

SPORT SCIENCE

Vol. 6, Issue 1. June 2013.

INTERNATIONAL SCIENTIFIC JOURNAL OF KINESIOLOGY

Publisher: Faculty of Education – University of Travnik, Bosnia & Herzegovina

Print ISSN 1840-3662, Web ISSN 1840-3670

UDK 796, Catalogued in: COBISS BH

Editor-in-Chief: DOBROMIR BONACIN (Travnik, B&H)

Consultant: NIHAD SELIMOVIĆ (Travnik, B&H)

Executive Editor: DANIJELA BONACIN (Travnik, B&H)

Scientific Adviser: VINKO LOZOVINA (Split, Croatia)

Public relations: MERSIHA BEGANOVIĆ (Travnik, B&H)

Indexed in:

'CAB Abstracts', 'CABI Leisure Recreation and Tourism Abstracts', 'CABI Leisure Tourism Database', 'CABI Global Health', 'CABI Nutrition Abstracts and Reviews Series A: Human and Experimental', 'SafetyLit', 'FSO', 'CABI Abstracts on Hygiene and Communicable Diseases', 'Elsevier Scopus', 'Open-J Gate', 'getCITED', 'ProQuest CSA Physical Education Index', 'ProQuest CSA Natural Sciences', 'ProQuest CSA Social Sciences', 'Genamics Journal Seek', 'Electronic Journals Index (SJSU)', 'Directory of Open Access Journals (DOAJ)', 'EBSCO SPORTDiscus with Full Text', 'EBSCO TOC Premier', 'EBSCO Current Abstracts', 'Index Copernicus',

Editorial Board

Marko Aleksandrović (Niš, Serbia), Dijana Avdić (Sarajevo, B&H), Dana Badau (Brasov, Romania), Panteleimon Bakirtzoglou (Athens, Greece), Sukru S. Balci (Konya, Turkey), Ricardo M. L. Barros (Campinas, Brasil), Mato Bartoluci (Zagreb, Croatia), Duško Bjelica (Podgorica, Montenegro), Stipe Blažević (Rijeka, Croatia), Jonathan Bloomfield (Ulster, N.Ireland), Tudor O. Bompă (Toronto, Canada), Manuel F. Botelho (Porto, Portugal), Radoslav Bubanj (Niš, Serbia), Marina M. Bulatova (Kyiv, Ukraine), Lisette Burrows (Otago, New Zeland), Michael Y. H. Chia (Nanyang, Singapore), Ming Kai Chin (Cedar Falls, USA), Rasim Dacić (Travnik, B&H), Gudrun Doll-Teppe (Berlin, Germany), Raquel Escobar Molina (Granada, Spain), Ken Hardman (Worcester, UK), Fatih Hazar (Aydin, Turkey), Toivo Jurimae (Tartu, Estonia), Mark King (Leicester, UK), Azra Kozarčanin (Sarajevo, B&H), Monia Laccheb (Tunis, Tunisia), Patrick Lacleme (Troyes, France), Farid Ljuca (Tuzla, B&H), Mario A.C. Marques (Covilhã, Portugal), Boyanka I. Peneva (Sofia, Bulgaria), Izet Rađo (Sarajevo, B&H), Hazir Salihu (Pristine, Kosovo), Brandon S. Shaw (Tshwane, South Africa), Maurizio Sibilio (Salerno, Italy), Clarissa T. Stefani (Sao Paulo, Brasil), Branko Škof (Ljubljana, Slovenia), Jose A. P. Turpin (Alicante, Spain), Tommi Vasankari (Tampere, Finland), Kasuhiko Watanabe (Hiroshima, Japan), Erika Zemkova (Bratislava, Slovakia)

Section Editors

Sports Theory:

Zarko Kostovski (Skopje, Macedonia), Vladan Papić (Split, Croatia), Slavko Trninić (Split, Croatia)

Sports Anthropology:

