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EDITORIAL

Among the factors relating to a country's and wider society's responsibility and attitude to changes and directions towards sustainable development, we also need to include the adaptability of individual disciplines and fields of study, which reveal a turning point in both the quality of life and build-up of lifestyle. Kinesiology, the science of man's movement, is a field of study, which goes hand in hand with a healthy diet and the quality adjustment of one's environment allowing man to be active, thus nowadays representing one of the most important factors as far as our health is concerned. Our ancestors became aware of it almost two thousand years ago, "Positive orientation in health requires the knowledge of man's physique and the knowledge of importance of diet, both natural and processed. However, taking care of diet is not sufficient for health. It is necessary to take exercise and to be familiar with its effects. The combination of these two things creates a scheme, according to which attention should be paid also to the season, change of wind, individual's age and his/her situation at home. Should there be a lack in diet or exercise the body will fall ill." (Hippocrates, 480 BC: The international Life Sciences Institute). The above mentioned value ("scheme") is vital for each individual in every period of life, from the childhood to old age and in different environments. Modern life differs in many ways from the lifestyles of previous generations including yesterday's generations (considering the fact that our own body represents the closest residential environment of every individual). Despite the early warning signs, we are still not able to place and use the possibilities offered by kinesiology as an integrative contemporary science in various areas of study.

Despite both fundamental realization and awareness the process of changes remains a considerable problem, usually present in all processes connected to the changing of a man's life patterns, regardless of his/her age, sex, education, health conditions … Such a process can only be expected to be long in duration as well as demanding and exceedingly complex. In order to reach such long-term goals and eventual changes, we need to be sufficiently informed through raised awareness as well as by keeping ourselves later on, directed, guided, attended and stimulated. Each step down the path of these changes demands an adequate stimulating environment and a suitable expert, a qualified leader and a process manager who has acquired the appropriate competencies.

Professor Rado Pišot, Ph.D.
Editor-in-Chief

UVODNIK

Med dejavnike odgovornega obnašanja države in širše družbene skupnosti, ki želi slediti spremembam in biti naravnana v trajnostni razvoj, moramo všteti tudi prilagodljivost posameznih disciplin in področij, ki predstavljajo vzvod kakovosti življenja in oblikovanja življenjskega sloga. Kineziologija, kot znanost o gibanju človeka, je ena tistih disciplin, ki z roko v roki z zdravo prehrano in s kakovostno prilagoditvijo okolja, v katerem posameznik deluje, predstavlja danes enega pomembnejših dejavnikov. Mineva že skoraj dva tisoč let, odkar so naši predniki spoznali njen pomen – "Pozitivno zdravje zahteva znanje o človekovi telesni konstituciji in znanje o moči prehrane, tako tisti naravni kot tisti, ki jo človek predela. Vendar samo hrana ni dovolj za zdravje. Potrebna je vadba, katere učinke moramo prav tako poznati. Kombinacija teh dveh stvari ustvari shemo, ko ji mora biti dana tudi prava pozornost glede na letni čas, spremembe vetrov, starost posameznika in njegovo situacijo doma. Če pride do pomanjkanja pri hrani ali vadbi, bo telo zbolelo". (Hipokrat, 480 p. n. š: The international Life Sciences Institute). Ta vrednota (»shema«) pa je za posameznika pomembna v vseh življenjskih obdobjih, od otroštva do starosti, in v različnih okoljih. Sodobno življenje se v marsičem, še posebej pomembno pa v odnosu do svojega okolja (upoštevajoč dejstvo, da je lastno telo najbližje okolje bivanja slehernega posameznika), razlikuje od življenja predhodnih, še včerajšnjih, generacij. Kljub zgodnjim opozorilom pa še danes nismo sposobni umestiti in izkoristiti možnosti, ki jih kineziologija kot integrativna sodobna znanost ponuja na različnih področjih njenega delovanja.

Navkljub načelnemu zavedanju in osveščenosti ostaja velik problem proces sprememb, ki je običajno prisoten v vseh procesih spreminjanja življenjskih vzorcev človeka ne glede na njegovo starost, spol, izobrazbo, zdravstveno stanje … Ta je dolgotrajen, zahteven in nadvse sestavljen. Za doseganje dolgoročnih ciljev in končnih sprememb moramo biti najprej ustrezno podučeni – osveščeni, nato usmerjani, vodeni, spremljani in spodbujani. V vsakem koraku teh sprememb pa nujno potrebujemo ustrezno spodbudno okolje in ustreznega strokovnjaka, kompetentnega usmerjevalca in vodjo procesa, ki si je pridobil ustrezne kompetence.

Prof. dr. Rado Pišot
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KEY COMPETENCES OF SLOVENIAN SPORT MANAGERS

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ABSTRACT

The paper presents the results of research that examined the key competences in the management field in Slovenian sports. The success rate of sport organisations and sportsmen is based on the creative, innovative and quality expert work of employees or/ and volunteers. Their work is planned, organised, managed and supervised by a sport manager who possesses knowledge as well as managerial, technical, social, creative and other competences. The purpose of the presented research, which involved successful Slovenian sport managers, was to establish which competences are the most important for successful work in the field of sport management. The paper also presents the technical framework for the selected determination of sport management terminology and competences as well as a competence structure model, prepared by the authors. We have found that the human resources management competence most significantly contributes to the success of Slovenian sport managers in the field of general competences. Respondents evaluated the competence of developing a positive working environment as the most important specific competence that supplements general competences.

Key words: *sport management, competence structure, key competences*

KLJUČNE KOMPETENCE SLOVENSKEGA ŠPORTNEGA MENEDŽERJA

IZVLEČEK

V prispevku predstavljamo rezultate raziskave, s katero smo proučevali ključne kompetence za področje menedžmenta v slovenskem športu. Uspešnost športnih organizacij in športnikov temelji na ustvarjalnem, inovativnem in kakovostnem strokovnem delu zaposlenih ali/in prostovoljcev. Njihovo delo načrtuje, organizira, vodi in nadzoruje športni menedžer, ki ima poleg znanja tudi vodstvene, tehnične, socialne, ustvarjalne in druge kompetence. Namen predstavljene raziskave, v kateri so sodelovali uspešni slovenski športni menedžerji, je bil ugotoviti, katere kompetence so najpomembnejše za uspešno delo na področju športnega menedžementa. V prispevku je poleg ugotovitev predstavljen teoretični okvir izbrane opredelitve pojmov športnega menedžmenta in kompetenc ter avtorsko oblikovan model strukture kompetenc. Ugotovili smo, da na področju splošnih kompetenc k uspešnosti slovenskih športnih menedžerjev najbolj prispeva kompetenca sposobnosti ravnanja z ljudmi. Kot najpomembnejšo specifično kompetenco, ki dopolnjuje splošne kompetence, so anketiranci ocenili kompetenco razvijanja pozitivnega delovnega okolja.

Ključne besede: *športni menedžment, struktura kompetenc, ključne kompetence*

INTRODUCTION

In the past decade, the situation in the sport labour market has been, as it has been elsewhere, rapidly and profoundly changing. On the one hand, in the case of global competition, employers strive to acquire top qualified experts who know how to appropriately predict market trends and how quickly they can react and, together with their teams, to change the demands, needs and expectations of buyers. On the other hand, employees want to improve their work performance competences and, consequently, to improve their employability and job position as well as their economic and social status. Studying sport organisations shows that organisations make up a relatively sensitive system, since they require qualified sport managers to achieve success in overall management. A modern sport organisation requires a sport manager that is able to respond rapidly, adapt and be flexible and who has developed the most important competences for fulfilling the expectations and demands of sport services users (employed in sport organisations) and the interests of owners. Since the key competences for successful sport management still remain a professional issue, a founded necessity for scientific consideration of competencies exists, since it could explain the competence structure for successful work in the field of sport management. There is no general definition that would clearly define the term management in sports. Therefore, we

summarised a definition from various sources (Chelladurai, 1994; Bednarik, Kolenc, Petrović, Simoneti, & Šugman, 1998; Šugman, Bednarik, & Kolarič, 2002; Tušak & Tušak, 2001; Retar, 2006; Jurak, 2006; Kolar, Jurak, Bednarik, & Kolenc, 2007; Svetlik & Zupan, 2009, Verle & Markič, 2012): "*Management in sports is a process of key resources management and cooperation with important stakeholders, and which enables efficient realisation of business and sports goals of an organisation and/or sportsman in all management functions."*

There are several competence determinations that play an important role in the management of today's organisations. Competences have become a modern tool that assists in efficient human resources management. Individuals can only be successful at work if they possess knowledge as well as skills to use the aforementioned knowledge as well as acquired experience, motivation, beliefs, habits and values, in one word: competences. Lipičnik (1998) states that "man's success depends on their skills, knowledge and motivation*"*, Muršak (1999) defines competences as the "*co*nsequence of an individual's concrete practical experience, which is proven when the acquired theoretical or practical knowledge can be used in practice*"*, Vukasovič-Zontar and Korade Purg (2008) state that "desired knowledge and management are the skills and abilities of an individual, thus conditioning the successful performance of work and tasks within the scope of a job in a concrete business environment". Along with general competences, in today's society knowledge must be accompanied by new special competences in connection with human resources management on all organisation levels. Therefore, a new aspect of management is being formed – management as the collection of competences that present values, knowledge and skills and which have to be proven through successful managerial cooperation (Verle & Markič, 2012). For the purposes of our research, we have summarised the term competence as *the ability to apply knowledge, skills, personal characteristics, experience and motivation in order to uniquely and efficiently perform an expected type of work or task*. According to Kodelja (2005), the essence of a competence is not the key question today, but rather, which competences are essential. The competence-based approach has both advantages and weaknesses. Training merely in the field of key competences can result in the reduced professional and work autonomy of a sport manager, who will only be qualified for certain tasks and will not possess the required range of knowledge for fast adaptation to the sport labour market (Retar & Plevnik, 2012).

Jurak (2006) and Bednarik, Kolenc, Petrović, Simoniti and Šugman (1998) emphasise the fact that generally, volunteers with an inappropriate amount of professional knowledge are the ones dealing with sport organisation management highlighting it as the main problem of Slovenian sport management. More than one third of volunteer workers in sports do not have the appropriate professional education. An average Slovenian sport manager harmonises the work of various people, and this is mostly done on a voluntary basis (Jurak, 2006). This type of work is mostly conducted by presidents (67.4 %), followed by secretaries (20 %) and others (12.6 %), including coaches, assistant secretaries and treasurers. Kolar, Bednarik, Jurak and Kolenc (2007) have found that the structure of managerial staff in sport organisations is quite heterogeneous ac-

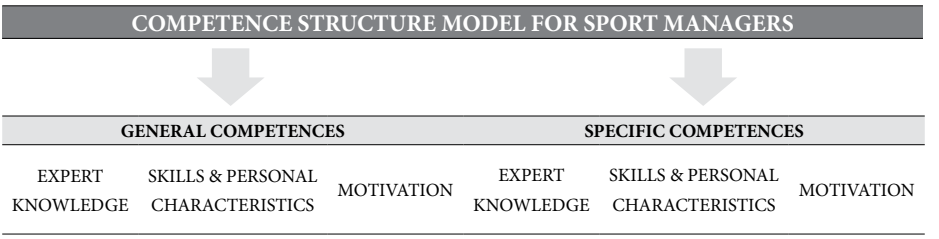
cording to their roles in organisations (companies) as well as according to their education and experience, and also the development of competences.

Based on a study of various works, (Pfeffer, Hatano, & Santalainen, 1995; Oeij & Weizer, 2002; Laval 2005; Juceviciene & Lepaite, 2005; Šubic Kovač & Istenič Starčič, 2006; Istenič Starčič & Vonta, 2010; Kolar, Jurak, Bednarik, & Kolenc, 2007; Hozjan 2009; Retar & Plevnik, 2012; Verle & Markič, 2012) we have formed a theoretical competence structure model for a sport manager. Based on the literature we can summarise that the general knowledge, motivation, values and standing points of sport managers support their competences for sport organisation management. The sport managers competences can be divided into general and specific competences that determine the expert knowledge as well as the abilities and personal characteristics in three important fields of work: sport, management, as well as research and development.

We started by applying the findings of authors Verle and Markič (2012) who have found that a new and modern insight into successful management as a range of competences is possible. They confirm that we can form a tool that enables insight into successful management based on the appropriate range of competences. The first goal of our study was to form a range of relevant competences, variables, and to compare them with similar models. In the formation of a range of competences, we relied on reference research in the field of sport management study (Kolar, Jurak, Bednarik, & Kolenc, 2007; Verle & Markič, 2012; Retar & Plevnik 2012; Šubic Kovač & Istenič Starčič, 2006; Istenič Starčič & Vonta, 2006; Pfeffer, Hatano, & Santalainen, 1995; Laval, 2005). We also considered the NASPE-NASSM American independent accreditation organisation's model, which set the standards for assessing education programmes in sport management.

Based on the most general definition of the term "competences" (i.e. that they embody the knowledge, skills, personal characteristics and motivation of an individual to efficiently perform a certain task) we used the presented competence model to determine the required expert knowledge, skills and personal characteristics that enable work in sport management (Figure 1).

Figure 1: The basic theoretical competence structure model for sport managers



Then we distributed them according to the set connected with sports, management and research. We decided to implement this division on the basis of certain authors (Kolar, Jurak, Bednarik, & Kolenc, 2007; Slack, 1997) who state that a wide structure

of various types of knowledge in the field of sport management as well as in the field of social and economic role and sport organisation is required for successful and efficient work in the field of sport management. According to both practice and literature, competences were divided in two groups: general and specific competences; this distribution was formed into a theoretical competence structure model of a Slovenian sport manager (Table 1).

Table 1: The theoretical competence structure model of a Slovenian sport manager

			AREAS		
			SPORT	MANAGEMENT	RESEARCH & DEVELOPMENT
COMPETENCES	GENERAL COMPETENCES	EXPERT KNOWLEDGE	Basic knowledge in sport profession.	Basic knowledge about management.	Knowledge of IT basic. Foreign language.
		SKILLS & PERSONAL CHARACTERISTICS	Ability to apply knowledge in practice.	Ability to cooperate with people.	Ability to conduct research. Oral and written communication in mother tongue. Ability to cooperate in an interdisciplinary group. Ability to create new ideas. Criticism and self-criticism.
		MOTIVATION			Motivation for lifelong learning.
	SPECIFIC COMPETENCES	EXPERT KNOWLEDGE	Sustainable planning and implementing business processes of producing sport services.	Understanding marketing and brand management in sports. Sport infrastructure management. Financial resources management and the knowledge to resolve financial problems. Mastering project management. Analysing work processes, jobs, designing work and tasks. Organising work and delegating tasks. Introduction to work. Understanding ethical and expert obligations.	
		SKILLS & PERSONAL CHARACTERISTICS	Recognising talented sportsmen and adaptation to their specialties. Understanding and realising business goals. Representing professional and moral authority. Establishing partner relationships. Readiness for changes needed for improvement of operations.	Designing appropriate strategy for conflict management and stress situation management. Employing and selecting candidates for jobs. Public relations, communication with the media and key stakeholders. Developing a positive working environment. Stimulating for work, supervision, awarding and forming success rate indicators. Taking responsibility for co-workers, the environment, the society with regards to the results of their work.	
		MOTIVATION		Striving to operate on the basis of good business relations.	Cooperation in research projects.

METHODS

We designed a survey for research purposes and thus interviewed sport managers, used descriptive statistics to establish the general socio-economic characteristics of respondents (gender, age, education level, period of employment and work post) and eliminated the most important competences according to their opinions. The data was processed using SPSS software.

Sample of respondents

The criteria for sample selection were determined on the basis of research results, performed by Jurak (2007). The research sample included sport managers who professionally perform the work and tasks of a sport manager or work related to sport management in an organisation for at least one year. The following condition for the inclusion in the survey was that the sport organisation had 100,000 EUR of annual income and at least one employee.

The sample of the interviewed sport managers did not show any deviation from the stereotype deviation that sport is managed by men. The sample only included 8.2 % females. The age structure of the respondents showed that the average age of an interviewed Slovenian sport manager is 45 years and 4 months, whereas the youngest respondent was 28 years and the oldest was 65 years old. Only 5.9 % of the respondents were older than 60 years. The majority of the respondents, 68 %, fell in the age range from 30 to 50, which explains the fact that Slovenian sport managers are middle-aged. The survey included respondents from 27 Slovenian places. As expected, the majority, 36, were from Ljubljana, which presents 42.4 % of all the respondents, since the largest sport organisations are located in Ljubljana. They were followed by the respondents from Koper (11.8 %), Nova Gorica (7.1 %), Maribor (4.2 %) and Kranj (4.2 %) as well as other places with two or one respondent.

Data collection

The data was collected with a survey questionnaire in electronic form, which was sent to official electronic addresses of 150 selected sport managers, and after numerous requests we were able to acquire 85 managers who agreed to cooperate. It proved that the anticipated problem in the research realised, i.e. that there would be limitations in collecting important information such as the relevance of personal work competences, since managers do not want or may not reveal sensitive data. The reliability of the questionnaire was calculated with a reliability test that showed, considering the questionnaire structure that was based on the study of standpoints, relatively high values for general (Cronbach's Alpha = 0.790) as well as specific competence (Cronbach's Alpha = 0.790). The importance of competence was evaluated by the respondents by

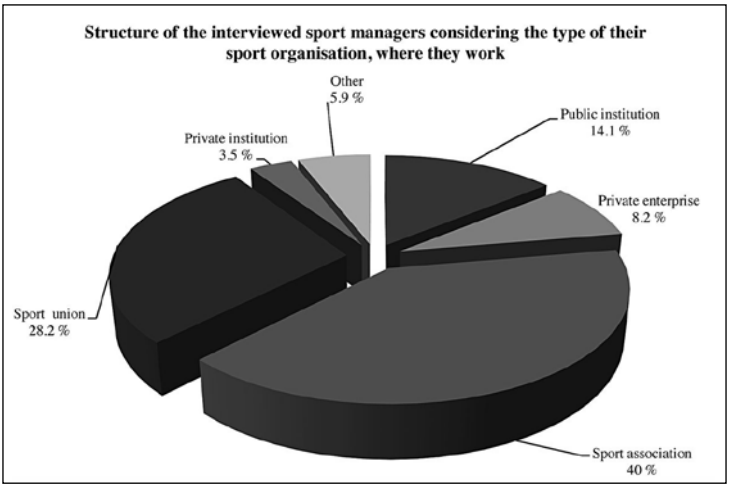
using a 6-grade assessment scale, with values ranging from 1 (not important) to 6 (very important). By selecting the 6-grade scale the authors tried to avoid the possibility of the respondents to choose medium and socially acceptable grades.

RESULTS AND DISCUSSION

The research was conducted in order to establish some features of Slovenian sport managers structure and to establish the model of general and specific competence for successful work in the field of sport management, as determined by the Slovenian managers.

