice specific dynamic movement skills over a period of time to improve performance

Learning/Teaching Advice:

- Dynamic skills include: body roll; shoulder roll; gallop; slide; leap; ready position; running; running jump; skipping; travelling hop; two-foot stop; walk
- striking an object, kicking an object, capturing an object, dodging, jumping, using a manipulative object, and running

- The activity can be a game, an invented game or a team relay.
- striking skills used in pickleball, baseball, hockey, golf, tennis; serving used in badminton, tennis, volleyball, table tennis
- The teacher should introduce a new activity or game which requires the students to use a variety of previously learned movement skills.
- The teacher should give opportunities for the students to discuss the learned movements that will be needed to successfully complete the activity.
- The student should have an opportunity to freely explore a variety of movement options for the tasks of the activity.
- The teacher should give the students an opportunity to discuss the connections to prior learning.
- The student can be reminded to concentrate on each individual movement as they participate in the activity.

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UNAPREĐENJE PROCESA NASTAVE I UČENJA U FIZIČKOM VASPITANJU: UPOTREBA RAZVOJNOG KONTINUUMA I ELIMINISANJE TRADICIONALNOG OCJENJIVANJA

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Sažetak: Metode provjere znanja i sposobnosti u fizičkom vaspitanju, kao i sam odnos prema učenju, su u većini slučajeva još uvek vjerni tradiciji, čime se učenicima ne dozvoljava da budu potpuni, aktivni učesnici entuzijasti u procesu usvajanja fizičkih sposobnosti i zdravstveno-relevantog znanja. Ovo istraživanje ispituje efekte ukidanja tradicionalnih ocjena i nastavnog plana i programa struktuiranog po razredima, te uvođenje razvojnog kontinuumuma, a sa težnjom ka potencijalnom pospješenju odgovornosti učenika u odnosu na vlastito učenje u nastavi fizičkog vaspitanja. Cilj istraživanja je da se identificuje odnos između motivacije učenika, njihovog interesovanja za sam proces učenja, kao i odgovornosti za ostvarivanje vlastitih ciljeva u oblasti fizičkog vaspitanja, a u situaciji kada su ocjene zamijenjene jasnim opisima učeničke performanse i razvoja na šemi znanja i sposobnosti. Istraživanje je pokazalo da su sprovedene modifikacije u nastavnom procesu poboljšale vlastita iskustva ispitanika vezana za usvajanje relevantnih znanja i sposobnosti. Ukipanjem tradicionalnih ocjena i pružanjem mogućnosti za diferencirano učenje je utvrđeno da učenici pokazuju veće interesovanje i motivaciju za učenje. Rezultati istraživanja takođe pokazuju da su učenici preuzeeli veću odgovornost i vlasništvo nad vlastitim procesom učenja, te se stoga – a u cilju istinskog razotkrivanja individualnih potencijala – preporučuje podsticanje učenika ka preuzimanju rizika, te podrška pri ispoljavanju i uticaj na razvoj radoznalosti, odgovornosti i interesovanja uopšte.

Ključne riječi: razvojni kontinuum, ocjenjivanje, svojina, odgovornost, fizičko vaspitanje.

CHANGES IN THE PHYSIOLOGICAL PROCESSES DURING TRAINING AND OFFICIAL COMPETITIONS IN YOUNG KARATE ATHLETES

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Abstract: It was conducted functional and anthropological tests on a sample of ten male karate athletes aged between 15-18 years, with long training experience, and who are candidates for the National Team of the Republic of Macedonia. The research was conducted so that the dynamics and changes in the heart rate and blood lactate levels of the karate athletes can be determined during training and during official competition. The differences in the values of blood lactates and the heart rate which emerged during training and official competition are determined by using the T-test. The resulting values for the blood lactate level show a statistically significant difference during training and official competition in all measurements at the level $p < 0.00$. The same conclusion applies to the heart rate values, where we can also register a statistically significant difference in the values gathered during training and during official competition ($p < 0.00$) as well as after warm up and after the measurements in all three fights.

Key words: karate, blood lactates, heart rate, training, competition.

INTRODUCTION

Karate is one of the most popular individual sports in the world. The dynamics during the fight and the high frequency of movements by the karate players requires having a high level of motor and functional abilities with a special emphasis on the speed, power and coordination.

The success in any sport and thus also in karate depends on the mutual action of several factors: techniques, tactics, speed of decision making and mental abilities, but it certainly also depends on the physiological characteristics of the karate player. It is known that the best karate players are characterized by the highest level of readiness (Chaabene, Hachana, Franchini, et al. 2012) which entails the role of the high level of development of aerobic as well as anaerobic abilities (Beneke, Beyer, Jachner, Erasmus & Hutler, 2004). It can be said that the physiological parameters may have a key role in the observance of the performance in the training program and the readiness of the karate athletes to perform at official competitions. According to recent researches (Beneka et al, 2004), the structural profile of the acyclic activity of the karate fight suggests that the aerobic metabolism is the dominant source of energy with anaerobic compensation, mainly energy rich in phosphates. The already mentioned purpose of this research is to determine whether the young karate athletes experience various changes in certain physiological parameters during training and during the official competition.

MATERIAL AND METHODS

The research was conducted on a sample of ten experienced karate players at the age of 15-18 years, candidates for the national team of Macedonia. Anthropological and functional tests were made for the realization of this research, with the main objective to determine the dynamics and the changes that occur in heart frequency and the levels of blood lactate in young karate players during and after the fights in the official competitions. In accordance with the set aim of the research, hypothesis was made that there are statistically significant differences in the functional abilities during training fights and after official competitions. The following sets of indicators were measured for the realization of this study:

- general anthropometric characteristics: body height BH, body mass BM, Body mass index (kg/m^2) – BMI.
- functional abilities: maximum oxygen consumption VO_{2max}, oxygen saturation% SpO₂, hemoglobin level Hg g/dl, heart frequency HF and blood lactate level L.

During the research, all competitors were in good health condition and all of them gave written consent for participation in the study.

During the training, each respondent made three fights in his weight category of two minutes and two minutes break between each fight (just as in the official matches), with a judge supervising the fights. Before the start of the research, the respondents were warming up 15 minutes in the following sequence: 5 minutes running, 5minutes general preparation exercises and 5minutes specific karate exercises. The blood sample was taken by the medical laboratory technician immediately after the warm up and after each fight. The lactate analyzer Lactate SCOUT + EKF Diagnostics was used for the determination of the level of lactate in the blood and NONIN Onyx for the determination of the oxygen saturation. The oxygen consumption was determined with indirect method using Agility shuttle Run test. The height and weight of each respondent was measured using stadiometer (Stadiometer, SECA, Leicester, UK) and electronic scale. All measurements were conducted in the Office of Sports Medicine (Laboratory of Sports Medicine) at the Faculty of Medicine-Skopje.

STATISTIC ANALYSIS

The obtained values of the measured variables, the characteristics and the size of the samples determined the manner and method of processing the results. The central and dispersive parameters are shown as mean values and standard deviations. The normality of the distribution of the results is calculated with the Kolmogorov-Smirnov method. The differences that emerged during the training and after the official competition were determined with the t-test. The statistical processing of the results is calculated by applying the statistical package program SPSS for Windows, Release 15.0; SPSS, CHICAGO, IL, USA.

RESULTS

Ten karate athletes who are candidates for the national team of Republic of Macedonia were supervised in their competitive part in the annual periodization, before their participation in the World Karate Championship which is to be held in Jakarta, Indonesia in 2015. All karate athletes were males, with an average age of 16.10 years, body height 177.50 cm, body weight 67.60 kg, i.e. BMI of 21.45. Based on the results from the Kolmogorov- Smirnov method, we can conclude that there is normal distribution of the results, which points to the fact that it is a matter of homogenous group of respondents, i.e. there is no deviation in their anthropological and functional characteristics in relation to their age category.

Table 1. Key features and anthropological measures of the participants in the survey

Parameters	Average values \pm SD	max D	K-S
Age	16.10 \pm 1.20	0.32	p > .20
Body height (cm)	177.50 \pm 5.54	0.19	p > .20
Body weight (kg)	67.60 \pm 8.73	0.17	p > .20
Body mass index (kg/m^2)	21.45 \pm 2.49	0.22	p > .20
VO _{2max}	49.67 \pm 6.04	0.19	p > .20
Hg (g/dl)	14.43 \pm 1.15	0.15	p > .20

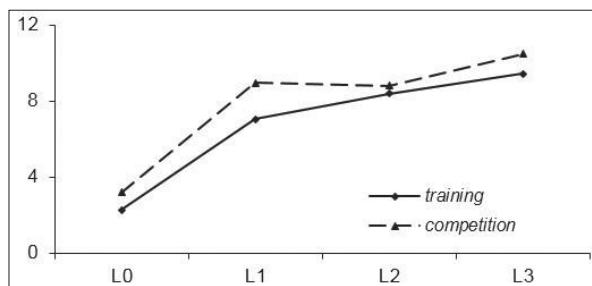
The level of lactates in the blood statistically differs significantly during the training matches and the official matches in all measurements i.e. after the warm up, after the first fight, after the second fight and after the third fight. (p₁ < 0.003, p₂ < 0.000, p₃ < 0.000, p₄ < 0.000, separately) The values of the lactates after the warm up in the trainings in this study resulted with 2.29 mmol/L, while in the official competitions they resulted with 3,20 mmol/L. These results have similar values with the results obtained previously in similar studies when athletes from several martial arts

were analyzed (Eaton con Sterkowitz 1997; Kreamer et al, 2001; Aziz et al, 2002; Karninčić et al, 2009) The lactate values obtained after the first two fights and at the end of the fights are very similar with the values obtained from the previously made analyzes made on competitors from related martial arts. (Yoon et al., 1994; Eaton con Sterkowitz et al., 1997; Da Lima et al., 2004; Karninčić et al., 2009.) After the third fight, the middle values of the lactates resulted slightly higher (9.43 and 10.49 mm/L), i.e. during the training from 5:40 to 12.60 and after the official competition from 7.10 to 17.70 mm/L.

Table. 2. Values of lactate during training and during competition

Parameters	Average values ± SD	max D	K-S
Age	16.10 ± 1.20	0.32	p > .20
Body height (cm)	177.50 ± 5.54	0.19	p > .20
Body weight (kg)	67.60 ± 8.73	0.17	p > .20
Body mass index (kg/m ²)	21.45 ± 2.49	0.22	p > .20
VO ₂ max	49.67 ± 6.04	0.19	p > .20
Hg (g/dl)	14.43 ± 1.15	0.15	p > .20

Graph 1. Values of lactate during training and during competition



The higher levels of lactates obtained during the competitions are probably due to the higher motivation of the competitors and also their will to do their best so that they reach the criteria for entry in the national team, i.e. a greater overall engagement of the competitors during the official competition. (Marić et al., 1985; Sharrat et al., 1986; Nilsson et al., 2002.).

In this study, we can see that there is a significant increase in the lactates only after the warm up and immediately after the first fight. The results obtained after the second and the third fight are more stable with a slight increase from fight to fight. What is noticeable is that the results in lactate values have the same behavior during training and during official matches. The obtained results indicate that in the competitive part of the training period the usage of the interval method with submaximal and maximal effort during training justifies the expectations for good specific preparation of the karate athletes. The similar way of work during the trainings which corresponds with the manner and the approach during the official competition fights, has great contribution for the athletes to adapt and raise their lactate tolerance level and their anaerobic tolerance level higher and thus increase the energy potentials and elimination and place the balance in the excretion of lactic acid higher in their individual functional abilities. With this method we can also improve the tactical-technical part of work of the karate players. It can also be said that the increase of lactate concentration in the blood is determined by the physical exertion, i.e. taking in consideration the fact that the excretion of lactates is faster than their removal during intense muscular effort (Klisuras, 2013). Table 3 shows the values of the oxygen saturation during different efforts, measured immediately after the end of the fights. By analyzing the data it can be concluded that no statistically significant difference is registered in the values of oxygen saturation (SpO₂) during the training fights and the official competitions for all four measurements.

The arterial blood gases are measured using the noninvasive method for monitoring the oxygen saturation and the results show normal values of 95-99. Values below 90-91 which are considered abnormal are not obtained during the training or during the official competitions. This indicates that regardless of the level of effort, the respiratory

system provides an adequate oxidation of blood, meaning that primarily the neural and secondary the humoral factors influence the breathing regulation during activity.

Table 3. Values of oxygen saturation during training and competition.

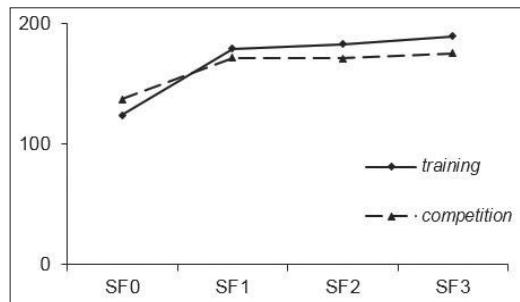
Parameter	During training	During official competitions	P
SpO ₂ 0	96.70 ± 1.42	96.00 ± 1.63	NS
SpO ₂ 1	96.20 ± 1.48	96.90 ± 2.18	NS
SpO ₂ 2	95.80 ± 1.32	95.70 ± 1.64	NS
SpO ₂ 3	96.00 ± 1.63	95.40 ± 1.71	NS

The analysis of the data presented in Table 4. And Graph 2, which refer to the values of heart rate, show that there is a statistically significant difference in the values which are gathered during the training fights and during the official competitions ($p < 0.001$), as well as after the warm up and the measurements after the three fights. In the warm up period in both measurements, the competitors reached the level of heart rate over 120 beats/min (during training 124.10 and 137.50 during competition), which means that the karate athletes entered the second zone of effort or sustained maximum preparation for further efforts in both cases. It can be noticed that, in all three fights the athletes have a greater heart rate during the training than during the competition. This occurrence is expected because during training the athletes do not take account of the outcome, but more important emphasis is given to the intensity of work, techniques used, the frequency and the number of attacks and defenses during the match so that they adapt to win points with a larger specter of techniques. Thus they use more effort (submaximal and maximal mode) and therefore the heart rate is increased. During the official competitions, a slightly different situation occurs because each battle has tremendous importance for the karate athletes given that only victory takes them to the next round. Because of that, a greater use of tactical elements is present and the heart rate is slightly lower during the fight..

Table 4. Values of heart rate during training and competition.

Parameter	During training	During official competitions	P
HF 0	124.10 ± 11.23	137.50 ± 18.86	< 0.001
HF1	179.40 ± 9.08	171.60 ± 14.53	< 0.001
HF2	183.10 ± 9.75	171.20 ± 10.73	< 0.001
HF3	189.70 ± 12.80	175.50 ± 20.08	< 0.001

Graph 2. Values of the heart rate during training and competition



CONCLUSION

Based on the obtained results and the analysis we have reached these following conclusions: Statistically significant differences were determined in the dynamics of the heart rate and the blood lactates in all marked periods, which confirms the null hypothesis. This research also determined that the lactates increase significantly only in the

first round, in the measurement performed immediately after the warm up. From the measurements performed after the second and third fight, we can conclude that there is slight increase in the lactate curve and the results are very close to the research made in the related martial arts. The energy systems of glycolysis and the phosphagen system are dominant sources of energy during one karate fight, which leads to the conclusion that athletes adapt to the functional abilities and therefore there is a better distribution of the energy potentials in the second and third fight. Only in exceptional moments of the karate fight the athletes deal with lack of oxygen and oxygen deficiency. In those situations it was noticed that the heart rate has its highest values. Therefore it can be assumed that with certain modification and more frequent use of the interval method of work, the athletes can not only improve their technical-tactical part and the influence in the development of specific skills, but they can also gain quality in the development of specific skills and a greater anaerobic capacity adaptation. With these primarily functional adaptations, the organism of the athletes can develop a bigger tolerance and thereby contribute in the moving of the anaerobic tolerance margin and the lactic tolerance curve, without the occurrence of fatigue of the basic motor skills in the performance of the learned moves, which bring points in the karate fights.

Authorship statement

The authors have contributed equally.

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We declare that we have no conflicts of interest.

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PROMJENE U FIZIOLOŠKIM PROCESIMA ZA VRIJEME TRENINGA I ZVANIČNIH TAKMIČENJA KOD MLADIH KARATISTA

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Rezime: Sprovedeno je funkcionalno i antropometrijsko testiranje deset iskusnih mladih karatista 15-18 godina starosti, koji su kandidati za reprezentaciju Republike Makedonije. Istraživanje je sprovedeno tako da su dinamika i promjene srčane frekvence i nivoa laktata u krvi mjereni tokom treninga i za vrijeme zvaničnih takmičenja. Razlike u vrijednostima laktata u krvi i srčane frekvence, koje su se pojavile za vrijeme tokom treninga i za vrijeme zvaničnih takmičenja su određene primjenom T-testa. Vrijednosti nivoa laktata u krvi tokom treninga i za vrijeme zvaničnih takmičenja su pokazale statistički značajne razlike u svim mjeranjima na nivou značajnosti $p < 0,00$. Isti zaključak se izvodi i za vrijednosti srčane frekvence, gdje su registrovane statistički značajne razlike u rezultatima dobijenim tokom treninga i zvaničnih takmičenja ($p < 0,00$), kao i poslije zagrijavanja i poslije mjerenja u sve tri borbe.

Ključne riječi: karate, krvni laktati, srčana frekvenca, trening, takmičenje.

UTICAJ UGLOVNOG POLOŽAJA POJEDINIХ SEGMENTA TIJELA BACAČA U PROJEKCIJI X OSE NA DUŽINU DOMETA KUGLE

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Sažetak: Istraživanje je provedeno s ciljem da se utvrdi uticaj uglovnog položaja pojedinih segmenta tijela bacača u projekciji X ose na dužinu dometa kugle (rotacionom tehnikom). Provedeno je na jednom entitetu, a to je bosansko-hercegovački državni reprezentativac bacač kugle Hamza Alić. Izbor varijabli je uskladen sa uzorkom ispitanika koji je u ovom istraživanju specifičan i koji je uslovljen postavljenim senzorima na pojedine segmente tijela ispitanika prilikom snimanja. Za utvrđivanje kinematičkih parametara, A = ubrzanje pojedinih segmenta tijela bacača kugle u osi X, primijenjene su 22 varijable (prediktorski skup) i kriterijska varijabla za procjenu kinematičkih parametara bacača kugle koju čini dužina dometa kugle (tretranih 36 ispravnih hitaca). Na osnovu rezultata koji su dobiveni regresionom analizom može se vidjeti da povećanjem uglova desnog i lijevog lakta te lijevog koljena dužina ostvarenog rezultata u bacanju kugle se povećava. Trenutak izbačaja se dešava kao posljedica aktivnog uglovnog kretanja prediktorskih modeliranih kinematičkih varijabli u X osi.

Ključne riječi: uglovni položaj, bacač kugle, rotaciona tehnika, dužina dometa.

Uvod

Početna brzina kugle rezultat je brzine koju kugla dobije u incijalnom ubrzavanju tokom okreta koju dobije u finalnom ubrzavanju tokom faze izbačaja. Obje brzine su posljedica koordinisanog kretanja i brzina više različitih segmenta kinematičkog lanca tijela bacača kugle. Svaki segment kinematičkog lanca pri tome odvija se rotacijom oko proksimalne osi zglobova i zajedno sa zglobovima, a brzina kugle jednaka je vektorskoj sumi njihovih brzina. Do-

IMPACT OF THE ANGULAR POSITION OF INDIVIDUAL BODY SEGMENTS OF A SHOT PUTTER IN THE PROJECTION ONTO THE X-AXIS TO THE DISTANCE OF THE SHOT RANGE

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Summary: The study was conducted with the objective to determine the impact of the angular position of individual body segments in the projection onto the x-axis to the distance of the shot range. It was conducted on one individual who is Bosnia and Herzegovina's national team shot putter Hamza Alić. The selection of variables was adjusted to the sample of the examinee which was specific in the study and which was conditioned by placing sensors on the examinee's individual body segments during the recording. For determining kinematic parameters, A = acceleration of shot putter's individual body segments in the x-axis, 22 variables were applied (predictor group) and criterion variable for calculating kinematic parameters of the shot putter which is made up of the distance of the shot range (36 proper throws). On the basis of the results gathered in regression analysis it can be inferred that by increasing the angle of the right and left elbow as well as left knee, the distance of the achieved result in throwing a shot put is increased.

Key words: angular position, shot putter, rotational technique, shot range

INTRODUCTION

The initial velocity of the shot put is the result of the velocity that the shot put gains in the initial acceleration during the rotation that it gets in the final acceleration in the release phase. Both velocities are a product of coordinated movements and speed of various segments of the kinematic body chain of the shot putter. Every segment of the kinematic chain occurs by rotation around the proximal axis around the wrist and with the wrist, while the velocity of the shot put is equal to the vector sum of

sadašnja istraživanja pokazuju da se prirast brzine kugle podudara sa akcijom bacača kugle u drugoj dvopotpornoj fazi bacanja od 80 do 90% (Kerssenbrock, 1974; Stepanek i Sušanka, 1987; Palm, 1990; Bartonietz, 1994). Po rezultatima istraživanjima (Zaciorsky, Lanka i Shalmanov, 1981; Bartonietz, 1994; Lanka, 2000) najveći prirast brzine podudara se s momentom početka kretanja desnog ramena i desne ruke tokom faze izbačaja. Većina autora (Grigalka, 1974; Bartonietz, 1994; Luhtanen, Blomqvist i Vanttinens, 1997; Lanka, 2000) slažu se da je aktivnost bacača kugle u fazi finalnog naprezanja pri izbačaju najvažnija za nagli porast brzine kugle koja čini 85-90% početne brzine kugle što na kraju doprinosi dužini dometa kugle.