Mirna Andrijašević (Zagreb, Croatia), Vinko Lozovina (Split, Croatia), Fadilj Eminović (Belgrade, Serbia)

Sports Management:

Danijela Bonacin (Travnik, B&H), Dalibor Misirača (Banja Luka, B&H), Nihad Selimović (Travnik, B&H)

Sports System:

Zarko Bilić (Mostar, B&H), Bojan Matković (Zagreb, Croatia), Goran Oreb (Zagreb, Croatia),

Sports Methodology:

Dobromir Bonacin (Travnik, B&H), Goran Sporiš (Zagreb, Croatia), Živorad Torlić (Travnik, B&H)

Reviews:

Mersiha Beganović (Travnik, BiH)

Advisory Board:

Vullnet Ahmeti (Tetovo, Macedonia), Ismet Bašinać (Travnik, B&H), Zoran Bogdanović (Novi Pazar, Serbia), Branislav Crnogorac (Sarajevo, B&H), Refik Čatić (Zenica, B&H), Georgi Georgiev (Skopje, Macedonia), Denis Hauw (Montpellier, France), Gonca Ince (Adana, Turkey), Aleksandar Joksimović (Niš, Serbia), Mislav Lozovina (Split, Croatia), Živorad Marković (Jagodina, Serbia), Zoran Mašić (Belgrade, Serbia), Aleksandra Pejčić (Rijeka, Croatia), Francesco Perrotta (Naples, Italy), Martin Pupiš (B. Bystrica, Slovakia), Aleksandar Raković (Niš, Serbia), Mohamed Salama (Alexandria, Egypt), Anatolij Shirjayev (St.Petersburg, Russia), Ljerkica Srhoj (Split, Croatia), Aleksa Stanković (Zenica, B&H), Vlatko Šeparović (Tuzla, B&H), Munir Talović (Sarajevo, B&H), Hana Valkova (Olomouc, Czech), John C.K.Wang (Nanyang, Singapore), Marta Zalewska (Warsaw, Poland)

Print & Web:

Print: Travnik doo 72270 Travnik, Aleja Konzula 5. B&H; Printed: 300 copies
Front page design and DTP/Web preparation: Dobromir Bonacin, Travnik – B&H

Lector: Dobromir Bonacin, Travnik - B&H

Webhosting: Agencija Genesis - Cazin, B&H; Illustrations: Danijela Bonacin, Travnik - B&H

Publishing

Sport Science publishes twice a year in English with Bosnian abstracts.

Cost: 15 Euro, overseas 30 Euro + postal costs.

Communication:

Sport Science – International scientific journal of kinesiology.

Faculty of Education – University of Travnik

72270 Travnik, Aleja Konzula 5., Bosnia & Herzegovina

Tel.: +387 (0)30 514 567, +387 (0)62 907 430, Fax: +387 (0)30 540 876

E-mail: dobromirb@sposci.com, danijelab@sposci.com, mersihab@sposci.com

Power of waterfall is nothing but a multitude of drops that work together.

(Anonymous author)

Dear reader,

Impressions that one has about the world in which he lives, sometimes really deeply surprise. This is because life often remind us that we are at the same time very big and small, strong and weak, strong and gentle, thoughtful and emotional. This mysterious and beautiful world, full of small and great concerns but also the countless moments of happiness, giving us and giving. What we take from it depends not only on us, but to a large extent on what we want to share with others, what we want to give. Is man merely a drop in the sea or a giant kind of we cannot even imagine? And, if it is a drop in the sea, what was then the sea? Perhaps on these questions we have answers. In this issue, which has surprised all of us in the manner just as has been said, there are several valuable review papers: on the basis of kinesiology, the extreme loads in the running, the sport pedagogy, determining somatotype and prevention of tennis elbow injuries. Experimental articles are no less interesting and testify about plyometrics for basketball, the analysis of the recovery of athletes, the role of local and visiting courts for basketball, the speed of the athlete, volleyball evaluation techniques, quantitative changes in basketball, football skills of young players and training agility in school. Special groups equally interesting articles brings: analysis of using green tea in obese, interhemispher training transfer, psychological questionnaire for coaches and table tennis, controlling movement of switches in gymnastics and impact of morphological dimensions to success in sailing. All of these individual articles together, each as a single drop, ultimately become irresistible Sport Science waterfall where teamwork is exactly what brings results. And it is now, and will be tomorrow, even more visible and measurable.