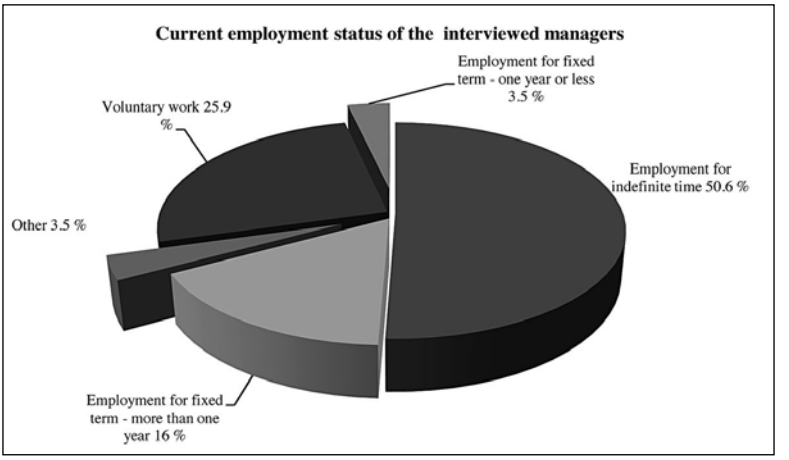
The question regarding the length of the respondents' employment at their sport organisation was answered by 16.5 % of the respondents that they had been working at the organisation for 3 years; the second largest group, i.e. 10.2 % of the respondents answered that they had been working for 20 years. The data show that 17.6 % of the respondents were employed as presidents of sport organisations, 16.5 % of the respondents stated that they worked as sport directors, 16.5 % of the respondents performed the work and tasks of a secretary or a treasurer of a sport organisation, 9.4 % of them worked as sport managers, 12.9 % of them worked as coaches and managers at the same time, which shows that the work of a Slovenian sport manager is very heterogeneous considering the diverse work posts, where the respondents worked and implemented management functions.

Therefore, we can conclude that 82.3 % of the respondents were employed in the public sector and civil society, while the remaining employees worked in private sector, which is the typical type of organisation in Slovenian sport that is based on sport associations (Graph 1).



Graph 1: The structure of the interviewed sport managers considering the type of sport organisation, where they work.

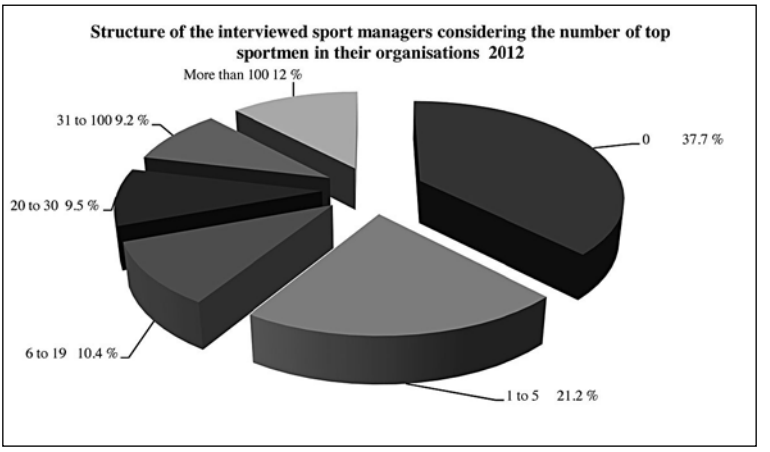
Most respondents had university education. Only 21.2 % of them had high school education; 43.5 % of the respondents achieved higher or university level; 5.9 % of them were Doctors of Science; 8.2 % of the respondents were Masters of Science; 8.2 % of them had high/professional education and 12.9 % higher formal education. 50.6 % of the respondents were employed for indefinite time, therefore, we can assume that there is a need for regular and permanent employment of sport managers in sport organisations (Graph 2). It is also evident that 25.9 % of the sport managers in Slovenia perform work on a voluntary basis.



Graph 2: The current employment status of the interviewed managers.

More than half, 52.9 % of the respondents answered the question about the total income of their organisation in 2012 that the total annual income of the organisation amounted to between 100,000 EUR and 300,000 EUR. The data show that slightly more than a half of the respondents were employed in organisations with relatively moderate annual budgets. Only 7.1 % of the respondents replied that their organisation's income ranged between 300,000 EUR and 500,000 EUR; 16.5 % of the respondents replied that the income of their organisation was between 500,000 EUR and 1,000,000 EUR. 23.5 % of respondents replied that their sports organisation had more than 1,000,000 EUR of annual income in 2012. We can conclude that the sport managers from moderate as well as financially better-off Slovenian sport organisations cooperated in the survey.

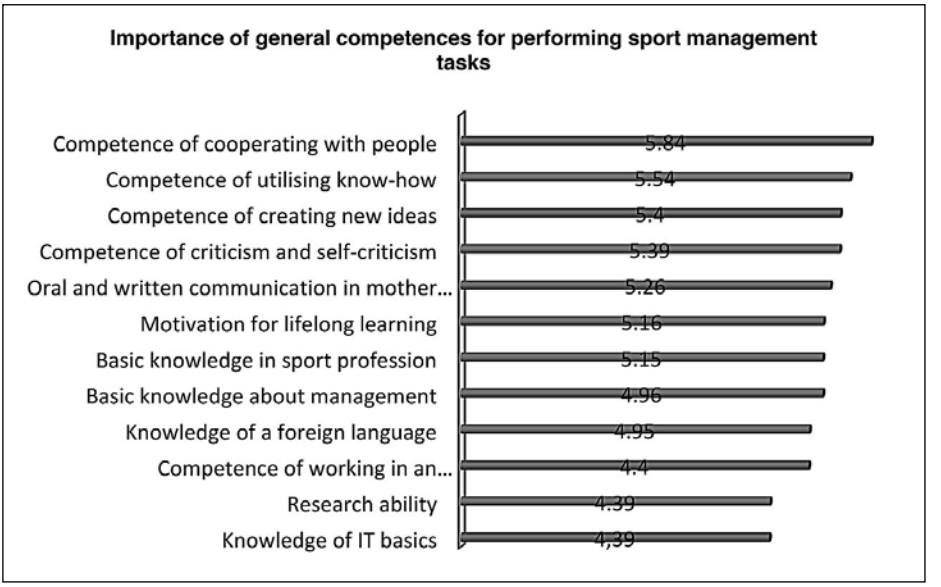
Only 37.7 % of the respondents replied to the question about the number of top sportsmen categorised on the basis of the Slovenian Olympic Committee's categorisation in 2012, i.e. that no such sportsmen were categorised in their sport organisations (Graph 3).



Graph 3: The structure of the interviewed sport managers considering the number of top sportsmen in their organisations in 2012 (categorised on the basis of Slovenian Olympic Committee's categorisation).

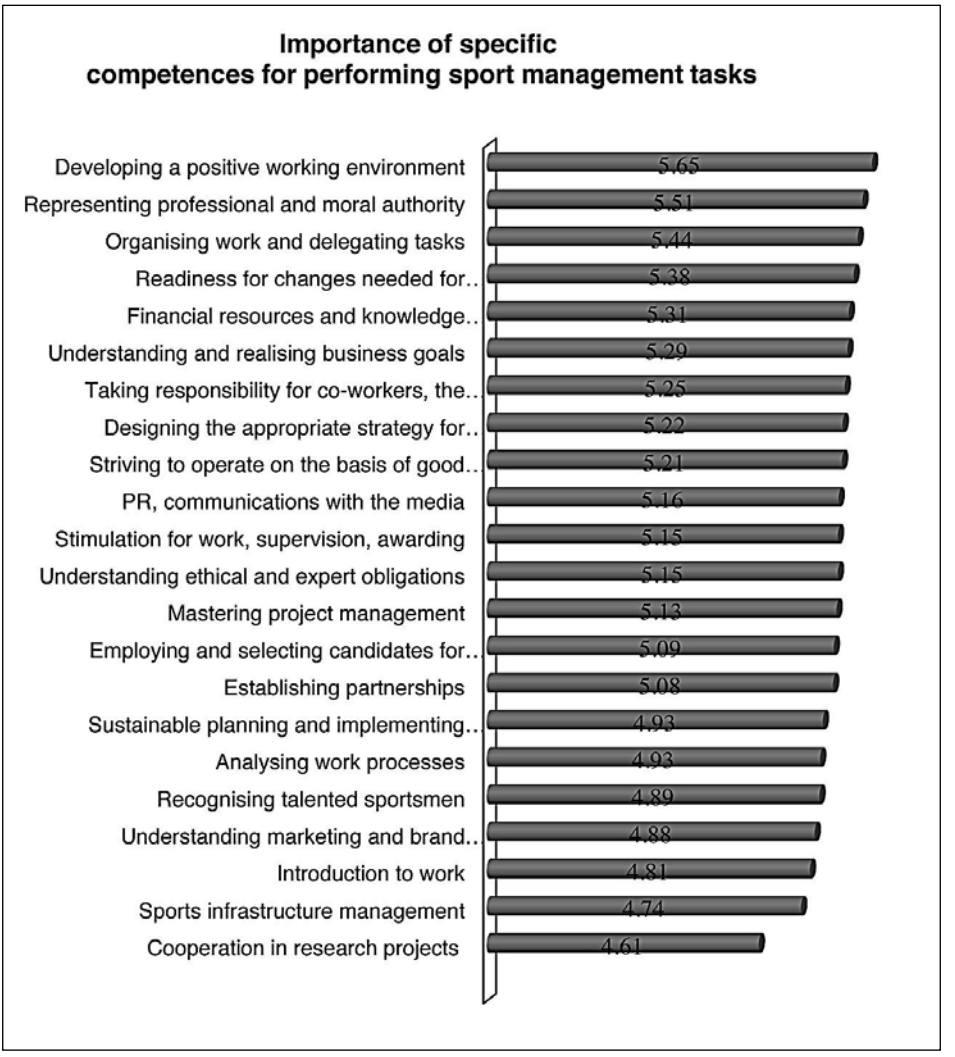
The survey also contained a theoretical model of competence structure, therefore, we asked the respondents to evaluate with grades from 1 (not important) to 6 (very important) the general and later also the specific competences that are typical for performing the tasks of a sport manager. The respondents emphasised that the most important competence was human resources management ability (grade 5.84). The structure of importance of general competences is presented in Table 2.

Table 2: The evaluation of the most important general competences for performing the tasks of a sport manager as assessed by the interviewed Slovenian sport managers.



We also asked them to evaluate specific competences for performing the tasks of a sport manager (Table 3). The respondents believe that the most important specific competence is the competence of developing a positive working environment (grade 5.65).

Table 3: The evaluation of the most important specific work competences for performing the tasks of a sport manager as assessed by the interviewed Slovenian sport managers.



CONCLUSION

The current world crisis is also the crisis of management. More than ever before, management and managers are being tested, since the old recipes for achieving success do not work anymore. Managers face many new challenges like sustainable development, exceptional competition, demanding buyers, aware and competent human resources, technological progress, thus demanding from them to acquire new compe-

tences through lifelong learning. The classic role of a sport manager, who must organise and supervise, is replaced by innovation and efficient human resources management.

Since competences are important for explaining individual's managerial success and because of the emergence of importance of individual differences for work efficiency, the modern successful managers are refocusing to the recognition and development of the most important competences for successful management in sport, thus strengthening the competitiveness of the organisations they manage. The acquired empirical findings show that the **development of a positive working environment, working and acting as a professional and moral authority as well as appropriate organisation and delegation of tasks** are of key importance for Slovenian sport managers. The competences involving the **ability to cooperate with people and use the acquired knowledge in practice as well as the ability to create new ideas** are also very important.

REFERENCES

Bednarik, J., Kolenc, M., Petrović, K., Simoneti, M., & Šugman, R. (1998). Ekonomski pomen slovenskega športa – vidiki organiziranosti in financiranja športnih organizacij v Sloveniji. Ljubljana: Fakulteta za šport, Inštitut za šport.

Chelladurai, P. (2001). Managing organizations for sport and physical activity. Scottsdale: Holcomb Hathaway Publications.

Hozjan, D. (2009). Key competences for the development of lifelong learning in the European Union. European journal of vocational training, 44(1), 196–207.

Istenič Starčič, A., & Vonta, T. (2010). Mentorstvo na delovnem mestu – ocena učinkov sodelovanja v mentorskih timih in e-portfoliu na razvoj splošnih kompetenc. Vzgoja in izobraževanje, 41(6), 38–43.

Juceviciene, P., & Lepaite, D. (2005). Competence as derived from activity: the problem of their level correspondence. Kaunas: University of Technology. Institute of Educational Studies.

Jurak, G. (2006). Značilnosti vodenja prostovoljcev v športnih organizacijah v Sloveniji. Magistrsko delo. Ljubljana: Univerza v Ljubljani, Ekonomska fakulteta.

Jurak, G. (2007). Nekateri kazalniki uspešnosti športnih organizacij v Sloveniji. Koper: Univerza na Primorskem, Znanstveno-raziskovalno središče, Inštitut za kineziološke raziskave, Založba Annales.

Kodelja, Z. (2005). Šola ni podjetje. Neoliberalni napad na javno šolstvo. Lavalova kritika neoliberalne doktrine izobraževanja. Ljubljana: Krtina.

Kolar, E., Jurak, G., Bednarik, J., & Kolenc, M. (2007). Struktura znanj športnega menedžerja. Šport, 55(supl. 2), 40–48.

Laval, C. (2005). Šola ni podjetje. Neoliberalni napad na javno šolstvo. Ljubljana: Krtina.

Lipičnik, B. (1998). Menedžment z ljudmi pri delu (Human Resources management). Ljubljana: Gospodarski vestnik.

Muršak, J. (1999). Kvalifikacije, kompetence, poklici: poskus sinteze. Ljubljana: Sodobna pedagogika, 50(2), 28–45.

Oeij, P., & Weizer, N. (2002). New Work Organization, Working Conditions and Quality of Work: Towards the Flexible Firms. Luxembourg: European Foundation for the Improvement of Living and Working Conditions.

Pfeffer, J., Hatano, T., & Santalainen, T. (1995). Producing the sustainable competitive advantage trough the effective management of people. New York: The Academy of Management Executive, 9(1), 55–72.

Retar, I., & Plevnik, M. (2012). Kaj delodajalci v športu pričakujejo od izobraževalcev? Didakta, 22(1), 52–54.

Retar, I. (2006). Uspešno upravljanje športnih organizacij. Koper: Univerza na Primorskem, Znanstveno-raziskovalno središče Koper, Inštitut za kineziološke raziskave, Založba Annales.

Slack, T. (1997). Understanding Sport Organizations. The Aplication of Organization Theory. Champaign: Human Kinetics.

Svetlik, I., & Zupan, N. (Eds.) (2009). Menedžment človeških virov. Ljubljana: Fakulteta za družbene vede, 191–279 and 409–466.

Šubic Kovač, M., & Istenič Starčič, A. (2006). Kompetence diplomantov gradbeništva – evropski raziskovalni projekt Tuning. Gradbeni vestnik, 55, 178–186.

Šugman, R., Bednarik, J., & Kolarič, B. (2002). Športni menedžment, Ljubljana: Univerza v Ljubljani, Fakulteta za šport.

Tušak, M., & Tušak, M. (2001). Psihologija športa. Ljubljana: Znanstveni inštitut Filozofske fakultete.

Verle, K., & Markič, M. (2012). Kompetence vršnih menedžerjev in organiziranost kot osnova uspešnosti organizacije. Koper: Univerza na Primorskem, Fakulteta za menedžment.

Vukasović-Žontar, M., & Korade Purg, Š. (2008). Ključne kompetence zaposlenih v praksi. Maribor: Forum Media.

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THE RELATIONSHIP BETWEEN CHILDREN'S PHYSICAL FITNESS AND GENDER, AGE AND ENVIRONMENTAL FACTORS

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ABSTRACT

The main aim of the research was to determine how children's physical fitness development is related to age, gender, and certain environmental factors at the onset of puberty. The research was carried out on a representative sample of 897 children (47.9 % females and 52.1 % males) aged eleven and fourteen. Twelve tests were used to assess their physical fitness. Based on the duration of the physical activities, the children were divided into four categories: inactive, occasionally active, active and highly active. In the case of paternal education and maternal education, the children were classified into three categories: low, average and high. Considering their school grades in mathematics, the children were divided into three groups: less successful, successful and very successful. In the case of their place of residence, the children were divided into three groups: urban, suburban and rural. A component model of factor analysis was used to identify their basic coordinate system of physical fitness. To solve the problem of the integration of physical fitness into environmental factors, age and gender, a factorial analysis of variance was used. The results show that most of the differences in physical fitness can mainly be explained through age and gender. We can conclude that the significant factors to physical fitness development are growth, development and the maturation rate of individuals, which are predominantly hereditarily determined. Place of residence, physical activity, school grades and parental education have less influence on physical fitness development and serve only as an additional impulse to further stimulate or inhibit the physical development of children.

Keywords: *physical fitness development, environment, factorial analysis of variance, effect size.*

POVEZANOST GIBALNE UČINKOVITOSTI OTROK S SPOLOM, STAROSTJO IN OKOLJSKIMI DEJAVNIKI

IZVLEČEK

Osnovni cilj raziskave je bil ugotoviti, kako je gibalna učinkovitost otrok povezana s starostjo in spolom ter z nekaterimi okoljskimi dejavniki na začetku pubertetnega obdobja. Raziskava je bila opravljena na reprezentativnem vzorcu 897 otrok starih enajst in štirinajst let. Za oceno gibalnih sposobnosti je bilo uporabljenih 12 testov. Merjenci so bili na osnovi časa, ki ga namenjajo športni dejavnosti, razdeljeni v štiri kategorije: nedejavne, občasno dejavne, dejavne in zelo dejavne. Na osnovi izobrazbe očeta in matere so bili merjenci razvrščeni v tri kategorije: nižja, srednja in višja. Na temelju ocene pri matematiki so bili merjenci razdeljeni v tri skupine: slabši in povprečni, dobri, zelo dobri. Na osnovi kraja bivanja so bili merjenci razdeljeni v tri skupine: mestno, primestno in podeželsko. S komponentnim modelom faktorske analize smo v prostoru gibalnih sposobnosti opredelili bazični koordinatni sistem. Za reševanje problema povezanosti gibalnih sposobnosti z okoljskimi dejavniki, starostjo in spolom je bila uporabljena večfaktorska analiza variance. Glede na dejstvo, da največji del razlik v gibalnih sposobnostih merjencev pojasnjujeta starost in spol, lahko ugotovimo, da so ključni dejavniki razvoja gibalnih sposobnosti rast, razvoj in hitrost zorenja posameznika, ki so pretežno dedno determinirani. Kraj bivanja, športna dejavnost, učna uspešnost in izobrazba staršev imajo na gibalno učinkovitost bistveno manjši vpliv in predstavljajo le dodatni impulz, ki dodatno spodbudi ali zavira gibalno učinkovitost otrok.

Ključne besede: *razvoj gibalnih sposobnosti, okolje, večfaktorska analiza variance, velikost učinka*

INTRODUCTION

The health of the adult population is closely related to health in childhood, and the health of children depends on their physical activity, physical fitness, and motoric skills, while mental health also depends on physical and motoric self-concepts (Jürimäe & Jürimäe, 2001; Eisenmann, Wickel, Welk, & Blair, 2005; Janssen & LeBlanc, 2010). A high level of physical fitness is a positive criterion of health level, while regular physical activity of appropriate intensity, frequency, type, and duration increases physical fitness (Mišigoj-Duraković, 2003). Through play and physical activities, children learn the limits of their physical fitness and improve their motoric efficiency.

The development of children and adolescents occurs integrally, dynamically, con-

tinuously, and according to certain rules. It depends on the hereditary predispositions, the environment we live in, and one's physical activity. Physical activity is one of the key stimuli of children's growth and development in the period before puberty (Jürimäe & Jürimäe, 2001; Malina, Bouchard, & Bar-Or, 2004; Brettschneider & Naul, 2007). Delemarre-van de Waal (1993) claims that growth and development depend on hereditary and environmental factors that are complexly intertwined into a grid. Environmental factors can be understood as the physical and social environment that is related to the person (Stokols, 1992). Environmental factors include geographic, climate, social, economic, cultural, family, and nutritional factors as well as lifestyle and physical activity. They are interrelated and affect a person's growth and development (Pařízková, 2010). Genetically conditioned factors and environmental influences present the basis for the development of a person's abilities and characteristics. We can influence the genetically conditioned factors in different ways and by the application of different contents, whereas we have to be aware that the influence is never divided and it integrally influences the bio-psychosocial image of the child and adolescent (Strel & Kovač, 2004).