S obzirom da su sportske kretne strukture veoma kompleksne naravi neophodno je da se mjerjenje segmentarnih pokreta mišićno-skeletnog sistema sprovodi stereofotogrametrijskim postupcima koji dozvoljavaju 3D-rekonstrukciju. Pošto savremena biomehanička analiza zahtijeva da se dijagnostika sprovodi u pretežno takmičarskim (situacionim) uslovima, od raspoloživih fotogrametrijskih sistema mogu se upotrijebiti samo oni koji se baziraju na kompletном zapisu kretanja. Kinematičkim postupcima, koji se često obilježavaju i kao kinematografski postupci, određuju se kinematičke veličine put i vrijeme kao i iz toga izvedene veličine brzina i ubrzanje (Čuk i Čoh, 1993; Čoh, 2001; Čoh i Štuhec, 2008.).

Cilj ovog istraživanja bio je utvrđivanje uticaja uglovnog položaja pojedinih segmenta tijela bacača u projekciji X ose na dužinu dometa kugle.

METOD RADA

Uzorak ispitanika

Ovo istraživanje sprovedeno je na jednom entitetu, a to je bosansko-hercegovački državni reprezentativac bacač kugle Hamza Alić (hronološke dobi 27 godina, tjelesne visine 1,95 m i tjelesne mase 129,5 kg).

Uzorak varijabli

Izbor varijabli je uskladen sa uzorkom ispitanika koji je u ovom istraživanju specifičan i koji je uslovljen postavljenim senzorima na pojedine segmente tijela ispitanika prilikom snimanja.

Prediktorski skup varijabli čine:

Za procjenu kinematičkih parametara, primjenjena su 4 parametra: S (prijedeni put), V (brzina), A (ugao) i w (ugaona brzina).

Za utvrđivanje kinematičkih parametara, A = ubrzanje pojedinih segmenta tijela bacača kugle u osi X,

their velocities. Studies up to now show that the increase in velocity of the shot put coincides with the activity of the shot putter in the double-support second phase of the throw from 80% to 90% (Kerssenbrock, 1974; Stepanek i Sušanka, 1987; Palm, 1990; Bartonietz, 1994). According to studies (Zaciorsky, Lanka & Shalmanov, 1981; Bartonietz, 1994; Lanka, 2000) the highest increase in velocity coincides with the moment the right shoulder and right arm start moving in the release phase. Most authors (Grigalka, 1974; Bartonietz, 1994; Luhtanen, Blomqvist & Vanttinens, 1997; Lanka, 2000) agree that the shot putter's activity in the phase of final exertion during release is the most important for rapid increase of velocity of the shot put and makes up 85-90% of the initial velocity of the shot put which at the end contributes to the distance of the shot range.

Considering that sports movement structures are of very complex character it is necessary for measuring segmental movement of the musculoskeletal system to be carried out by stereophotogrammetric methods that allow for 3D – reconstruction. Since modern biomechanical analysis requires diagnosis to be carried out in competition (situational) settings, taking into account all the available photogrammetric systems, only the ones that are based on a complete record of movement can be used. Kinematic methods, which are often termed as kinematographic methods, the kinematic size of direction and time is determined and from that the size of velocity and acceleration. (Čuk & Čoh, 1993; Čoh, 2001., Čoh & Štuhec, 2008.).

The aim of this study was determining the impact of the angular position of individual body segments of the shot putter in the projection onto the x-axis to the distance of the shot range.

STUDY METHODOLOGY

Sample of examinee

This study was conducted on an individual who is Bosnia and Herzegovina's national team shot putter Hamza Alić. (age: 27; height: 1.95 m; weight: 129.5 kg).

Sample of variables

The selection of variables was adjusted to the sample of the examinee which was specific in the study and which was conditioned by placing sensors on the examinee's individual body segments during the recording.

The predictor group of variables is made up of:

For determining kinematic parameters, 4 parameters were applied: **S** (distance travelled), **V** (velocity), **A** (angle) i **w** (angular velocity)

primjenjene su 22 varijable i to: AxL5S1 (L5 lumbalni pršljen i S1 krsni region), AxL4L3 (L4L3 lumbalni pršljenovi), AxL1T12 (L1 lumbalni pršljen i T12 grudni pršljen), AxT9T8 (T9T8 grudni pršljenovi), AxT1C7 (T1 grudni pršljen i C7 vratni pršljen), AxC1GL (C1 vratni pršljen i glava), AxDC7R (desni C7 vratni pršljen i rame), AxDRAM (desno rame), AxDLAK (desni lakat), AxDRZG (desni ručni zglob), AxLC7R (lijevi C7 vratni pršljen i rame), AxLRAM (lijevo rame), AxLLAK (lijevi lakat), AxLRZG (lijevi ručni zglob), AxDKUK (desni kuk), AxDKLJ (desno koljeno), AxDNZG (desni nožni zglob), AxDSTO (desno stopalo), AxLKUK (lijevi kuk), AxLKLJ (lijevi koljeno), AxLNZG (lijevi nožni zglob) i AxLLSTO (lijevi stopalo).

Kriterijska varijabla

Kriterijsku varijablu za procjenu kinematičkih parametara bacača kugle rotacionom tehnikom čini dužina dometa kugle (tretiranih 36 ispravnih hitaca).

Uslovi i tehnike mjerena

Snimanje i mjerjenje rotacione tehnike bacanja kugle na ispitaniku izvedeno je u prelaznoj takmičarskoj fazi priprema za Olimpijske igre u Londonu 2012. godine. Snimanje je obavljeno na stadionu Šiška u Ljubljani (Republika Slovenija). Korišten je krug za bacanje kugle prečnika 2,135m, sa segmentom i baždarenim metalnim metrom prema standardima IAAF. Teren i vremenski uslovi su bili optimalni. Na testiranju je snimljeno 85 izbačaja. Atletičar je bacao kuglu desnom rukom. Kod konačne analize uzeto je u obzir 36 najboljih i ispravnih hitaca. Snimanje je obavljeno sa dvije sinhronizovane kamere (Casio EX – F1) stavljenе pod uglom 90° na njihovu optičku osovinu. Treća kamera (Casio EX – F1) stavljenja je na visini 4 m, tačno iznad centra kruga za bacanje (Slika 1).

Analizirani prostor kruga bio je kalibriran sa referentnim okvirom dimenzije 1 m x 1 m x 2 m, a pri tome je za kalibriranje uzeto osam referentnih rubova (Slika 2). Dužinu analiziranog kretanja definisali smo sa "x" osom, visinu sa "y" osom i dubinu sa "z" osom. Za determinisanje kinematičkih parametara tehnike upotrijebili smo 3-D softver APAS (Ariel Dynamics Inc., San Diego, Ca). Obavljena je digitalizacija 15-segmentnog modela tijela bacača, kojeg smo definisali sa 18 referentnih tačaka. Osamnaesta tačka bila je definisana sa centrom kugle. Segmenti modela prikazuju dijelove tijela povezane sa tačkastim zglobovima. Mase i centri gravitacije segmenata kao i centar gravitacije tijela izračunati su na osnovu antropometrijskog modela (Dempster, 1955). Koordinate

For determining kinematic parameters, A = acceleration of shot putter's individual body segments in the x-axis, 22 variables were applied: AxL5S1 (L5 lumbar vertebrae and S1 loin area), AxL4L3 (L4L3 lumbar vertebra), AxL1T12 (L1 lumbar vertebrae and T12 thoracic vertebra), AxT9T8 (T9T8 thoracic vertebrae), AxT1C7 (T1 thoracic vertebra and C7 cervical vertebra), AxC1GL (C1 cervical vertebra and head), AxDC7R (right C7 cervical vertebra and shoulder), AxDRAM (right shoulder), AxDLAK (right elbow), AxDRZG (right wrist), AxLC7R (left C7 cervical vertebra and shoulder), AxLRAM (left shoulder), AxLLAK (left elbow), AxLRZG (left wrist), AxDKUK (right hip), AxDKLJ (right knee), AxDNZG (right ankle), AxDSTO (right foot), AxLKUK (left hip), AxLKLJ (left knee), AxLNZG (left ankle) and AxLLSTO (left foot).

Criterion variable

Criterion variable for calculating kinematic parameters of the shot putter which is made up of the distance of the shot range (36 proper throws).

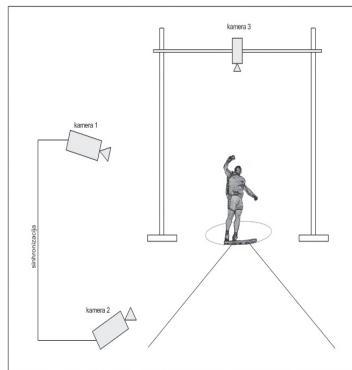
Conditions and techniques for measurement

The recording and measuring of the rotational technique of the examinee's shot put throwing was conducted in the transitional competition training phase for the 2012 Olympic Games in London. Recording was done at the Šiška stadium in Ljubljana (Republic of Slovenia). A shot put circle was used with a diameter of 2.135 meters, with a segment and calibrated metal meter in accordance with IAAF standards. The field and weather conditions were ideal. We recorded 85 throws at the testing. The athletes threw with their right arm. The best and most proper 36 throws were taken into account for final analysis. Recording was carried out with two synchronized cameras (Casio EX-F1) placed at a 90° angle. The third camera (Casio ExX-F1) was placed at a 4 meter height above the shot put circle (picture 1).

The analyzed range of the circle was calibrated with a reference frame of 1 m x 1 m x 2m, while for calibrating we took eight reference borders (picture 2). The distance of analyzed movement was defined with an »x« axis, height with a »y« axis and depth with a »z« axis. . For determining kinematic parameters of technique we used 3-D software APAS (Ariel Dynamics Inc., San Diego, Ca). Digitalization was done of a 15-segment model of the shot putter's body, which we defined with 18 reference points. The eighteenth point was defined with the centre of a shot put ball. Model segments show body parts connected with joints. Mass and centre of gravity segments as well as center of body gravity were calculated on the basis of the anthropometric

tjelesnih tački izravnate su sa digitalnim Butterworthovim filterom 7. stepena. Sa programskim paketom ARIEL dooviđeni su podaci o S-putu, V-brzini, A-uglu, w-ugaonoj brzini u X, Y i Z osi.

Slika 1. Položaj kamere / Picture 1. Situation of camera



Da bi utvrdili uticaj prediktivnih vrijednosti kinematičkih parametara pojedinih segmenata tijela bacača kugle - uglovnih A vrijednosti u X osi u trenutku izbačaja (prediktorski skup varijabli) na dužinu dometa kugle (kriterijska varijabla), primijenjena je regresiona analiza.

REZULTATI I DISKUSIJA

Regresiona analiza dužine izbačaja na osnovu varijabli uglovnih (A) vrijednosti u X osi – trenutak izbačaja

models (Dempster, 1955). Coordinates for body points were arranged with a digital 7th order Butterworth filter. With the program packet ARIEL we gathered data on S-trajectory, V-velocity, A-angle, w-angle velocity in x, y and z axes.

Slika 2. Metode obrade podataka / Picture 2. Methods for data processing



In order to determine the impact of predictor values of kinematic parameters of a shot putter's individual body segments – angular A values in the x-axis at the moment of release (predictor variable group) onto the distance of the shot put range (criterion variable), a regression analysis was applied.

RESULTS AND DISCUSSION

Regression analysis of the distance of the throw on the basis of angular variable (A) values in the x-axis – moment of release.

Tabela 1. / Table 1. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate R Square Change	Change Statistics				
					F Change	df1	df2	Sig. F Change	
dimension0	1	.923 ^a	.853	.632	.21907		.853	3.862	21 14 .006

a. Prediktori: (konstanta), AxLSTO, AxDKLJ, AxLRAM, AxLKUK, AxDC7R, AxLNZG, AxLRZG, AxLKLJ, AxDSTO, AxLC7R, AxDNZG, AxDRZG, AxLLAK, AxDLAK, AxDRAM, AxT9T8, AxC1GL, AxDKUK, AxL4L3, AxL5S1, AxT1C7

a. Predictors: (Constant), AxLSTO, AxDKLJ, AxLRAM, AxLKUK, AxDC7R, AxLNZG, AxLRZG, AxLKLJ, AxDSTO, AxLC7R, AxDNZG, AxDRZG, AxLLAK, AxDLAK, AxDRAM, AxT9T8, AxC1GL, AxDKUK, AxL4L3, AxL5S1, AxT1C7

Tabela 2. / Table 2. ANOVAb

Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.892	21	.185	3.862 .006 ^a
	Residual	.672	14	.048	
	Total	4.564	35		

a. Prediktori: (konstanta), AxLSTO, AxDKLJ, AxLRAM, AxLKUK, AxDC7R, AxLNZG, AxLRZG, AxLKLJ, AxDSTO, AxLC7R, AxDNZG, AxDRZG, AxLLAK, AxDLAK, AxDRAM, AxT9T8, AxC1GL, AxDKUK, AxL4L3, AxL5S1, AxT1C7

a. Predictors: (Constant), AxLSTO, AxDKLJ, AxLRAM, AxLKUK, AxDC7R, AxLNZG, AxLRZG, AxLKLJ, AxDSTO, AxLC7R, AxDNZG, AxDRZG, AxLLAK, AxDLAK, AxDRAM, AxT9T8, AxC1GL, AxDKUK, AxL4L3, AxL5S1, AxT1C7

b. Završna varijabla: Dužina

b. Dependent Variable: Distance

Tabela 3. / Table 3. Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients		Correlations			
	B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part
(Constant)	25.380	1.938		13.097	.000			
AxL5S1	.110	.095	1.026	1.155	.267	-.011	.295	.118
AxL4L3	1.531	1.171	.874	1.307	.212	.025	.330	.134
AxT9T8	-.058	.207	-.205	-.282	.782	.082	-.075	-.029
AxT1C7	-.264	.155	-2.331	-1.704	.111	-.008	-.414	-.175
AxC1GL	.195	.159	1.466	1.227	.240	-.031	.312	.126
AxDL7R	-.027	.035	-.237	-.766	.456	-.027	-.201	-.079
AxDARAM	-.074	.034	-.707	-2.142	.050	.176	-.497	-.220
AxDLAK	.058	.026	1.126	2.251	.041	.121	.516	.231
AxDRZG	-.018	.012	-.572	-1.493	.158	.020	-.371	-.153
AxLC7R	-.172	.058	-1.133	-2.942	.011	-.168	-.618	-.302
AxLRAM	-.020	.022	-.319	-.919	.373	-.010	-.239	-.094
AxLLAK	.073	.027	1.458	2.746	.016	.189	.592	.282
AxLRZG	-.001	.006	-.023	-.111	.913	-.343	-.030	-.011
AxDKUK	-.141	.043	-1.827	-3.295	.005	.074	-.661	-.338
AxDKLJ	-.022	.078	-.077	-.282	.782	-.040	-.075	-.029
AxDNZG	-.017	.014	-.336	-1.205	.248	-.278	-.307	-.124
AxDSTO	-.012	.009	-.314	-1.400	.183	-.066	-.350	-.144
AxLKUK	-.223	.067	-3.012	-3.324	.005	-.147	-.664	-.341
AxLKLJ	.119	.054	.404	2.208	.044	-.157	.508	.226
AxLNZG	.008	.010	.140	.729	.478	-.006	.191	.075
AxLSTO	-.031	.014	-.409	-2.125	.052	-.104	-.494	-.218

Zavisna varijabla: Dužina / Dependent Variable: Distance

U Tabeli 1. prikazani su rezultati regresione analize prediktorskog sistema uglovnih vrijednosti pojedinih segmenata tijela u X osi u trenutku izbačaja sa kriterijskom varijablom dužina dometa kugle.

Koeficijent multiple korelacije koji iznosi $R=.92$ i koeficijent determinacije $R^2 = .85$ ukazuju da je objašnjeno 85% zajedničke varijanse kriterijske varijable, odnosno da istraživani prediktorski sistem generalno objašnjava 85% uticaja na dužinu dometa kugle, dok preostali dio uticaja od 15 % pripada drugim endogenim i egzogenim faktorima koji nisu istraživani ovim radom.

Povezanost ova dva sistema je na nivou značajnosti $p<.01$, što znači da možemo pristupiti daljem analiziranju parcijalnog uticaja prediktorskog sistema uglovnih vrijednosti pojedinih segmenata tijela u X osi u trenutku izbačaja sa kriterijskom varijablom dužina dometa kugle.

Statistički značajane koeficijente parcijalne korelacijske na nivou $p<.01$ imaju vrijednosti ugla desnog kuka – AxDKUK (Beta=−1.82) i lijevog kuka AxLKUK (Beta

Table 1. shows the results of regression analysis of the predictor system of angular values of individual body segments in the x-axis at the time of release with a criterion variable of the distance of the shot put throw.

The coefficient of multiple correlation which is $R=.92$ and the coefficient of determination $R^2 = .85$ indicate that 85% of the common variance of the criterion variable is explained, namely that the studied predictor system generally explains 85% of the impact onto the distance of the shot range, while the remaining impact share of 15% belongs to other endogenous and exogenous factors that were not examined in this study.

The correlation of these two systems is on the level of significance $p<.01$, which means that we can advance to further analysis of the partial impact of the predictor system of angular values of individual body segments in the x-axis at the moment of release with the criterion variable of the distance of the shot put throw.

Statistically significant coefficients of partial cor-

=-3.01), čije su projekcije na kriterijsku varijablu negativne.

Negativni predznak pojedinačnog uticaja na kriterijsku varijablu sa statističkom značajnošću $p<.05$ ima ugao desnog ramena AxDRAM (Beta=-.70) i ugao lijevog ramena u nivou sedmog vratnog pršljena AxLC7R (Beta = -1.13) (Tabela 3).

Iz dobijenih rezultata možemo vidjeti da manje vrijednosti ostvarenih uglova, desnog ramena, desnog i lijevog kuka ugla i lijevog ramena u nivou sedmog vratnog pršljena doprinose većoj dužini bacanja kugle. Trenutak izbačaja se dešava kao posljedica aktivnog uglovnog kretanja prediktorskih modeliranih kinematičkih varijabli u osi X. Rotaciona tehnika je uslovljena uglovnim položajem svih segmentata tijela tokom cijelog njenog izvođenja. U trenutku izbačaja manje uglovne vrijednosti navedenih varijabli doprinose većoj dužini hica kao kriterijskoj varijabli. To pokazuje da će dužina hica biti veća ako se bacač u trenutku izbačaja nalazi u što manjem uglovnom položaju sa X osom, tj. desni i lijevi kuk, desno i lijevo rame dolaze i postavljaju u poziciju tako da su paralelni sa osom X, tj. okomiti na smjer izbačaja kugle. Takođe, negativni predznak projekcije u trenutku izbačaja ose X, ima ugao lijevog ramena u nivou sedmog vratnog pršljena koja je nastala uglovnim pomijeranjem ramenog sistema u negativnu projekciju ose X u odnosu na smjer bacanja što je prouzrokovalo pozitivan efekat na dužinu hica kao kriterijsku varijablu.

Rotaciona tehnika bacanja kugle karakteriše se veoma kompleksnim kretanjem koje se izvodi velikom brzinom u ograničenom prostoru. Radi lakše analize tehnike, usavršavanja tehnike i u svrsi naučnog istraživanja, rotaciona tehnika bacanja kugle podijeljena je u četiri faze, u biomehaničkoj analizi može se dijeliti na sedam faza, ali ipak ona je cjelovita tako da se kod njenog izvođenja ne primjećuje prelaz iz faze u fazu. Zbog velikog uglovnog odstupanja prilikom kretanja, tj. moguće greške nastale u jednoj fazi mogu uticati na pravilno izvođenje kretanja tijela u sljedećoj fazi i poslije izbačaja kugle, dovodi krajnji domet kugle u pitanje.

Domet bacanja (rezultat takmičenja) definisan je dužinom puta djelovanja sile na kuglu, na koju utiču brzina izbacivanja, ugao izbacivanja i visina izbacivanja (Palm, 1990; Gemer, 1990; Bartonietz, 1994; Oesterreich et. al., 1997; Luhtanen et. al., 1997; Lanka, 2000; Hubbard et. al., 2001).

Brzina izbacivanja jedan je od najvažnijih parametara tehnike na kojeg utiču predhodne faze, naročito faza konačne akceleracije. Na visinu izbacivanja utiču naročito antropometrijske karakteristike (tjelesna visina,

relation with a level $p<.01$ are present in the value of the right hip angel- AxDKUK (Beta=-1.82) and left hip AxLKUK (Beta =-3.01), whose projections onto the criterion variable are negative.