*Editor-in-Chief
Assoc.Prof.Dobromir Bonacin, PhD*

Snaga vodopada nije ništa drugo nego mnoštvo kapljica koje djeluju zajedno.

(Anonimni autor)

Dragi čitatelju,

Impresije koje čovjek ima o svijetu u kojemu živi, zaista ponekad duboko iznenađuju. To iz razloga što nas život često podsjeti da smo u isto vrijeme veliki i mali, snažni i slabi, čvrsti i popustljivi, misaoni i emocionalni. Ovaj tajnoviti i predivni svijet, prepun sitnih i velikih briga ali i bezbrojnih trenutaka sreće, daje nam i daje. Što ćemo mi od toga uzeti ne ovisi isključivo o nama samima, već u velikoj mjeri i o tome što s drugima želimo podijeliti, što im želimo dati. Je li čovjek samo kap u moru ili je gigant kakvoga ne možemo ni zamisliti? A ako i jest kap u moru, što je tada more? Možda na ova pitanja i imamo odgovore. U ovom broju časopisa, koji je i nas sve iznenadio baš onako kako je rečeno, donosimo nekoliko vrijednih preglednih radova: o temeljima kineziologije, o ekstremnim opterećenjima u trčanju, o sportskoj pedagogiji, o određivanju somatotipova i o prevenciji povrede teniskog lakta. Eksperimentalni članci nisu ništa manje zanimljivi i svjedoče o pliometriji kod košarkaša, analizi oporavka sportaša, uloge domaćeg i gostujućeg terena kod košarkašica, brzini kod atletičara, evaluaciji odbojkaške tehnike, kvantitativnim promjenama kod košarkašica, sposobnostima mladih nogometnih reprezentativaca, treningu agilnosti u školi. Posebna grupa jednako zanimljivih članaka donosi, analizu korištenja zelenog čaja kod pretilih, međuhemisferni trenažni transfer, psihološki upitnik za trenere i stolnotenisače, upravljanje pokretom sklopke u gimnastici i utjecaj morfoloških dimenzija na uspjeh u jedrenju. Svi ovi pojedini članci zajedno, svaki kao jedna kap, u konačnici postaju nezadrživi Sport Science vodopad u kojemu je upravo timski rad ono što donosi rezultat. A on je sad, i bit će sutra još više vidljiv i mjerljiv.

*Glavni urednik
Prof.dr.Dobromir Bonacin*

SPORT SCIENCE

International scientific journal of kinesiology

Vol. 6 (2013), Issue 1 (1-119)

Contents:

Dear reader	5
Goran Sporiš, Marko Badrić, Ivan Prskalo and Dobromir Bonacin (Review paper)	
Kinesiology – systematic review	7
Abbas Asadi (Original scientific paper)	
Effects of in-season plyometric training on sprint and balance performance in basketball players	24
Alireza Babai Mazreno, Ibrahim Salmani Nodoushan and Nadjme Hajian (Original scientific paper)	
Comparison of the effects of active and passive recovery after incremental exercise to exhaustion on serum testosterone and progesterone levels of athletes	28
Eleftherios Dimitros, Vasiliki Garopoulou, Panteleimon Bakirtzoglou and Christodoulos Maltezos (Original scientific paper)	
Differences and discriminant analysis by location in A1 greek women's basketball league	33
Ivan Čillík, Martin Pupiš, Ondrej Ďurják, Ratko Pavlović and Dobromir Bonacin (Original scientific paper)	
Speed and speed-strength abilities of the representatives for Slovakia in short-distance runs in the pupils category in athletics	38
Sharifi Gholamreza, Hasanizade Reza, Ahmad Esmailzade, Babai Mazreno Alireza, Ibrahim Salmani Nodoushan and Nadjme Hajian (Original scientific paper)	
Comparison between aerobic exercise and consumption of green tea on weight loss in overweighted men	44
Arta Dodaj, Anita Dodaj and Mladenka Vukojević (Original scientific paper)	
Interhemispheric transfer of training in right-handed subjects	49
Joško Sindik, Natalija Novokmet and Dubravka Havaš-Auguštin (Original scientific paper)	
The application of psychological skills inventory for sports at croatian coaches and recreational table tennis players	54
Zoran Grgantov, Damir Jurko and Mirjana Milić (Original scientific paper)	
Evaluation of volleyball techniques – differences between expert and novice coaches	61