Researchers from different fields are trying to uncover the essence of and causes for the connection between individual abilities, characteristics, and features as systematically, integrally, and objectively as possible as well as attempting to establish how an individual and their surroundings influence each other. An individual's behavior is influenced by intrapersonal factors (biological, psychological), interpersonal factors (social, cultural), organizational factors, social community, physical environment, and politics (Sallis, Owen, & Fisher, 2008; Van Tuyckom, 2011). Most features of today's information-consumer society deter children from healthy lifestyles and physical activity. Children are most susceptible to the various technological novelties that chiefly enable a comfortable lifestyle in front of computers and televisions (Bar-Or et al., 1998; Jurak, 2006), while simultaneously alienating children from their environment and physical activity. In Slovenia, according to the HBSC1 data from 2001 and 2002, more than half of boys and girls aged eleven through fifteen were insufficiently physically active (Janssen et al., 2005). One of the factors that can tip the scale, decrease the negative influence of the modern lifestyle, and ensure the balance of psychical and physical development of children is physical education class in school in combination with other extracurricular and leisurely sports activities. Sports activities, which stand out from other physical activities due to its higher intensity and target orientation towards improving well-being, health, physical fitness, and physical components, influences the biological, psychical, and social components of an individual's personality (Strel et al., 2003). The system of a person's psychosomatic dimensions can be understood as an organized, open, and dynamic system composed of subsystems that are intertwined in continuous co-dependency.

There have been several researches conducted globally in the field of physical fitness and motoric development in primary school children (Bouchard & Shepard,

1 Health Behaviour in School-Aged Children Study

1994; Baunen & Malina, 1996; Jürimäe & Jürimäe, 2001; Malina, Bouchard, & Bar-Or, 2004). The connection between physical fitness and physical activity, the children's social status, and success in school has been studied somewhat less, whereas the findings of the researchers often differ (Jürimäe & Jürimäe, 2001; Malina, Bouchard, & Bar-Or, 2004). The main reason definitely lies within the complexity and intricacy of the individual areas and the connections between them. Additional reasons can also be found in the fact that, in the case of children, there is a gap between chronological and biological age, which causes extreme difficulty in the evaluation and interpretation of the results, as for some, this is still a period of pre-puberty and, for others, a period of puberty. Non-harmonized measuring procedures for determining physical fitness also cause significant problems (Jürimäe & Jürimäe, 2001). Until now the research concerning the correlation between physical fitness and physical activity, social status, and success in school (in boys and girls) has not been conducted, therefore it is reasonable to research the relationships between physical space and the aforementioned environmental factors, age and gender.

The basic purpose of this research is to determine in what way motoric development is related to age, gender, and certain environmental factors, namely in the case of sports activities, paternal education, maternal education, success in school and place of residence during the period of slower growth and at the onset of puberty.

METHODS

Participants

Female and male individuals who turned 11 and 14 in the six months before or after October 1, 2003 were included in the research. The actual sample includes 897 children, of which 467 are boys and 430 are girls. There are 450 children in the age group of eleven-year-olds and 447 children in the age group of fourteen-year-olds. The assessments were performed only on those pupils who were healthy on the day of the assessment. The subjects' parents gave their written consent for their children to be included in the research. The entire sample was divided according to regions and selected randomly within regions. The chosen schools were from larger and smaller towns (Metlika, Trebnje, Žalec, Trbovlje, Ormož, Ljubljana, Izola, Tolmin, Jesenice, and Ravne na Koroškem) where the assessments had been performed since 1970.

Measurments

Physical fitness assessment. The selection of the group of tests for physical fitness assessment of the studied sample of subjects was based on the hypothetical model by Strel et al. (1992). Hypothetically, the tests belong to nine different latent dimensions of physical fitness space. The research included 12 tests: hand plate tapping for

20 seconds, standing broad jump, 60-meter run, hands drumming, shoulder flexibility, forward bend, flamingo balance test, sit-ups in 60 seconds, bent arm hang, polygon backwards, 20-meter endurance shuttle run, and 600-meter run. We decided to use only the tests that, according to the previous researches (Kovač, 1999), are representative for individual motoric dimensions. The subjects performed two repetitions of energetically less demanding tests, whereas the second repetition was used in data analysis. Only one repetition of energetically more demanding tests was performed.

Physical activity assessment. Other methods of physical activity assessment might be more accurate (Jürimäe & Jürimäe, 2001), but the use of a questionnaire enables working with larger samples. For assessing physical activity, the adopted questionnaire of Strel et al. (1992), was used. Based on the duration of moderate to vigorous physical activity, we divided the subjects into four categories: inactive (up to 3 hours/week), occasionally active (from 3 to 6 hours/week), active (from 6 to 9 hours/week), and highly active (more than 9 hours/week).

Social status assessment. Social status of children can be defined in several ways and considering numerous parameters, but it is frequently the education of the "dominant" parent that is the base for determining a child's social status (Malina, Bouchard, & Bar-Or, 2004). Based on paternal and maternal education, the subjects were classified in three categories: low (unfinished primary school, primary school), average (vocational school, 4-year secondary school), and high (bachelor's degree or more).

*Academic achievement assessment. T*here are numerous methods for determining academic achievement: standardized national tests for academic achievement, literacy, knowledge of arithmetic, reading skills, subjective knowledge assessments by the subjects, subjective assessments by the teachers or principles, grade average, general academic achievement, and mathematics grade (Trudeau & Shepard, 2008). Reading skills and especially the knowledge of mathematics in the early educational period are the most reliable indicators of a general academic achievement, i.e. school performance in the higher grades (Duncan et al., 2007). For this reason, in our research we also decided to define the general academic achievement based on the grade in mathematics. Based on the grade in mathematics the subjects were divided in three groups: less successful (grades 1, 2, or 3), successful (grade 4), very successful (grade 5).

Residence. Based on the place of residence the subjects were divided in three groups: urban (Ljubljana, Ravne, Trbovlje, Jesenice), suburban (Žalec, Izola, Trebnje), and rural (Metlika, Ormož, Tolmin) as was defined in previous researches (Strel, 1992).

Research design

The assessments were performed at primary schools in September and October 2003. The parents of all the subjects were acquainted with the purpose and the course of assessment and gave written consent prior to the assessment. At the end of the 2002/03 school year all the schools included in the sample were informed of the purpose and the performance of the assessment. No later than ten days before the start of the assess-

ment, they received the instructions and the assessment program; after that an interview with the coordinator was conducted at each school and the course of the assessment was harmonized. The assessment took place in favorable weather conditions and normally in good material conditions. It was performed in indoor and outdoor school facilities at the temperature between 16 and 24 °C. The assessment took place outdoors only if there was no rain or strong wind. The order of motoric tests was precisely defined and subjects had no systematically organized warm-up between individual assessments. However, they were allowed a practice run of individual tasks before the assessment. The subjects were divided into smaller groups to perform the motoric tests and they stayed in these groups during the whole assessment. Prior to performing the tasks, the subjects received detailed instructions from the examiners on how to perform the individual tasks. During the task performance, the examiners did not encourage the subjects. In case of an incorrectly performed task the subject had to repeat it. The assessments took place between 8 a.m. and 5 p.m. and only exceptionally before and after that period. The assessments took two or three days at an individual school. All the physical fitness assessments were completed on the first day, except the long distance run that was performed on the second day. An overall assessment time for each child was not longer than one hour.

Data Analyses

Before carrying out data analyses, screening procedures tested the parametric tests assumptions (normality, linearity). The Kolmgorov-Smirnov test showed that the distributions of hand plate tapping for 20 seconds, standing broad jump, 60-meter run, hand drumming, shoulder flexibility, forward bend, flamingo balance test, sit-ups in 60 seconds, bent arm hang, polygon backwards, 20-meter endurance shuttle run, and 600-meter run values statistically significantly deviate from normal distribution, therefore the transformation of data was performed. In the physical fitness space we separately defined the basic coordinate system with the component model of factorial analysis. Firstly, the Bartlett test was conducted to establish if the correlations between the variables are high enough to present a good basis for component analysis. And secondly, the Kaiser-Mayer-Olkin (KMO) measure was determined, and the variables communalities were calculated. With the Principal Component Analysis method we determined the component eigenvalues and the percentages of the explained variance. We limited the extraction to one component presenting the condensation of all variables in one dimension which carries most information we could gain from this set of variables. After determining the principal component, we analyzed the factor saturations of manifest variables vectors with the first main component of the physical fitness space. To solve the problem of physical fitness integration with some environmental factors, gender and age, we chose the multifactor analysis of variance. We limited the interpre-

tation of statistically significant interactions of environmental factors (sports activities, paternal and maternal education, place of residence, and academic achievement), gender, and age with the first principal component in the physical fitness space to two factors. Statistical significance was set at the α level of 0.05.

RESULTS

Principal Components of the Physical Fitness Space

The value of Kaiser-Mayer-Olkin (KMO) measure is 0.885, which points to the justified use of the component analysis in the physical fitness space. The value of Bartlett test is statistically significant (p = 0.000) which points to the fact that the correlations between the variables are high enough to present a good basis for the component analysis. Based on the component analysis there were twelve components extracted in the physical fitness space, but only the first component eigenvalue (λ = 4.580), the second component eigenvalue (λ = 1.388), and the third component eigenvalue (λ = 1.132) were higher than one. Given the fact that the first component explains 38.165 % of physical fitness variance and the second and third only 11.563 % and 9.431 % respectively, we decided to keep only the first extracted component, which we named **physical fitness component**.

Table 1: Final parameters of physical fitness space factorization.

Factors	h^2	λ	%
1	.374	4.580	38.165
2	.711	1.388	11.563
3	.634	1.132	9.431
4	.183	.838	6.985
5	.000	.765	6.379
6	.062	.674	5.619
7	.183	.565	4.709
8	.411	.543	4.527
9	.375	.473	3.941
10	.581	.399	3.324
11	.561	.376	3.136
12	.505	.267	2.221

h^2 = comunality; λ = eigenvalue; % = percentage of the explained variance

Table 2: Saturation of physical fitness variables with physical fitness component (F1).

Physical fitness tests	F 1
Standing broad jump	.843
60-meter run	–.796
Polygon backwards	–.762
20-meter endurance shuttle run	.749
600-meter run	–.711
Sit-ups in 60 seconds	.641
Bent arm hang	.612
Hand Plate tapping for 20 seconds	.611
Hands drumming	.427
Flamingo balance test	–.427
Forward bend	.249
Shoulder flexibility	.017

Table 2 shows the saturation of physical fitness manifest variables with the extracted physical fitness component. The values present the correlation of an individual variable with the physical fitness component. Given the fact that all the values of factor saturation, except the lowest two are higher than 0.40, we can determine that the extracted component represents the whole physical fitness space well. Only in the forward bend and shoulder flexibility variables the values of saturation with the physical fitness component are lower. Given the fact that the tests are representative for flexibility assessments it is possible to conclude that the physical fitness component provides the least information on flexibility.

The relation of age, gender, and environmental factors to the physical fitness space

The presumption of the homogeneity of variances is justified, which is pointed out by the values of Leven test ($F = 0.816$; $p = 0.983$). Therefore, the use of variance analysis is justified.

Table 3: Statistically significant diferences in physical fitness component regarding environmental factors, gender, and age, separately (ANOVA) and the measure of effect size.

Variable		Mean (SD)	ANOVA		
			F	p	η^2
Physical activity	Inactive	–.066 (.154)	1.505	.212	.006
	Occasionally active	.033 (.156)			
	Active	.167 (.157)			
	Highly active	.157 (.156)			
School grade	Less successful	–.097 (.157)	1.758	.173	.004
	Successful	.011 (.143)			
	Very successful	.303 (.211)			
Place of residence	Rural	.080 (.145)	3.017	.050	.007
	Suburban	176 (.150)			
	Urban	–.038 (.144)			
Paternal education	Low	.149 (.246)	0.077	.926	.000
	Average	.079 (.056)			
	High	–.010 (.323)			
Maternal education	Low	–.008 (.317)	.174	.840	.000
	Average	.061 (.085)			
	High	.166 (.193)			
Gender	Male	.284 (.136)	27.538	.000	.033
	Female	–.139 (.144)			
Age	Eleven	–.424 (.142)	145.890	.000	.152
	Fourteen	.570 (.139)			

η2 = effect size

Table 3 shows that the differences in *physical fitness component* between the urban, suburban, and rural children are statistically significant ($F = 3.017$; $p = 0.050$). The children from the suburbs reach the highest values, while the urban children reach the lowest values. More interesting is the fact that the place of residence explains only 0.7 % variance of physical fitness of children. The probability of the proof of statistically significant differences that are not practically important (as shows η^2) increases with

the sample size. Table 3 shows that the differences in the *physical fitness component* with regard to the age are statistically significant ($F = 145.890$; $p < 0.001$). The fourteen-year-old children have higher values than the eleven-year-old ones. The extremely high relation of age and the *physical fitness component* should be pointed out as it explains 15.2 % of the variance of children's physical fitness ($\eta^2 = 0.152$). As the results of the variance analysis show in Table 3, the difference in the *physical fitness component* with regard to gender is statistically significant ($F = 27.538$; $p < 0.001$). The boys have higher values. It must be pointed out that the relation of gender and the *physical fitness component* is substantially lower than the relation of age in spite of the same level of statistical significance and it explains 3.3 % of children's physical fitness variance ($\eta^2 = 0.033$).

DISCUSSION

The findings of our research show that regarding the environmental factors (place of residence, maternal education, paternal education, academic achievement, and sports activity) the subjects differ in the physical fitness with statistical significance only with regard to the place of residence. The children from the suburbs reach the highest values, while the urban children reach the lowest values. More interesting is the fact that the place of residence explains only 0.7 % variance of physical fitness of children. The probability of the proof of statistically significant differences that are not practically important (as shows η^2) increases with the sample size. The share of the explained variance of subjects' physical fitness is extremely low for all the environmental factors and does not exceed 0.7 % (Table 64). In other words, this means that the relation of individual environmental factors (place of residence, maternal education, paternal education, academic achievement, and sports activities) and the differences in the subjects' physical fitness is negligible. The results of our research show that the living conditions in the Slovenian countryside and in the cities are uniformed to the extent that they practically do not generate differences in physical fitness between the urban and rural children. It is frequently presupposed (Sallis, McKenzie, & Alcaraz, 1993; Mountjoy et al., 2011) that sports activity is connected with the level of physical fitness, thus the children more active in sports have a higher level of physical fitness, but the results of this research do not support this. Maline et al. (2004) came to similar findings, namely, that in children and adolescents the connection between the regular sports activity and the physical fitness is relatively low. The quality of planning and teaching the sports activity is also of great importance in the development of physical fitness (Starc & Strel, 2012). Therefore, we speculate that this is also the main reason why our research did not find the differences in physical fitness regarding the amount of physical activity, since we were asking, not only about the organized but also about the voluntary and non-organized physical activity.

The findings of our research show that the subjects' age and gender explain the differences in physical fitness with statistical significance, which is in accordance with the findings of numerous other authors (Strel et al., 2003; Malina et al., 2004; Starc, Strel, & Kovač, 2010). The age thus explains 15.2 % of variance of subjects' physical fitness (Table 3). As expected, the physical fitness component in eleven-year-old subjects is less pronounced than in the fourteen-year-olds. Even though the gender explains the differences in the physical dimensions with statistical significance, it explains only 3.3 % physical fitness variance (Table 3). As expected, the physical fitness component in girls is less pronounced than in boys. The influence of genetically conditioned factors on the physical fitness is higher than the environmental factors influence, whereas it is necessary to point out, same as with the physical characteristics, the influence of age and the differences in the subjects' physical fitness (Matejek, 2013). Pařízková (2010) finds that the children of better-educated fathers have higher endurance and that there is a trend of better results in 500-meter run and standing broad jump, while children do not differ in physical fitness with regard to maternal education, but the results of our research do not confirm this. Tomkinson et al. (2007) found that the weak connections of the different economic status indicators and the amount of physical education with the level of physical fitness suggest that the accessibility of means is not a key factor that influences the level of physical fitness. These findings coincide with the findings from our research which also show that parental education as a measure of socio-economic status as well as the time children spend doing sports activities are not the key generators of the differences in physical fitness.

Given the fact that the majority of differences in subjects' physical fitness is explained by the age factor, we can conclude that the key factors of physical fitness development are growth, development, and the maturation rate. This means that the level of physical fitness changes regardless of whether children receive the incentive from the environment or not. It is the homogeneity of the environment and thus the uniformity of the environmental factors in Slovenia (Atkinson, Marlier, Montaigne, & Reinstadler, 2010; Vrabič Kek, 2012), i.e. relatively small differences in social environments in which children and adolescents grow up, that is of key importance in understanding and interpreting the findings. Therefore, the differences in the various lifestyles of children are not important to the extent that they generate the differences in the motoric development.

CONCLUSIONS

Understanding the significance of genetically determined factors in the motoric development of adolescents and children is one of the main contributions of this research. However, the results must be viewed in a broader context. It is a fact that the Slovenian environment is relatively homogenous. The findings of the European Commission (Atkinson et al., 2010) and the Statistical Office of the Republic of Slovenia (Vrabič Kek, 2012) also point this out, establishing that among all the EU countries Slovenia

has one of the lowest risk of poverty rate as well as one of the lowest inequalities of income distribution among households. This is also due to Slovenia's social aspect with its redistribution function that uses different forms of social transfers to alleviate the distress of households with insufficient incomes. It is the homogeneity of the environment and thus the uniformity of the environmental factors in Slovenia (Atkinson et al., 2010; Vrabič Kek, 2012), i.e. relatively small differences in social environments in which children and adolescents grow up, that is of key importance in understanding and interpreting the findings. Appropriate healthcare, a good education system that includes a sufficient amount of physical education, appropriate diet, and natural goods are accessible to all children and adolescents in Slovenia. All the aforementioned factors are equally available to children from urban, suburban, and rural areas as well as to children of parents with low, average, or high education. Therefore, it is possible to claim that the influence of genetically conditioned factors is predominant as the environment, in which the children grow up, is homogenous enough not to generate further differences in the motoric and physical development. This is a fundamental finding of our research that is becoming even more important in the time of recession and in the context of diminishing social rights. By diminishing the social rights and lowering standards in education and healthcare the differences between certain environments and social groups will increase, which will also influence the physical and motoric development of an individual. The socially underprivileged children that at this point get enough support from the education and healthcare systems in order to adequately develop their genetic potential will be marginalized and will neither be able to follow the privileged peers nor be equally included into society. These findings require additional consideration about the sensibility and justification of the spending cuts at the expense of children's health and development. To a great extent, the results are surprising as they offer a new view of the discussed space, and confirm the claims of Pařízkova (2010) that due to the change of environmental factors and in relation with individual factors resulting from a continuous development, their importance and influence on the individual's growth and development are also changing.

REFERENCES

Atkinson, A. B., Marlier, E., Montaigne, F., & Reinstadler, A. (2010). Income poverty and income inequality. In A. B. Atkinson, & E. Marlier (Eds.), Income and living conditions in Europe (pp. 101–131). Luxembourg: Publications Office of the European Union.

Bar-Or, O., Joreyt, J., Bouchard, C., Brownell, K. D., Dietz, W. H., Ravussin, E., et al. (1998). Physical activity, genetic and nutritional considerations in childhood weight management. Medicine & Science in Sports & Exercise, 30, 2–10.