A negative sign of individual impact onto the criterion variable with statistical significance $p<.05$ is seen in the angle of the right shoulder AxDRAM (Beta=-.70) and the angle of the left shoulder at the level of the seventh cervical vertebrae AxLC7R (Beta = -1.13) (Table 3).

From the gathered results we can see that lower values of the reached angels, the right shoulder, right and left hip and the left shoulder at the level of the seventh cervical vertebrae contribute to the longer distance of a shot put throw. The moment of release occurs as a result of active angular movement of predictor model variables in an x-axis. The rotational technique is conditioned with the angular position of all body segments during the entire execution. At the time of release, lower angular values of mentioned variables contribute to the longer distance of the throw as a criterion variable. It shows that the distance of the throw will be longer if the shot putter is in a lower angular position with the x-axis at the time of release, meaning the right and left hip, as well as the right and left shoulder are in a position parallel to the x-axis, that is vertical to the direction of the shot put throw. Another negative sign of the projection at the time of release of the x-axis can be seen with the angle of the left shoulder at the level of the seventh cervical vertebrae which is a result of angular shifting of the shoulder system in a negative projection of the x-axis in relation to the direction of the throw and which has caused a positive effect on the distance of the throw as a criterion variable.

The rotational technique of a shot put throw is characterised with very complex movement which is performed at a high speed in a limited space. For the purpose of easier technique analysis, improving the technique and for scientific study, the rotational technique of the shot put throw is divided into four phases; in biomechanical analysis it can be divided into seven phases, but after all it is integral and transition from phase to phase cannot be noticed in its execution. Due to high angular discrepancies during movement, the possible mistakes that occur in one phase can have an effect on proper body movement in the next phase and after the shot put release, which has an impact on the ultimate distance of the shot put.

The throwing distance (competition result) is defined with the length of influence of force onto the shot put, which is influenced by the release velocity, angel of release and the height of release (Palm, 1990; Gemer, 1990; Bartonietz, 1994; Oesterreich et. al., 1997; Luhtanen et. al., 1997; Lanka, 2000; Hubbard et. al., 2001).

dužina ruke) i tehnika bacanja. Povećanje visine izbacivanja proporcionalno utiče na povećanje dužine bacanja (Lanka, 2000).

Statistički značajan pojedinačni uticaj Beta koeficijenta sa pozitivnim predznakom na nivou $p<.05$ imaju vrijednosti ugla desnog lakta – AxDLAK (Beta=1.12), lijevog lakta AxLLAK (Beta =1.45) i lijevog koljena AxLKLJ (Beta=.40), čije su projekcije na kriterijsku varijablu pozitivne.

Analizirajući rezultate regresione analize dužine izbačaja na osnovu varijabli uglovnih (A) vrijednosti pojedinih segmenata tijela u X osi, u trenutku izbačaja, koji prediktorskim sistemom varijabli daju uticaj na tretiranu kriterijsku varijablu dužina izbačaja kugle se povećava, povećanjem uglova desnog i lijevog lakta te lijevog koljena.

ZAKLJUČAK

Može se zaključiti da se sa povećanjem uglova desnog i lijevog lakta, te lijevog koljena dužina ostvarenog rezultata u bacanju kugle povećava. Trenutak izbačaja se dešava kao posljedica aktivnog uglovnog kretanja prediktorskih modeliranih kinematičkih varijabli u X osi.

Rotaciona tehnika je uslovljena uglovnim položajem svih segmenata tijela tokom cijelog njenog izvođenja. U trenutku izbačaja pozitivan uticaj na tretiranu kriterijsku varijablu u osi x (čeono) imaju uglovni položaj lijevog lakta, koji uslijed kretne inercije tijela vrši pozitivno uglovno kretanje u odnosu na smjer bacanja, odnosno nalazi se okomito sa osom X i svojim zaustavljanjem, za sobom povlači uglovni položaj desnog lakta u pozitivnu projekciju ose X koji svojim uglovnim položajem sistemu desna šaka–sprava omogućava pozitivno i pravilno kretanje prema trenutku izbačaja.

Takođe, pozitivnu projekciju u trenutku izbačaja ose X, ima ugao lijevog koljena koji je nastao vertikalnim opružanjem lijeve noge, potpomognut djelovanjem kretne aktivnosti i sile iz desne noge, sistema kukova i kretnom inercijom centripetalne sile. Što je veća visina izbačaja, a time i elevacioni ugao, dužina hica će biti veća. To je direktno povezano sa povećanjem uglovnih vrijednosti tretiranih varijabli.

Release velocity is one of the most important technique parameters which is influenced by previous phases, especially the final acceleration phase. The height of release is especially inflenced by anthropometric characteristics (body height, arm length) and throwing technique. The increase of release heighth propoirtinally impacts the increase of the throwing distance (Lanka, 2000).

Statistically significant individual effect of Beta coefficient with a positive sign at the level of $p<.05$ are seen in angle values of the right elbow– AxDLAK (Beta=1.12), left elbow AxLLAK (Beta =1.45) and left knee AxLKLJ (Beta=.40), whose projection onto the criterion variable are positive.

Analysing the results of regression analysis of the throwing distance on the basis of angular value variables (A) of individual body segments in the x-axis, at the moment of release, which give an effect to the referred criterion variable of the throwing distance by the predictor system.

CONCLUSION

It can be concluded that with the increase of the angles of the right and left elbow, as well as the left knee, the distance of the throw is increased. The moment of release occurs as a result of active angle movement of predictor model kinematic variables in an x-axis.

The rotational technique is conditioned by the angular position of all body segments during its entire execution. At the time of release, there is a positive effect on the referred criterion variable in an x-axis (lateral) with the angular position of the left elbow, which in the midst of body momentum performs a positive angular movement in relation to the direction of the throw, namely it is parallel to the x-axis and by halting, it effects the angular position of the right elbow in a positive projection of the x-axis which enables by way of its angular position for the right hand-instrument system to have positive and proper movement at the time of release.

A positive projection at the time of release of the x-axis is seen in the angle of the left knee which has emerged by vertically extending the left leg, supported by the movement activity and force from the right leg, the hip systems and moving momentum of centripetal force. The higher the release height and thereby the elevation angle, the distance of the throw will be longer. It is directly related to the increase of angular values of referred variables.

Authorship statement

The authors have contributed equally.

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Mi izjavljujemo da nemamo konflikt interesa.

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FUNKCIONALNA SPOSOBNOST KARDIOVASKULARNOG SISTEMA KOD ADOLESCENATA

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Sažetak: Ispitivanjem funkcije kardiovaskularnog sistema najčešće se mijere tjelesna sposobnost i funkcionalna sposobnost transportnog sistema ili njegovih dijelova. Mnoga istraživanja su pokazala povezanost pretilosti sa smanjenjem funkcionalne sposobnosti kardiovaskularnog sistema koja je u korelaciji sa tjelesnom sposobnošću za rad. Ovo istraživanje je provedeno sa ciljem utvrđivanja funkcionalne sposobnosti kardiovaskularnog sistema kod adolescenata radi procjene o potrebi bavljenja fizičkom aktivnošću u ovom uzrastu. Uzorak ispitanika činilo je 55 učenika srednje škole, muškog pola, uzrasta 16 godina (+/- 6 mjeseci). Za potrebe ovog istraživanja indeks tjelesne mase korišten je kao kriterij za formiranje grupe ispitanika. Funkcionalna sposobnost kardiovaskularnog sistema posmatrana je preko varijabli: sistolni i dijastolni pritisak prije i poslije opterećenja i srčana frekvencija prije i poslije opterećenja nakon izvođenja Astrandovog testa na bicikl ergometru. Analizom nivoa funkcionalnih sposobnosti kardiovaskularnog sistema ispitanika prije i poslije opterećenja, primjećeno je da su se kod ispitanika koji su imali veći indeks tjelesne mase, pokazale veće vrijednosti sistolnog i dijastolnog krvnog pritiska prije i poslije opterećenja, kao i veće vrijednosti srčane frekvencije prije i poslije opterećenja. Ovim istraživanjem su se potvrdila brojna ranija istraživanja, kojima se navodi da povećan indeks tjelesne mase dovodi do štetnog uticaja na kardiovaskularni sistem.

Ključne riječi: kardiovaskularni sistem, fizička aktivnost

Uvod

Na osnovu dosadašnjih istraživanja najčešće su identifikovana četiri osnovna faktora koji određuju morfološku strukturu čovjeka, a koja se primjenjuju u praksi: longitudinalna dimenzionalnost skeleta, transverzalna

FUNCTIONAL ABILITY OF CARDIOVASCULAR SYSTEM IN ADOLESCENTS

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Abstract: Testing function of cardiovascular system is measured, the most often, physical ability and functional capacity of transport system or its parts. Many studies have found an association with obesity by reducing functional capacity of cardiovascular system that is correlated with physical ability to work. This research was conducted in order to determine the functional ability of cardiovascular system in adolescents to assess need of their sports activities at this age. The sample consisted of 55 high school students, male, 16 years old (+/- 6 months). For this research, the body mass index is used as a criterion for forming groups of respondents. The functional capacity of cardiovascular system is observed through variables: systolic and diastolic blood pressure before and after load and heart rate before and after load after performing Astrand test of ergometar bicycle. Analysis of functional abilities cardiovascular respondents before and after load, it was noted that in respondents who had a higher body mass index, showed higher values of systolic and diastolic blood pressure before and after load, as well as higher values of heart rate before and after load. This study confirmed previous numerous studies, stating that increased body mass index leads to harmful effects on cardiovascular system.

Keywords: cardiovascular system, physical activity.

INTRODUCTION

Based on research, the most commonly identified are four main factors that determine morphological structure of man, which is applied in practice: longitudinal dimension of skeleton, transverse dimensions of skeleton, weight and volume of body and subcutaneous adipose tissue (Malacko, 1991, Malacko and Rado, 2004). Factor of subcutaneous adipose tissue was defined by total amount off fat in body, but actually, di-

dimenzionalnost skeleta, masa i volumen tijela i potkožno masno tkivo (Malacko, 1991). Faktor potkožnog masnog tkiva definisan je ukupnom količinom masti u organizmu, ali se zapravo direktno mjeri količina potkožnog masnog tkiva, jer se pretpostavlja da postoji povezanost između potkožne masti i ukupne količine masti u tijelu. Svjetska zdravstvena organizacija (WHO) razlikuje prekomjernu težinu, značajno prekomjernu težinu (pretilost) i izrazito prekomjernu težinu (morbidna pretilost). U zemljama u razvoju pothranjenost prouzrokovana hronično nedovoljnim unosom hrane i čestim infekcijama i danas je vodeći uzrok zaostajanja u rastu (Zdravković i sar., 2011), a može uzrokovati i mnogobrojne poremećaje funkcije imunog sistema, te smanjenje broja limfocita iz slezine i limfnih čvorova (Ljekarinfo, 2014). Sa druge strane, mnoga istraživanja govore o štetnosti velikog nivoa indeksa tjelesne mase. Pod prekomjernom težinom smatra se tjelesna težina iznad normalne vrijednosti s indeksom tjelesne mase od 25 do 29 kg/m² (Mišigoj-Duraković, Heimer i Duraković, 1996) dok se pretilost posmatra kao prisutnost prevelike količine tjelesne masti ili adipoznog tkiva u odnosu na nemasnu (ili mišićnu) tjelesnu masu. Vranešić i Alebić (2005) smatraju da je osoba pretila kada je količina adipoznog tkiva u njenom tijelu 20% viša u odnosu na optimalnu količinu. Pretilost ozbiljno ugrožava kvalitetu života i smanjuje očekivanu životnu dob čovjeka (Hainer, Toplak i Mitrakou, 2008). Povezanost raspodjele tjelesnog masnog tkiva i povišenog krvnog pritiska, osim kod odraslih, primjećena je i kod djece. Takođe, istraživanja pokazuju da postoji sve veći broj djece koji obolijevaju od dijabetesa tipa 2 upravo zbog pretilosti (Hunter, Bamman i Hester, 2000 i Wang i sar., 2006). Westcott (2006) navodi da pretilost povećava mogućnost pojave koronarnih problema, povišenog nivoa šećera u krvi, povećane količine holesterola u tijelu, te povišenog krvnog pritiska. Takođe, Pucarin-Cvetković i sar. (2006) iznose podatke koji govore da pretilje osobe imaju značajno povišen nivo holesterola, triglicerida, glukoze i povišen sistolni i dijastolni pritisak u odnosu na osobe normalne tjelesne težine. Funkcionalna sposobnost kardiovaskularnog sistema je sposobnost srca i krvnih sudova da opskrbi organizam dovoljnim količinama krvi u mirovanju i pri raznim opterećenjima. Među varijablama koje se najčešće koriste kao indeksi kardiovaskularne sposobnosti ubraja se frekvencija srca, arterijski krvni pritisak i minutni volumen. Niska kardiorespiratorna sposobnost smatra se prediktorom kardiovaskularnog obolijevanja, kardiovaskularnog mortalitet i smrtnosti od svih uzroka (Kodama i sar. 2009). Srčana frekvencija jednostavan je pokazatelj kardiovaskularnog

rectly is measuring amount of subcutaneous adipose tissue, because it is assumed that there is a relationship between subcutaneous fat and total amount of fat in body. The World Health Organization (WHO) distinguishes overweight, significantly overweight (obesity) and extremely overweight (morbid obesity).

In developing countries, chronic malnutrition caused by insufficient food intake and frequent infections, today is leading cause of stunting (Zdravković et al., 2011) and can cause numerous disruptions functions of immune system, and reducing the number of lymphocytes from spleen and lymph nodes (Ljekarinfo, 2014). On other hand, many studies talk about harmful effects of high levels of body mass index. Under overweight is considered a weight above normal values with a body mass index of 25 to 29 kg/m² (Mišigoj-Duraković, Heimer and Duraković, 1996), while obesity is seen as presence of excessive amount of body fat or adipose tissue in relation to lean (or muscle) weight. Vranešić and Alebić (2005) find that person is obese when amount of adipose tissue in body is 20% higher than optimal amount. Obesity seriously threatening the quality of life and reduces the life expectancy of a man (Hainer, Toplak and Mitrakou, 2008). Connection between distribution of body fat and high blood pressure, except in adults, is observed at children as well. Also, research shows that there are a growing number of children who suffer from Type 2 diabetes because of obesity (Hunter, Bamman and Hester, 2000 and Wang et al., 2006). Westcott (2006) states that obesity increases possibility of cardiac problems, high blood sugar, increased amounts of cholesterol in body and high blood pressure. Also, Pucarin-Cvetkovic et al. (2006) present data which suggesting that obese people have significantly elevated levels of cholesterol, triglycerides, glucose, and elevated systolic and diastolic blood pressure compared to people with normal weight. The functional capacity of cardiovascular system is ability of heart and blood vessels that supply the body with sufficient amounts of blood at rest and at various loads. Among variables that are commonly used as indices of cardiovascular ability is one of heart rate, blood pressure and cardiac output. Low cardio respiratory capacity is considered a predictor of cardiovascular morbidity, cardiovascular mortality and mortality from all causes (Kodama et al. 2009). Heart rate is a simple indicator of cardiovascular stress and on exertion, it is directly proportional to oxygen consumption. In isometric muscle contraction, increases heart rate, and systolic and diastolic blood pressure, stroke volume varies very slightly, and blood flow to

stresa i prilikom napora, ona je izravno proporcionalna potrošnji kiseonika. Pri izometrijskoj mišićnoj kontrakciji, povećava se frekvencija otkucanja srca, kao i sistolni i dijastolni pritisak, udarni volumen se mijenja sasvim neznatno, a protok krvi u mišićima se smanjuje, dok se pri izotoničnoj kontrakciji naglo povećava frekvencija otkucanja srca i udarni volumen. Krvni pritisak je pritisak krvi na zidove krvnih sudova, koji nastaje radom srca, a održava ga otpor kretanju krvi. Ukoliko je brzina kretanja čestica krvi veća, i krvni pritisak je veći. Zato se kaže da je krvni pritisak mjerilo energije krvi u pojedinim dijelovima sistema za cirkulaciju (Šentija, 2009). Tjelesna sposobnost za rad ograničena je najviše funkcijom kardiovaskularnog sistema, te se ispitivanjem funkcije kardiovaskularnog sistema najčešće mjeri tjelesna sposobnost i funkcionalna sposobnost transportnog sistema ili njegovih dijelova. Nivo tjelesne aktivnosti se počinje smanjivati tokom adolescencije, pa je ovo životno razdoblje u kojem se dešava odrastanje vrlo bitno za istraživanje promjena statusa uhranjenosti i funkcionalne sposobnosti kardiovaskularnog sistema. Tucker (2008) je zaključila kako samo 54% djece predškolske dobi zadovoljava potreban nivo dnevne fizičke aktivnosti i s obzirom na takvo stanje, predviđela da će se pretilost među predškolskom djecom sve više povećavati. Hunter, Bamman i Hester (2000) tjelesnu aktivnost navode kao faktor koji sprječava pojavu prekomjernih kilograma, dok Westcott (2006) preporučuje sklop vježbi za sprečavanje pretilosti kod djece. Istraživanja pokazuju da se rizik od kardiovaskularnih bolesti može redukovati umjerenom fizičkom aktivnošću i do 20%, a kod osoba koje su fizički aktivnije i do 27% (Lee, Folsom i Blair, 2003; Williams, Fleg, Ades i sar., 2002).

Budući da su mnoga istraživanja pokazala povezanost pretilosti sa smanjenjem funkcionalne sposobnosti kardiovaskularnog sistema, koja je u korelaciji sa tjelesnom sposobnošću za rad, ovo istraživanje je provedeno sa ciljem utvrđivanja funkcionalnih sposobnosti kardiovaskularnog sistema kod adolescenata radi dobijanja informacija koje bi se mogle iskoristiti prilikom procjene o potrebi bavljenja fizičkom aktivnošću u ovom uzrastu.

METODE

Uzorak ispitanika u ovom istraživanju je određen kao namjeran u odnosu na grupe ispitanika, tako da je ovu grupu ispitanika činilo 55 učenika srednje škole, muškog pola, uzrasta 16 godina (+/- 6 mjeseci). Ispitanici nisu bili članovi sportskih klubova, niti su se bavili nekom od sportskih aktivnosti. Prije provođenja istraživanja ispitanici su bili podvrgnuti ljekarskom pregledu, kojim

the muscles is reduced, while at isotonic contraction rapidly increasing heart rate and stroke volume. Blood pressure is pressure of blood on walls of blood vessels, resulting from work of heart and keeps it resistance to the movement of blood. If velocity of blood particles is larger, and blood pressure is higher. Therefore it is said that blood pressure is a measure of energy levels in some parts of circulatory system (Šentija, 2009). Physical ability to work is limited by maximum function of cardiovascular system, and testing function of cardiovascular system is the most commonly measured physical ability and functional capacity of transport system or its components. The level of physical activity begins to decline during adolescence, so this period of life which is going to grow up is very important for research into changes of nutritional status and functional capacity of cardiovascular system. Tucker (2008) concluded that only 54% of preschool children meet the required level of daily physical activity with regard to this situation, predicted that obesity among preschool children is going to grow up. Hunter, Bamman and Hester (2000) cite physical activity as a factor that prevents the occurrence of overweight, while Westcott (2006) recommended a set of exercises for preventing obesity in children. Research shows that the risk of cardiovascular disease can reduce moderate physical activity up to 20%, and in people who are physically active and to 27% (Lee, Folsom and Blair, 2003; Williams, Flagg, Ades et al., 2002). Since many studies have shown an association between obesity and reduction of functional ability of cardiovascular system, which is correlated with physical ability to work, this research was conducted in order to determine functional capacity of cardiovascular system in adolescents in order to obtain information that could be used when assessing the need of practicing physical activity at this age.