SPORT SCIENCE

International scientific journal of kinesiology

Vol. 6 (2013), Issue 1 (1-119)

Contents (continuing):

Behudin Bajgorić, Žarko Bilić and Danijela Bonacin (Original scientific paper) Determination of qualitative changes of programmed work at attendees in basketball school	66
Milan Čoh (Review paper) Extreme loadings of locomotor system in the running	73
Francesco Perrotta and Angelo Pannelli (Review paper) Sport pedagogy applied to the knowledge of the marriage of sports and training of the person	78
Thomas Heinen, Katrin Apitius, Farhang Mirzaie, Marc Nicolaus and Pia Maria Vinken (Original scientific paper) Movement regulation of the glide kip in gymnastics	82
Jaroslav Teplan, Tomáš Malý, František Zahálka and Lucía Malá (Original scientific paper) Values of speed and aerobic capacity parameters as indicators of physical fitness in U18 and U19 soccer teams at the beginning of the pre-season period	87
Jaromír Šimonek (Original scientific paper) Speed and coordination improvement by means of agility training at school PE lessons	95
Goran Oreb, Nikola Prlenda and Josip Kolega (Original scientific paper) The influence of morphological characteristics on effectiveness of teaching sailing	99
Mislav Lozovina, Vinko Lozovina and Dobromir Bonacin (Review paper) What kind of approach to somatotype determining in kinesiology?	104
Jelena Gudelj and Zdenko Kosinac (Review paper) Prevention and treatment of 'tennis elbow'	113
Guidelines for authors	118

SPORT SCIENCE

Međunarodni znanstveni časopis iz kineziologije

Vol. 6 (2013), Broj 1 (1-119)

Sadržaj:

Dragi čitatelju	5
Goran Sporiš, Marko Badrić, Ivan Prskalo i Dobromir Bonacin (Pregledni rad)	
Kineziologija – sistematski pregled	7
Abbas Asadi (Izvorni znanstveni članak)	
Učinci pliometrijskog treninga za vrijeme sezone na sprint i balans izvedbu košarkaša	24
Alireza Babai Mazreno, Ibrahim Salmani Nodoushan i Nadjme Hajian (Izvorni znanstveni članak)	
Usporedba učinaka aktivnog i pasivnog oporavka nakon stupnjevito opterećivanja do iscrpljenja na serum testosterona i progesterona u krvi sportaša	28
Eleftherios Dimitros, Vasiliki Garopoulou, Panteleimon Bakirtzoglou i Christodoulos Maltezos (Izvorni znanstveni članak)	
Razlike i diskriminacijska analiza po lokaciji u a1 Grčkoj ženskoj košarkaškoj ligi	33
Ivan Čillík, Martin Pupiš, Ondrej Ďurják, Ratko Pavlović i Dobromir Bonacin (Izvorni znanstveni članak)	
Sposobnosti brzine i brzinske izdržljivosti kod reprezentativaca Slovačke u sprintu u kategoriji učenika u atletici	38
Sharifi Gholamreza, Hasanizade Reza, Ahmad Esmailzade, Babai Mazreno Alireza, Ibrahim Salmani Nodoushan i Nadjme Hajian (Izvorni znanstveni članak)	
Usporedba aerobne tjelovježbe i konzumiranja zelenog čaja na gubitak težine kod pretilih muškaraca	44
Arta Dodaj, Anita Dodaj i Mladenka Vukojević (Izvorni znanstveni članak)	
Međuhemisferni transfer treninga kod desnorukih subjekata	49
Joško Sindik, Natalija Novokmet i Dubravka Havaš-Auguštin (Izvorni znanstveni članak)	
Primjena inventara psihologijskih vještina u sportu na hrvatskim trenerima i rekreativcima u stolnom tenisu	54
Zoran Grgantov, Damir Jurko i Mirjana Milić (Izvorni znanstveni članak)	
Evaluacija odbojkaške tehnike – razlike između trenera eksperata i početnika	61