Baunen, G., & Malina, R. M. (1996). Growth and biological maturation: relevance to athletic performance. In O. Bar-Or (Ed.), The Encyclopedia of Sport Medicine: The Child and Adolescent Athlete (pp. 3–24). Oxford: Blackwell Scientific Publications.

Bouchard, C., & Shepard, R. (1994). Physical activity, fitness and health: the model and key concepts. In C. Bouchard, R. Shepard, & T. Stephens (Eds.), Physical activity, fitness and health: International proceedings and consensus statement (pp. 77–88). Champaign, IL: Human Kinetics Publishers.

Brettschneider, W. D., & Naul, R. (2007). Obesity in Europe: Young people's physical activity and sedentary lifestyles. In W. D. Brettschneider, & R. Naul (Eds.), Obesity in Europe: Young people's physical activity and sedentary lifestyles (pp. 7–26) Sport sciences international, Vol. 4. Frankfurt am Main: Peter Lang.

Delemarre-van de Waal, H. A. (1993). Environmental Factors Influencing Growth and Pubertal Development. Environmental health Perspectives Supplements, 101(Suppl. 2), 39–44.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., et al. (2007). School readiness and later achievement. Developmental Psychology, 43(6), 1428–1446.

Eisenmann, J. C., Wickel, E. E., Welk, G. J., & Blair, S. N. (2005). Relationship between adolescent fitness and fatness and cardiovascular disease risk factors in adulthood: The Aerobics Center Longitudinal Study (ACLS). American Heart Journal, 149(1), 46–53.

Janssen, I., Katzmarzyk, P., Boyce, W., Vereecken, C., Mulvihill, C., Roberts, C., et al. (2005). Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. Obesity Reviews, 6(2), 123–132.

Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. International Journal of Behavioral Nutrition and Physical Activity, 7(1), 40. BioMed Central.

Jurak, G. (2006). Sporting lifestyle vs. »cigarettes & coffee« lifestyle of Slovenian high school student. Anthropological notebooks, 12(2), 79–95.

Jürimäe, T., & Jürimäe, J. (2001). Growth, Physical Activity and Motor Development in Prepubertal Children. Boca Raton, Florida: CRC Press.

Kovač, M. (1999). Analiza povezav med nekaterimi gibalnimi sposobnostmi in fluidno inteligentnostjo učenk, starih od 10 do 18 let. Doktorska disertacija, Ljubljana: Fakulteta za šport.

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). Growth, Maturation and Physical Activity. Champaign: Human Kinetics.

Matejek, Č. (2013). Povezanost telesnih razsežnosti in gibalnih sposobnosti z nekaterimi okoljskimi dejavniki otrok, starih 11 in 14 let. Doktorska disertacija, Ljubljana: Fakulteta za šport.

Mišigoj-Duraković, M. (2003). Uvod. In M. Mišigoj-Duraković, M. Kovač, & J. Strel (Eds.), Telesna vadba in zdravje (pp. 12–13). Ljubljana: Zveza društev športnih pedagogov Slovenije, Fakulteta za šport, Univerza v Ljubljani.

Mountjoy, M., Andersen, L. B. L., Armstrong, N., Biddle, S., Boreham, C., Bedenbeck, H.-P. B., et al. (2011). International Olympic Committee consensus statement on the health and fitness of young people through physical activity and sport. British journal of sports medicine, 45(11), 839–848.

Pařízková, J. (2010). Nutrition, Physical Activity, and Health in Early Life, Second Edition. Boca Raton, Florida: Taylor and Francis, CRC Press.

Sallis, J. F., McKenzie, T. L., & Alcaraz, J. E. (1993). Habitual physical activity and health-related physical fitness in fourth-grade children. The Americal Journal of Diseases of Children, 147(8), 890–896.

Sallis, J. F., Owen, N., & Fisher, E. B. (2008). Ecological models of health behavior. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), Health behavior and health education (pp. 465–485). San Francisco: Jossey-Bass.

Starc, G., Strel, J., & Kovač, M. (2010). Telesni in gibalni razvoj slovenskih otrok in mladine v številkah: Šolsko leto 2007/2008. Ljubljana: Fakulteta za šport.

Starc, G., & Strel, J. (2012). Influence of the quality implementation of a physical education curriculum on the physical development and physical fitness of children. BMC public health, 12(1), 61.

Stokols, D. (1992). Establishing and maintaining healthy environments: toward a social ecology of health promotion. American Psychologyst, 47, 6–22.

Strel, J., & Kovač, M. (2004). Uvod. In M. Kovač, G. Starc, & M. Bučar Pajek (Eds.), Analiza nekaterih povezav gibalnih sposobnosti in telesnih značilnosti z drugimi razsežnostmi psihosomatičnega statusa slovenskih otrok in mladine (pp. 8–12). Ljubljana: Fakulteta za šport, Inštitut za kineziologijo.

Strel, J., Kovač, M., Jurak, G., Bednarik, J., Leskošek, B., Starc, G., et al. (2003). Nekateri morfološki, gibalni, funkcionalni in zdravstveni parametri otrok in mladine v Sloveniji v letih 1990–2000. Ljubljana: Fakulteta za šport, Inštitut za kineziologijo.

Strel, J., Šturm, J., Štihec, J., Kovač, M., Tušak, M., Ambrožič, F., et al. (1992). Analiza razvojnih trendov motoričnih sposobnosti in morfoloških značilnosti in relacij obeh s psihološkimi in sociološkimi dimenzijami slovenskih otrok in mladine med 7.–18. letom starosti v obdobju 1970–1983–1993. Projekt raziskave. Ljubljana: Fakulteta za šport, Inštitut za kineziologijo.

Tomkinson, G. R., Olds, T. S., & Borms, J. (2007). Who are the Eurofittest? In J. Borms, M. Hebbelinck, & A. P. Hills (Eds.), Pediatric Fitness. Secular Trends and Geographic Variability. Medicine and Sport Science (pp. 104–128). Basel: Karger.

Trudeau, F., & Shephard, R. (2008). Physical education, school physical activity, school sports and academic performance. The international journal of behavioral nutrition and physical activity, 5(1), 10. BioMed Central.

Van Tuyckom, C. (2011). Macro-environmental factors associated with leisure-time physical activity: A cross-national analysis of EU countries. Scandinavian Journal of Public Health, 39(4), 419–426.

Vrabič Kek, B. (2012). Kakovost življenja. Ljubljana: Statistični urad Republike Slovenije.

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LONG-TERM EFFECTS OF REGULAR EXERCISING IN ELDERLY WOMEN

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ABSTRACT

The purpose of the research was to evaluate the long-term effects of regular physical activity for elderly women (over 65 years old) on their functional physical fitness. At the beginning, 32 women (69.68 ± 3.83 years) were included into an exercise (experimental) group and 32 women (70.75 ± 3.67 years) into a control group, who were not included into active exercise. The exercise took place at the Rudolf Maister School Centre in Kamnik and lasted for five years. It was performed intensively twice a week for 60 minutes from October 2006 to June 2007 and once a week for 60 minutes from October 2007 to June 2011. The Fullerton test battery was used to measure motor skills related to strength, power, flexibility, balance, endurance, speed and coordination. The first set of measurements for the members of the exercise group was taken in October 2006, the second after 6 months of exercise in July 2007 and the third in July 2011, including 20 women from the same exercise group who were still actively participating after four years. The measurements for the control group were only performed in October 2006 and July 2011, when 17 women from the same control group had their measurements taken again. The results of the Fullerton test battery showed a significant ($p < 0.05$) improvement in all tests after half a year of adapted exercise; additionally, significant ($p < 0.05$) progress was also noted in most tests following 4.5 years of exercising. Moreover, the exercise group, in comparison with the control group, also performed significantly ($p < 0.001$) better in most of the tests. Exercise can have a significant impact on the improvement of the motor skills of the elderly, which may result in the independent performance of all basic hygiene tasks as well as dressing, household and domestic work, shopping and other tasks related to freedom of movement, expansion of living space and an independent and autonomous life without the assistance of others.

Keywords: *elderly, women, adjusted physical activity, physical abilities, health.*

DOLGOROČNI UČINKI REDNE VADBE PRI STAREJŠIH ŽENSKAH

IZVLEČEK

Namen študije je bil ovrednotiti dolgoročne učinke redne telesne aktivnosti na funkcionalno telesno zmogljivost žensk po 65. letu starosti. V začetku raziskave je bilo 32 žensk (69.68 ± 3.83 let) vključenih v vadbeno (eksperimentalno) skupino in 32 žensk (70.75 ± 3.67 let) v kontrolno skupino, ki v vadbo niso bile vključene. Vadba je potekala pet let v Šolskem centru Rudolfa Maistra Kamnik. Intenzivno se je izvajala od oktobra 2006 do junija 2007, in sicer dvakrat tedensko po 60 minut, nato pa med oktobrom 2007 in junijem 2011 le enkrat tedensko po 60 minut. Za spremljanje gibalnih sposobnosti, vezanih na silovitost, moč, gibljivost, ravnotežje, vzdržljivost, hitrost in koordinacijo, je bila uporabljena Fullertonova baterija testov. Začetne meritve so bile za vadbeno skupino opravljene oktobra 2006, vmesne po polletni vadbi, julija 2007 in končne julija 2011, ko je po štirih letih še vedno aktivno sodelovalo 20 žensk iste vadbene skupine. Meritve za kontrolno skupino smo izvedli le v začetku, oktobra 2006, in na koncu, julija 2011, ko se je ponovnih meritev udeležilo 17 žensk iste kontrolne skupine. Rezultati Fullertonove testne baterije so bili značilno ($p < 0.05$) boljši po končani polletni prilagojeni vadbi pri vseh testih, prav tako pa se je pojavil značilen ($p < 0.05$) napredek pri večini testov tudi po 4,5 letih vadbe. Prav tako je vadbena skupina v primerjavi s kontrolno v večini testov dosegla tudi značilno ($p < 0.001$) boljše rezultate. Ugotavljamo, da lahko z redno vadbo pomembno vplivamo na izboljšanje gibalnih sposobnosti, kar se lahko odraža v samostojnem opravljanju vseh osnovnih higienskih opravil, oblačenju, opravljanju gospodinjskih in hišnih del, nakupovanju in drugih opravil, vezanih na svobodno gibanje, razširitev bivanjskega prostora in neodvisno ter samostojno življenje brez pomoči drugih.

Ključne besede: *starostniki, ženske, prilagojena telesna vadba, gibalne sposobnosti, zdravje*

INTRODUCTION

The world's population is aging. The aging of the European Union population will continue intensively as the number of people older than 65 is likely to have risen to 30 % while the number of people over 80 is likely to reach 12.1 % by 2060 (Vertot, 2008). In Slovenia, an increasing number of elderly people began to emerge when the generations born before and during World War II started to retire. These generations, compared to today's birth rates, are great in number and represent a significant portion of the population due to social, societal, biological and economic factors. It is assumed that in Slovenia in 2020, according to the data acquired in 1999, around 16 % of people will be over 65 years old (Jakoš, 1999) or, according to data collected in 2009, perhaps

even 19 % of the population will be over 65 (Sedej, 2009). It has also been calculated that by the year 2050, 39 % of the population will be over 60 years of age, with 12 % of these expected to be over 80 (Vertot, 2008). In the modern world, the definition of "old age" is also changing. One of the most popular expressions has become the newly coined "active aging", which represents the opposite of "old age" as a dependent and passive period of life. The World Health Organization (WHO) defines active aging as "the process of optimizing opportunities for health, participation and safety in order to improve the quality of life of elderly people". Active aging implies the ability of the elderly to live productive lives in both society and the economy. Active aging, in its broadest sense, can be understood as the continuous engagement of the elderly in social, economic, cultural and civil matters, namely, not only in the form of increased physical activity or brain fitness and extended employment (Kuhar, 2007). It is very important to distinguish healthy aging from the phenomena of diseases and pathological aging. The functional capabilities of a 70-year-old may be influenced by daily exercise in such a way that they do not differ from the functional capabilities of a 45-year-old (Tomek-Roksandić et al., 2003).

In old age, an individual's physical and mental health is of the utmost importance. Chronological age does not explain exactly what happens to a man as he grows older; it only explains that he is growing old, but not how. If we wanted to research the age of an individual, it would be necessary to assess his physiological functions. Erotological physiologists are of the opinion that physiological functions can be assessed by metabolic, structural and functional changes in the organism, preferably by checking homeostatic parameters such as blood pressure, blood sugar, breathing and the adaptation of the organism to stress (Chodzko-Zajko & Moore, 1996). In the old age period, in addition to the weakening of all organ systems, diseases such as type 2 diabetes, osteoporosis, hypertension, arthritis, hearing impairments, etc. (Timiras, 1988) occur more frequently. Infections of the lower respiratory tract, urinary tract, skin and soft tissues are frequent. Sepsis, infections of the abdominal cavity, infective endocarditis, bacterial meningitis, herpes zoster and tuberculosis also tend to break out more frequently (Videčnik Zorman & Maraspin Čarman, 2010). Through the growth of the elderly population, sarcopenia (Sumukadas & Burton, 2010), which plays an important role in the basic functional activities of an individual in his independent life later on in his old age, becomes more and more prominent as it causes a gradual reduction in muscle mass, strength and bodily functions. Due to a generally inactive lifestyle in old age, characterized particularly by too much sitting, diseases of the cardio-vascular system, strokes, colon cancers and breast cancers (Katzmarzyk et al., 2000) also appear more frequently; furthermore, the changes in the cardio-vascular system also affect the brain function. When one's memory starts to collapse, concentration is reduced and we are no longer able to perform certain tasks as effectively as we used to (Pustavrh, 2010). Such bodily changes generally appear as changes in the skin, bones and muscles, in the cardio-vascular system, respiratory system, nervous system and sense-organs as well as in the gastrointestinal tract, genitals, urinary tract and immune and hormonal systems (Rotovnik Kozjek, 2011). It has been proven that the impact of physical activity in old

age (Oražem Grm, 2008) is reflected positively in the cardio-vascular and muscular-skeletal systems as well as in psycho-social components of health. As aging changes one's physical appearance and physical abilities, it is important to establish the appropriate physical activity, for example walking, in order to enhance physical performance in old age. Regular training improves bone density, which consequently reduces the risk of osteoporosis (Strojnik, 2009). There is evidence that moderate physical activity in old age reduces the risk of cardio-vascular diseases, prevents an increase in the content of the C-reactive protein and, thus, atherosclerosis (Sasaki, 2011) while also preventing thrombosis by reducing blood coagulation and the activity of thrombocytes, activating the fibrinolysis system (Wang, 2006). Furthermore, physical activity reduces the concentration of the negative LDL-cholesterol and increases the concentration of the beneficial HDL cholesterol (Hardman, 1999). Physical activity in old age also protects the body against type 2 diabetes by increasing insulin sensitivity and preventing glucose intolerance, which improves the glucose metabolism and reduces the overall body fat content (Ryan, 2000).

Participation in regular physical exercise programs in old age also contributes to a longer life expectancy, improves functional abilities and enables a better well-being (Chodzko-Zajko et al., 2009). Daily activities, such as dressing, bathing, walking, eating, the maintenance of personal hygiene along with instrumental activities such as cooking, shopping, washing, handling money, using the phone, household tasks, cleaning, using a means of transport, taking medication and other activities related to independent life at home are very important for functional qualifications (Finkel, 2003).

Regular exercise is important for maintaining and improving one's level of health, preventing the development of non-infectious diseases in adults and the elderly, treating and rehabilitating numerous acute and chronic diseases, maintaining the ability for independent life in old age and increasing functional abilities or physical fitness (Mišigoj-Duraković et al., 2003). During the period of old age, exercising regularly can even prevent particular mental diseases such as depression, dementia and Alzheimer's disease as well as improving one's mental condition while also affecting their well-being (Fox et al., 2007; Mlinar, 2007). It is an effective method for overcoming stress, as it brings one both enjoyable entertainment and relaxation (Tušak, 2002).

Although aging is an inevitable bio-physiological process, the decline of physiological functions can be slowed down (Berčič, 2002), therefore each individual should, if it is within his power, attempt to slow the aging process as much as possible through daily physical and engaging in sports / recreational activities. When planning exercise programs for the elderly, the ability of an individual, his health status, diseases and physical fitness should be taken into account (Pendl Žalek, 2004). Consideration should be given to the type of activity, intensity, frequency, duration as well as to the gradual approach and regularity of exercise while also including a selection of joyful, simulative and pleasing exercises because only then we can persevere. Therefore, it was the aim of the presented study to assess the impact of longitudinal regular exercise programs on the bodily characteristics and functional physical fitness of elderly women.

METHODS

Subjects

The sample of the 2006/07 subjects included 32 women in the exercise (experimental) group and 32 women in the control group, aged 65 and over, from the cities of Kamnik and Domžale and its surroundings. In 2006, the average age of the exercise group participants was 69.68 ± 3.83 years and the average age of the control group participants was 70.75 ± 3.67 years. In 2011, only 20 (62.5 %) participants of the same exercise group were still included in the exercise group, 74.75 ± 4.17 years old on average; and only 17 (53.1 %) women of the control group, on average 75.12 ± 2.97 years old, had their measurements taken again. The reasons for lower participation in the measurements included the termination of participation in the research due to poor states of health or even deaths of the participants.

Procedures

The exercise program was intended to improve physical abilities of its participants, with the emphasis on strength, flexibility and balance. The training session was adapted to the abilities of participants and divided into the introductory period – learning exercises and intensifying the repetition and strain. We started every training session with warm-up exercises, followed by different exercises for the development and maintenance of physical abilities (with the stress on strength, balance and flexibility of the entire body) as well as exercises for muscle relaxation. Exercises were carried out gradually, comprising a part of the body from head to feet at a time (topological approach). The group performed an adapted exercise program in a small gym and fitness center at the Rudolf Maister School Centre in Kamnik from October 2006 to July 2007 twice a week for 60 minutes and once a week for 60 minutes from October 2007 to July 2011.

Measurements

The measurements of physical parameters, height and weight and motor-functional tests for the exercise group were carried out both before the beginning of the six-month exercise program in October 2006, and at the end of it, in June 2007, as well as after 5 years, in July 2011. The measurements for the control group were performed only at the beginning of the research, in 2006, and at the end of the research, in 2011.

The information about physical and functional abilities of participants was collected by using the Fullerton test battery (Rikli & Jones, 1999), since it includes the tests which determine the abilities that are necessary for independent life: getting up from a chair for 30 seconds (the number of repetitions), weightlifting in sitting position for 30 seconds (the number of repetitions), torso bending forward on the bench (in cen-

timetres), touching hands on the back (in centimetres), stand-up and go (in seconds), 9-minute walking (the number of meters), balance on one leg with eyes open (in seconds) and grip strength (in kilograms).

To perform the measurements, we used the devices intended to test pupils. Grip strength was measured by a dynamometer (Jamar Hydraulic Hand Dynamometer ─ 5030J1, Sammons Preston, Providence, ZDA) from the Department for Physiotherapy at the Health Centre in Kamnik. For weightlifting in sitting position a 2.27 kg handle was used.

Statistics

For statistical analysis the SPSS 16.0 program was used (SPSS Inc., IBM Corporation, Chicago Illinois, USA, 2008). The two-way RM ANOVA was used to assess the differences in physical parameters and motor-functional abilities for the exercise group, at the beginning (October 2006), after 6 months (June 2007) and at the end of the exercise program (July 2011). The Bonferroni correction was used for post hoc analysis. The variance analysis (the F-test) was used to assess the differences of physical parameters and motor-functional abilities among the members of the exercising group and the control group to compare the periods of 2006 and 2011. All statistically significant differences were verified at the p-level < 0.05.

RESULTS

Body weight did not differ significantly ($p > 0.05$) between the exercise and control group and it did not change significantly ($p > 0.05$) with time for the exercise group (Figure 1).