METHODS

The sample in this study is defined as intent in relation to groups of respondents, so that this group of respondents comprised of 55 high school students, male, 16 years old (+/- 6 months). Respondents were members of sports clubs, not have dealt with some of the sports activities. Before conducting the survey respondents were subjected to medical examination, it was established that they were healthy and without injuries of locomotor apparatus. Respondents were divided into three groups according to value of body mass index (Vranesić and Alebić, 2005): the first group consisted of 20 respondents who had the value of body mass index

je ustanovljeno da su bili zdravi i bez povreda lokomotornog aparata. Ispitanici su bili podijeljeni u tri grupe, prema vrijednosti indeksa tjelesne mase (Vranesić i Alebić, 2005): prvu grupu je činilo 20 ispitanika koji su imali vrijednost indeksa tjelesne mase ispod 18,5 (pothranjenost), drugu grupu je činilo 19 ispitanika koji su imali vrijednosti indeksa tjelesne mase između 18,5 i 25 (adekvatna tjelesna masa) i treću grupu je činilo 16 ispitanika čija je vrijednost indeksa tjelesne mase bila između 25 i 30 (prekomjerna tjelesna masa). Funkcionalna sposobnost kardiovaskularnog sistema posmatrana je preko varijabli: sistolni i dijastolni pritisak prije i poslije opterećenja i srčana frekvencija prije i poslije opterećenja. Istraživanje je provedeno u Dijagnostičkom institutu Fakulteta fizičkog vaspitanja i sporta Univerziteta u Banjoj Luci, u jutarnjim časovima. Vrijednost srčanog pritiska je mjerena na sljedeći način. Ispitanik je bio u sportskoj opremi, prostorija je imala temperaturu od 20 stepeni. Krvni pritisak je mјeren pomoću OMRON M3 tlakomjer za nadlakticu prema važećem protokolu. Ispitanik je zauzimao sjedeći položaj i pri tome je bio potpuno opušten. Srčana frekvencija je mjerena monitorom srčane frekvencije Polar 620i. Vrijednosti srčanog pritiska i frekvencije srca su utvrđivane prije i poslije opterećenja, odnosno prije i poslije izvođenja Astrandovog testa na bicikl ergometru. Astrandov test se koristi za procjenu VO_{2max}. U ovom radu Astrandov test je bio „sredstvo“ kojim se izazvalo opterećenje i dovelo do promjena u vrijednostima frekvencije srca i krvnog pritiska. Te promjene odnose se na funkcionalnost kardiovaskularnog sistema i eventualno postojanje narušene tjelesne sposobnosti. Za ostvarenje ovog testa korištena je sljedeća aparatura: stacionirani bicikl ergometar i štopericica. Test se izvodio po utvrđenom protokolu (Sudarov i sar., 2007). Za dobijanje valjanih podataka i izvođenje zaključaka korištena je deskriptivna statistika, komparativna statistika (ANOVA-razlika varijanse) i post hoc Bonferoni analiza. U obradi je korišten statistički program SPSS (verzija 17.0).

REZULTATI

U Tabeli 1. dati su deskriptivni statistički pokazatelji centralne tendencije i varijabilnosti izmјerenih vrijednosti za posmatrane funkcionalne sposobnosti kardiovaskularnog sistema ispitanika po grupama prije opterećenja.

below 18.5 (underweight), the second group consisted of 19 respondents who had values body mass index between 18.5 and 25 (adequate body weight) and the third group consisted of 16 respondents with a value of body mass index was between 25 and 30 (overweight). The functional capacity of cardiovascular system is observed through the variables: systolic and diastolic blood pressure before and after load and heart rate before and after load. The survey was conducted in the Diagnostic Institute on Faculty of Physical Education and Sport, University of Banja Luka, in the morning. Cardiac pressure value is measured in following manner. Respondent was in sports equipment, room had a temperature of 20 degrees. Blood pressure is measured with OMRON M3 pressure arm according to the current protocol. Respondent occupied a sitting position and at the same time he was completely limp. Heart rate is measured by a heart rate monitor Polar 620i. The values of cardiac pressure and heart rate were measured before and after the load, or before and after performing Astrand test on a cycle ergometer. Astrand test is used to estimate VO_{2max}. In this paper Astrand test was a “tool” that caused the load and led to changes in the values of heart rate and blood pressure. These changes were related to functionality of cardiovascular system and possible existence of impaired physical abilities. To accomplish this test the following apparatus: stationary bike and treadmill stopwatch. The test is performed according to the established protocol (Sudarov et al., 2007). In order to obtain valid data and draw conclusions was used descriptive statistics, comparative statistics (ANOVA difference variance) and post hoc Bonferroni analysis. In the analysis used statistical program SPSS (version 17.0).

RESULTS

In Table 1 are shown descriptive statistical indicators of central tendency and variability of measured values for observed functional capacity of cardiovascular system participants in group before load.

tjelesne mase) i 3 (prekomjerne tjelesne mase). Vrijednost signifikantnosti za pomenutu vartijablu iznosi 0.02, što predstavlja statistički značajnu razliku na nivou 0.05.

Tabela 5. Analiza razlika između rezultata funkcionalnih sposobnosti poslije opterećenja kod ispitanika grupa 1, 2. i 3. (pot-hranjeni. adekvatne tjelesne mase. prekomjerne tjelesne mase)

	Suma kvadrata / Sum of Squares	Df	Aritmetička sredina kvadrata / Mean Square	F	Značajnost / Sig.
krvni pritisak sistolni poslije opterećenja / systolic blood pressure after the load	Između grupe / Between Groups	473.57	236.78	1.77	0.18
	Unutar grupe / Within Groups	6944.13	133.54		
	Total / Total	7417.70	54		
krvni pritisak dijastolni poslije opterećenja / diastolic blood pressure after the load	Između grupe / Between Groups	213.38	106.69	0.61	0.54
	Unutar grupe / Within Groups	9010.72	173.28		
	Total / Total	9224.10	54		
srčana frekvencija poslije opterećenja / heart rate after load	Između grupe / Between Groups	914.09	457.04	1.00	0.37
	Unutar grupe / Within Groups	23546.63	452.82		
	Total / Total	24460.72	54		

U Tabeli 5. su pomoću analize varijanse (ANOVA) prikazani rezultati analize razlika između korištenih varijabli, između sve tri grupe ispitanika poslije opterećenja. Ova parametrijska statistička procedura je korištena iz razloga što je vrijednost KS testa (Tabela 2.) za sve varijable koje su procjenjivale funkcionalne sposobnosti kardiovaskularnog sistema poslije opterećenja pokazala normalnost rasporeda. Validna statistička procedura je korištena na nivou 0.05 i pokazala je da između grupa ispitanika na svim analiziranim varijablama ne postoji statistički značajna razlika. Dobijena signifikantnost za sve varijable iznosi 0.18, 0.54 i 0.37 što ukazuje da nije bilo statistički značajne razlike na nivou 0.05.

DISKUSIJA

Iz dobijenih prosječnih vrijednosti varijabli na osnovu kojih se analizirao nivo funkcionalnih sposobnosti kardiovaskularnog sistema, uočavaju se najveće vrijednosti sistolnog i dijastolnog krvnog pritiska i srčane frekvencije prije određenog opterećenja kod ispitanika treće grupe (ispitanici sa prekomjernom tjelesnom masom). Međutim, iako su se kod ispitanika iz treće grupe pokazale najviše vrijednosti sistolnog i dijastolnog krvnog pritiska i srčane frekvencije prije određenog opterećenja u odnosu na druge dvije grupe, nije utvrđena statistički značajna razlika između grupa na rezultatima sistolnog i dijastolnog krvnog pritiska prije opterećenja. Međutim, kao što je prikazano u Tabeli 3. ustavljena je statistički značajna razlika između grupa samo kod rezultata testa srčana frekvencija prije opterećenja, što

dents (adequate body weight) and 3 (overweight). Value of significance for said variable is 0.02, which represents a statistically significant difference at the 0.05 level.

Tabela 5. Analiza razlika između rezultata funkcionalnih sposobnosti poslije opterećenja kod ispitanika grupa 1, 2. i 3. (pot-hranjeni. adekvatne tjelesne mase. prekomjerne tjelesne mase)

In Table 5 by using analysis of variance (ANOVA) shown results of analysis of differences between variables which are used, among all three groups of respondents after load. This parametric statistical procedure was used because the value of the KS test (Table 2) for all variables that have assessed the functional capacity of cardiovascular system after load showed normality schedule. Valid statistical procedure was used at the 0.05 level and showed that group of respondents in all analyzed variables, no statistically significant differences. Resulting significance for all variables is 0.18, 0.54 and 0.37, which indicates that there were no statistically significant differences at the 0.05 level.

DISCUSSION

The obtained average values of variables on which is analyzed level of functional ability of cardiovascular system, observed the highest values of systolic and diastolic blood pressure and heart frequency energies before the specified loading third group of respondents (respondents with overweight). However, although respondents in third group showed the highest values of systolic and diastolic blood pressure and heart frequency energies before a particular burden in relation to other two groups, there were no significant differences between the groups on results of systolic and diastolic blood pressure before loading. However, as shown in Table 3. there was a significant difference between groups only for test results before burden on heart rate, which is confirmed by a

je i potvrdilo deskriptivnu analizu. Iz ovih rezultata se može pretpostaviti da je prekomjerna tjelesna masa, odnosno povećan indeks tjelesne mase, faktor koji se negativno odražava na krvni pritisak i srčanu frekvenciju. Ovi ispitanici su imali vrijednost sistolnog krvnog pritiska iznad prosječne vrijednosti sistolnog krvnog pritiska djece koja su pubertetskog uzrasta. Takođe se pokazalo da imaju i veću vrijednost srčane frekvencije koja je iznad prosjeka za djecu ovog uzrasta. Dobijeni rezultati ovog istraživanja su potvrdili neka ranija istraživanja o uticaju povećane tjelesne mase na zdravlje (Westcott, 2006; Pucarin-Cvetković i sar., 2006). Najveće vrijednosti sistolnog i dijastolnog krvnog pritiska i srčane frekvencije poslije opterećenja, utvrđene su kod ispitanika treće grupe (ispitanici sa prekomjernom tjelesnom masom). Međutim, iako su se kod ispitanika iz treće grupe pokazale najviše vrijednosti sistolnog i dijastolnog krvnog pritiska i srčane frekvencije poslije određenog opterećenja u odnosu na druge dvije grupe, nije utvrđena statistički značajna razlika između grupa na rezultatima svih testova, kao što je prikazano u Tabeli 5. Iz ovih rezultata se može pretpostaviti da je prekomjerna tjelesna težina, odnosno povećan indeks tjelesne mase, faktor koji se negativno odrazio na krvni pritisak i srčanu frekvenciju poslije opterećenja. Najveće vrijednosti sistolnog i dijastolnog krvnog pritiska i srčane frekvencije prije i poslije opterećenja utvrđene su kod ispitanika sa povećanim indeksom tjelesne mase. Iako su se kod tih ispitanika pokazale najviše vrijednosti sistolnog i dijastolnog krvnog pritiska i srčane frekvencije u odnosu na druge dvije grupe, nije utvrđena statistički značajna razlika između grupa na rezultatima sistolnog i dijastolnog krvnog pritiska prije opterećenja. Međutim, ustanovljena je statistički značajna razlika između grupa samo kod rezultata testa srčana frekvencija prije opterećenja. Malina i Katzmarzyk (1999) smatraju da u svrhu očuvanja zdravlja indeks tjelesne mase treba održavati u granicama između 21 i 23. Postoji mogućnost da su dobijeni podaci usko povezani sa ekonomsko-socijalnim faktorima i materijalnim uslovima u kojima žive ispitanici, te da nemaju adekvatnu ishranu i uslove života. Takođe, neadekvatno upražnjavanje sportskih aktivnosti moglo je da bude jedan od faktora koji je doprinio ovakvim rezultatima. Warner (2005) je došao do zaključka da su pretile osobe dvostruko sklonije povredama od osoba koje su normalne tjelesne težine. Također, postoji pretpostavka koja pokazuje da su pretila djeca sklonija frakturama kostiju, jer nisu u mogućnosti vježbati kako bi ojačala koštani i mišićni sistem. Isto istraživanje pokazuje da je kod odraslih osoba koje su prekomjerne težine učestalija pojava artritisa (Završnik, 2004). Da bi se lakše prevazišla kriza koju izaziva promjena životnog stila, načina ishrane i povećanog obima različitih fizičkih aktivnosti treba iskoristiti

descriptive analysis. From these results it can be assumed that overweight and increased body mass index are factor that has a negative effect on blood pressure and heart frequency. These respondents had a value of systolic blood pressure above the average systolic blood pressure of children who are in puberty. It was also shown to have a higher value in heart rate above the national average for children in this age. The results of this study confirmed the previous research on impact of increased body weight on health (Westcott, 2006; Pucarin-Cvetković et al., 2006). The highest values of systolic and diastolic blood pressure and heart frequency energies after load have been determined in third group of respondents (respondents with overweight). However, although in participants in third group showed the highest values of systolic and diastolic blood pressure and heart rate after a certain load in relation to the other two groups, there were no significant differences between the groups on results of all tests, as shown in Table 5. From these results it can be assumed that being overweight or increased body mass index, a factor that has a negative impact on blood pressure and heart frequency after load. The highest values of systolic and diastolic blood pressure and heart frequency energies before and after load were determined in respondents with increased body mass index. Although in these respondents showed the highest values of systolic and diastolic blood pressure and heart frequency energies in relation to other two groups, there were no significant differences between groups on results of systolic and diastolic blood pressure before load. However, statistically significant difference between groups only for test results before heart rate burden. Malina and Katzmarzyk (1999) argue that in order to preserve health body mass index should be maintained within the limits between 21 and 23. There is a possibility that data is closely linked to economic and social factors and material conditions in which lives respondents, and that they have adequate nutrition and living conditions. Also, inadequate exercise sports activities could have been one of the factors that contributed to these results. Warner (2005) came to the conclusion that obese people are twice more prone to injuries than people who have normal body weight. Also, there is a presumption that shows that obese children are more prone to bone fractures because they are not able to practice in order to strengthen bone and muscular system. The same research shows that among adults who are overweight prevalence has arthritis (Završnik, 2004). To make it easier to overcome the crisis caused by change of lifestyle, diet and increased volume of different physical activity should take advantage of

ti potrebu pozicioniranja u grupi kao dodatnu motivaciju za istraživanje u programu. Programom društvenih aktivnosti i različitim sadržajima ciljano se investira u homogenizaciju grupe, formiranje zajedničkog cilja i građenje dobrih komunikacija unutar grupe. Očekuje se formiranje ambijenta usmerene dobrovoljnosti u kojima će se kroz radionice, igre i aktivnosti na otvorenom i u zatvorenom prostoru podsticati njihova kreativnost i otvoriti prostor za lični doprinos i pozicioniranje unutar grupe. Vrlo je bitno na osnovu toga promijeniti životne navike, prehranu, te se podvrgnuti sistematskom bavljenju fizičkom aktivnošću kao najboljim lijekom. Redovna fizička aktivnost sprečava naglo povećanje tjelesne mase i nastanak bolesti koje su vezane sa gojaznošću. U kombinaciji dijetalnog programa ishrane i fizičke aktivnosti može se značajno uticati na redukciju tjelesne mase i promjenu metabolizma, odnosno, mehanizam deponovanja masti u organizmu (Mitić, 2011).

ZAKLJUČAK

Ovim istraživanjem su se potvrdila i brojna ranija istraživanja, kojima se navodi da povećan indeks tjelesne mase dovodi do štetnog uticaja na kardiovaskularni sistem. Mnogi autori, između ostalih (Pucarin-Cvetković i sar., 2006. i Mitić, 2011) rješenje ovog problema nalaze u redovnoj fizičkoj aktivnosti i korekciji ishrane. Analizom rezultata validnim statističkim procedurama koje su ispitivale nivo funkcionalnih sposobnosti kardiovaskularnog sistema kod sve tri grupe ispitanika prije i poslije opterećenja, došlo se do određenih zaključaka. Analizom deskriptivne statističke primjećeno je da su se kod ispitanika koji su imali veći indeks tjelesne mase, odnosno pripadali grupi sa prekomernom tjelesnom masom, pokazale veće vrijednosti sistolnog i dijastolnog krvnog pritiska prije i poslije opterećenja, kao i veće vrijednosti srčane frekvencije prije i poslije opterećenja. U ovom radu su se potvrdila i brojna ranija istraživanja, koja su ostvarila slične rezultate povećanog indeksa tjelesne mase na zdravlje uopšte. Terapijski program kod gojazne djece i adolescenata koji podrazumijeva povećani obim fizičkih i mentalnih aktivnosti, kao i režim smanjenog kalorijskog unosa hrane moglo bi biti rješenje za poboljšanje morfoloških karakteristika, smanjenje masnog tkiva i poboljšanje funkcionalnih sposobnosti kardiovaskularnog sistema što bi sve vodilo ka poboljšanju tjelesne sposobnosti za rad i sportske aktivnosti adolescenata.

need of positioning the group as an additional motivation for persistence in program. The program of social activities and a variety of amenities aimed to invest in homogenization of group, forming a common goal of building good communication within the group. It is expected the formation of environment aimed voluntariness in which through workshops, games and outdoor activities and indoor encourage their creativity and space for personal contribution and positioning within the group. It is vital on the basis of lifestyle changes, diet, and be subjected to systematic physical activity as the best medicine. Regular physical activity prevents a sudden increase in weight and development of disease that are associated with obesity. Combination of diet programs diets and physical activity can significantly affect on reduction of body weight and metabolic changes, and on mechanism of deposit of fat in body (Mitić, 2011).

CONCLUSION

This survey is confirmed by numerous previous studies that suggested an increased body mass index leads to harmful effects on cardiovascular system. Many authors, among others (Pucarin-Cvetković et al., 2006 and Mitić, 2011), solution of this problem find in regular physical activity and dietary changes. Analysis of results by valid statistical procedures that have examined level of functional capacity of cardiovascular system in all three groups of respondents before and after load, there are some conclusions. The analysis of descriptive statistics it was noted that the in respondents who had a higher body mass index, or belonged to group with overweight, showed higher values of systolic and diastolic blood pressure before and after load, as well as higher values of cardiac frequency energies before and after load. This work is confirmed by numerous previous studies that have achieved similar results of increased body mass index on health in general. The therapeutic program in obese children and adolescents, implies increased volume of physical and mental activities, as well as the regime of reduced caloric intake of food could be a solution to improve the morphological characteristics, reduce body fat and improve functional capacity of cardiovascular system, which would all lead to improvement of physical abilities for work and sports activities of adolescents.

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USPOREDBA ANTROPOLOŠKIH ODREDNICA PLIVANJA I SINKRONIZIRANOG PLIVANJA KOD MLADIH SPORTAŠICA

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Apstrakt: Plivanje i sinkronizirano plivanje su dva slična sporta, no sa bitnim razlikama u posebnim strukturama pokreta u sinkroniziranom plivanju. Ovaj članak pokušava dati pregled sličnosti i razlika među mlađim sportašicama uključenima u ove sportove, prvenstveno u morfološkim obilježjima plivačica, a u širem kontekstu njihovih funkcionalnih kapaciteta i motoričkih karakteristika. Distinkтивna obilježja sinkroniziranog plivanja u odnosu na klasično plivanje proizlaze dominirano zbog veće složenosti tehnike pokreta u tom sportu.

Ključne riječi: plivanje, sinkronizirano plivanje, antropološke karakteristike, usporedba.

Uvod

Tema ovog članka je stjecanje uvida u distinkтивne karakteristike sinkroniziranog plivanja u odnosu na klasično plivanje, prvenstveno u morfološkim obilježjima plivačica, a u širem kontekstu funkcionalnih kapaciteta i motoričkih karakteristika.

Kako bi poboljšale vlastite fizičke i mentalne potencijale, djevojke koje su sportski aktivne (ili kao amateri ili vrhunski sportaši) moraju koristiti i znanstvene spoznaje za razvoj i održanje svoje snage, fleksibilnosti, koordinacije i izdržljivosti (Wells, Fasting i Dahm, 2013). Biološka dob je jedan od velikih čimbenika utjecaja na plivačice u ranoj adolescentnoj dobi (Antulov, Ćavar i Zenić, 2007), te stoga u tom periodu dolazi čak i do odustajanja od sporta. Plivanje je vrsta sporta kojim se možemo baviti cijeli život, jedan je od osnovnih sportova, važan u održavanju zdravlja u djece i adolescenata (Ortega, Ruiz, Castillo i Sjöström, 2008; Gisladottir, Haga i Sigmundsson, 2013) te utječe na pravilan fizički i mentalni razvoj djeteta (Sindik, 2009; Badrić et al., 2014).

A COMPARISON OF THE ANTROPOLOGICAL DETERMINANTS FOR SWIMMING AND SYNCHRONIZED SWIMMING IN YOUNG FEMALE ATHLETES

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Abstract: Swimming and synchronized swimming are two similar sports, but with main differences in specific structures of the movements in the synchronized swimming. This article attempts to provide an overview of the similarities and differences among young female athletes involved in these sports, primarily in the morphological characteristics of swimmers, as well as in the broader context of their functional capacity and motor characteristics. The distinctive features of the synchronized swimming in comparison with the traditional swimming are arising mainly due to the higher complexity of the technique of the movements in this sport.

Key words: swimming, synchronized swimming, morphological characteristics, comparison.

INTRODUCTION

The topic of this article is to gain insight into the distinctive features of synchronized swimming, in comparison with the traditional swimming, primarily in the morphological characteristics of swimmers, in the wider context of functional capacities and motor characteristics.

In order to enhance their physical and mental potential, girls who are exercising (either as amateur or top athletes) should use the scientific knowledge, to develop and maintain their strength, flexibility, coordination and endurance (Wells, Fasting & Dahm, 2013). Biological age is one of the main motor suppressing impact on the swimmers in general in early adolescent age (Antulov, Ćavar & Zenić, 2007). Swimming is a life-long sport, one of the basic sports, an important marker of health in children and adolescents (Ortega, Ruiz, Castillo & Sjöström, 2008; Gisladottir, Haga & Sigmundsson, 2013), and affects the proper physical and mental development of the child (Sindik, 2009; Badrić et al., 2014). Synchronized swimming is a combination of swim-

Sinkronizirano plivanje je kombinacija plivanja, sportske i ritmičke gimnastike, baleta i plesa u vodi (Skender, Grčić-Zubčević i Gričar, 2009).