SPORT SCIENCE

Međunarodni znanstveni časopis iz kineziologije

Vol. 6 (2013), Broj 1 (1-119)

Sadržaj (nastavak):

Behudin Bajgorić, Žarko Bilić i Danijela Bonacin

(Izvorni znanstveni članak)

Određivanje kvalitativnih promjena programiranog rada s polaznicama škole košarke. 66

Milan Čoh

(Pregledni rad)

Ekstremno opterećenje lokomotornog sistema kod trčanja 73

Francesco Perrotta i Angelo Pannelli

(Pregledni rad)

Sportska pedagogija primjenjena na spoznaju 'ženidbe' sporta i usavršavanja osobe 78

Thomas Heinen, Katrin Apitius, Farhang Mirzaie, Marc Nicolaus i Pia Maria Vinken

(Izvorni znanstveni članak)

Regulacija pokreta klizne sklopke u gimnastici 82

Jaroslav Teplan, Tomáš Malý, František Zahálka i Lucía Malá

(Izvorni znanstveni članak)

Vrijednosti parametara brzine i aerobnog kapaciteta kao pokazatelji tjelesne kondicije U18 i U19 nogometnih momčadi na početku razdoblja predsezona 87

Jaromír Šimonek

(Izvorni znanstveni članak)

Poboljšanje brzine i koordinacije korištenjem treninga agilnosti na nastavi TIZO 95

Goran Oreb, Nikola Prlenda i Josip Kolega

(Izvorni znanstveni članak)

Utjecaj morfoloških karakteristika na učinkovitost u nastavi jedrenja 99

Mislav Lozovina, Vinko Lozovina i Dobromir Bonacin

(Pregledni rad)

Kako pristupiti određivanju somatotipova u kineziologiji? 104

Jelena Gudelj i Zdenko Kosinac

(Pregledni rad)

Prevenција i liječenje 'teniskog lakta' 113

Upute za autore 119

KINESIOLOGY – SYSTEMATIC REVIEW

Goran Sporiš¹, Marko Badrić¹, Ivan Prskalo² and Dobromir Bonacin³¹ Faculty of Kinesiology, University of Zagreb, Croatia² Faculty of Education, University of Zagreb, Croatia³ Faculty of Education, University of Tarnik, Bosnia & Herzegovina