Weight (Figure 1) was on average slightly reduced at the members of the exercising group in the period before and after the exercising in 2006/07; after a four-year period the weight increased, but the differences, before and after the exercising in 2006 /07 as well as in the four-year period up to 2011, were not statistically significant ($p > 0.05$). Even at the members of the control group, in the four-year period, no statistically significant differences in weight were observed, also these differences were not observed between the groups at the initial measurement in 2006 /07 and the measurement in 2011, also no differences were observed in the change between the initial and the final state ($p = 0{,}723$).

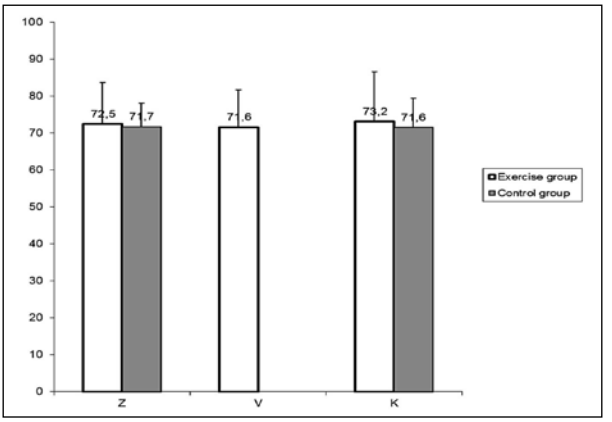

Figure 1: Body weight (kg).

*Legend: Z – initial measurement (October 2006), V – measurement after 6 months of exercise (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

Figures 2 and 3 represent the results of motor-functional tests for assessing the power of the upper and lower muscles for both the members of the exercise group and control group.

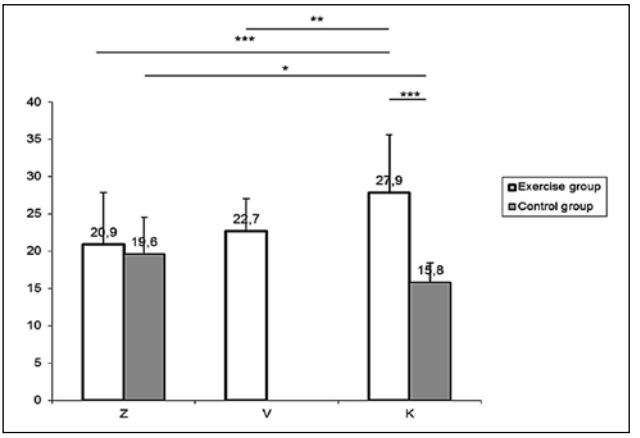

Figure 2: Getting up from the chair for 30 seconds (the number of repetitions).

*Legend: Z – initial measurement (October 2006), V – measurement after 6 months of exercise (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

The test results of getting *up from the chair for 30 seconds* were not statistically significant for the members of the exercise group (Figure 2) neither before nor after the finished exercising in 2006/07, but they were statistically significant when we compared the results of the test before the start of exercise in 2006/07 and after a four-year period in 2011 ($p = 0.000$) as well as after the finished exercise in 2006/07 and four years later ($p = 0.004$). On average, the members of the exercise group reached better results in the test of *getting up from the chair for 30 seconds* when comparing the first measurement in 2006/07 to the final measurement in 2011, as the average number of lifting increased from 20.9 ± 6.9 to 27.9 ± 7.7. Statistically significant differences ($p = 0.013$) also appeared during a four-year period at the members of the control group, namely they reduced the number of lifting on average from 19.6 ± 4.9 to 15.8 ± 2.6. The comparison of the exercise group and control group before the start of exercise in 2006/07 showed no statistically significant differences ($p > 0.05$); statistically significant differences were observed between the groups present in the final measurement in 2011 ($p = 0.000$) since the members of the exercise group achieved in *getting up from the chair for 30 seconds* test an average number of 27.9 ± 7.7 of lifting, the members of the control group only 15.8 ± 2.6. Also, the comparison of both groups showed statistically significant differences in the change between the initial and final state ($p = 0.001$).

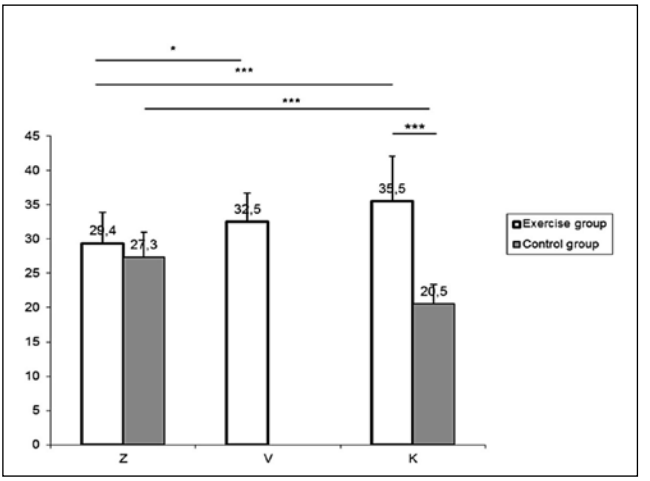

Figure 3: Weightlifting in sitting position for 30 seconds (the number of repetitions).

*Legend: Z – initial measurement (October 2006), V – measurement after 6 months of exercising (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

The comparison of results (Figure 3) of the exercise group members in the *weight-lifting in sitting position for 30 seconds* test before and after the exercise in 2006/07 showed a statistically significant difference (p = 0.025), in favour of the test performed six months after exercise; a statistically significant difference (p = 0.000) was also observed when we compared the results of the tests performed before the start of exercise in 2006/07 and after a four-year period in 2011. Before the start of exercise the exercise group members attained an average result of 29.4 ± 4.5, at the end of exercise in 2006/07 32.5 ± 4.2 and 35.5 ± 6.5 lifts of weight in 30 seconds four years later. Statistically significant differences (p = 0.000) also appeared in the same test with the control group members; the control group members on average reached lower results after four years compared to the first measurement, since the average number of weight lifts in 30 seconds decreased from 27.3 ± 3.7 to 20.5 ± 2.8. The comparison between the exercise group members and the control group before the start of exercise in 2006/07 showed no statistically significant differences (p > 0.05); statistically significant differences (p = 0.000) between the two groups occurred during the final testing in 2011, in favour of the exercise group members and between the two groups, in the change between the initial and final state (p = 0.000).

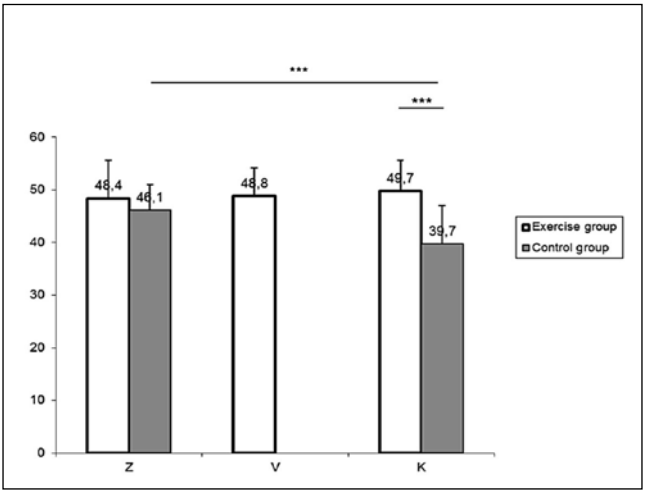

Figure 4: Bending forward on the bench (cm).

*Legend: Z – initial measurement (October 2006), V – measurement after 6 months of exercise (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

The results of the flexibility test *bending forward on the bench* (Figure 4) were not statistically significant for the members of the exercise group, neither in the period before and after exercise in 2006 /07 nor four years later in 2011 ($p > 0.05$). a statistically significant difference ($p = 0.000$) appeared for the control group members, between the first and the final measurement, namely the average test results four years later were lower than the results of the initial measurements. The average measured value of *bending forward on the bench* was 46.1 ± 4.8 in 2006/07 and 39.7 ± 2011 7.3 cm in 2011. Also, the comparison of the exercise group and control group before the start of exercise in 2006/07 showed no statistically significant differences ($p > 0.05$); but statistically significant differences were observed between the groups at the final measurement in 2011 ($p = 0.000$), as the members of the exercise group in *bending forward on the bench* test achieved the average result 49.7 ± 5.8 cm and the members of the control group 39.7 ± 7.3 cm. Also, the comparison between the two groups showed statistically significant differences in change between the initial and final state ($p = 0.003$).

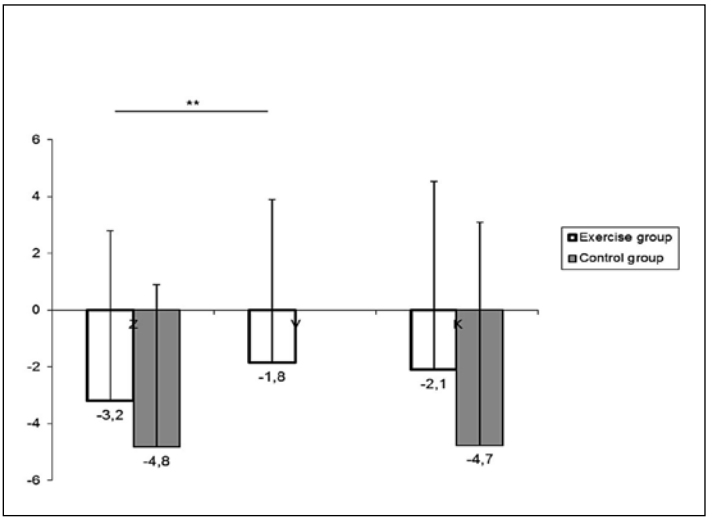

Figure 5: Touching hands on the back (cm).

*Legend: Z – initial measurement (October 2006), V – measurement after 6 months of exercise (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

The results of the *touching hands on the back* test (Figure 5) were statistically significant ($p = 0.001$) for the exercise group members only six months after exercise in 2006/07, as the average distance between the tips of the middle fingers of both hands on the back was reduced from -3.2 ± 5.9 to -1.8 ± 5.7 cm from the time of the first measurement at the beginning to the end of exercise. Statistically significant differences

of *touching hands on the back* test were not noticed (p > 0.05) for the members of the control group after a four-year period; neither were these differences noticed between the groups at the initial measurement in 2006/07 and 2011, nor were the differences in change noticed between the initial and final state (p = 0,267).

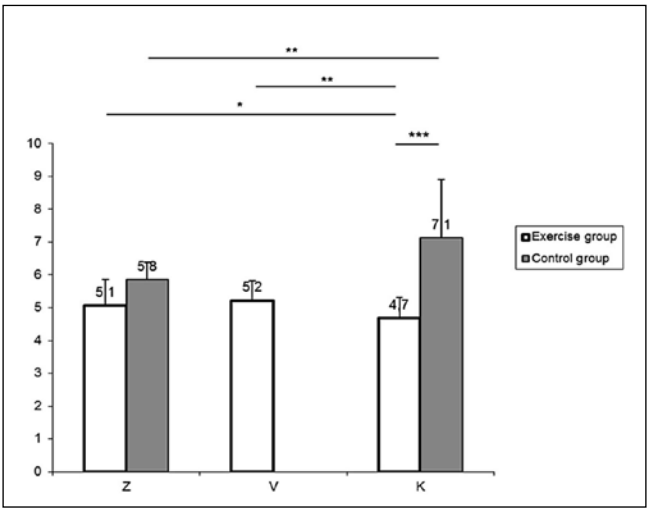

Figure 6: Stand-up and go (s).

*Legend: Z – initial measurement (October 2006), V – measurement after 6 months of exercise (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

The test results of *stand-up and go* test (Figure 6) were not statistically significant for the members of the exercise group before and after exercise in 2006/07, but they were statistically significant when compared to the results before the beginning of exercise in 2006/07 as well as after a four-year period in 2011 (p = 0.012) and after the end of exercise in 2006/07 and after four years (p = 0.004). On average the members of the exercise group achieved better results from the time of the first measurement in 2006 /07 to the final measurement in 2011, as the average time of the finished task was shortened from 5.1 ± 0.8 seconds to 4.7 ± 0.6 seconds. Statistically significant differences (p = 0.007) also appeared at the control group members after a four-year period, namely the average duration of the test was extended from 5.8 ± 0.5 to 7.1 ± 1.8 seconds. The comparison of the two groups showed no statistically significant differences (p > 0.05) before the start of exercise in 2006/07; statistically significant differences were observed between both groups at the final measurement in 2011 (p = 0.000). The exercise group members achieved in *stand-up and go* test the average 4.7 ± 0.6 seconds performing time and the members of the control group 7.1 ± 1.8 seconds. The comparison between both groups showed a statistically significant difference in the change between the initial and final state (p = 0.000).

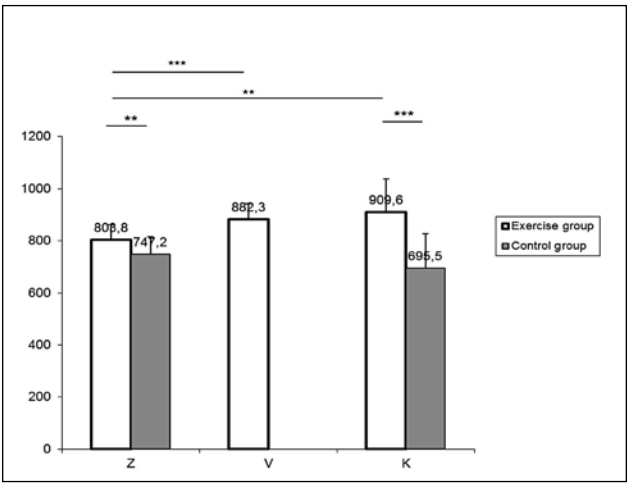

Figure 7: 9-minute walking (m).

*Legend: Z – initial measurement (October 2006), V – measurement after 6 months of exercise (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

The comparison of results of a *9-minute walking* test of the exercise group (Figure 7) before and after the exercising in 2006 /07 showed a statistically significant difference ($p = 0.000$) in favour of the test six months after exercise; a statistically significant difference ($p = 0.001$) was also present when we compared the test results before the start of exercise in 2006/07 and after a four-year period in 2011. The exercise group members were able to walk on average 803.8 ± 56.8 meters in 9 minutes before the start of exercise, and 882.3 ± 60.7 meters at the end of exercise in 2006/07 and 909.6 ± 128.3 meters four years later. For the control group members, the statistically significant differences were not present ($p > 0.05$) in the same test, but they were able to walk on average 747.2 ± 66.9 meters in 9 minutes at the first measurement, and 695.5 ± 131.8 meters four years later. At the first measurement, before the start of exercise in 2006/07 the comparison of the exercise group results and control group showed a statistically significant difference in favour of the exercise group ($p = 0.009$); a statistically significant difference ($p = 0.000$) was also observed between the two groups at the final testing in 2011 and again in favour of the exercise group members. Statistically significant differences ($p = 0.000$) in the change between the initial and final state was shown also by the comparison of both groups.

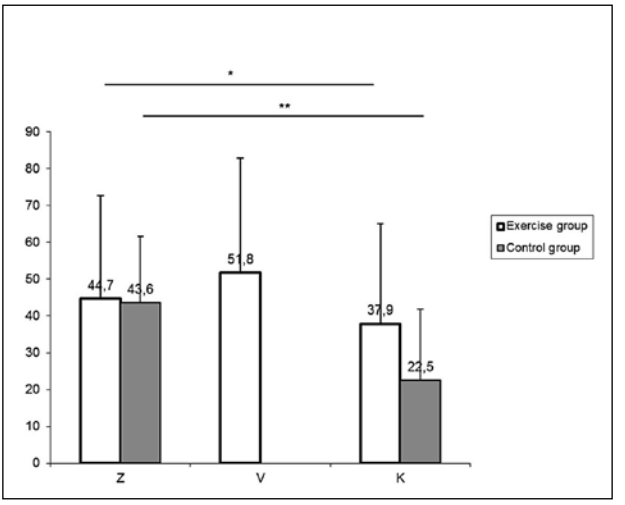

Figure 8: Balance on one leg with eyes open (s).

*Legend: Z – initial measurement (October 2006), V – measurement after 6 months of exercise (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

The test result of *balance on one leg with eyes open* test (Figure 8) were for the members of the exercise group statistically significant compared to the beginning of exercising in 2006/07 and after four years in 2011 ($p = 0.013$), namely after four years the members of the exercise group achieved lower test results, as the average time of *balance on one leg with eyes open* test was shortened for 6.8 ± 0.7 seconds. The same test also showed a statistically significant difference ($p = 0.001$) for the members of the control group, thus, after four years the members of the control group reached significantly lower results compared to the first measurement, since the average time of *balance on one leg with eyes open* test was shortened from 43.6 ± 17.9 to 22.5 ± 19.4 seconds. The comparison of the two groups showed no statistically significant differences ($p > 0.05$) before the start of exercise in 2006/07 and after the exercise in 2011; statistically significant differences were also not present in the change between the initial and final state ($p = 0.121$).

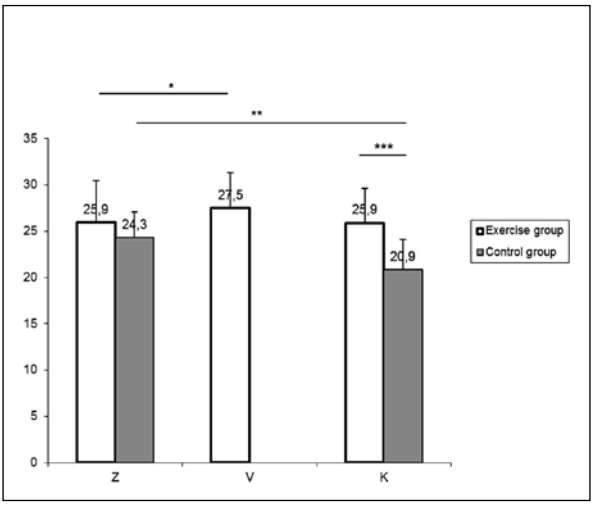

Figure 9: Grip strength (kg).

*Legend: Z – initial åmeasurement (October 2006), V – measurement after 6 months of exercise (June 2007), K – final measurement after 4.5 years (July 2011). Statistical significance: * P < 0.05 ** P < 0.01, *** P < 0.001.*

A statistically significant difference (p = 0.046) was noted with the exercise group members at the *grip strength by a dynamometer* test (Figure 9) regarding the measurements before and after the exercise in 2006/07, as the average power of the grip strength measured by the dynamometer increased from 25.9 ± 4.5 to 27.5 ± 3.8 kg after six months of exercise. The average measured grip strength decreased to 25.9 ± 3.7 kg four years later, but the difference was not statistically significant (p > 0.05). The average measured power of the *grip strength by a dynamometer* test was significantly reduced when observing the control group members, namely from 24.3 ± 2.8 to 20.9 ± 3.2 kg (p = 0.004) in the period from 2006/07 to 2011. The comparison made between the exercise and control group showed no statistically significant difference (p > 0.05) at the first measurement, before the start of exercise in 2006/07; a statistically significant difference (p = 0.000) was present at the final test in 2011 as the measured *grip strength by a dynamometer* test showed 25.9 ± 3.7 kg for the exercise group members and 20.9 ± 3.2 kg for the control group members. The comparison between the two groups also showed statistically significant differences between the initial and final state (p = 0.003).