Motoričke karakteristike i funkcionalni kapaciteti kod plivačica i sinkroniziranih plivačica

Kako na motoričke sposobnosti utječe jednako fiziološki i anatomska čimbenici, pretpostavka je da su u oba sporta slične motoričke sposobnosti podjednako važne. Oba sporta zahtijevaju određenu fleksibilnost, koja se razvija do aproksimativno dvanaeste godine života djeteta (Sekulić i Metikoš, 2007). Plivanje je jedan od cikličkih sportova, u kojem dominiraju relativno jednostavni pokreti, koji su stalno jednak i naizmjenično se ponavljaju tijekom plivanja određenom tehnikom (Bartlet, 2007). Pri analizi izvedbe sinkroniziranog plivanja, može se pretpostaviti da su kretanja u ovom sportu kombinacija visoko složenih motoričkih obrazaca (Perić, Petrić i Žižić, 2007). Stoga je važno odrediti motoričke sposobnosti i vještine važne za uspjeh u sinkroniziranom plivanju. Sinkronizirano plivanje je sport koji se sastoji od estetski dizajniranih pokreta plivanja, položaja i figura, koji se spajaju u obvezne i slobodne sastave, koje plivačice plivaju u skladu jedna s drugom i sa glazbom.

Među funkcionalnim kapacitetima za plivačice oba sporta je najvažniji prijenos kisika ovisan najviše o stanju plućnog sustava (Volščanšek, 2002). I najbolji sportaši brzo gube svoje teško stečene funkcionalne sposobnosti, koje, međutim, mogu održavati uz znatno manje truda nego što je potrebno prilikom postizanja istih (Petković, Petković i Grčić-Zubčević, 2003).

Morfološke karakteristike plivačica i sinkroniziranih plivačica

Među morfološkim karakteristikama, visina i težina tijela u velikoj mjeri utječe na uspjeh sportašica u oba sporta, dajući jasne kriterije za izbor sportaša u cjelini (Claessens Lefevre, Beunen i Malina, 1999). U sinkroniziranom plivanju, problem kod tih kriterija javlja se u akrobacijama tijekom rutina i tjelesnom potrebom za boljom plovnosti u vodi, koja zapravo ne dopušta visoku mišićavost ili vrlo niske razine tjelesne masnoće (Lundy, 2011). Poželjna visina je slična populacijskim normama prosječnih stanovnika, ali indeks tjelesne težine i tjelesne mase (BMI) mora biti prilično nizak (Bante Bogdanis, Chairopoulou i Maridaki, 2007). Stoga, preporučene mjere poželjne visine i sastava tijela u plivanju i sinkroniziranom plivanju bi trebale biti prosječna visina i niska tjelesna težina u odnosu na visinu.

Čini se da su duži udovi također jedna poželjna osobina za sinkronizirane plivačice, jer tako mogu

ming, sports and rhythmic gymnastics, ballet and dance in the water (Skender, Grčić-Zubčević & Gričar, 2009).

Motor characteristics and functional capacities of the swimmers and synchronized swimmers

When analyzing the performance of synchronized swimming, it can be presumed that the movements in this sport are the combination of highly complex motor patterns (Perić, Petrić & Žižić, 2007). Therefore, it is important to determine motor skills and knowledge important for successful engagement in synchronized swimming. As the motor skills are affected equally by physiological and anatomical factors, the assumption is that in both types of swimming and synchronized swimming, similar motor skills are equally important. Both swimming and synchro swimming require certain flexibility that is developing to a maximum of 12-years of age (Sekulić & Metikoš, 2007).

Swimming is one of the cyclic sports, in which dominate relatively simple movements, which are constantly equal and alternately repeated, during swimming specific techniques (Bartlet, 2007). Synchronized swimming is a sport based on 'classic' swimming, which consists of aesthetically designed swimming movements, positions, figures and compulsory and free compositions that swimmers perform in water, in line with each other and with the music.

Among functional capacities important for the swimmers, the transfer of the oxygen should be emphasized. It depends of the features of pulmonary system (Volščanšek, 2002). The swimmers quickly lose their functional capacity, which, however, can be maintained with considerably less work than it is needed to achieve it (Petković, Petković & Grčić-Zubčević, 2003).

Morphological characteristics of the swimmers and synchronized swimmers

Among the morphological characteristics, body height and weight strongly influences on the success of the athletes in these two sports, giving clear criteria for the selection of athletes in general (Claessens Lefevre, Beunen & Malina, 1999). In the synchronized swimming, the problem about these criteria arises in those minor acrobatics and body need for better buoyancy in the water, which does not allow high muscularity or very low levels of body fat (Lundy, 2011). Desirable body height is similar to the population norms of the average population, but the body weight and body mass index (BMI) must be quite low (Bante, Bogdanis, Chairopoulou & Maridaki, 2007). Therefore, recommended measures of desirable height and body composition in swimming and synchronized swimming should be average height with low body weight, in relation to the height.

postići veću visinu van vode zbog jačeg potiska, koji im također omogućava i veću brzinu, kao i plivačicama klasičnog plivanja (Lundy, 2011). Budući da su oba sporta aktivnost koja se odvija u vodi, poželjan sastav tijela je da bude što plovnije, da je u stanju stvoriti veću propulzivnu energiju te da istovremeno stvara što manji frontalni otpor na vodu (Leko, Šiljeg i Mikulić, 2011). Plivanje zahtijeva određenu morfološku strukturu tijela koja će omogućiti sve navedeno sa što manjim indeksom tjelesne težine (BMI), a ipak sa dovoljno snage za izvođenje potrebnih zadatka (Katić i Rogulj, 2005).

Čini se da je u sinkroniziranom plivanju poželjan mršav i atletski izgled, kao i visok stupanj ujednačenosti stasa unutar reprezentacije ili dva (Lundy, 2011) što i nije tako nužno u „klasičnom“ plivanju. Slučaj je zapravo sličan u klasičnom plivanju uz neke male razlike. Jedno istraživanje je pokazalo da su velike dužine kostiju ekstremiteta negativno povezane s uspješnosti u plivanju na 100 metara, u kojoj važnu ulogu imaju snaga plivača i anaerobne komponente (Leko, Šiljeg i Mikulić, 2011). Također se u istom istraživanju ukazala pozitivna veza BMI-a i bodovnih vrijednosti isplivanih rezultata na 100 metara na način koji zahtjeva potrebu za određenom mišićnom masom tijela za postizanje kvalitetnog rezultata.

Bante i sur. (2007) su utvrdili da je grčki nacionalni tim sinkroniziranih plivačica imao tanje noge naspram drugih timova, kao i značajnu korelaciju s rezultatima uspjeha ($r = .84$, $p < .05$), što može značiti da je mišićnost nogu zapravo specifična prilagodba sporta. Hawes i Sovak (1994), su otkrili u svojim longitudinalnim studijama o visokim performansama sinkroniziranih plivačica, kako olimpijske i nacionalne prvakinje imaju relativno uzak promjer kosti u odnosu na druge manje uspješne sportašice na međunarodnoj razini. To bi mogla biti značajka koja pomaže u izvedbi, ili bi to mogao biti dio estetske prednosti. Neovisno o izuzecima, smatramo uvjete navedene u opisu stasa uglavnom kozmetičkim i da ne utječu izravno na bolju ili lošiju izvedbu. U prilog navedenome, Chu (1999) raspravlja o antropometrijskim podacima prikupljenim iz zemalja koje su se natjecale na FINA Svjetskom kupu 1997. godine u Peilingu. Iako postoji sličnost između karakteristika svih plivačica, Ruskinje, kao najuspješnije u osvajanju zlatnih medalja na Olimpijskim i svjetskim prvenstvima, opisane su kao plivačice najpoželjnijeg izgleda i najveće razine ujednačenosti među plivačicama tima ili dva (Chu, 1999). U usporedbi s izmjeranim plivačicama iz drugih zemalja, Ruskinje imaju šira ramena, duže ruke i uže bokove (Chu, 1999). Zapravo se sličan izgled pojavljuje i kod plivačica u klasičnom plivanju. Najvjerojatnije zbog podjednakog

It seems that longer limbs are desirable characteristics for synchronized swimmers, because with these predispositions, thrust is better, creating a higher altitude and higher speed (Lundy, 2011). Since swimming is activity that takes place in water, desirable composition of the body has to be as buoyant as possible, which can create a greater propulsive force, simultaneously with as small as possible frontal resistance (Leko, Šiljeg & Mikulić, 2011). Swimming requires a certain structure of the body that will allow better navigability, and yet enough strength for operating of the required task (Katić & Rogulj, 2005).

It seems desirable that in synchronized swimming, the athletes have lean and athletic appearance, as well as a high level of uniformity in stature within the team or duo (Lundy, 2011) which is not utterly the case in classical swimming. The case is similar to the classic swimming with some minor differences. One study found that swimmers with longer bones have a negative relationship with performance in swimming up to 100 meters, where is of great importance strength and force with anaerobic components, and they play an important role of energy production (Leko, Šiljeg & Mikulić, 2011). The same study also pointed out a positive relation of BMI and scoring value of results swum out in 100 meters in a way that requires the need for a specific muscle mass of the body to achieve quality results.

Bante et al. (2007) found that the Greek national team athletes had slimmer legs of other junior athletes, as well as a significant correlation with the results of success ($r = .84$, $p < .05$), which may indicate that the leg muscularity is actually specific adaptation of the sport. Hawes and Sovak (1990, 1994), have found in their longitudinal studies of high-performance synchronized swimmers, that the Olympic and national champions have a relatively narrow diameter of the bone compared to other less successful female athletes at the international level. Narrow diameter of the bone is a feature that could help in performance for buoyancy, or it could be part of the aesthetic advantages. Regardless of the exceptions, the requirements specified in stature are mostly cosmetic and do not affect directly the performance. In support of the above, Chu (1999) discusses the anthropometric data collected from countries that competed at the FINA World Cup 1997 in Peiling. Although there is similarities between the characteristics of the stature of all swimmers, Russian women, as the most successful in winning gold medals at the Olympic and World Championships, have been described as the most desirable swimmer stature and a high level of uniformity among swimmers of duo or team. Compared to the measured athletes from other countries, Russian athletes have broader shoulders, longer arms and narrow hips (Chu, 1999).

rada i korištenja istih mišićnih skupina na isti način, čisto zbog medija u kojem se nalaze (voda) (Chu, 1999).

Američki tim koji je osvojio osmo mjesto, ima višu razinu varijabilnosti unutar svake kategorije mjerena. Čini se da jednoobraznost fizičkog izgleda i mršavi atletski izgled, postignut razvojem mišića i održavanjem niske razine tjelesnih masnoća, su najkritičniji čimbenici za selekciju u sinkroniziranom plivanju (Lundy, 2011). U klasičnom plivanju se nije moglo pronaći da je izgled presudan faktor u bilo kakvoj selekciji plivačica, što je najvjerojatnije povezano sa činjenicom da je plivanje individualni sport gdje estetika nije primarni cilj, pa nema potrebe za usklađivanje prema izgledu (Chu, 1999).

Estetika je posebno važna prilikom subjektivne procjene plivačice (Chu, 1999), s obzirom da njihovo vrijeme provedeno pod vodom ograničava stvarnu izloženost pogledu u usporedbi s umjetničkim klizanjem ili gimnastikom, gdje su sportaši uvijek vidljivi. Kako se prvih 10 sekundi koreografije (koja se izvodi na glazbu prije skoka u vodu) održava izvan vode, kao i prezentacija samih plivačica tijekom dolaska i namještanja za početak rutine u trajanju do 30 sekundi, mogla bi se istaknuti važnost prvog dojma u sinkroniziranom plivanju. S obzirom da je fizički izgled od velike važnosti u prezentaciji koreografija, bilo bi zanimljivo provesti antropometrijska mjerena svih elitnih, tj. najuspješnijih sinkroniziranih plivačica. Duljina udova i proporcije, promjer kosti, kao i razina mišićavosti tijela i pretilosti upravo tih plivačica, će nam vjerojatno pružiti bolje razumijevanje optimalnih svojstava tijela potrebnih za ovaj specifičan sport (Lundy, 2011).

Plivanje i ronjenje su zapravo baza sinkroniziranog plivanja, jer je preduvjet za postati sinkro-plivačica potrebno je biti dobra plivačica. Dakle, proces treninga, kao i većina optimalnih morfoloških karakteristika u klasičnom i sinkroniziranom plivanju, su zapravo isti. Naime, tijekom nastupa u određenim medijima (voda), mjerena su zapravo vrlo slična u oba sporta, jer je utjecaj tijela na sportsku izvedbu zapravo vrlo sličan.

ZAKLJUČAK

Moglo bi se zaključiti da se plivanje i sinkronizirano plivanje razlikuju samo u (nekim) potrebnim obrascima pokreta, koji su složeniji u sinkroniziranom plivanju. Međutim, oba sporta posjeduju slične predispozicije koje se očituju u podjednakim važnim motoričkim sposobnostima, funkcionalnim sposobnostima i morfološkim obilježjima. Među morfološkim obilježjima, u sinkroniziranom plivanju naglašena je važnost harmoničnih tjelesnih proporcija i fizičkog izgleda.

The American team won the eighth place and found to have a higher level of variability within each category of measurement. It seems that the uniformity of physical appearance and lean athletic look, achieved by the development of muscles and maintaining low body fat, are the most critical factors for selection in this sport (Lundy, 2011). In classical swimming, we could not find that appearance is a critical factor in any selection for swimmers, which is most likely related to the fact that this is an individual sport where the aesthetics is not primary goal, so there is no need for the harmonization in their appearance (Chu, 1999). Actually, a similar appearance occurs with swimmers of classical swimming as well. Most likely due to the similar operations and use of the same muscle groups in the same way, because of the media where they are (water) (Chu, 1999).

The aesthetics is particularly important within a subjective evaluation of the sport (Chu, 1999), given that their time under water is limiting the actual exposure of participants compared with the figure skating or gymnastics, where athletes are always visible. Since first 10 seconds of the choreography (deck movement) is held out of water and presentation of swimmers during the arrival of the 30 seconds (walk on), can be evidence of the importance of the first impression in that sport. It seems that the physical appearance is of great importance in the presentation of routine, and it would be crucial to make research on all the elite or the best synchro swimmers. The length of the limbs and proportions, the diameter of the bone, as well as the level of muscularity and obesity of high performers will help us provide a better understanding of the optimal characteristics of the body required for the sport (Lundy, 2011).

Swimming and diving are actually the base of the synchronized swimming, because any synchro swimmer is required to be a good swimmer to become a synchronized swimmer. Thus, the process of training, as well as the most of the optimal morphological characteristics in the classic and 'synchro' swimming are actually the same. Namely, during the performance in the specific media (water), the measurements are actually very similar in both sports, because the influence of the body on the performance is actually very similar.

CONCLUSION

It could be concluded that the swimming and synchronized swimming are different sports only in (some) required patterns of movements. However, both sports have the similar predispositions in important motor abilities, functional capacities and morphology. Among the morphological features, in synchronized swimming are emphasized the importance of harmonious body proportions and physical appearance.

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UTICAJ RADNOG OPTEREĆENJA NA RAZVOJ SINDROMA KARPALNOG TUNELA

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Apstrakt: Sindrom karpalnog tunela (CTS) predstavlja najčešću kompresivnu neuropatiju koja zahvata od 3 do 6% osoba u generalnoj populaciji. Predstavlja jedan od najznačajnijih zdravstvenih i finansijskih problema u radnoj populaciji. Našim istraživanjem obuhvaćeno je 98 ispitanika (77 žena ili 78,6% i 21 muškarac 21 ili 21,4%). Ispitanici su bili starosti $52 \pm 11,1$ godina. Ispitanici su bili zaposleni u privrednim sektorima na poslovima visokog rizika za nastanak CTS: poljoprivreda i stočarstvo, uslužne djelatnosti, građevinarstvo, prehrambena proizvodnja i javna uprava. Ispitanicima je urađen detaljan fizikalni pregled i EMNG radi postavljanja dijagnoze i stepena neurogenog oštećenja. Utvrđeno je da su prisutna hipotrofija i slabost (MMT) mišića tenara, kao i pozitivan Phalenov znak pokazali statistički visoko značajnu razliku u odnosu na stepen neurogene lezije.

Ključne riječi: sindrom karpalnog kanala, radno opterećenje, fizikalni pregled, EMNG.

Uvod

Kompresivne neuropatije po definiciji predstavljaju stanje disproporcije između zapremine perifernog nerva i prostora kroz koji nerv u ekstremitetu prolazi. Karpalni tunel sindrom (CTS) predstavlja grupu simptoma i znakova uzrokovanih iritacijom i kompresijom nerva medijanusa u predjelu karpalnog tunela. Predstavlja najučestaliju kompresivnu fokalnu neuropatiju u kliničkoj praksi sa prevalencom od 1,3-16% (Aroori i Spence, 2008; Atroshi, Englund, Turkiewicz, Tägil i Petersson, 2011). Žene češće obolijevaju od muškaraca (3:1), a najveća učestalost pojavljivanja CTS je kod radno sposobnog stanovništva između 45.i 60.godine života (Aroori i Spence, 2008).

Prvi put je 1947. godine ustanovljena povezanost CTS sa specifičnim poslovima koji zahtijevaju pojačanu

WORKLOAD IMPACT ON CARPAL TUNNEL SYNDROME GROWTH

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Abstract: Carpal tunnel syndrome (CTS) is the most common compression neuropathy that affects 3 to 6% of people in the general population. It represents one of the most significant health and financial problems in the working population. Our study included 98 patients. The women were 77 (78.6%) and men 21 (21.4%). Age has averaged 52 ± 11.1 years. The respondents were employed in sectors of the economy in jobs at high risk for the occurrence of CTS: agriculture and livestock breeding, services, construction, food production and public administration. The respondents were subject of a detailed physical examination and electromyoneurographic tests (EMG) to confirm the diagnosis and level of neurogenic damage. It was found that the hypotrophy and weakness of thenar muscle and a positive Phalen's sign showed statistically highly significant difference in relation to the level of neurogenic lesions.

Keywords: Carpal tunnel syndrome, workload, physical examination, EMG.

INTRODUCTION

The compressive neuropathies, by definition, represent the state of disproportion between the volume of the peripheral nerve and the space through which a nerve in extremities passes. Carpal tunnel syndrome (CTS) is a group of signs and symptoms caused by irritation of the nerve and compressing medianum in the area of the carpal tunnel.

The most common compressive focal neuropathy in clinical practice has a prevalence of 1.3 to 16% (Aroori & Spence, 2008; Atroshi, Englund, Turkiewicz, Tägil, & Petersson, 2011). Women suffer more often than men (3:1), and the highest incidence of CTS is the working-age population between 45 and 60 years of age (Aroori & Spence, 2008).

upotrebu zgloba šake (Brian, Wright i Wilkinson, 1947). Incidencu CTS je povećana kod osoba sa nervnom disfunkcijom (hereditarne neuropatije), pridruženim obolegenjima (dijabetes, hipotiroidizam, sistemska bolest vezivnog tkiva, gojaznost, bubrežna oboljenja), u trudnoći, kod dugotrajnog uzimanja hormonskih kontraceptiva, kod mehaničkog nadražaja (loše srasle frakture u predelu ručnog zgloba, gangliomi)-(Armstrong, Dale, Franzblau i Evanoff, 2008).

Biološki faktori, kao što su genetska predispozicija i antropometrijski parametri su značajnije povezani sa nastankom CTS u odnosu na faktore radne sredine i okruženja.

U većini slučajeva se ne može identifikovati neki ključni etiopatogenetski uzročnik, pa se govori o idiopatskom sindromu, odnosno o stanju koje je posljedica sindroma prepričanja (Crnković, Bilić i Kolundžić, 2008).

Određene profesionalne aktivnosti nose povećan rizik od CTS. Studija Yves Roouelaurs et al., iz 2008 (prema Jagga, Lehri i Verma, 2011) daje visoko kvalitetne informacije o radu udruženja CTS. Uočena je visoka prevalenca u proizvodnji (42-93% za oba pola), gradevinarstvu (66% muškaraca), uslužnim djelatnostima (66% za žene) i u trgovini i ekonomskom sektoru (49% za žene).

Brza i pouzdana dijagnoza postavlja se na osnovu karakterističnih anamnestičkih podataka, kliničkog pregleda i elektrodijagnostičkog ispitivanja, a kao dopunske analize mogu poslužiti rentgen, ultrazvuk, nuklearna magnetna rezonanca (Keith i sar., 2014).

Pacijenti se žale na bolove sa osećajem žarenja i trjenja, u inervacionom području medijalnog nerva, koji dominiraju tokom noći. Manje uobičajeni simptomi su osjećaj nespretnosti i slabost koji upućuju na pogoršanje kliničke slike. Tegobe se često javljaju obostrano, a nešto češće ili izraženije su na dominantnoj ruci (Keith i sar., 2014).