Original scientific paper

Abstract

The absence of movement, as a biotic need of every living being, has severe consequences on human health. This fact is extremely important in the modern world characterised by a growing tendency to neglect movement. This has been recognised by scientists who have generated a vast body of research tackling this issue. This is a very advanced area of research considering the complexity of human movement and the fact that the study of the development of principles of movement require an interdisciplinary approach. Movement has been studied throughout the history and there has been a long-standing need to produce a name for a scientific study of movement applicable in the areas of education, sport, recreation and kinesitherapy. The most adequate term for the science of movement is kinesiology. The word "kinesiology" was coined in Europe in the mid 19th century. In Croatia, it only came into wider use in 1967. In Europe, the predominant use of the word "sport" in the terms sport science(s) or sport studies is probably a result of social, economic and historical factors shaping the meaning of the word "sport" in Europe. The term kinesiology is increasingly recognised and accepted as the adequate term for the science dealing with an extensive scope of multidisciplinary study of human movement, regular physical activity of different duration, intensity, purpose and content, as well as its effect on the body and life of the individual and society as a whole. The situation within kinesiology does not necessarily affect the wider academic community; however, this problem concerns the position of kinesiology in the wider scientific community and its struggle for recognition and identity. In the structure of sciences, kinesiology falls into the group of social sciences. All these sciences are mutually intertwined, whereby the findings from one science are adopted by the other in a different form. There are no independent sciences. Kinesiology and its disciplines constitute a homogenous research area reflecting distinct and real human needs which cannot be addressed without adopting a scientific approach (Mraković, 1997).

Key words: kinesiology, definition, content, integration, terminology, purpose

Introduction

Kinesiology is the scientific study on the principles governing the maximum efficiency of human movement (Momirović 1969). Kinesiology is a scientific study on specially conditioned movement whose aim is to establish principles of transformational processes affected by that movement (Mraković, 1971). In other words, kinesiology is the scientific study of the principles governing exercise processes and the effects of these processes on human body (Mraković, 1992). The word kinesiology has roots in Greek words *kinesis* (motion, movement) and *logos* (science, study). Thus, kinesiology is etologically a scientific study of movement. The word kinesiology is of the Greek origin (*kinesis* /κίνησις/ - motion, movement and *logos* /λογος/ - word, evidence, theory, affirmation, which, when put together, means the study of movement. Kinesiology is the scientific study of the principles of structured exercise processes and the effects of these processes on the human body. As every other scientific study, kinesiology does not deal with its subject matter only conceptually, but rather it provides scientific evidence based on valid research methodology which allows for the verification of certain principles. Definition of what is considered scientific depends on the convention of competent experts in the given period.

Kinesiology does neither study all human movement nor the movement of all objects. Movement is a biological need of every living being (Starosta, 2001). In the process of building the modern civilisation, people have forgotten their biological needs. The sedentary way of life has resulted in numerous civilisation diseases and illnesses. In this situation people are faced with two possibilities – they will either put effort in their physical health or the number of kinesiologyally disabled people will continue to grow. Over the years, movement has been the subject of various fields of study (Starosta, 2001). Its meaning was simply defined by Aristotle: „Movement is life“. A number of different names that were given to the study of human movement show a great interest that other fields of study have taken in this budding area of research, especially in the 20th century. The fact of multiple names for this field of study indicates the extensity of the scope of study of human movement. Scientific study of human movement has always had a universal meaning, since it encompasses all people, regardless of their sex, age, race, occupation, etc. The paradox we are facing today is that our professional activities require an ever growing level of motor skills, while the level of motor skills is generally decreasing.

The orthopaedist Senger has put the meaning of movement in one sentence: "Movement is life – life is movement." This sentence best describes the essential value of movement – human life begins and ends with it. Possibly, Senger was inspired by the great thinker of the Antic period, Aristotle, when phrasing this definition of movement. Aristotle described the link between movement and life in simple terms: Movement is life and the physical activity and creativity – whether its nature is productive, professional, artistic or athletic – always manifests itself through movement. Movement exists even when its external manifestation is less noticeable, in, for example, the process of breathing, blood circulation, metabolism, digestion, etc. Movement is the universal need of all living beings; without movement there would be no life, and movement is also necessary if we want to change location, express emotions, work or perform any other activity. The study of movement and its principles has a long history. First findings regarding the essence of movement date back to the time of the Roman physician Galen (130 – 200). In his work, we find experiments observing muscle contraction occurring during the transfer of the movement impulse by the nerve. Likewise, Leonardo da Vinci (1452 – 1519), one of the greatest Renaissance polymaths, also studied certain aspects of movement. He was one of the first theoreticians to tackle the question of how human body is subject to the laws of mechanics. An important role in the history of the study of kinetics is occupied by the scientist Borelli, a mathematician and a physician. Borelli conducted research into the classification of the loco-motor movements in humans and animals and the location of the body's centre of balance. Orthopaedist Bayer formulated the so-called kinetic chain theory, which was further developed by Schmidt. One of the first studies into the fundamental development of motor abilities was carried out by Woodworth in the late 19th century. He looked into the basic principles of the performance of the fast movements of the arm and the hand. Evidence provided by Thorndike (1914) also had a major effect on the development of new trends in research. This evidence concerns the very root of the learning phenomena and other habitual behaviour. He pointed to the purpose of linking reward and motivation in repetitive exercises. He pioneered research on individual differences in the results of physical activities.