DISCUSSION

Independent living plays an important role for the elderly, therefore the subjective factors such as age, accessibility and proximity of home, physical exercise and physical fitness, desire for doing certain sport, family situation and financial situation, have greater influence on sports activities than the objective ones. Fox (1992) states that self-confidence plays an important role as an indicator of psychological well-being and engagement in sport. For many people, being active in sport means active spending of free time and socializing, where the criterion is primarily the well-being. The positive correlations between physical activity and longer life expectancy (Seguin et al., 2010) were determined on the sample of older generation women from 23 American States. In the United States and Brazil they tested the 6-minute walk, stand-up and go, touching hands on the back and getting up from a chair on a sample of 1,033 participants by using the Fullerton test batteries, which both outlined the guidelines about normal fluctuations of functional abilities in older women and enabled the planning of better awareness of the positive effects in health policy for the elderly (Krause et al., 2009). In California, a research on the effects of 6-week fitness training on strength and flexibility was made on a small sample of 8 men and 14 women aged from 60 to 79. For each exercise, the participants performed 12 to 15 repetitions using the fitness equipment, preceded by a 20-minute warm-up and stretching exercises. 15 elderly people of the same age participated in the control group. Both groups were tested before and after the exercise by using the Fullerton test battery for measuring functional physical fitness: a 6-minute walk, getting up from a chair for 30 seconds, touching of hands on the back, stand-up and go and grip strength. The control group showed a substantially lower physical fitness; the testing group showed better results in grip strength, shoulder flexibility, the number of repetitions of getting up from a chair, walking speed and stand-up and go (Cavani et al., 2002). A similar research was also conducted in Oregon in cooperation with 22 men and women aged from 78 to 86. After a 10-week training program, which was based on everyday life activities, they also used the functional physical fitness test and they came to similar conclusions (Dobek et al., 2006). In Arizona (Klein et al., 2002) functional physical fitness, strength and flexibility was monitored in men and women from 73 to 94 years of age who were involved in a 5-week exercise program. The progress before and after the exercise was shown in the majority of tests which measure strength and flexibility except at the shoulder girdle; also there were no differences observed in the functional physical fitness tests (stand-up and go and getting up from a chair). The impact of walking on health was monitored in a longitudinal research at the University of California, San Francisco, in which 7,527 older women and men participated, aged 70 and more. The survey showed that 14.5 % of men and 8.9 % of women regularly walk every day, a negligible number of them walk 4 to 6 or 2 to 3 days a week, however, 46.2 % of men and 59.1 % of women never walked. The comparison of health status and walking was interesting, where the correlation between better health and walking appeared (Früs et al., 2003). Very similar results were found when we tested our group, as the members of the exercise group achieved better results

in the flexibility of the shoulder girdle, which was shown in touching hands on the back test; in the strength of the upper extremities, which was shown in weightlifting in sitting position for 30 seconds test and grip strength by the dynamometer test; in the power of the lower extremities, which was shown in the getting up from a chair for 30 seconds test and in general endurance, shown in a 9-minute walking test. We have also noticed that during the second testing after the end of exercise in 2006/07 and 2011 the motor abilities in the members of the exercise group were still improving which was shown by the tests of getting up from a chair for 30 seconds, weightlifting in sitting position for 30 seconds, torso bending forward on the bench, stand-up and go and a 9-minute walking. The decline of motor abilities four years later was observed only in the *balance on one leg with eyes open* test due to the links between the sensory-neuronal system and α-motor neurons, which die with age and weaken the stabilizing of the knee joint (Madhavan et al., 2005 & 2009); it was demonstrated by the comparative research between the young and the elderly over 65. They found out significant differences between the young and the elderly by *standing on one leg with squatting* exercise, at first with eyes open and then with eyes closed. Comparing the sample results of the control group members for the period from 2006/07 to 2011, and four years later we noticed the reduction of all motor abilities, because the measured results were lower in all tests, except at touching hands on the back. The comparison of the test results between the exercise group members and the control group and among the members of the control group in a four-year period additionally confirms the crucial importance of exercise for maintaining the motor abilities, flexibility and balance. It is well known (Pistotnik, 2003) that the movement of people at daily activities, professional work and sport, depends on their capabilities, characteristics and skills. Flexibility is an important factor of optimal physical fitness and well-being and it affects the quality of life of an individual, since the muscle relaxation linked to an adequate level of flexibility is closely associated with reduction of psychological tension and enables undisturbed autonomous and independent performance of daily and instrumental (Finkel, 2003) or functional and fun activities and self-sufficiency (Rogers & Keller, 2009). The mentioned research carried out in Slovenia and abroad shows a significant effect of exercise on the quality of life of the elderly. It can be concluded that the active life enables a better well-being; it has a positive influence on health, on greater autonomy and independence later in life.

CONCLUSION

The results of this research are part of the recognition that with adapted physical exercise, with an emphasis on strength, flexibility and balance, we can significantly influence the improvement in the function of the locomotors system, as well as that of balance and strength in the elderly. The exercise was, for all of the participants, a form of motivation and a challenge to do something for themselves; it allowed them to attend a pleasant gathering, to relax, and to enjoy both the pleasure and satisfaction of

socializing; it enhanced the affiliation to the group and the individual approval "to be important; I have a great time; I make a positive contribution to the common good" and also achieved the participants' regular attendance of the exercise classes, and for the time being, swapped their home environment for a gym or fitness centre. We hope that the results of the adapted physical exercise contributed to the decision-making process of the wider female and male population, aged 65 and over, to include physical activity into their way of their life. Further researches concerning the physical activity of the elderly (over the age of 65) would definitely be interesting as a follow-up on the national level in order to determine the functional capacity of older people, which would allow us to plan the development of programs for active lifestyles in the third period.

REFERENCES

Berčič, H. (2002). Redno športno-rekreativno udejstvovanje je eden od temeljev uspešnega staranja. Ljubljana: Revija Šport, 50 (2), 26–31.

Burton, L., & Sumukadas, D. (2010). Optimal management of sarcopenia. Clinical Interventions in Aging, 7(5), 217–228.

Cavani, V., Mier, C. M., Musto, A. A., & Tummers, N. (2002). Effects of a 6- week resistance – training program on functional fitness of older adults. Journal of aging and physical activity, 10, 443–452.

Chodzko-Zajko, W. J., & Moore, K. (1996). Physical fitness and cognitive functioning in aging. Exercise and sport science reviews, 22, 195–220.

Chodzko-Zajko, W. J., Schwingel, A., & Park, C. H. (2009). Successful Aging: The Role of Physical Activity. American Journal of Lifestyle Medicine, 3(1), 20–28.

Dobek, J. C., White, K. N., & Gunter, K. B. (2006). The effect of a novel ADL – based training program on performance of activities of daily living and physical fitness. Journal of aging and physical activity, 15, 13–25.

Finkel, T. (2003). A toast to long life. Nature, 425, 132–133.

Fox, K. (1992). The complexities of self - esteem promotion in physical education and sport. In T. I. Williams, L. Almond, & A. Sparkes (Eds.), Sports and physical activity – moving towards excellence (pp. 382–389). London: E & FN Spon.

Fox, K. R., Stathi, A., Mckenna, J., & Davis, M. G. (2007). Physical activity and mental well-being in older people participating in the better ageing project. European journal of applied physiology, 100 (5), 591–602.

Früs, R. H., Nomura, W. L., MA, C. X., & Swan, J. H. (2003). Socio epidemiology and health - related correlates of walking for exercise among the elderly: Results from the longitudinal study of aging. Journal of aging and physical activity, 11, 54–65.

Hardman, A. E. (1999). Physical activity, obesity and blood lipids. International Journal of Obesity and Related Metabolic Disorders, 23(3), 64–71.

Jakoš, A. (1999). Starejše prebivalstvo v Sloveniji – demografsko stanje in projekcije. Ljubljana: Inštitut za varovanje zdravja RS. Zdravstveno varstvo 38(1/2), 50–53.

Katzmarzyk, P. T., Gledhill, N., & Shephard, R. J. (2000). The economic burden of physical inactivity in Canada. Canadian Medical Association, 11, 163.

Klein, D. A., Stone, W. J., Phillips, W. T., Gangi, J., & Hartman, S. (2002). PNF training and physical function in assisted - living older adults. Journal of aging and physical activity, 10, 476–488.

Krause, M. P., Januário, R. S, Hallage, T., Haile, L., Miculis, C. P., Gama, et al. (2009). A comparison of functional fitness of older Brazilian and American women. Journal of aging and physical activity, 17(3), 387–397.

Kuhar, M. (2007). Sociološki vidik: prevrednotenje staranja in starosti. Retreived July 29th 2009 from: http://www.kapitalskadruzba.si/files/506/kad_zborn ik2007_metka_kuhar.pdf.

Madhavan, S., Burkart, S., Carpenter, G., Read, K., Teckenburg, T., Zwanziger, M., et al. (2005). Influence of age on neuromuscular control of the knee. Journal of Neurological Physical Therapy, 29(4), 190.

Madhavan, S., Burkart, S., Baggett, G., Nelson, K., Teckenburg, T., Zwanziger, M., et al. (2009). Influence of age on neuromuscular control during a dynamic weight-bearing task. Journal of aging and physical activity, 17, 329–343.

Mišigoj–Duraković, M. (2003). Telesna vadba in zdravje. Ljubljana: Zveza društev športnih pedagogov Slovenije, Fakulteta za šport Univerze v Ljubljani, 85–106.

Mlinar, S. (2007). Športna dejavnost in življenjski slog medicinskih sester, zaposlenih v intenzivnih enotah kliničnega centra v Ljubljani. Doktorska disertacija. Ljubljana: Fakulteta za šport Univerze v Ljubljani.

Oražem Grm, B. (2008). Telesna aktivnost – inovativno polje za razvijanje medgeneracijskih programov. Ljubljana: Kakovostna starost, 11(2), 41.

Pendl Žalek, M. (2004). Aktivno življenje – zdravo življenje. Maribor: Založba Rotis.

Pistotnik, B. (2003). Osnove gibanja. Ljubljana: Fakulteta za sport.

Pustavrh, N. (2010). Hrana za možgane. Viva – portal za zdravo življenje. Retreived January 9th 2011 from: http://www.viva.si/Zdrav-na%C4%8Din-prehrane/ 2541/ Hrana-za-mo%C5%BEgane.

Rikli, R., & Jones, J. (1999). Development and validation of a functional fitness test for community-residing older adults. Journal of Aging and Physical Activity, 7(2), 129–162.

Rogers, C., & Keller, C. (2009). Roy's Adaptation Model To Promote Physical Activity Among Sedentary Older Adults. Geriatric Nursing, 30(2), 21–26.

Rotovnik Kozjek, N. (2011). Šport in zdravje v zrelih letih. Polet. Retreived March 8th 2011 from: http://www.polet.si/maratonec/sport-zdravje-v-zrelih-letih.

Ryan, A. S. (2000). Insulin resistance with aging: effects of diet and exercise. Sports medicine, 30(5), 327–346.

Sasaki, J. (2011). Exercise therapy for prevention of atherosclerosis. Nippon rinsho. Japanese journal of clinical medicine, 69(1), 119–124.

Sedej, M. (2009). Izobraževanje starejših v luči trga dela in strategije aktivnega staranja – utemeljitev strategije aktivnega staranja. In Zbornik – 13. andragoški kolokvij Izobraževanje starejših odraslih v letu ustvarjalnosti in inovativnosti. Ljubljana: Ministrstvo za delo, družino in socialne zadeve, Direktorat za trg dela in

zaposlovanje (pp. 1–16). Retrieved November 3rd 2013 from: http://tvu.acs.si/datoteke/AK/2009/Prispevek_Sedej.pdf.

Seguin, R. A., Economos, C. D., Palombo, R., Hyatt, R., Kuder, J., & Nelson, M. E. (2010). Strength training and older women: a cross-sectional study examining factors related to exercise adherence. Journal of aging and physical activity, 18(2), 201–218.

SPSS – statistični program (2008). SPSS Inc. Chicago Illinois, ZDA: IBM Corporation.

Strojnik, V. (2009). Vadba za moč pri starejših ljudeh. Postani FIT – Revija za zdravo in aktivno življenje, 2, 14–15.

Timiras, P. S. (1988). Aging and disease. In P. S. Timiras (Ed.), Physiological basis of aging and geriatrics (pp. 27–42). New York: MacMillan Publish. Co.

Tomek-Roksandić, S., & Čulig, J. (Eds.) (2003). Živjeti zdravo aktivno starenje. Zagreb: Centar za gerontologiju Zavoda za javno zdravstvo grada Zagreba, Pliva d. d., Ured za razvoj odnosa s korisnikom.

Tušak, M. (2002). Nekateri psihološki problemi ukvarjanja s športno rekreacijo. V H. Berčič (Ed.), Zbornik 3. slovenskega kongresa športne rekreacije: Otočec, 21.–22. november (pp. 64–65). Ljubljana: Olimpijski komite Slovenije.

Vertot, N. (2008). Prebivalstvo Slovenije se stara – potrebno je medgeneracijsko sožitje. Ljubljana: Statistični urad RS (pp. 15–30). Retreived November 3rd 2013 from: http://www.stat.si/doc/pub/Staranje_prebivalstva_slo.pdf.

Videčnik Zorman, J., & Maraspin Čarman, V. (2010). Okužbe pri starostnikih. Medicinski razgledi, 2(49), 157–168. Retreived November 3rd 2013 from: http://www.medrazgl.si/e107_files/public/datoteke/mr10_2_04.pdf.

Wang, J. S. (2006). Exercise prescription and thrombogenesis. Journal of biomedical science, 13(6), 753–761.

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THE EFFECTS OF PROLONGED PHYSICAL INACTIVITY INDUCED BY BED REST ON COGNITIVE FUNCTIONING IN HEALTHY MALE PARTICIPANTS

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ABSTRACT

A growing body of scientific evidence indicates that physical activity beneficially influences cognitive functioning. Less thoroughly investigated are the cognitive outcomes of reduced physical activity levels. The purpose of the study was to determine the effects of prolonged physical inactivity induced by bed rest on the participant's cognitive functioning.

Bed rest is a well-accepted method by which an acute stage of human adaptation to weightlessness in space flights is simulated, as well as an important model to study the consequences of extreme physical inactivity in humans. The subjects participating in the study consisted of fifteen healthy males aged between 19 and 65 years who were exposed to 14-day horizontal bed rest in a strict hospital environment. To assess the cognitive functions of the participants, a neuropsychological test battery was administered before and after the bed rest experiment. There was no significant impairment in cognitive performance after the 14-day bed rest on all tests, except in the measurements of delayed recall in the group of older adults. The results suggest that cognitive functions remained relatively stable during the period of physical immobilization. The obtained results have been discussed taking the possible contributing factors into account such as the practice effect, the relatively short duration of bed rest, and the choice of the cognitive measures administered. The study also provides evidence that favourable living and psychosocial conditions can protect one against cognitive decline in the case of extreme physical inactivity.

Keywords: *physical inactivity, bed rest studies, cognitive functioning, adults*

UČINKI DOLGOTRAJNE GIBALNE NEAKTIVNOSTI V POGOJIH SIMULIRANE BREZTEŽNOSTI NA KOGNITIVNO DELOVANJE PRI ZDRAVIH UDELEŽENCIH

IZVLEČEK

Vse več znanstvenih izsledkov potrjuje, da ima gibalna aktivnost ugoden vpliv na kognitivno delovanje. Manj pa je raziskav, ki bi preučevale kognitivne zmožnosti pri izrazito omejenem obsegu gibalne aktivnosti. Ena od pomembnejših metod za spremljanje učinkov popolne gibalne neaktivnosti na človekov organizem je bed rest (BR) model, ki predvideva daljše mirovanje v ležečem položaju. Namen raziskave je bil proučiti učinke skrajne gibalne neaktivnosti na kognitivno delovanje odraslih udeležencev. Petnajst zdravih moških, starih med 19 in 65 let, smo vključili v eksperiment 14-dnevnega mirovanja v strogo vodoravnem položaju v bolnišničnem okolju. Njihove kognitivne funkcije smo ocenili s pomočjo nevropsihološke baterije testov pred in po eksperimentu. Rezultati so pokazali, da pri udeležencih ni prišlo do upada kognitivnih sposobnosti po obdobju skrajne gibalne neaktivnosti, z izjemo mere odloženega priklica, pri kateri so se rezultati poslabšali le v skupini starejših udeležencev. Na podlagi ugotovitev lahko sklenemo, da so ostale kognitivne sposobnosti relativno stabilne skozi eksperimentalno obdobje. V prispevku opozorimo na morebitne dejavnike, ki so lahko prispevali k dobljenim rezultatom, na primer učinek učenja, razmeroma kratko trajanje bed rest raziskave in izbira uporabljenih kognitivnih testov. Prav tako poudarimo pomen ugodnih bivanjskih in psihosocialnih pogojev v času popolne gibalne neaktivnosti, ki so lahko predstavljali pomembno varovalo pred poslabšanjem kognitivnih funkcij.

Ključne besede: *gibalna neaktivnost, bed rest raziskave, kognitivno delovanje, odrasli*

INTRODUCTION

The beneficial effects of regular physical activity and sports on the human body are well-documented. Sufficient physical activity provides the maintenance of an adequate psychophysical condition and the functional abilities of the body (Turner & Robling, 2004) while also playing an important role in the preservation and enhancement of mental health (Kim et al., 2012; Landers & Arent, 2007). Some current epidemiological studies have also established the beneficial effects of regular physical activity on cognitive functions, such as attention, concentration, working memory, speed in information processing and problem-solving ability (Antunes et al., 2006; Etnier, Nowell, Landers, & Sibley, 2006; Smith, 2010).

On the other hand, physical inactivity is becoming a very serious problem in modern society. Strong evidence shows that physical inactivity increases the risk of many adverse health conditions, including major non-communicable diseases such as coro-

nary heart disease, type 2 diabetes, breast and colon cancers, and shortens life expectancy (Lee et al., 2012).

Less clear is how reducing physical activity levels affect cognition, as it is very difficult to induce and monitor long-term physical inactivity in everyday life. The extent to which cognition is affected by prolonged physical inactivity is potentially addressed by studies that have investigated the consequences of bed rest (Lipnicki & Gunga, 2009). Simulated weightlessness, better known as *bed rest (BR) experiments*, were introduced and recognized as a valid ground-based model for studying the effects of zero gravity on humans. The BR model, particularly as conducted in a head-down position (HDBR), has been used to study physiological changes associated with spaceflight, including those that occur to the cardiovascular system, regulation of body fluid, skeletal muscle, and bone (de Boer et al., 2008; Pavy-Le Traon, Heer, Narici, Rittweger, & Vernikos, 2007; Pišot et al., 2008; Rittweger et al., 2009). BR experiments, which presuppose strict rest in a horizontal position, today represent an important method for studying the consequences of prolonged physical inactivity.

Microgravity due to prolonged BR may cause changes in cerebral circulation, which in turn can affect brain functions (Montgomery & Gleason, 1992). Although there are not many studies that have examined cognitive functions in response to BR, they have provided quite inconsistent outcomes (Lipnicki & Gunga, 2009).

Randa L. Shehab and her colleagues (1998) studied the effects of a 17-day HDBR on cognitive performance in eight male volunteers with the application of the NASA Performance Assessment Workstation test battery, which measures six performance tasks to assess directed and divided attention, spatial, mathematical and memory skills as well as tracking ability. No statistically significant differences in performance were observed when comparing BR with the baseline period. In a more recent study, Ishizaki and her colleagues (2009) examined the effects of a 16-day period of HDBR on executive functions in twelve healthy young men. Four kinds of neuropsychological tests were performed on the baseline and on the day 16 of the experiment. There was no significant difference in the results between pre- and post-BR period for any of the tests (Ishizaki et al., 2009). Also, in a particularly long-term BR study, Seaton and colleagues (2009) reported no detrimental effects following a 90-day confinement to bed rest to the participants' cognition.