Od kliničkih testova za postavljanje dijagnoze koriste se: Tinelov znak, Falenov test, dijagram šake po Katzu i drugi (Katz i Simmons, 2002). Pregledom (inspekcijom) utvrđujemo prisutnu hipotrofiju mišića tenara, amanuelnim mišićnim testom se procjenjuje slabost mišića tenara inervisanih medijalnim nervom (Ibrahim, Khan, Goddard i Smitham, 2012). Elektromioneuroografsko ispitivanje (EMNG) kao dijagnostička metoda izbora, koristi se pri postavljanju dijagnoze ovog senzomotornog ispada (Robinson, 2007). Za dijagnostiku je od izuzetnog značaja prepoznavanje kliničke slike koja je vrlo šarolika i prije svega ovisi o trajanju i jačini pritiska na nerv. Smetnje senzibiliteta su prvi i najstalniji simptom i po-

It was first determined in 1947 that the CTS is connected with specific jobs that require increased use of wrist (Brian, Wright & Wilkinson, 1947). The incidence of CTS is increased in people with nerve dysfunction (hereditary neuropathy), comorbid diseases (diabetes, hypothyroidism, systemic connective tissue disorder, obesity, renal disease), during pregnancy, with long-term use of hormonal contraceptives, the mechanical irritation (poorly coalesced fractures in the wrist, ganglii) (Armstrong, Dale, Franzblau & Evanoff, 2008).

The biological factors, such as genetic predisposition and anthropometric parameters were significantly associated with the development of CTS in relation to the factors of the environment and the environment. In most cases you cannot identify any key etiopathogenic cause, and there is a possibility that it is about idiopathic syndrome or a condition that is the result of overuse injuries (Crnković, Bilić & Kolundžić, 2008).

Certain professional activities carry an increased risk of CTS. Study Yves Roouelaurs et al. from 2008 (see Jagga, Lehri & Verma, 2011) provides a high-quality information on the activities of the association CTS. There was a high prevalence in production (42-93% for both sexes), construction (66% of men), services (66% for women) and in the trade and economic sector (49% for women). Fast and reliable diagnosis set-up on the basis of characteristic anamnesis, clinical examination and electrical diagnostic tests, as additional analysis may be used X-ray, ultrasound, magnetic resonance imaging (Keith et al, 2014).

The patients complain of pain with a burning sensation and numbness in innervation territory of the median nerve, which dominates during the night. Less common symptoms include a feeling of clumsiness and weakness pointing to worsening of the clinical picture. The problems often occur on both sides or are more pronounced on the dominant hand (Keith et al, 2014). For the purpose of diagnosis from the clinical tests we used: Tinel's sign, Falen's test, hand diagram by Katz et al (Katz et al, 2002). A review (inspection) determined the present weakness of thenar muscle, and a manual muscle test assesses weakness of thenar muscles innervated by median nerve (Ibrahim et al, 2012). Electromyoneurographic testing (EMG) as a diagnostic method of choice is used in the diagnosis of sensorimotor failure (Robinson, 2007).

For diagnosis it is crucial to recognize the clinical picture, which is very diverse and primarily depends on the duration and severity of the pressure on the nerve. Sensitivity disorders are the first and most persistent

javljaju se u 80% oboljelih (Crnković, Bilić i Kolundžić, 2008; Phalen, 1972). Česti simptomi su parestezije i bol koja je izraženija noću. Motoričke smetnje u inervacionom području nerva medijanusa nastaju u bolesnika s dugotrajnom intenzivnom kompresijom nerva, a smetnje motiliteta očituju se kao nespretnost i nesigurnost pokreta te hvatanja prstima i palcem. Hipotrofija radikalne grupe tenarnih mišića pojavljuje se u oko 40% bolesnika sa sindromom karpalnog kanala (Crnković, Bilić i Kolundžić, 2008).

Klinička dijagnostika se bazira na prepoznavanju tri osnovna simptoma: poremećaj senzibiliteta, poremećaj motiliteta i atrofija mišića šake. Odlučujuća je neurofiziološka obrada nerva pomoći koje se može odrediti tačno mjesto kompresije. Često, težina simptoma i znakova CTS nije u korelaciji sa stepenom oštećenja nerva. Na pogoršanje simptoma CTS utiče promjena položaja gornjih ekstremiteta pri određenim aktivnostima. Bilateralni CTS je često prva prezentacija kod 65% pacijenata, a predstavlja loš prognoistički faktor (Ashworth, 2011).

Veoma je bitna pravovremena dijagnoza i liječenje CTS, jer duže trajanje bolesti i dugotrajnija kompresija, osim subjektivnih tegoba, dovode do težeg oštećenja nerva I smanjuju izglede.

Uspješnosti liječenja. To rezultira smanjenjem radne sposobnosti te individualnim i širim društvenim i ekonomskim posljedicama (Fowler, Gaughan i Ilyas, 2011; Ibrahim i sar., 2012)

Cilj našeg rada bio je da se ustanovi uticaj radnog opterećenja na razvoj CTS kao i da se utvrdi postojanje i stepen korelacije kliničkog nalaza i težine neurogene lezije dobijene elektromioneurografskim (EMNG) ispitivanjem pacijenata.

ISPITANICI I METODE

Izvršena je retrospektivna analiza podataka iz elektronskih kartona pacijenata liječenih u periodu od septembra 2013. godine do marta 2015. godine u našem CBR centru. Uzorak je obuhvatio 98 pacijenta koji su u navedenom periodu liječeni pod dijagnozom sindroma karpalnog kanala.

Ispitanici su bili zaposleni u privrednim sektorima na poslovima visokog rizika za razvoj CTS: poljoprivredu i stočarstvo, uslužne djelatnosti, građevinarstvo, prehrambena proizvodnja i javna uprava.

Kriterijumi za uključivanje u studiju:

1. najmanje pet godina rada na određenom radnom mjestu prije dijagnostikovanja CTS,
2. bez prethodne terapije za CTS (fizikalna, operativna, injekcije kortikosteroida),

symptoms and occur in 80% of patients (Crnkovic et al, 2008; Phalen, 1972). The common symptoms as paresthesias and pain are more pronounced at night. The motor disorders in the area of median nerve innervation occur in patients with a prolonged and intense compression of the nerve, and motility disorders are manifested as the awkwardness and uncertainty of movement and capturing with fingers and thumb. The hypotrophy of thenar muscles occurs in approximately 40% of patients with carpal tunnel syndrome (Crnkovic et al, 2008).

The clinical diagnosis is based on identifying three main symptoms: disturbance of sensibility, motility disorder and the muscle atrophy of hands. Crucial method is neurophysiological processing of the nerve which helps to determine the exact location of the compression. Often, the severity of symptoms and signs of CTS are not correlated with the degree of damage of the nerve. The worsening of the symptoms of CTS is affected by the change of the position of the upper extremities in certain activities. The bilateral CTS is often the first presentation of the disease in 65% of patients, and it is a poor prognostic factor (Ashworth, 2011). Very important is timely diagnosis and the treatment of CTS, because the longer duration of the disease and prolonged compression, in addition to subjective problems, will lead to severe nerve damage and reduce the prospects of the treatment success. This result in reduction of working capacity and has individual and wider social and economic consequences (Fowler, Gaughan & Ilyas, 2011; Abraham et al, 2012).

The aim of our study was to determine the effect of the workload on the development of CTS, as well as to determine the existence and the degree of correlation of clinical findings and severity of neurogenic lesions obtained by the electromyoneurography (EMG) examination of patients.

PATIENTS AND METHODS

We analysed electronic records of patients treated between september 2013 and march 2015 in our CBR center. The sample included 98 patients with carpal tunnel syndrome. The respondents were employed in the sectors of the economy in jobs at high risk for developing the CTS: the agriculture and cattle breeding, services, construction, food production and public administration.

Criteria for inclusion in the study:

1. at least five years of work at the specific workplace before the diagnosis of CTS,
2. without therapy for CTS (physical, operational, injections of corticosteroids),

3. urađeno EMNG ispitivanje radi potvrde dijagnoze CTS.

Iz studije su isključeni pacijenti koji su imali operaciju i/ili povredu na gornjim ekstremitetima. U EMNG pregledu su ispitivani denervacioni potencijali i interferentni obrazac. Od dijagnostičkih parametara praćene su: motorna i senzitivna brzina (MB, SB), njihove terminalne letence (MTL, STL), i elektromiografska (EMG) spontana aktivnost. Pod normalnim vrijednostima za ove prametre podrazumijevale su se sljedeće vrijednosti: MTL= 4,2ms, MB \geq 50m/s, SB \geq 50m/s. Stepen neurogenog oštećenja u odnosu na vrijednost senzitivne i motorne TL, odnosno sniženje senzitivne i motorne brzine podijelili smo na :

1. blag CTS: granična vrijednost motorne TL (4,2ms), lako sniženje senzitivne brzine, bez redukcije inervacionog uzorka,
2. umjerjen CTS: vrijednost motorne TL u opsegu od 4,2ms – 5,5ms, sniženje senzitivne brzine, EMG nalaz - prisustvo neuropatskih akcionalih potencijala, blaga do umjerena redukcija inervacionog uzorka,
3. težak CTS: vrijednost motorne TL preko 6ms, znatno sniženje senzitivne brzine do nemjerljivih vrijednosti, EMG nalaz - prisustvo neuropatskih akcionalih potencijala, jaka redukcija inervacionog uzorka.

Podaci su analizirani savremenim metodama deskriptivne i analitičke statistike uz računarsku podršku i softverski paket SPSS 12,0. Pod statističkom značajnošću podrazumijevala se vrijednost $p < 0,05$.

REZULTATI

Analizirano je 98 ispitanika. Žena je bilo 77 (78,6%) a muškaraca 21 (21,4%). Zastupljenost žena bila je statistički značajno veća u odnosu na zastupljenost muškaraca ($p < 0,01$).

Starost ispitanika iznosila je prosječno $52 \pm 11,1$ godina.

U vrijeme ispitivanja, 63% žena i 87% muškaraca oboljelih od CTS je bilo zaposleno, a 81% žena i 97% muškaraca je imalo najmanje 5 godina radnog staža ispitivanim privrednim sektorima prije dijagnostikovanja bolesti.

Procentualna zastupljenost ispitanika u određenim privrednim djelatnostima, prikazana je na *Slici 1*.

3. EMG test conducted to confirm the diagnosis of CTS.

This study excluded patients who had surgery and/or injury of the upper extremities. We conducted the EMG examination to check the denervation potentials and interference pattern. Out of the diagnostic parameters we monitored the motor and sensitive velocity (MB, SB), their terminal latencies (MTL, STL), and electromyographic (EMG) spontaneous activity. Under normal values for these drive parameters implied the following: MTL = 4.2 ms, MB \geq 50 m / s, SB \geq 50 m / s.

The degree of neurogenic damage in relation to the value of the sensitive and motor TL, and reduced sensory and motor speed we divided to:

1. mild CTS limit value motor TL (4.2 ms), light sensitive lowering speed, without reduction of innervated sample,
2. moderate CTS: value chain TL in the range of 4.2 ms - 5.5 ms, lowering speed sensitive, EMG finding - the presence of neuropathic action potentials, mild to moderate reduction of innervated sample,
3. heavy CTS: value chain TL than 6 ms, significantly lowering the speed sensitive to the immeasurable value, EMG finding - the presence of neuropathic action potentials, strong reduction of innervated sample.

Data were analyzed by contemporary methods of descriptive and analytical statistics with the computer support and software package SPSS 12.0. Under the statistical significance implied value of $p < 0.05$.

RESULTS

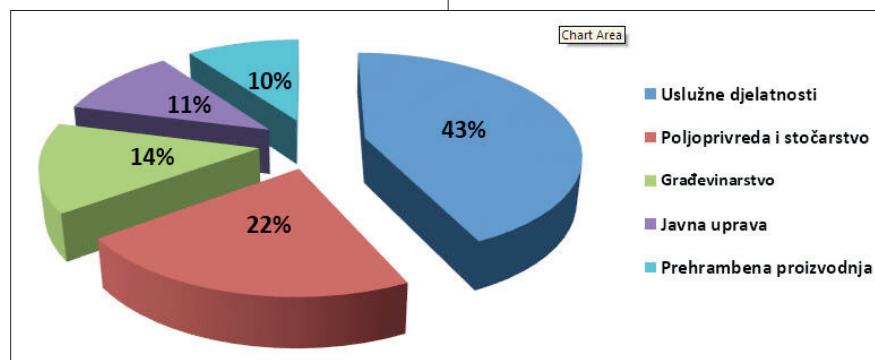
We analyzed 98 patients, 77 (78.6%) women and 21 (21.4%) men. The representation of women was significantly higher than the representation of men ($p < 0.01$).

The average age was 52 ± 11.1 years. For men, the average age was 53.4 ± 14.2 years and for women 55.6 ± 11.3 years.

During the tests, 63% of women and 87% of men suffering from CTS were employed. 81% of women and 97% of men had at least 5 years of experience in the monitored sectors of the economy, prior to diagnosis of the disease.

The percentage of respondents in certain economic activities is shown in *Figure 1*.

Slika 1. Procentualna zastupljenost ispitanika u privrednim djelatnostima



Uočavamo da je najviše ispitanika bilo u uslužnim djelatnostima (43%), a najmanje u prehrambenoj proizvodnji (10%).

U toku EMNG ispitivanja, ustanovljeno je da je najveća zastupljenost CTS bila na desnoj ruci ispitanika (47,3%), nešto manja zastupljenost na obe ruke (43%) i značajno manja zastupljenost na lijevoj ruci (9,7%). Ovaj rezultat ima visok statistički značaj ($X^2 = p < 0,01$)

Analizirajući odnos između kliničkog nalaza i stepena neurogene lezije, dobijen EMNG analizom, utvrđili smo da su svi klinički nalazi pokazali statistički visoko značajnu razliku u odnosu na stepen neurogene lezije (Tabela 1).

Tabela 1. Odnos između kliničkog nalaza i stepena neurogene lezije

Figure 1. Percentage of respondents in economic activities



The most of the respondents were employed in the service sector (43%) and least in the food production (10%). During the EMG test, it was found that the greatest incidence of CTS was on the right hand of the respondents (47.3%), slightly lower representation in both arms (43%) and significantly less representation on the left arm (9.7%). This result has a high statistical significance ($X^2 = p < 0.01$). Analyzing the relationship between clinical findings and the degree of neurogenic lesions, obtained by EMG analysis, we found that all of the clinical results showed a highly statistically significant difference in relation to the level of neurogenic lesion (Table 1).

Table 1. The relationship between the clinical findings and the degree of neurogenic lesions

Stepen neurogene lezije (EMNG) / The degree of neurogenic lesions (EMG)								
		Blaga / Mild		Umjerena / Moderate		Teška / Severe		
		N	%	N	%	N	%	
Phalenov znak / Phalen sign	-	18	90	13	30.95	0	0	
	+	2	10	29	69.05	36	100	
Klinički nalaz / Clinical finding	Hipotrofija / Hypotrophy	Ne	20	100	31	73.8	10	27.77
		Da	0	0	11	26.2	26	72.23
	Slabost (MMT) / Weakness (MMT)	Ne	20	100	25	59.52	8	22.22
		Da	0	0	17	40.48	28	77.78
Ukupno / Total		20		42		36		
						98		

DISKUSIJA

Prosječna starost naših ispitanika, bila je $52 \pm 11,1$ godina što se slaže sa drugim istraživanjima koja su pokazala da je najveća incidenca pojave CTS između 55. i 60. godine života (Ansari, Adelmanesh, Naghdi i Mousavi, 2008).

Bez obzira na etiologiju nastanka, najveća procentualna zastupljenost sindroma karpalnog tunela kod ispitanici

DISCUSSION

The average age of our patients was 52 ± 11.1 years, which is consistent with other studies that have shown that the highest incidence of CTS is between the age of 55 and 60 (Ansari, Adelmanesh, Naghdi & Mousavi, 2008).

Regardless of the etiology, the greatest percentages of carpal tunnel syndrome among the respondents, was on

ka, bila je na dominantnoj, desnoj ruci (47,3%), nešto niža zastupljenost na obe ruke (43%) i najniža na lijevoj ruci (9,7%). Slične rezultate su dobili i Galea, Gatt i Sciberras (2007) i Nora, Becker, Ehlers i Gomes (2004).

Naši rezultati nakon ispitivanja odnosa stepena neurogene lezije i fizikalnog nalaza, ukazuju na statistički visoko značajnu razliku u odnosu praćenih parametara. U svom radu Nora i sar. (2004) ispitivali su odnos stepena neurogene lezije, subjektivnih tegoba i kliničkog nalaza kod 1039 pacijenta sa CTS i dobili rezultate slične našim.

Naša saznanja o povećanom riziku od razvoja CTS u navedenim privrednim djelatnostima su u skladu sa epidemiološkim studijama koje je 2001. godine sproveo NRC (National Research Council, Washington). Slične rezultate su imali i Galea, Gatt i Sciberras (2007).

Uprkos značaju pozitivnog uticaja na javno zdravstvo, vrlo malo je objavljenih radova na temu povećanog rizika nastanka CTS kod osoba izloženih radnom opterećenju kod nekih zanimanja (Punnett i sar., 2004; Galea, Gatt i Sciberras, 2007).

Rad u uslužnim djelatnostima sa značajnjom zastupljenosću žena (75%), nego muškaraca (21%) povećava i rizik oboljevanja od sindroma karpalnog kanala kod žena i istovremeno smanjuje rizik oboljevanja kod muškaraca.

Zastupljenost muškaraca (12%) u građevinskim djelatnostima, koja je mnogo veća nego zastupljenost žena (2%), povećava rizik oboljevanja kod muškaraca.

U prehrambenom sektoru zastupljenost oba pola (žene 6 %, muškarci 4%) bila je slična.

To potvrđuje činjenicu da interventni preventivni programi moraju uzeti u obzir ne samo razine rizika u pojedinim djelatnostima nego i brojčanu i polnu zastupljenost radnika. Naši rezultati ukazuju na činjenicu da interventni program mjera treba fokusirati na prehrambenu industriju (za oba spola), građevinski sektor (za muškarce) i na uslužne djelatnosti za žene (npr blagajnice, frizeri, ugostiteljski radnici...) - Palmer, Reading, Calnan i Coggon (2008).

ZAKLJUČAK

Zbog svoje visoke osjetljivosti i specifičnosti, EMNG ispitivanje ostaje zlatni standard u dijagnostici sindroma karpalnog kanala. Ova metoda pruža preciznu i ranu dijagnozu CTS i pomaže u izboru terapijskog tretmana.

Uz prepostavku da ostali faktori rizika ostaju nepromijenjeni i da postoji uzročna veza između izlaganja radu i CTS u visokorizičnim zanimanjima, htjeli smo otkriti udio CTS slučajeva koji bi mogli biti spriječeni nakon smanjenja rizika od njihovog nastanka na radnom mjestu. Takve informacije pružaju mogućnost procjene maksimalnog potencijalnog uticaja programa prevencije CTS-a radnom

right (dominant) hand (47.3%), slightly lower representation on both hands (43%) and lowest on the left hand (9.7%). Similar results were obtained by Galea, Gatt & Sciberras (2007) and Nora, Becker, Ehlers & Gomes (2004).

Our results after testing the level of relations of neurogenic lesions and physical findings, are showing statistically significant difference compared to the monitored parameters. In his work, Nora et al. (2004) examined the relationship of the degree of neurogenic lesions, subjective complaints and clinical findings in 1039 patients with CTS and get results similar to ours. Our findings of an increased risk of developing CTS in these economic activities are in line with the epidemiological study conducted by the NRC (National Research Council, Washington), 2001. Similar results had Galea et al. (2007). Despite the importance of the positive impact on public health, very few have published papers on the subject of the increased risk of CTS in persons exposed to the workload in some occupations (Punnett et al., 2004; Galea et al., 2007).

Working in the service industry with significant representation of women (75%) than men (21%) increases the risk of developing carpal tunnel syndrome in women and at the same time it reduces the risk of the disease in men. Representation of men (12%) in the construction sector, which is much higher than the proportion of women (2%) increases the risk in men.

This is confirmed by the fact that emergency prevention programs must take into account not only the level of risk in specific activities, but also a number and the gender representation of the employees. Our results indicate that intervention programs of measures should focus on the food industry (for both sexes), construction sector (for men) and service activities for women (eg cashiers, hairdressers, catering workers ...) (Palmer et al., 2008). In the food sector we found similar results for both genders (women 6%, men 4%).

CONCLUSIONS

Because of its high sensitivity and specificity, EMG testing remains the gold standard in the diagnosis of carpal canal. This method provides an accurate and early diagnosis of CTS and helps in the selection of therapeutic treatment.

Assuming that other risk factors remain unchanged and that there is a causal relationship between exposure to work and CTS in high-risk occupations, we wanted to discover the share of CTS cases that could be prevented after the reduction of the risk of their occurrence in the workplace. Such information provides the ability to estimate the maximum potential impact of CTS prevention

mjestu. Ovo bi bilo posebno korisno za politiku preventivnih programa i za određivanje koji sektori ili zanimanja zahtijevaju intervenciju. U ovoj studiji htjeli smo procijeniti zastupljenost CTS u odnosu na glavne industrijske sektore i radne kategorije i na taj način ukazati na zanimanja sa visokim rizikom od razvoja CTS.

programs in the workplace. This would be particularly useful for policy and prevention programs to determine which sectors or occupations are requiring intervention. In this study, we wanted to assess the presence of CTS in relation to the main industrial sectors and occupational categories, and thus indicate the occupations with high risk of developing CTS.