History of the concept of kinesiology

The word kinesiology was first coined by the Swedish gymnast Carl August Georgi, and the first record of the word appears in 1854 in the biography of Per Henrik Ling, the founder of the Swedish gymnastics system. The word kinesiology originates from two Greek words: *kinesis*, meaning movement and *logos* meaning study. The term has a 150-year old tradition and it dates back to 1857, the year in which Nicolas Dally gave his book on movement the title *Cinesilogie*

(Renson, 2000) and defined the term kinesiology as the scientific study of movement related to education, hygiene and therapy. Literally translated into English, the word kinesiology means the study of movement. Some consider Aristotle the father of the study of movement, while others mention N. Dally, the author of the first booklet entitled *Cinesilogie*, published in 1857. However, the scientific approach to motion and movement only became possible in the 20th century. New ideas in the field of the study of human movement were introduced by Bernstein (1897 – 1966) and published in his fundamental books: *On Building Movement* (1947), *An Outline of Physiology of Movement, Physiology of Activity* (1966), and *On Agility and its Development* (1991). His ideas were very advanced at the time (Starosta, 2001). A number of new topics in study of movement were also introduced by Meinel, who synthesised the existent body of work in the area of human kinetics. The many years of work yielded the book entitled *Bewegungslehre*, (eng. Movement Teaching), published in 1962. Meinel complemented the title with a lengthy subtitle: *The Attempt to Form Theories of Sport Movements in Pedagogical Aspects*. In the aforementioned synthesis Meinel proved to be an extremely versatile researcher who was, despite his humanistic education, also successful at other types of study. The scientific study of movement has been given a number of names throughout history, such as kinesiology, anthropomotorics, kinanthropology, motorics or psychomotorics. These are not the only terms used to cover the definition of this field of study. Some of these terms have their origin in other, more general attempts at defining this academic discipline: science on human movement, science on physical activity, anthropokinetics (Blahus, 1999), "reflexomotorics", somatomotorics, sensomotorics, psychomotorics, kinetics, technomotorics, anthropomotorics, sports motorics (Hirtz, Kirchner, Pöhlmann 1994). Throughout history, the following terms were proposed for the study of human movement instead of the term physical education: kinesiology, exercise, sport science, movement science (Thomas, Nelson, 1990). The number and diversity of the proposed names indicates the great interest that many experts from different fields of study took in the development of this discipline. This interest is entirely justified, since the study of movement bears great significance for all people, regardless of their sex, age, race, occupation, and other characteristics. Development of a new scientific field opens up a vast uncharted territory and numerous prospects for the future development of interdisciplinary studies. Furthermore, the scope of study is very wide and it lends itself to researchers from almost all fields of study. Looking for an adequate term for the scientific study of movement involves a tinge of rivalry in tackling the "super-problem" that allows everyone to find their own place. Additionally, the choice of the name probably determines the leading area of research.

Education authorities opted for the term kinesiology, referring to the scientific study consisting of areas of study that focus on the research and application of physical education (Wuest and Bucher, 1991). In the Central European countries, especially Germany, Austria and the Czech Republic, this term is very often used in the context of physical therapy, functional anatomy and medical science (Blahus, 1999). In the same year, Renson proposed the name "kinanthropology", pointing the origin of the word to the Greek words *kinein* (to move), *anthropos* (human being), and *logos* (study, science). Some people would agree with Blahus (1999), at least with regard to the concepts close to kinanthropology and kinesiology.