Some research findings have indicated a worsening in cognitive performance due to BR. A study by Lipnicki, Gunga, Belavý and Felsenberg (2009), found that a 60-day HDBR had a detrimental effect on executive functions assessed using the Iowa Gambling Task in twenty-four young men. Their results also showed longer reaction time latencies under HDBR (Lipnicki et al., 2009). Similar results were reported by Liu, Zhou, Chen and Tan (2012) who used an emotional flanker task to evaluate the effect of 45 days HDBR on executive functioning in sixteen young participants at different time periods throughout the experiment. The task results (accuracy and reaction time) provided some evidence as to the detrimental effects of prolonged BR on executive functions (Liu et al., 2012). In some earlier studies, the authors reported a worsening of performance in at least one cognitive measure, but no effect for other measures

(Asyamolov, Panchenko, Karpusheva, Bondarenko, & Vorob'ev, 1986; Ryback, Lewis, & Lessard, 1971).

Alternatively, some studies witnessed improvements in cognitive performance during BR. For example, Pavy-Le Traon and her colleagues analysed the effects of a 28-day HDBR on several cognitive abilities (attention span, short-term memory, spatial representation, grammatical reasoning) in male participants. While the majority of the studied abilities remained stable during BR, the participants' performance on tests of short-term memory and automated perceptual attention were enhanced (Pavy-Le Traon et al., 1994). Similarly, DeRoshia and Greenleaf (1993) studied cognitive function during a 30-day HDBR in eighteen healthy male subjects who completed different cognitive tests, including verbal reasoning, visuo-spatial ability, short-term memory, and simple reaction time before, during and after the BR period. Although a mild decrease in the parameter of reaction time was established at the mid-point of the experiment, overall cognitive performance improved in response to prolonged BR.

In a recent review, Lipnicki and Gunga (2009) emphasized that the reported effects of bed rest on cognitive performance vary considerably, from the generally expected deterioration to improvements. It should be noted that these mixed results can be at least partially attributed to methodological issues such as the number and selection of subjects, an inconsistent use of cognitive measures, and the duration of BR studies.

Due to the lack of research concerning cognitive aspects of reduced physical activity and the aforementioned inconsistency of the previous findings, we conducted a study aimed to establish the effects of 14-day bed rest on cognitive condition in healthy male volunteers using a wide range of neuropsychological tests. An important element of added value in the study was also the inclusion of older participants, since BR studies normally address younger individuals. The research findings provide strong support for age-related changes in cognitive performance, particularly in the field of executive function abilities (Gunstad et al., 2006). Thus, the results of the effects of prolonged physical inactivity on cognitive functions were presented separately for the groups of younger and older participants.

METHODS

Participants

Twenty-three males aged between 19 and 65 volunteered to participate in the project *"Bed Rest Study – PANGeA, Valdoltra 2012 – The effects of simulated weightlessness on the human organism"*. The participants were divided into two groups based on age: the first group included seven young adults (19 – 28 years old; $M = 23.1$ $SD = 2.9$), while the second group comprised sixteen older adults (53 – 65 years old; $M = 59.6$; $SD = 3.4$). The participant selection process consisted of two steps: first, an interview about a past history and a present condition of the participant's physical and psycho-

social status, followed by a thorough medical examination to exclude skeletal muscle and cardiovascular diseases. The selected participants were healthy, non-smokers and took no medications or drugs. A written informed consent was obtained after a detailed explanation of the study (its purpose and research hypotheses, experimental procedures and methods, research conditions). The participants received a financial award after the study had been completed. The National Committee for Medical Ethics at the Ministry of Health, Slovenia, approved the experimental procedure.

For the purposes of the present study only fifteen participants were included: the group of young adults (already presented above) and a part of the older adult group (N = 8; 56–65 years old; M = 59.9; SD = 3.3). These participants were subject only to the BR experiment, while the other older participants went additionally through a mental training program during the BR period. In order to exclude the possible influence of this confounding factor in determining the effects of prolonged physical inactivity on cognition, the group with mental training intervention was not taken into account.

Experimental protocol

The study investigating the effects of simulated microgravity on human organism was conducted in August and September 2012 at the Orthopaedic Hospital Valdoltra, Slovenia, and was part of a broad-based research project *PANGeA: Physical Activity and Nutrition for Quality ageing.*

BR refers to bed confinement in a horizontal supine position for 14 days. The participants were housed in hospital rooms (3-4 in each room) and were under constant video surveillance and provided with 24-hour medical care. Physicians regularly checked physical condition of the participants. They performed all daily activities lying down and were not allowed to leave their beds. The participants were transferred with their beds to the bathroom for personal hygiene. They received standard hospital meals three times a day at 7.30 a.m., 12 a.m. and 6 p.m. The bedrooms were air-conditioned and the room temperature was kept comfortably below 25 °C. Throughout the whole BR experiment the participants were allowed to freely communicate with each other, to watch television and video, to listen to radio, to read books and magazines, to work on computer and use the Internet, and to receive visitors. The BR experiment was followed by a 30-day rehabilitation period. The BR study comprised two types of interventions carried out on a subgroup of participants: mental training intervention during the BR period and a nutrition intervention during rehabilitation. All measurements were performed during the pre-BR period, after the BR period and at the end of the rehabilitation period.

In order to evaluate the BR effects on cognitive functioning, participants were tested with a battery of cognitive tests before BR (3 days prior to the experiment) and after BR (on day 14 of the experiment). The neuropsychological testing was conducted in the morning, after breakfast, in a quiet environment. The participants completed the tasks individually in a sitting position.

Instruments

The following cognitive tests were used in the study:

1. *Rey's Auditory Verbal Learning Test (RAVLT)* is a neuropsychological assessment designed to evaluate verbal memory. The test consists of two 15-word lists; the person listens to a sequence of words in each trial and is asked to recall as many words as possible from the list. RAVLT provides scores for assessing immediate memory, new verbal learning, susceptibility to interference (proactive and retroactive), retention of information after a period of time and memory recognition (Van der Elst, Van Boxtel, Van Breukelen, & Jolles, 2005). In this study, the dependent measures used were the total number of words recalled after five learning trials (RAVLT – TL) and the total number of words recalled after 30 minutes (RAVLT – DR). With these measures we assessed new verbal learning and delayed recall.
2. *Trail Making Test (TMT).* The TMT (Reitan & Wolfson, 1985) is a test of visual attention and task switching and provides information on visual search, scanning, speed of processing, mental flexibility and executive functioning (Tombaugh, 2004). It consists of two parts, A and B. Both parts consist of 25 circles distributed over a sheet of paper. In part A, the circles are numbered from 1 to 25. The participant is required to connect the numbers in the increasing order, beginning with 1 and ending with 25, in the shortest possible time. Part B is more complex than Part A because it requires the participant to connect numbers and letters in an alternating pattern (1-A-2-B-3-C, etc.) as fast as possible. The latency scores in seconds, separately for Part A and Part B, were used as dependent measures for analyses (TMT-A, TMT-B).
3. *Digit Span* subtest of the Wechsler Adult Intelligence Scale-III (WAIS-III) (Wechsler, 1987) was used to evaluate working memory. The test consists of two parts: Digits Forward requires the subject to repeat sequences of digits which are read aloud to them that increase in length from three to nine digits; Digits Backward requires sequences of two to eight digits to be repeated in reverse order. The total score was calculated as an average of the longest correctly repeated forward and backward digit strings.
4. *Verbal Fluency Test FAS.* Verbal fluency is a cognitive function that facilitates information retrieval from memory. There are two types of verbal fluency tests: semantic and phonemic. The FAS test is probably the best known phonemic fluency test. Although it was developed as a test of language abilities, it is also considered a test of executive functions (Barry, Bates, & Labouvie, 2008). A subject has to name as many words as possible beginning with letters "F", "A" and "S", one at a time for one minute, excluding proper nouns, such as city, people or river names and the same words with a different suffix. The subjects were given the following instruction: "I will say a letter. Then, I want you to give me as many words you can that begin with this letter, as quickly as possible. For example, if I say "B", you can say

bird, bad, but you can't say Brazil or Barbara. Also, you can't say the same word with a different ending (brother and then brotherhood)." The average number of words per letter was used as a dependent measure.

5. *Mental Rotation Test (MRT)* is a test of spatial abilities (Peters et al., 1995). It is based on a redrawn version of the Vandenberg and Kuse (1978) mental rotation test. An individual is presented with 24 drawings of 3-dimensional objects composed of a series of 10 connected tubes. Each drawing is presented with four alternatives. The subject must select two out of four alternatives that represent the drawing in a rotated position. 3 minutes are given for each subset of 12 drawings, separated by 4 minutes. Dependent variable is the number of correctly solved items (both alternatives are correctly chosen). Thus, the maximum score is 24.
6. *Perspective Taking/Spatial Orientation Test (PTSOT)*: This test was revised by Hegarty, Kozhevnikov, and Waller (2008) from the test used by Kozhevnikov and Hegarty (2001). The PTSOT measures the ability to imagine different perspectives or orientations in space from a configuration of objects. The participants are asked to imagine being at one of the objects of the configuration, facing another object, and to indicate the direction of a third. A circle was used for representing the responses, made by drawing an arrow out towards the edge of the circle itself. There were 12 items in this test, one on each page. Five minutes were allotted for completing this task. Dependent variable was an average deviation in degrees from the veridical location of the target. A higher score indicates poorer performance.

Statistic analysis

The data was analyzed with the software package SPSS for Windows. The paired samples *t*-test was used to determine the differences in the studied variables before and after the BR experiment. In addition to statistical significance testing, practical significance (Kline, 2004) was assessed using the effect sizes, which are resistant to sample size influences (Ferguson, 2009). There is no agreement on what magnitude of effect is necessary to establish practical significance. Cohen (1988) presented the benchmarks for interpreting the differences between two groups (*d* coefficient), whereby 0.2 equates to a small effect, 0.5 equates to a medium effect, and effects larger than 0.8 equate to large effects. Ferguson (2009) offers slightly different guidelines: the recommended minimum effect size representing a "practically significant effect" for social science data is 0.41. The cut-off that equates to a medium effect is 1.15 and the cut-off for strong effect is 2.70. Due to the nature of the study, we decided to use Ferguson's recommendations for the interpretation of effect sizes, so the weak effect sizes are not overinterpreted.

RESULTS

The mean (*M*) and standard deviation (*SD*) of scores on neuropsychological tests in the group of younger participants are presented in Table 1. The paired sample *t*-test showed that there was no significant change following the BR period in any of the measurements of cognitive functions, except in spatial visualization (as measured by Mental Rotation Test). Younger participants performed significantly better after the BR period than at the baseline (before the BR period). Cohen's *d* coefficient additionally showed practically significant improvements in verbal fluency, visual attention (TMT-A), perspective and spatial orientation (PSTOT).

Table 1: Differences in neuropsychological tests before and after BR in younger participants.

Neuropsychological tests	before BR M (SD)	after BR M (SD)	difference M	t (df=6)	p	d
RAVLT – TL	52.86 (5.58)	53.43 (6.58)	-0.57	-0.28	0.79	-0.09
RAVLT – DR	12.43 (2.22)	11.71 (2.36)	0.71	1.51	0.18	0.31
Mental Rotation	8.28 (5.53)	11.43 (3.41)	-3.14	-2.42	0.05	-0.68
Trial Making-A*	25.28 (9.25)	21.00 (5.74)	4.28	1.92	0.10	0.56
Trial Making-B*	52.17 (18.58)	47.33 (15.96)	4.83	.86	0.43	0.28
Digit Span	6.14 (1.07)	6.00 (1.19)	0.14	0.47	0.65	0.12
Verbal fluency	8.81 (1.56)	9.81 (2.77)	-1.00	-1.34	0.23	-0.44
PTSOT*	27.28 (11.93)	19.00 (8.52)	8.28	1.94	0.10	0.80

*Note: *Higher scores denote poorer performance; RVLT-TL: Rey's Auditory Verbal Learning Test — total learning; RVLT-DR: Rey's Auditory Verbal Learning Test — delayed recall; PTSOT: Perspective Taking/Spatial Orientation Test*

Table 2: Differences in neuropsychological tests before and after BR in older participants.

Neuropsychological tests	before BR M (SD)	after BR M (SD)	difference M	t (df=7)	p	d
RAVLT - TL	44.38 (3.58)	44.88 (5.46)	-0.50	-0.31	0.76	-0.11
RAVLT – DL	8.50 (2.14)	7.12 (2.30)	1.38	2.31	0.05	.62
Mental Rotation	5.12 (3.60)	5.50 (3.42)	-0.38	-0.53	0.61	-0.11
Trial Making-A*	43.00 (26.61)	38.38 (18.10)	4.62	0.53	0.62	0.20
Trial Making-B*	98.12 (42.73)	96.12 (46.10)	2.00	0.18	0.86	0.04
Digit Span	5.56 (1.29)	5.18 (1.36)	0.38	1.16	0.28	0.29
Verbal fluency	8. 54 (1.79)	9.75 (2.31)	-1.21	-1.86	0.10	-0.58
PTSOT*	77.62 (52.91)	67.00 (54.27)	10.62	0.71	0.50	0.20

*Note: *Higher scores denote poorer performance; RVLT-TL: Rey's Auditory Verbal Learning Test — total learning; RVLT-DR: Rey's Auditory Verbal Learning Test — delayed recall; PTSOT: Perspective Taking/Spatial Orientation Test*

Table 2 shows mean (*M*) and standard deviation (*SD*) scores on neuropsychological tests in the older age group. There was no significant change following the BR period in any of the measurements of cognitive functions, except in delayed recall, assessed by RAVLT test. In the second testing (after the BR period) the participants showed poorer performance than at the baseline. Cohen's *d* coefficient (for paired samples) also showed practically significant improvement in verbal fluency.

DISCUSSION AND CONCLUSIONS

To evaluate the effects of BR on cognitive functioning in participants, a neuropsychological test battery was used before and after the experiment. The tests administered in the study included different cognitive measures: verbal learning, delayed recall, executive functions, working memory, processing speed, verbal fluency, mental visualization and spatial orientation.

According to research, there is a generally accepted assumption that cognitive abilities decline with age, especially in terms of processing speed, memory and executive functions (Hedden & Gabrieli, 2004), therefore the results have been presented separately for the younger and older age groups.

There was no significant difference in the results of the neuropsychological tests between the baseline and the day 14 of BR in the young adult group, except in the result of mental visualization assessed by the Mental Rotation Test, where a significant improvement was observed after the BR experiment. Also, a tendency towards improved

performance was noticed in the measures of executive functions (e.g. visual attention, task switching) and spatial orientation assessed by Perspective Taking/Spatial Orientation Test and Trial Making Test, respectively.

In the older age group, no significant changes in cognitive performance occurred after prolonged physical inactivity, except in the results of delayed recall, where a significant impairment was noticed, indicating that older participants exhibited more difficulties in retrieving words after a time period at the end of the BR experiment compared with the beginning. There was also a slight tendency towards an improvement in language abilities, assessed by Verbal Fluency Test in the older age group. On average, they were able to generate more words beginning with a specific letter after the BR period compared to the baseline.

On the basis of the results of both age groups, we can assume that in general cognitive functions were not deteriorated following the period of total physical inactivity. Our findings are in accordance with some previous studies that generally reported no effects in cognitive functioning (Ishizaki et al., 2009; Seaton et al., 2009; Shebab et al., 1998), while mostly inconsistent with other studies indicating a multi-measure impairment of cognitive performance after BR (Lipnicki et al., 2009; Liu et al., 2012). It is often difficult to compare the results of different BR studies with each other, as they can vary considerably in terms of BR duration (short-term or long-term), position (horizontal or head-down), as well as in the choice of cognitive test administered. Therefore, these factors should be considered when interpreting research findings.

It should be noted, that the Bed Rest Study – PANGeA, Valdoltra 2012, was performed in horizontal position, while the majority of BR studies were conducted in a head-down tilt position, since this type comes closest to matching the conditions of weightlessness that occurs during space flights. This specificity of the experimental protocol may influence our results, although the comparison between the two types has revealed that cognitive test results obtained from subject in a head-down position during BR were as variable as those obtained from subjects positioned horizontally (Lipnicki & Gunga, 2009).

One potential element that should be taken into account when explaining our results is practice effect, defined as improvements in cognitive test performance due to repeated evaluation with the same test materials. Practice effects have been discussed in relation to BR studies, suggesting that greater the overall task exposure the more likely was a performance effect to be found that was higher on a scale from worsening, though no effect, to improvement (Lipnicki & Gunga, 2009). Furthermore, the authors assume that practice effect could mask an underlying detrimental effect of bed rest on cognitive functioning. In our case the practice effect on some of cognitive measures can be attributed to relative short duration of the BR experiment and therefore short interval between the two test applications. In some tests, a tendency towards a positive change in performance is probably a result of a generalized rule or method learned by the participants.

It has been reported in many studies that due to prolonged BR, microgravity causes cardiovascular deconditioning (Antonutto & di Prampero, 2003) that affects brain circulation processes (Montgomery & Gleason, 1992). Higher brain functions and executive functions are expected to be particularly sensitive to these psycophysiological changes (Ishizaki et al., 2009). The results of our study suggest that these changes were perhaps too small to affect higher brain functions. It can be observed that those BR studies that were longer in duration reported some clear evidence for a detrimental effect of bed rest on executive functioning (Lipnicki et al., 2009; Liu et al., 2012), whereas the study of Ishizaki and colleagues (2009) which was comparable to our study by duration found no worsening of cognitive function due to bed rest. Another possible explanation which was already highlighted in some previous studies (Dolenc & Pišot, 2011; Seaton, Bowie, & Sites, 2009) is that cognitive performance is related to the mental health of the subjects. The results obtained in our study may also be associated with the highly favourable habitability factors that were present during the BR experiment. These factors included maintenance of a stimulating environment, the possibility to use various media, acess to various means of communication to stay in touch with friends and relatives, as well as researchers and medical personnel. The participants were allowed to a variety of mental activities, such as reading, writing, working on a PC, playing games, using e-mail and the Internet, watching TV etc., which may have contributed to the maintenance of high motivation and preservation of cognitive function levels. Our results suggest that the provision of favourable living conditions, a positive psychological state of participants along with the maintenance of mental activity during the period of prolonged physical immobilisation represent some kind of "protective factors" that might alleviate an impairment of cognitive condition.

Although the comparison of results between the younger and the older group showed similar patterns of stability and change, there were also some specifics. The younger age group showed stability in cognitive functions or even a tendency towards a better performance after the BR period, whereas in the older group the cognitive performance remained stable, with the exception of memory functions, which reflected a decline across the BR period. Memory represents a cognitive domain that shows decline with age (Zupančič, 2004). Based on our findings it seems that long-term physical inactivity or extremely sedentary lifestyle could have an additional adverse effect on memory functions in older adults. This leads to the conclusion that participation in physical activities may be of particular importance when other risk factors for cognitive decline are present (Aichberger et al., 2010).

An important contribution of the present research within the "Bed Rest Study Project – PANGeA, Valdoltra 2012 was the inclusion of older adult participants, since the previous BR studies examined young adults and primarily used this paradigm as a model for determining the effects of weightlessness related to space flight. Moreover, this study emphasized the usefulness of the BR model for evaluating the consequences of long-term physical inactivity. Thus, it seems reasonable to pay bigger attention to the study of psychological and cognitive aspects under the conditions of restricted physical activity in the future.