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NIVO SPECIFIČNE IZDRŽLJIVOSTI I TEHNIČKO-TAKTIČKE EFIKASNOSTI MLADIH FUDBALERA RAZLIČITOG STEPENA TAKMIČENJA

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Sažetak: Sa ciljem da se utvrdi na kom su nivou specifična izdržljivost i tehničko-taktička efikasnost mladih fudbalera različitog stepena takmičenja, i dalj stepon takmičenja može da bude pokazatelj razlike nivoa ovih sposobnosti, provedeno je istraživanje na uzorku mladih fudbalera uzrasta od 14 do 16 godina iz osam klubova, od kojih se polovina takmičila u višem, a druga u nižem stepenu takmičenja. Uzorak mjernih instrumenata je činilo 13 testova za procjenu pet faktora specifične izdržljivosti: startne izdržljivosti, izdržljivosti u održavanju plitke formacije, izdržljivosti u brzom vođenju lopte i presing izdržljivosti na loptu, kao i ocjena tehničko-taktičke efikasnosti fudbalera. Rezultati istraživanja su pokazali da su mladi fudbaleri višeg stepena takmičenja imali značajno veću tehničko-taktičku efikasnost, kao i specifičnu izdržljivost u testovima gdje je bilo zastupljeno krivolinijsko kretanje i vođenje lopte, kao i kontrola i dodavanje lopte u kretanju, ali da ta razlika nije evidentirana kod pravolinijskih kretanja i sprinteva.

Ključne riječi: razlike, specifična izdržljivost, tehničko-taktička efikasnost, mladi fudbaleri.

Uvod

Analizom fudbalske igre (strukturnom, funkcionalnom, anatomskom, biomehaničkom, motoričkom ...) dolazimo do značajnih informacija o zahtjevima sa kojima se fudbaleri suočavaju na utakmici i treningu (Krsmanović, 2014). Fudbal se ubraja u polistrukturalna, ciklična i aciklična kretanja, gdje su motoričke sposobnosti zastupljene kompleksno sa visokim nivoom maksimalne potrošnje O₂ (Castagna i sar., 2006; Ramsbottom i sar., 1988; Leger i Lambert, 1982). Intenzitet se mijenja od

THE LEVEL OF SPECIFIC ENDURANCE AND TECHNICAL AND TACTICAL EFFICIENCY OF YOUNG FOOTBALL PLAYERS OF DIFFERENT LEVEL OF COMPETITION

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Summary: In order to determine at which level is the specific performance and technical and tactical efficiency of young players of different level of competition, and whether the level of competition can be an indicator of level differences of these abilities, a research was conducted on the sample of young football players aged 14 to 16 from the eight clubs, half of them competing in the higher and the other half in the lower level of competition. A sample of measuring instruments consisted of 13 tests for evaluation of five factors of specific endurance: starting endurance, stamina in maintaining the shallow formation, endurance during fast dribbling, ball pressing endurance, and evaluation of technical and tactical efficiency of football players. The results of the research showed that the young players of higher level of competition had significantly greater technical and tactical efficiency, as well as specific performance in tests which included curvilinear movement and dribbling, as well as control and passing the ball in motion, but the difference is not recorded with straight-line movements and sprints. **Key words:** differences, specific endurance, technical and tactical efficiency, young football players.

INTRODUCTION

By analyzing football game (structurally, functionally, anatomically, mechanically, motorically...), we receive important information on requests which football players face during games and trainings (Krsmanović, 2014). Football is included in poly-structural, cyclic and acyclic movements, where motoric movements are complexly represented with a high level of maximum consumption of O₂ (Castagna et al.,

umjerenog do maksimalnog. Izvršeni obim rada i ukupna potrošnja energije je velika zbog dugotrajnog rada aktivnosti velikog inteziteta. Fudbaleri imaju visoke nivoje laktatne izdržljivosti i aerobnih sposobnosti zbog strukture i karaktera fudbalske igre (Reilly, Bangsbo i Franks, 2000). Savremena fudbalska igra se sastoji od velikog broja sprinteva, ubrzanja, zaustavljanja, promjena pravca kretanja, uklizavanja, skokova, udaraca, ubacivanja lopte, kretanja s loptom, kretanja bez lopte.

Savremeni fudbal zahtijeva od igrača ispoljavanje visokog nivoa funkcionalnih sposobnosti, tehničko-taktičke efikasnosti, jednom riječju morofunkcionalne univerzalnosti, kako bi uspješno djelovali u različitim situacijama igre, često u oskudici vremena, ograničenom prostoru i uz aktivno ometanje od strane protivnika (Molnar, 1998). Samo dobar nivo motoričkih i funkcionalnih sposobnosti omogućuje takvo fizičko stanje fudbalera (Reinikainen, 2012), da efikasno djeluje u uslovima visokog psihofizičkog opterećenja tokom svih 90 minuta utakmice.

Poznavanje hijerarhijske strukture elemenata od kojih zavisi rezultat u fudbalu predstavlja osnovni preduvjet racionalnog provodenja postupaka u usmjeravanju i selekciji potencijalnih fudbalera (Elsner, 1973), kao i značajan korak efikasnijeg planiranja, programiranja i kontrole treningnog procesa (Stojanović, Dragosavljević i Kostić, 2009), a na taj način bi se treningi proces optimizovao sa aspekta vremenskog i energetskog angažmana fudbalera (relacija zamor – oporavak) (Jakonić i Bajić, 1996) u odnosu na finalno efikasno izvođenje tehničko-taktičkih zadatka na utakmici.

Ovakav način kontrole nam omogućuje uvid u fazu igre i strukturu kretanja. Osim strukture tehničko-taktičkih elemenata, ovakve informacije nam govore o ponavljanju različitih načina kretanja bez i sa loptom. Posebno moramo istaći procjenu vremensko-prostornih odnosa koje igrač mora sinhronizovati pri rješavanju situacija (Petrić, 1994), a naročito vremenske i prostorne odnose sa kretanjem lopte, protivnikom i da pri tome poštuje pravila fudbalske igre.

Samo pravilno usmjeravanje djece ka sportu, dobra selekcija i dalji stručno-pedagoški rad u organizovanim klubovima zahtijeva planiranje rada po uzrasnim kategorijama na osnovu pokazatelja rasta i razvoja (Siozios, 1992). U radu se prate fizičke i funkcionalne sposobnosti (Molnar, 1998, 2003), smisao za igru, sposobnost rješavanja složenih zadatka i moralno-voljne osobine (Špirtović, 1989).

Cilj ovog istraživanja je da utvrdi na kom su nivou specifična izdržljivost i tehničko-taktička efikasnost mla-

2006; Ramsbottom et al., 1988; Leger & Lambert, 1982). The intensity varies from a moderate to a maximum. Completed scope of work and total energy consumption is high due to prolonged activities of high intensity. Football players have high levels of lactic endurance and aerobic abilities due to the structure and character of the football games (Reilly, Bangsbo & Franks, 2000). Modern football game consists of a large number of sprints, acceleration, stopping, changes of direction, sliding, jumps, kicks, throwing in the ball, movements with the ball and movements without the ball.

Modern football requires from players to demonstrate a high level of functional skills, technical and tactical efficiency, in one word, morpho-functional universality, in order to successfully respond in various situations during the game, often with the lack of time, limited space and with the active obstruction by an opponent (Molnar, 1998). Only a good level of motoric and functional abilities allows such physical condition of players (Reinikainen, 2012), that they can efficiently act under high psychological and physical stress during the 90 minutes of the match.

Knowing the hierarchical structure of the elements on which the result of football depends is a basic precondition for rational implementation of the procedures in directing and selecting process of potential players (Elsner, 1973), as well as a significant step for more efficient planning, programming, and control of the training processes (Stojanović, Dragosavljević & Kostić, 2009), thus to optimize the training process of players in terms of time and energy (liaison fatigue - recovery) (Jakonić & Bajić, 1996) with respect to the final effective implementation of the technical and tactical tasks in the match.

This method of control allows us to see stages of the game and the structure of movement. In addition to the structure of technical and tactical elements, this information tells us about the repetition of different ways of movement with and without the ball. We have to pay special attention to the assessment of temporal and spatial relations which the player must synchronize in order to resolve the situation (Petrić, 1994), and particularly the temporal and spatial relations with the movement of the ball, the opponent and at the same time to comply with football rules.

Only proper guidance of children towards sports, good selection and further professional and educational work in organized clubs requires planning work by age categories on the basis of growth and development indicators (Siozios, 1992). In the study, the physical and functional abilities (Molnar, 1998, 2003), a sense for the game, the ability to resolve complex and moral and volitional qualities are monitored (Špirtović, 1989).

The aim of this study is to determine at which level are the specific endurance and technical and tactical efficiency

dih fudbalera različitog stepena takmičenja, i da li stepen takmičenja može da bude pokazatelj razlike nivoa ovih sposobnosti.

METODE RADA

Uzorak ispitanika

Uzorak ispitanika obuhvaćen ovim istraživanjem je definisan kao namjeren uzorak mlađih fudbalera uzrasta od 14 do 16 godina, a čini ga 92 selektirana pojedinca, koji su uključeni u trenažni proces u fudbalskim klubovima kvalitetne lige pionira Republike Srpske, koji čine viši stepen takmičenja i Pionirske lige Federacije BiH, koji čine niži stepen takmičenja. Prvi subuzorak (EG1) čini 45 fudbalera koji se takmiče u pionirskoj ligi Republike Srpske iz sljedećih klubova: FK "Proleter" iz Teslića; AF „Sporting“ iz Teslića; FK „Sloga“ iz Doboja i FK „Željezničar“ iz Doboja. Drugi subuzorak (EG2) čini 47 fudbalera koji se takmiče u pionirskoj ligi Federacije Bosne i Hercegovine iz sljedećih klubova: NK „Borac“ iz Jelaha; NK „Tošk“ iz Tešnja; NK „Usora“ iz Tešanjke i NK „Pobjeda“ iz Tešanjke. Za ovo istraživanje dobijene su saglasnosti klubova, kao i roditelja ispitanika.

Uzorak mjernih instrumenata

Za potrebe ovog istraživanja konstruisana je pogodna baterija mjernih instrumenata izdržljivosti koja po mišljenju autora može da utvrdi postojanje strukture specifične izdržljivosti fudbalera. U konstruisanju baterije od 13 testova autori ovog istraživanja pošli su od zahtjeva: da svi testovi budu realne sekvence kretanja fudbalera; da svi testovi kao motorni zadaci mogu da se izvedu u maksimalnoj brzini; da se obavezno uvažavaju pravila, tehnika i uslovi fudbalske igre. Primenjeni su sljedeći testovi:

- I. Za procjenu faktora specifične startne izdržljivosti u otkrivanju i pokrivanju:
 1. brzo trčanje vijugavo neujednačeno 5x20 m s intervalnim odmorom od 10 sekundi (BTVN5x20)
 2. brzo trčanje s promjenom pravca pod pravim uglom 5x20 m s intervalnim odmorom od 10 sekundi (BTPP5x20)
 3. trčanje na poligonu oko zastavica, osmica, s intervalnim odmorom od 10 sekundi (TPOS-M).
- II. Za procjenu faktora specifične izdržljivosti u održavanju plitke formacije:
 1. brzo trčanje 5x60m s intervalnim odmorom od 10 sekundi (BT5x60)
 2. brzo trčanje 5x80m s intervalnim odmorom od 10 sekundi (BT5x80)

of young football players of different levels of competition, and whether the level of competition can be an indicator of the level differences of these abilities.

METHODS OF WORK

A sample of examinees

The sample included in this study is defined as a deliberate pattern of young football players aged 14 to 16, and it consists of 92 selected individuals, who are involved in the training process in football clubs of quality pioneers' league of Republic of Srpska that are at the higher level of competition and the pioneers' league of Federation of Bosnia and Herzegovina which are at the lower level of competition. The first subsample (EG1) consisted of 45 football players who compete in the pioneer league of Republic of Srpska from the following clubs: FC "Proleter" Teslić; FA "Sporting" from Teslić; FC "Sloga" from Doboј and FC "Željezničar" from Doboј. The second subsample (EG2) consists of 47 football players who compete in the pioneer league of Federation of Bosnia and Herzegovina from the following clubs: FC "Borac" from Jelah; FC "Tošk" from Tešanj; FC "Usora" from Tešanjka and FC "Pobjeda" from Tešanjka. For this study approvals from the clubs, as well as the parents of subjects were obtained.

A sample of measuring instruments

For the purposes of the research, suitable battery of measuring instruments of endurance was constructed, which according to the author can determine the existence of structure of specific endurance of players. In constructing the battery consisting of 13 tests, the authors of this study began from following requests: that all tests are realistic sequences of movement of football players; that all tests as motoric tasks can be performed at the maximum speed; to be sure to respect the rules, techniques and requests of the football game. The following tests were applied:

- I. For the assessment of factors of specific starting endurance in opening and covering:
 1. fast running winding unevenly 5x20m with resting interval of 10 seconds (BTVN5x20)
 2. fast running with a change of direction at right angle 5x20m with resting interval of 10 seconds (BTPP5x20)
 3. running on the polygon around flags, eights, with resting interval of 10 seconds (TPOS-M)
- II. For the assessment of factors of specific endurance in maintaining shallow formations:
 1. fast running 5x60m with resting interval of 10 seconds (BT5x60)
 2. fast running 5x80m with resting interval of 10 seconds (BT5x80)

- III. Za procjenu faktora specifične sprintske izdržljivosti:
1. brzo trčanje 5x20m s intervalnim odmorom od 10 sekundi (BT5x20)
 2. brzo trčanje 5x40m s intervalnim odmorom od 10 sekundi (BT5x40)
 3. brzo trčanje 200m (BT200)
- IV. Za procjenu faktora specifične izdržljivosti u brzom vođenju lopte:
1. brzo vođenje lopte vijugavo neujednačeno 5x20m s intervalnim odmorom od 10 sekundi (BVLV5x20)
 2. brzo vođenje lopte promjenom pravca pod pravim uglom 5x20m s intervalnim odmorom od 10 sekundi (BVPP5x20)
- V. Za procjenu faktora specifične presing izdržljivosti na loptu:
1. kombinovani test udarci lopte nogom i glavom u kretanju (KTULNG)
 2. kombinovani test udarci lopte glavom u skoku i padu (KTULG)
 3. kombinovani test udarci lopte glavom nakon primanja lopte grudima i hrptom stopala (KTULN).

Za procjenu tehničko-taktičkih sposobnosti mladih fudbalera projektovan je upitnik koga su ispunili nezavrsni licencirani treneri koji rade u klubovima koji su učestvovali u testiranju. Svim trenerima (ocjenjivačima) je dat upitnik za svakog igrača posebno, kako bi mogao zakružiti samo jedan od ponuđenih odgovora – zaključaka na predloženoj skali od 1 do 9. Treneri su istovremeno ispunili upitnik, bez mogućnosti međusobne komunikacije i dogovaranja. Nakon popune upitnika, za svakog ispitanika je izračunata srednja ocjena, tako što je zbir svih ocjena podijeljen sa osam i zaokružen na cijeli broj, a trenerima nije data mogućnost da imaju uvid u ocjene drugih ocjenjivača.

U procesu treninga, realizujući ili prateći procese obuke i usavršavanje tehničko-taktičkih sposobnosti, ovom skalom od 1 do 9 moguće je procijeniti ove sposobnosti obilježavanjem broja skale:

1. Fond kvalitet tehničko-taktičkih znanja u nivou sportiste početnika (nivo prepoznavanja elemenata),
2. Zna i uspješno primjenjuje mali broj tehničko-taktičkih elemenata,
3. Savladana osnovna tehničko-taktička znanja, ali ih u situacijama takmičenja ne primjenjuje,
4. Savladao osnovna tehničko-taktička znanja, ali ih u situacijama takmičenja teško primjenjuje,

- III. For the assessment of factors of specific sprint endurance:
1. fast running 5x20m with resting interval of 10 seconds (BT5x20)
 2. fast running 5x40m with resting interval of 10 seconds (BT5x40)
 3. fast running 200m (BT200)
- IV. For assessment of factors of specific endurance in fast dribbling:
1. fast dribbling winding unevenly 5x20m with resting interval of 10 seconds (BVLV5x20)
 2. fast dribbling with a change of direction at right angle 5x20m with resting interval of 10 seconds (BVPP5x20)
- V. For assessment of factors of specific pressing endurance on the ball:
1. combined test kicks of the ball with a leg and a head in motion (KTULNG)
 2. combined test kicks of the ball with a head during jump and fall (KTULG)
 3. combined test kicks of the ball with a head after receiving the ball with chests and the foot ridge (KTULN).

For the assessment of the technical and tactical abilities of young football players a questionnaire was designed and it was filled out by independent licensed coaches working in clubs that participated in testing. The questionnaire was given to all coaches (evaluators) for each player individually, in order to circle only one of the given answers- conclusions on presented scale from 1 to 9. Coaches filled out the questionnaire at the same time, without the possibility of mutual communication and consultation. After filling out the questionnaire, the average grade was calculated for each respondent, by dividing the sum of all grades with eight and rounded to an integer, and the coaches had no opportunity to have access into the assessment of other evaluators.

In the process of training, by realizing or following the process of training and improvement of technical and tactical abilities, with this scale from 1 to 9 it is possible to assess these abilities by marking the number of the scale:

1. The quality of technical and tactical knowledge at the level of beginner sportsman (level of recognition of elements).
2. He knows and successfully applies a small number of technical and tactical elements.
3. He mastered the basic technical and tactical knowledge, but he does not apply them in situations of competition.
4. He mastered the basic technical and tactical knowledge, but has difficulties in applying them in situations of

5. Vlada osnovom tehničko–taktičkih znanja i gotovo ih sve uspješno primjenjuje u situacijama takmičenja,
6. Savladao gotovo sve tehničko–taktičke elemente, a neke od njih primjerno primjenjuje u situacijama takmičenja,
7. Savladao sve tehničko–taktičke elemente i mnoge od njih izborni uspješno primjenjuje (na nivou automatizacije) u situacijama takmičenja.
8. Posjeduje znanja kompletног tehničko–taktičkog repertoara sporta, izborni ih koristi, često na nivou perfekcije u situacijama takmičenja.
9. Posjeduje znanja kompletног tehničko–taktičkog repertoara i u situacijama takmičenja gotovo sve elemente koristi na nivou perfekcije.

Metode obrade podataka

Za analizu osnovnih statističkih podataka i distribuciju rezultata za obje eksperimentalne grupe su primjenjeni deskriptivni statistički postupci, a izračunati su sljedeći parametri: aritmetička sredina (Mean); najmanji postignuti rezultat (Min.); najveći postignuti rezultat (Max.); raspon minimalnog i maksimalnog rezultata (Range); standardna devijacija aritmetičke sredine (Std.dev.); koeficijent varijacije (Coef.Var.); asimetričnost krivulje distribucije rezultata (Skew.) i spljoštenost krivulje distribucije rezultata (Kurt.) i vrijednost Kolmogorov-Smirnov testa (K-S). Za utvrđivanje razlika između parametara dvije eksperimentalne grupe, primjenjena je jednosmjerna analiza varianse na multivariatnom i univariatnom nivou (one way MANOVA/ANOVA). Podaci su obrađeni u statističkom paketu STATISTICA 7, (StatSoft, Inc., Tulsa, OK).

REZULTATI I DISKUSIJA

Vrijednosti centralnih i disperzionih parametara, mjera asimetrije i spljoštenosti u prostoru specifične izdržljivosti i tehničko taktičkih sposobnosti fudbalera višeg stepena takmičenja (EG1), usmjeravaju na mogućnost primjene parametrijskih postupaka (Tabela 1.). Minimalne (Min.) i maksimalne (Max.) vrijednosti varijabli specifične izdržljivosti fudbalera višeg stepena takmičenja ukazuju da se vrijednosti nalaze u očekivanom rasponu. Vrijednosti koeficijenata varijacije (Coef.Var.) ukazuju na homogenost uzorka fudbalera višeg stepena takmičenja kod svih varijabli, a kreću se u rasponu od 3.31 do 11.31. Vrijednosti simetričnosti krive raspodjele rezultata (Skew.) ukazuju da je raspodjela kod svih varijabli specifične izdržljivosti i tehničko taktičkih sposobnosti ispitanika simetrična, odnosno, da je kriva raspodjele rezultata u granicama normalne i da ima najviše rezultata

- competition.
5. He masters the basic technical and tactical knowledge and applies almost all of them successfully in situation of competition.
 6. He mastered almost all technical and tactical elements, and some of them he applies exemplary in situations of competition.
 7. He mastered all technical and tactical elements and he optionally and successfully applies many of them (at the level of automation) in situations of competition.
 8. He has knowledge of the complete technical and tactical sport repertoire, he uses them optionally, often at the level of perfection in situations of competitions.
 9. He has knowledge of complete technical and tactical repertoire and uses almost all elements on the level of perfection in situations of competition.