It should be noted that all the subjects of the BR studies volunteered to participate. They had been informed in advance about both the duration of the inactivity experimentsand the expected time of conclusion. These individuals are certainly intrinsically motivated in a different way than people who do not voluntarily choose a condition of inactivity. Although our findings cannot be directly related to ill and hospitalized people, we may conclude that the research on cognitive functioning within BR studies potentially has an applied value in the field of health prevention and rehabilitation. The obtained results can be applied to the individuals who are otherwise healthy but whose physical activity is temporarily very limited, e.g. orthopeadic post-operative conditions requiring long-term recovery or other indications which presuppose a longer period of physical inactivity. In all those cases additional means of maintaining psychological health and cognitive functioning should be vigorously pursued.

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REFERENCES

Aichberger, M. C., Busch, M. A., Reischies, F. M., Stroehle, A., Heinz, A., & Rapp, M. A. (2010). Effect of physical inactivity on cognitive performance after 2.5 years of follow-up. The Journal of Gerontopsychology and Geriatric Psychiatry, 23(1), 7–15.

Antonutto, G., & di Prampero, P. E. (2003). Cardiovascular deconditioning in microgravity: some possible countermeasures. European Journal of Applied Physiology, 90(3/4), 283–291.

Antunes, H. K. M., Santos, R. F., Cassilhas, R., Santos, R. V. T., Bueno, O. F. A., & de Mello, M. T. (2006). Reviewing on physical exercise and the cognitive function. Revista Brasileira de Medicina do Esporte, 12, 97–103.

Asyamolov, B. F., Panchenko, V. S., Karpusheva, V. A., Bondarenko, R. A., & Vorob'ev, O. A. (1986). Some human reactions during seven-day antiorthostatic hypokinesia. Space Biology and Aerospace Medicine, 20(1), 29–32.

Barry, D., Bates, M. E., & Labouvie, E. (2008). FAS and CFL forms of verbal fluency differ in difficulty: a meta-analytic study. Applied Neuropsychology, 15(2), 97–106.

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). New Jersey: Lawrence Erlbaum Associates.

de Boer, M. D., Seynnes, O., Di Prampero, P. E., Pišot, R., Mekjavić, I. B., Biolo, G., et al. (2008). Effect of 5 weeks horizontal bed rest on human muscle thickness and architecture of weigh bearing and non-weight bearing muscles. European Journal of Applied Physiology, 104(2), 401–407.

DeRoshia, C. W., & Greenleaf, J. E. (1993). Performance and mood state parameters during 30-day 6 degrees head-down bed rest with exercise training. Aviation, Space and Environmental Medicine, 64, 522–527.

Dolenc, P., & Pišot, R. (2011). Effects of long-term physical inactivity on depressive symptoms, anxiety, and coping behaviour of young participants. Kinesiology, 43(2), 178–184.

Etnier, J. L., Nowell, P. M., Landers, D. M., & Sibley, B. A. (2006). A mega-regression to examine the relationship between aerobic fitness and cognitive performance. Brain research reviews, 52(1), 119–130.

Ferguson, C. J. (2009). An Effect Size Primer: A Guide for Clinicians and Researchers. Professional Psychology: Research and Practice, 40(5), 532–538.

Hedden, T., & Gabrieli, J. D. (2004). Insights into the ageing mind: a view from cognitive neuroscience. Nature Reviews Neuroscience, 5(2), 87–96.

Hegarty, M., Kozhevnikov, M., & Waller, D. (2008). Perspective Taking/Spatial Orientation Test. University California Santa Barbara. Retreived May 15th 2012 from: https://labs.psych.ucsb.edu/hegarty/mary/instruments/ptsot.pdf.

Gunstad, J., Paul, R., Brickman, A., Cohen, R., Arns, M., Roe, D., et al. (2006). Patterns of Cognitive Performance in Middle-aged and Older Adults: A Cluster Analytic Examination. Journal of Geriatric Psychiatry and Neurology, 19, 59–64.

Ishizaki, Y., Fukuoka, H., Tanaka, H., Ishizaki, T., Fujii, Y, Hattori-Uchida, Y., et al. (2009). Executive function on the 16-day of bed rest in young healthy men. Acta Astronautica, 64(9/10), 864–868.

Kim, Y. S., Park, Y. S., Allegrante, J. P., Marks, R., Ok, H., Ok Cho, K., et al. (2012). Relationship between physical activity and general mental health. Preventive Medicine, 55(5), 458–463.

Kline, R. B. (2004). Beyond significance testing: Reforming data analysis methods in behavioral research. Washington, DC, US: American Psychological Association.

Kozhevnikov, M., & Hegarty, M. (2001). A dissociation between object-manipulation and perspective-taking spatial abilities. Memory & Cognition, 29, 745–756.

Landers, D. M., & Arent, S. M. (2007). Physical activity and mental health. The Handbook of Sport Psychology. John Wiley and Sons.

Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T., et al. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: ananalysis of burden of disease and life expectancy. Lancet, 380(9838), 219–229.

Lipnicki, D. M., & Gunga, H. C. (2009). Physical inactivity and cognitive functioning: results from bed rest studies. European Journal of Applied Physiology, 105(1), 27–35.

Lipnicki, D. M., Gunga H. C., Belavý, D. L., & Felsenberg, D. (2009). Bed rest and cognition: effects on executive functioning and reaction time. Aviation, Space and Environmental Medicine, 80(12), 1018–1024.

Liu, Q., Zhou, R., Chen, S., & Tan, C. (2012). Effects of Head-Down Bed Rest on the Executive Functions and Emotional Response. PLoS ONE 7(12), e52160.

Montgomery, L. D., & Gleason, C. R. (1992). Simultaneous use of rheoencephalography and electroencephalography for the monitoring of cerebral function. Aviation, Space and Environmental Medicine, 63(4), 314–321.

Pavy-Le Traon, A., Heer, M., Narici, M. V., Rittweger, J., & Vernikos, J. (2007). From space to Earth: advances in human physiology from 20 years of bed rest studies (1986 –2006). European Journal of Applied Physilogy, 101(2), 143–194.

Pavy-Le Traon, A., Feneyrols, R. D., Cornac, A., Abdeseelam, R., N'uygen, D., Lazerges, M., et al. (1994). Psychomotor performance during a 28-day head-down tilt with and without lower body negative pressure. Acta Astronautica, 32(4), 319–330.

Peters, M., Laeng, B., Latham, K., Jackson, M., Zaiyouna, R., & Richardson, C. (1995). A redrawn Vandenberg and Kuse Mental Rotations Test: Different versions and factors that affect performance. Brain and Cognition, 28, 39–58.

Pišot, R., Narici, M. V., Šimunič, B., de Boer, M. D., Seynnes, O., Jurdana, M., et al. (2008). Whole muscle contractile parameters and thickness loss during 35-day bed rest. European Journal of Applied Physiology, 104(2), 409–414.

Reitan, R. M., & Wolfson, D. (1985). The Halstead-Reitan neuropsychological test battery. Tucson, AZ: Neuropsychological Press.

Rittweger, J., Šimunič, B., Bilancio, G., De Santo, N. G., Cirillo, M., Biolo, G., et al. (2009). Bone loss in the lower leg during 35 days of bed rest is predominantly from the cortical compartment. Bone, 44(4), 612–618.

Ryback, R. S., Lewis, O. F., & Lessard, C. S. (1971). Psychobiologic effects of prolonged bed rest (weightlessness) in young healthy volunteers (Study II). Aerospace Medicine, 42, 529–535.

Seaton, K. A., Bowie, K. E., & Sipes, W. A. (2009). Behavioral and psychological issues in long-duration head-down bed rest. Aviation, Space and Environmental Medicine, 80(5 Suppl), A55–61.

Seaton, K. A., Slack, K. J., Sipes, W. A., & Bowie, K. E. (2009). Cognitive functioning in long-duration head-down bed rest. Aviation, Space and Environmental Medicine, 80(5 Suppl), A62–65.

Shehab, R. L., Schlegel, R. E., Schiflett, S. G., & Eddy, D. R. (1998). The NASA Performance Assessment Workstation: cognitive performance during head-down bed rest. Acta Astronautica, 43, 223–233.

Smith, P. J., Blumenthal, J. A., Hoffman, B. M., Cooper, H., Strauman, T. A., Welsh-Bohmer, K., et al. (2010). Aerobic exercise and neurocognitive performance: a meta-analytic review of randomized controlled trials. Psychosomatic Medicine, 72(3), 239–252.

Tombaugh, T. N. (2004). Trail Making Test A and B: Normative data stratified by age and education. Archives of Clinical Neuropsychology, 19(2), 203–214.

Turner, C. H., & Robling, A. G. (2004). Exercise as a metabolic stimulus for bone. Current Pharmaceutical Design, 10, 2629–2641.

Vandenberg, S. G., & Kuse, A. R. (1978). Mental rotation, a group test of three-dimensional spatial visualization. Perceptual & Motor Skills, 47, 599–604.

Van der Elst, W., Van Boxtel, M. P. J., Van Breukelen, G. J. P., & Jolles, J. (2005). Rey's Verbal Learning Test: Normative data for 1,855 healthy participants aged 24-81 years and the influence of age, sex, education, and mode of presentation. Journal of the International Neuropsychological Society, 11, 290–302.

Wechsler, D. A. (1997). Wechsler Adult Intelligence Scale (3rd ed.). San Antonio, TX: The Psychological Corporation.

Zupančič, M. (2004). Spoznavni razvoj in vsakdanja kompetentnost v pozni odraslosti. In L. Marjanovič Umek, & M. Zupančič (Eds.), Razvojna psihologija (pp. 774–791). Ljubljana: Znanstvenoraziskovalni inštitut Filozofske fakultete.

REWIEWS / POROČILA, 145–148

18TH ANNUAL CONGRESS OF THE »EUROPEAN COLLEGE OF SPORT SCIENCE«

Between 26th and 29th July 2013, the 18th annual European College of Sport Science (ECSS), entitled "Unifying Sport Science" was held in Barcelona, Spain. The congress was attended by a record number of participants (3,112) from 75 countries worldwide. It consisted of 4 plenary sessions, 143 invited speakers, 465 oral and 1,228 poster presentations where participants presented their latest research findings in the fields of sport, kinesiology, sport nutrition, physiology, neuroscience, physiotherapy, sport training, as well as sport pedagogy, sport management and engineering. The elite location of the Olympic Ring up on the Montjuic Hill offered an additional motivation for active participation in a number of sessions, as well as networking among young scientists and global leaders in individual research areas.

A competition among young researchers called "Young Investigators Award (YIA)" takes place at the ECSS every year. There were 538 young researchers registered for this year's competition. A preliminary assessment of the submitted scientific papers was made and only a half of them were granted an oral presentation at the congress. In this framework, I presented a paper entitled "Cognitive Training during 14-day Physical Inactivity Improves Dual-task Walking" where I came, together with co-authors, to some very interesting conclusions. We found that cognitive training (with spatial navigation, working memory and executive functions) can reduce deterioration of sensorimotor function that occurs during the prolonged inactivity or immobilization. The 10-minute presentation was followed by another 5 minutes of in-depth questioning by

the members of the ECSS Scientific Committee which announced four finalists, who presented their study once again on the last day of the ECSS congress. With my presentation, I was awarded second place and a prestigious award in my research field. All the YIA finalists receive the opportunity to participate in the YIA winner community where you can meet the winners from previous years, as well as gain numerous networking opportunities at the ECSS congresses.

After the official closure of the 18th annual ECSS congress a social program with delicious local food and excellent live music was organized at the Olympic Ring by a local institution.

No scientific achievement is a work of only one single individual. Therefore, I would like to thank my mentor, Professor Rado Pišot, Ph.D., and co-mentor Professor Vojko Kavčič, Ph.D., for all the effort they put into the bed rest study. I would like to thank the entire IKARUS team and the head of the IKARUS team Professor Boštjan Šimunič, Ph.D., with whom we worked continuously for several months in the hospital of Valdoltra, Slovenia. Finally, special thanks go also to Professor Romain Meeusen, Ph.D., and his team at the VUB, Brussels, Belgium, who helped me with good practice examples and motivation for optimizing my scientific paper as well as the presentation.

The next ECSS congress will be held on 2nd July 2014 in Amsterdam, the Netherlands.

Uroš Marušič

18. LETNI ZNANSTVENI KONGRES »EUROPEAN COLLEGE OF SPORT SCIENCE«

Od 26. do 29. junija 2013 je v Barceloni v Španiji potekal 18. letni kongres European College of Sport Science (ECSS), ki je največji znanstveni kongres na področju športne znanosti na svetu, z delovnim naslovom »Zedinimo znanost v športu«. Udeležilo se ga je rekordno število raziskovalcev (3112) iz 75 držav celotnega sveta. Kongres je zajemal štiri plenarne sekcije, 143 vabljenih predavanj, 465 ustnih in kar 1228 predstavitev na plakatih, kjer so udeleženci predstavili svoje najnovejše izsledke raziskav s področja športa, kineziologije, športne prehrane, fiziologije, nevroznanosti, fizioterapije, športnega treniranja pa tudi športne pedagogike, managementa in inženiringa. Elitna lokacija Olimpijskega obroča na hribu Montjuic je ponudila še dodatno motivacijo za aktivno udeležbo na številnih sekcijah ter spoznavanje in mreženje med še neuveljavljenimi znanstveniki, ki svojo karierno pot šele ustvarjajo, ter tistimi, ki so v samem svetovnem vrhu specifičnega raziskovalnega področja.

Vsako leto na kongresu ECSS podelijo nagrado za mlade raziskovalce imenovano »Young Investigators Award (YIA)«. Letos je bilo prijavljenih 538 mladih raziskovalcev. Po predhodnem ocenjevanju oddanih znanstvenih prispevkov nas je možnost predstavitve raziskave v kategoriji YIA dobila le polovica. Sam sem predstavil prispevek z naslovom »Cognitive training during 14-day physical inactivity improves dual-task walking«, v katerem smo s soavtorji prišli do zanimivih zaključkov. Ugotovili smo namreč, da je s pomočjo umo-vadbe (vadbe možganov s treningom prostorske navigacije, delovnega spomina in eksekutivnih funkcij) možno zadržati strm upad senzomotoričnih funkcij, ki nastopi po večdnevni neaktivnosti oz. imobilizaciji. Pred-

stavitev je trajala deset minut, čemur je sledilo še pet minut poglobljenih vprašanj s strani komisije v kategoriji YIA. Znanstveni odbor ECSS je nato razglasil štiri finaliste, ki smo za namen končne razvrstitve svoje študije ponovno predstavili zadnji dan kongresa v kongresni dvorani. Vesel sem, da sem si s svojo predstavitvijo opravljene študije prislužil drugo mesto in s tem prav najprestižnejšo nagrado na svojem raziskovalnem področju. Nagrada mi je odprla vrata v skupnost raziskovalcev (YIA winner community), ki so v prejšnjih letih zmagali, in možnosti srečevanja in mreženja na naslednjih ECSS kongresih.

Po izjemnem zaključku in uradnem zaprtju 18. kongresa ECSS je sledil bogat družabni program, ki so ga priredili domači gostitelji s številnimi lokalnimi dobrotami in odličnim glasbenim izborom na zgoraj omenjenem Olimpijskem obroču.

Noben znanstveni dosežek pa ni delo enega posameznika. Zato se želim zahvaliti svojemu mentorju prof. dr. Radu Pišotu in somentorju prof. dr. Vojku Kavčiču za ves trud pri izpeljani študiji. Prav tako gre zahvala celotni ekipi IKARUS-a ter predstojniku izr. prof. dr. Boštjanu Šimuniču, s katerimi smo nepretrgoma delali več mesecev v Ortopedski bolnišnici Valdoltra, Slovenija. Nenazadnje gre posebna zahvala tudi prof. dr. Romainu Meeusenu in ekipi iz Bruslja, ki je s primeri dobrih praks in z motivacijo vplivala na optimizacijo znanstvenega prispevka in predstavitve.

Naslednji kongres ECSS bo potekal od 2. do 5. julija v Amsterdamu na Nizozemskem.

Uroš Marušič

GUIDELINES FOR AUTHORS, 149–153

GUIDELINES FOR AUTHORS

1. **Aim and scope of the journal:**
   Annales Kinesiologiae is an international interdisciplinary journal covering kinesiology and its related areas. It combines fields and topics directed towards the study and research of human movement, physical activity, exercise and sport in the context of human life style and influences of specific environments. The journal publishes original scientific articles, review articles, technical notes and reports.

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e) The authors are obliged to prepare two **abstracts** – one short abstract in English and one (translated) in Slovene language. For foreign authors translation of the abstract into Slovene will be provided. The content of the abstract should be structured into the following sections: purpose, methods, results, and conclusions. It should only contain the information that appears in the main text, and should not contain reference to figures, tables and citations published in the main text, and should not exceed 250 words.

f) Under the abstract a maximum of 6 appropriate **Keywords** shall be given in English and in Slovene. For foreign authors the translation of the abstract into Slovene will be provided.

g) The **main text** should include the following chapters: Introduction, Methods, Results, Discussion, Conclusions, Acknowledgement (optional), and References. Individual parts of the text can form sub-sections.

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The journal uses the Harvard reference system (Publication Manual of the American Psychological Association, 5th ed., 2001), see also: http://www.apastyle.org). The list of references should only include work cited in the main text and being published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text. References should be complete and contain up to six authors. If the author is unknown, start with the title of the work. If you are citing work that is in print but has not yet been published, state all the data and instead of the publication year write „in print“.

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Examples of reference citation in the text

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Only the first author is cited: Di Prampero et al. (2008) or (Di Prampero et al., 2008).

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Books:
Latash, M. L. (2008). Neurophysiologic basis of movement. Campaign (USA): Human Kinetic.

Journal articles
Šarabon, N., Kern, H., Loefler, S., & Rošker. J. (2010). Selection of body sway parameters according to their sensitivity and repeatability. Basic and Applied Myology, 20(1), 5–12.
De Boer, M. D., Seynnes, O., Di Prampero, P., Pišot, R., Mekjavić, I., Biolo, G., & Narici, M. V. (2008). Effect of 5 weeks horizontal bed rest on human muscle thickness and architecture of weight bearing and non-weight bearing muscles. European journal of applied physiology, 104(2), 401–407.

Book chapters
Šimunič, B., Pišot, R., Mekjavić, I. B., Kounalakis, S. N., & Eiken, O. (2008). Orthostatic intolerance after microgravity exposures. In R. Pišot, I. B. Mekjavić, & B. Šimunič (Eds.), The effects of simulated weightlessness on the human organism (pp 71–78). Koper: University of Primorska, Scientific and research centre of Koper, Publishing house Annales.
Rossi, T., & Cassidy, T. (in press). Teachers' knowledge and knowledgeable teachers in physical education. In C. Hardy, & M. Mawer (Eds.), Learning and teaching in physical education. London (UK): Falmer Press.

Conference proceeding contributions

Volmut, T., Dolenc, P., Šetina, T., Pišot, R., & Šimunič, B. (2008). Objectively measures physical activity in girls and boys before and after long summer vacations. In V. Štemberger, R. Pišot, & K. Rupret (Eds.) Proceedings of 5th International Symposium A Child in Motion "The physical education related to the qualitative education" (pp 496–501). Koper: University of Primorska, Faculty of Education Koper, Science and research centre of Koper; Ljubljana: University of Ljubljana, Faculty of Education.

Škof, B., Cecić Erpić, S., Zabukovec, V., & Boben, D. (2002). Pupils' attitudes toward endurance sports activities. In D. Prot, & F. Prot (Eds.), Kinesiology – new perspectives, 3rd International scientific conference (pp 137–140), Opatija: University of Zagreb, Faculty of Kinesiology.

4. Manuscript submission

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The article should be submitted via e-mail: **annales.kinesiologiae@zrs.upr.si.**

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