Data processing methods

For the analysis of basic statistical data and distribution of results for both experimental groups, descriptive statistical methods were applied, and the following parameters were calculated: the arithmetic mean (Mean), lowest achieved score (Min.); highest achieved score (Max.); the range of minimum and maximum results (Range); standard deviation of arithmetic mean (Std.dev.); the coefficient of variation (Coef. Var.); the asymmetry of the distribution curve results (Skew.) and the flattening of the curve distribution of results (Kurt.) and the value of the Kolmogorov-Smirnov test (KS). In order to determine the difference between the parameters of the two experimental groups, the one-way analysis of variance on the multivariate and univariate level was applied (one way MANOVA/ANOVA). The data are processed in the statistical package STATISTICA 7, (StatSoft, Inc., Tulsa, OK).

RESULTS AND DISCUSSION

The values of central and dispersion parameters, measures of asymmetry and flattening in a area of specific endurance and technical and tactical abilities of football players of a higher level of competition (EG1), direct to the possibility of applying parametric methods (Table 1). Minimal (Min.) and maximal (Max.) values of the variables of specific endurance of football players of a higher level of competition indicate that the values are in the expected range. The values of the coefficient of variation (Coeff.Var.) indicate the homogeneity of the sample of football players of a higher level of competition in all the variables, ranging from 3.31 to 11.31. Values of symmetrical distribution curve results (Skew.) indicate that the distribution is symmetrical at all the variables of specific endurance and technical and tactical abilities of the exami-

oko srednje vrijednosti. Distribucija vrijednosti uglavnom se kreće u okviru normalne raspodjele (K-S) kod većine testova, osim kod kombinovanog testa udarci lopte nogom i glavom u kretanju (KTULNG), čije su vrijednosti veće od granične (K-S=0.27>0.243). Ovo ukazuje na dobru diskriminativnost svih testova.

Tabela 1. Deskriptivni parametri specifične izdržljivosti i efikasnosti izvodenja tehničko taktičkih zadataka fudbalera – viši stepen (EG1)

Varijabla	N	Mean	Min.	Max.	Range	Std.Dev.	Coef.Var.	Skew.	Kurt.	K-S
BTVN5x20	45	6.00	5.59	6.44	0.85	0.23	3.82	0.34	-0.93	0.14
BTTP5x20	45	6.58	5.92	7.31	1.39	0.39	5.91	0.33	-0.96	0.15
TPOSM	45	6.12	5.71	6.48	0.77	0.20	3.31	0.04	-0.83	0.09
BT5x60	45	9.14	8.25	9.99	1.74	0.36	3.99	-0.00	0.09	0.06
BT5x80	45	11.58	10.68	12.19	1.51	0.41	3.57	-0.58	-0.47	0.11
BT5x20	45	3.43	3.02	4.01	0.99	0.28	8.21	0.38	-1.18	0.15
BT5x40	45	6.19	5.46	6.81	1.35	0.30	4.80	-0.02	0.30	0.09
BT200	45	36.45	29.60	45.38	15.78	3.09	8.49	0.68	1.90	0.20
BVLV5x20	45	8.56	7.44	9.90	2.46	0.63	7.32	0.52	-0.41	0.09
BVPP5x20	45	9.47	8.32	10.81	2.49	0.59	6.20	0.37	-0.14	0.09
KTULNG	45	11.13	9.00	13.00	4.00	1.12	10.06	-0.58	-0.69	0.27*
KTULG	45	10.73	8.00	13.00	5.00	1.21	11.31	-0.26	0.19	0.18
KTULN	45	10.69	8.00	13.00	5.00	1.04	9.74	-0.34	0.07	0.24
OCENA TT	45	6.80	5.00	9.00	4.00	1.18	17.34	-0.03	-0.81	0.19

Legenda: N – broj ispitanika; Mean – aritmetička sredina; Std.Dev. – standardna devijacija; Min. – minimalni rezultat; Max. – maksimalni rezultat; Range – raspon rezultata; Coef. Var. – koeficijent varijacije; Skew. – simetričnost krive raspodele rezultata; Kurt. – spljoštenost krive raspodele rezultata; K-S – Kolmogorov-Smirnov test normalnosti krivulje distribucije (granična vrednost za uzorak od 45 ispitanika iznosi 0.243).

Vrijednosti centralnih i disperzionih parametara, mjera asimetrije i spljoštenosti u prostoru specifične izdržljivosti i tehničko taktičkih sposobnosti fudbalera nižeg stepena takmičenja, usmjeravaju na mogućnost primjene parametrijskih postupaka (Tabela 2.). Minimalne (Min.) i maksimalne (Max.) vrijednosti varijabli specifične izdržljivosti fudbalera nižeg stepena takmičenja ukazuju da se vrijednosti nalaze u očekivanom rasponu. Vrijednosti koeficijenata varijacije (Coef.Var.) ukazuju na homogenost uzorka fudbalera nižeg stepena takmičenja kod svih varijabli, a kreću se u rasponu od 4.59 do 13.69. Vrijednosti simetričnosti krive raspodjele rezultata (Skew.) ukazuju da je raspodjela kod svih varijabli specifične

nees, i.e. that the results distribution curve is within normal limits, having the most results around the mean value. Distribution of values generally remains within the normal distribution (K-S) with most tests, except for the combined test kicking ball with a leg and a head in movement (KTULNG), where the values are greater than the limit (K-S=0.27>0.243). This indicates good discriminability of all tests.

Tabela 1. Deskriptivni parametri specifične izdržljivosti i efikasnosti izvodenja tehničko taktičkih zadataka fudbalera – viši stepen (EG1)

Legend: N - number of subjects; Mean – arithmetic mean; Std. Dev. - Standard deviation; Min. - The minimum score; Max. - The maximum score; Range - the range of results; Coef. Var. - Coefficient of variation; Skew. - Symmetry of the curve distribution of results; Kurt. - Flattening the curve of distribution of results; HP - the Kolmogorov-Smirnov test for normality distribution curve (limit for the sample of 45 subjects was 0.243).

The values of central and dispersion parameters, measures of asymmetry and flattening in a area of specific endurance and technical and tactical abilities of football players of lower level of competition, direct to the possibility of applying parametric methods (Table 2.). Minimum (Min.) and maximal (Max.) values of the variables of specific endurance of football players of lower level of competition indicate that the values are in the expected range. The values of the coefficient of variation (Coef. Var.) indicate the homogeneity of the sample of players of lower level of competition in all the variables, ranging from 4.59 to 13.69. Values of symmetrical curve results distribution (Skew.) indicate that the distribution at all the variables of

izdržljivosti i tehničko taktičkih sposobnosti ispitanika simetrična, odnosno, da je kriva raspodjele rezultata u granicama normalne i da ima najviše rezultata oko srednje vrijednosti. Distribucija vrijednosti se kreće u okviru normalne raspodjele (K-S) kod svih testova, obzirom da su im vrijednosti manje od granične ($K-S < 0.238$). Ovo ukazuje na dobru diskriminativnost svih testova.

Tabela 2. Deskriptivni parametri specifične izdržljivosti i efikasnosti izvođenja tehničko taktičkih zadataka fudbalera – niži stepen (EG2)

Varijabla	N	Mean	Min.	Max.	Range	Std.Dev.	Coef.Var.	Skew.	Kurt.	K-S
BTVN5x20	47	6.32	5.52	7.04	1.52	0.35	5.49	0.25	-0.11	0.09
BTPP5x20	47	6.85	6.13	7.75	1.62	0.38	5.57	0.46	-0.18	0.09
TPOSM	47	6.39	5.84	7.18	1.34	0.38	6.00	0.59	-0.60	0.10
BT5x60	47	9.27	7.35	11.00	3.65	0.89	9.58	-0.29	-0.04	0.08
BT5x80	47	11.70	10.50	13.10	2.60	0.76	6.52	0.25	-1.18	0.12
BT5x20	47	3.49	2.97	4.06	1.09	0.29	8.25	0.26	-1.15	0.12
BT5x40	47	6.27	5.48	6.86	1.38	0.29	4.59	-0.10	0.61	0.09
BT200	47	36.59	29.70	45.43	15.73	3.15	8.61	0.66	1.46	0.19
BVLV5x20	47	8.99	7.68	10.86	3.18	0.73	8.07	0.79	0.53	0.10
BVPP5x20	47	9.91	8.71	11.75	3.04	0.71	7.21	0.71	-0.00	0.09
KTULNG	47	10.15	8.00	12.00	4.00	1.08	10.67	-0.09	-0.56	0.17
KTULG	47	10.09	8.00	13.00	5.00	1.38	13.69	0.72	0.04	0.21
KTULN	47	9.96	8.00	12.00	4.00	1.16	11.65	0.09	-0.71	0.17
OCENA TT	47	5.70	4.00	8.00	4.00	1.23	21.61	0.02	-0.99	0.19

Legenda: N – broj ispitanika; Mean – aritmetička sredina; Std.Dev. – standardna devijacija; Min. – minimalni rezultat; Max. – maksimalni rezultat; Range – raspon rezultata; Coef.Var. – koeficijent varijacije; Skew. – simetričnost krive raspodele rezultata; Kurt. – spljoštenost krive raspodele rezultata; K-S – Kolmogorov-Smirnov test normalnosti krivulje distribucije (granična vrednost za uzorak od 47 ispitanika iznosi 0.238).

Analizom dobijenih rezultata na multivarijantnom nivou, može se konstatovati da između fudbalera pionirskog uzrasta koji se takmiče u dva različita stepena takmičenja, postoji statistički značajna razlika u ispitivanom prostorima specifične izdržljivosti i tehničko taktičkih sposobnosti, čija vrijednost Wilks' Lambde (0.622) i Rao-ve aproksimacija ($F=3.34$), uz stepene slobode 14 i 77, ukazuju na statističku značajnost razlika na nivou $p=0.000$ (Tabela 3.).

specific endurance and technical and tactical abilities of subjects is symmetrical, i.e. that the results distribution curve is within normal limits, having the most results around the mean value. Distribution of values remain within the normal distribution (K-S) in all tests, considering that their values are less than the limit ($K-S < 0.238$). This indicates good discriminability of all tests.

Table 2. Descriptive parameters of specific endurance and efficiency of performing technical and tactical tasks of football players- lower level (EG2)

Legend: N - number of subjects; Mean – arithmetic mean; Std. Dev. - Standard deviation; Min. - The minimum score; Max. - The maximum score; Range - the range of results; Coef.Var. - Coefficient of variation; Skew. - Symmetry of the curve distribution of results; Kurt. - Flattening the curve of distribution of results; HP - the Kolmogorov-Smirnov test for normality distribution curve (limit value for the sample of 47 subjects was 0.238).

Analysing the results at the multivariate level, it can be concluded that between football players of the pioneer age who compete in two different levels of competition, there is a statistically significant difference in the examined areas of specific endurance and technical and tactical abilities, whose value Wilk's lambda (0.622) and Rao's approximation ($F=3.34$), with degrees of freedom 14 and 17, indicate a statistically significant difference at the level of $p=0.000$ (Table 3.).

Tabela 3. Multivarijantne razlike specifične izdržljivosti i efikasnosti izvođenja tehničko taktičkih zadataka između fudbalera višeg i nižeg stepena takmičenja

Wilks's Lambda	F	Effect df	Error df	Q
0.622	3.34	14	77	0.000*

Wilks' Lambda – vrijednost koeficijenta Wilksovog testa za jednakost centrioda grupa; *F* – vrednost koeficijenta *F*-testa za značajnost Wilks'ove Lamde; *Effect df* i *Error df* – stepeni slobode; *Q* – koeficijent značajnosti razlika centrioda grupa; *statistički značajna razlika.

Na univarijantnom nivou se može uočiti da su razlici između fudbalera različitih stepena takmičenja (Tabela 4.) doprinijele statistički značajne razlike na nivou značajnosti $p \leq 0.01$ u testovima za procjenu faktora startne izdržljivosti u otkrivanju i pokrivanju (BTVN5x20; BTPP5x20 i TPOS5x), faktora specijalne izdržljivosti u brzom vođenju lopte (BVLV5x20 i BVPP5x20) i faktora presing izdržljivosti na loptu (KTULNG; KTULG i KTULN), ali i razlika u tehničko taktičkim sposobnostima u korist fudbalera višeg stepena takmičenja. Kod testova za procjenu faktora specifične izdržljivosti u održavanju plitke formacije (BT5x60 i BT5x80) i faktora specifične sprinterske izdržljivosti (BT5x20; BT5x40 i BT200) nije konstatovana značajna razlika.

Tabela 4. Univarijantne razlike specifične izdržljivosti i efikasnosti izvođenja tehničko taktičkih zadataka između fudbalera višeg i nižeg stepena takmičenja

Varijabla	Mean (EG1)	Mean (EG2)	Diff.	F 1,90)	p
BTVN5x20	6.00	6.32	-0.32	26.83	0.000*
BTPP5x20	6.58	6.85	-0.27	11.04	0.001*
TPOS5M	6.12	6.39	-0.27	16.44	0.000*
BT5x60	9.14	9.27	-0.13	0.87	0.354
BT5x80	11.58	11.70	-0.12	0.94	0.335
BT5x20	3.43	3.49	-0.06	1.25	0.267
BT5x40	6.19	6.27	-0.08	1.47	0.229
BT200	36.45	36.59	-0.14	0.04	0.835
BVLV5x20	8.56	8.99	-0.43	9.49	0.003*
BVPP5x20	9.47	9.91	-0.44	10.20	0.002*
KTULNG	11.13	10.15	0.98	18.37	0.000*
KTULG	10.73	10.09	0.64	5.70	0.019*
KTULN	10.69	9.96	0.73	10.10	0.002*
OCENA TT	6.80	5.70	1.10	19.03	0.000*

Mean – aritmetička sredina; **Diff.** – razlika aritmetičkih sredina; *F* – vrednost *F*-testa za testiranje značajnosti razlika aritmetičkih sredina; *p* – koeficijent značajnosti razlika aritmetičkih sredina; *statistički značajna razlika.

Table 3. Multivariate differences of specific endurance and efficiency of performing technical and tactical tasks between football players of higher and lower level of competition

Wilks' Lambda - the value of coefficient of Wilks test for equality of group centroid; *F* - The coefficient of *F*-test for significance Wilks' Lampda; *Effect df Error and df* - degrees of freedom; *Q* - coefficient of difference significance of groups centroid; * Statistically significant difference.

At the univariate level, it can be noticed that the significant differences in the level of significance $p < 0.01$ in the tests for the assessments of the factors of starting endurance in opening and covering (BTVN5x20; BTPP5x20 i TPOS5x), special endurance factors in the fast dribbling (BVLV5x20 i BVPP5x20) and the factor of pressing endurance on the ball (KTULNG; KTULG i KTULN), as well as difference in the technical and tactical abilities in favour of players of a higher level of competition, contributed to the difference between football players of different level of competition (Table 4). In tests for assessment of factors of specific endurance in maintaining shallow formations (BT5x60 i BT5x80) and factors of specific sprint endurance (BT5x20; BT5x40 i BT200), significant difference was not noted.

Table 4. Univariate differences of specific endurance and efficiency of performing of technical and tactical tasks between football players of higher and lower levels of competition

Mean - arithmetic mean; **Diff.** - Differences in arithmetic means; *F* - value of *F*-test for testing significance of differences of arithmetic means; *p* - coefficient of the significance of differences of arithmetic means; * Statistically significant difference

U diskusiji utvrđenih razlika može se konstatovati da su fudbaleri pionirskog uzrasta višeg stepena takmičenja imali značajno bolje rezultate u prostoru specifične startne izdržljivosti u otkrivanju i pokrivanju, specifične izdržljivosti u brzom vođenju lopte i specifične presing izdržljivosti na loptu, dok ta razlika nije uočena u prostoru specifične izdržljivosti u održavanju plitke formacije i specifične sprinterske izdržljivosti. Uzroke ovakvih razlika možemo pripisati višem nivou tehničko-taktičkih sposobnosti fudbalera višeg stepena takmičenja, obzirom da nastale razlike egzistiraju u testovima gdje se zadaci izvode u krivolinijskom kretanju i vođenju lopte, kao i u testovima kontrole i dodavanja lopte u kretanju, dok tih razlika nema kod testova pravolinijskih sprinteva i sprinteva u cilju održavanja plitke formacije. Do ovakvih rezultata su došli i drugi istraživači (Čeremidžić, 2013; Hadžić, 2004). Nesumljivo je da nivo kontrole lopte značajno utiče na kvalitet izvođenja testova u kojima rezultat u velikoj mjeri zavisi od tehničke sposobnosti igrača (Siozios, 1992), a manje od njihove brzine i izdržljivosti (Bozalaczis, 1999), obzirom da je bolji rezultat onaj koji ima manju vrijednost u sekundama. Svaka greška koja se javlja u baratanju i vođenju lopte, kao i u kretanju po krivolinijskim putanjama, donosi značajne razlike u konačnom vremenu trajanja testova, te su i fudbaleri višeg i nižeg stepena takmičenja postigli različite rezultate u testovima ovih sposobnosti.

U daljoj diskusiji se može pretpostaviti da je i period bavljenja fudbalom igrača višeg i nižeg stepena takmičenja različit, odnosno da su fudbaleri višeg stepena duže u trenažnom procesu, obzirom da je nivo usvojenosti tehničkih elemenata fudbalske igre u značajnoj korelaciji sa dužinom treniranja. Nesporno je da i talent fudbalera ima uticaja na dužinu trajanja usvajanja tehnike, ali je ta zavisnost znatno veća u odnosu na dužinu treniranja, obzirom da se majstorstvo u fudbalu postiže tek nakon višegodišnjeg treninga.

ZAKLJUČAK

Eksperimentalni podaci koji su prikupljeni i prikazani u ovom istraživanju nedvosmisleno pokazuju da parametri specifične izdržljivosti i tehničko-taktičke efikasnosti imaju veće vrijednosti kod mlađih fudbalera višeg stepena takmičenja u odnosu na one iz nižeg stepena. Jedan od glavnih razloga ovakvih rezultata jeste činjenica, da je nivo tehničko-taktičke efikasnosti značajno uticao na ishod u testovima specifične izdržljivosti, obzirom da je sadržaj tih testova bio povezan sa rješavanjem složenih tehničkih zadataka za određeno vrijeme. Takođe se može konstatovati da su rezultati postignuti u testovima spe-

In the discussion of the determined differences it can be noted that players of pioneer age of higher level of competition had significantly better results in the area of specific starting endurance in opening and covering, specific endurance in fast dribbling and specific pressing endurance on the ball, whereas this difference was not noted in the area of specific endurance in maintaining shallow formations and specific sprint endurance. Causes of these differences can be attributed to the higher level of technical and tactical abilities of football players of a higher level of competition, considering that the differences exist in the tests where tasks are performed in curvilinear movement and dribbling of the ball, as well as tests of controls and passing of the ball in motion, whereas such differences were not present in tests of straight-line sprints with the aim of maintaining shallow formations. Various researchers also obtained these results (Čeremidžić, 2013; Hadžić, 2004). There is no doubt that the level of ball control significantly affects the quality of performance of tests in which result largely depends on the technical readiness of player (Siozios, 1992), and less on their speed and endurance (Bozalaczis, 1999), considering that the better result is the one having lower value in seconds. Any error that occurs in handling and dribbling, as well as in movement on the curvilinear paths, makes significant difference in the final duration of the tests, and the football players of higher and lower level of competition achieved different results in tests of these abilities.

In further discussion, it can be assumed that the period of playing football by football players of higher and lower level of competition is different, or that the players of a higher level of competition spent longer in the training process, given that the level of acquiring technical elements of football game is significantly correlated with the length of training. It is also indisputable that talent of players have an impact on the length of the adoption of the technique, but the dependence is much higher compared to the length of training, given that mastery in football is achieved only after years of training.

CONCLUSION

Experimental data collected and presented in this study unambiguously show that the parameters of specific endurance and technical and tactical efficiency have higher values with young football players of higher level of competition compared to those of the lower level. One of the main reasons for these results is the fact that the level of technical and tactical efficiency significantly influenced the outcome of the tests of specific endurance, considering that the content of these tests was associated with solving complex technical tasks in a certain period of time. It can also

cifične izdržljivosti koji su sadržali samo pravolinijska kretanja, bez zadataka sa loptom, bili istog nivoa u obje eksperimentalne grupe. Na osnovu ovakvih konstatacija se može izvesti zaključak, da stepen takmičenja nije presudan za postignuti nivo specifične izdržljivosti u kojoj su kretanja pravolinijska i ne sadrže baratanje loptom, ali da je važan u onim karakteristikama izdržljivosti, gdje je zastupljeno krivolinijsko kretanje i vođenje lopte, kao i kontrola i dodavanje lopte u kretanju.

be concluded that the results achieved in tests of specific endurance which contained only straight-line movement, without tasks with the ball, had the same levels in both experimental groups. On the basis of these statements it can be concluded that the level of competition is not crucial for the achieved level of specific endurance in which movements are straight-lined and do not include handling the ball, but it is important in characteristics of endurance in which curvilinear movement and dribbling of the ball are included, as well as control and passing the ball in motion.

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