The directions of the development of human movement (human kinesiology) and their different names

The brief overview of all the names that have been ascribed to the scientific study of movement also indicates the level of interest that almost all disciplines have taken in this subject (Starosta, 2001). This is an extremely advanced approach, considering the outstanding complexity of the performance of human movement and the fact that the study of the development and principles of movement indeed requires an interdisciplinary approach. A different scientific point of view may provide certain answers to at least a tiny segment of the wide and complex scope of study of human kinetics. Unfortunately, human kinetics is the term that has become the most commonly used to refer to this young academic discipline. However, of all the proposed names, kinesiology is considered the most adequate one (Starosta, 2001). Aside from the fact that this name emphasises the independence of this academic discipline as well as its scientific status, it also defines its subject matter in a precise and explicit manner. Nowadays, the term kinesiology is used to refer to the entire academic and scientific field of study of human movement. In Croatia, kinesiology is considered to be an empirical, experiment-based science that studies the laws, principles and patterns of controlled and targeted processes of physical exercise (activity) and their impact on human body (Mraković, 1992). Kinesiology is a fundamental scientific field which is superior to and which finds its application in various areas, such as sport, physical and health education, health, recreation, sport management and kinesitherapy. It contains fundamental principles which apply to all branches of kinesiology (systematic kinesiology, sport kinesiology, sport training, recreational sport, kinesitherapy and kinanthropology).

Term kinesiology in the names of higher education institutions

Kinesiology is not the only term in use for this academic field in Europe or North America. Over the past few decades, many names and their

varieties have been used to refer to this academic discipline, faculties, professional organisations or academic journals in the field of the study of human movement. There is no general consensus in the matter. Sport, sport science, exercise science, human performance, movement science, human kinetics, kinesiology, kinanthropology, anthropomotrics, anthropokinetics, anthropokinesiology, health, body education, physical education, recreation, leisure time study, training, sports training, tailored physical education, sport management and other terms and their combinations are currently in use. The research area exists regardless of the multiple terms used to define it. However, this variety in terminology may lead to confusion and misunderstandings in the academic community. Furthermore, Wade and Baker (as cited in Mills, 1992) warned that the lack of a clearly articulated and acceptable definition will have severe consequences on the structure of programmes in higher education (Čustonja et al., 2009). Even though the word kinesiology was coined in Europe in the mid 19th century, it had not come into official use in Europe until much later, namely 1967, when the Institute for Kinesiology was founded at the Faculty of Physical Education (*Fakultet za fizičku kulturu*) (in 2001 renamed Faculty of Kinesiology) of the University of Zagreb in Croatia in 1967. This is the first time that the word kinesiology was used as an official term in the context of the European higher education system, i.e. the European academic community. Currently, only one faculty in Belgium (the Catholic University in Leuven, Faculty of Kinesiology and Rehabilitation Science) and two faculties in Croatia (Faculty of Kinesiology of the University of Zagreb and Faculty of Kinesiology of the University of Split) have fully accepted the term kinesiology and incorporated it in its official name. In the United States of America the term kinesiology first appeared in 1886 and it became widely known when Baron Nilns Posse published "Special Kinesiology of Educational Gymnastics" in Boston in 1894 (Renson, 2002). The modern era of kinesiology as an academic discipline began in North America about 50 years ago when the first university departments began to use the word kinesiology in their names. The American Academy of Physical Education changed its name to the American Academy of Kinesiology and Physical Education (AAKPE) in 1993, acknowledging the importance and fundamental values of kinesiology as a multidisciplinary and cross-disciplinary science of human movement. Previously, the term kinesiology was often combined or even used interchangeably with the term biomechanics (Čustonja et al. 2009). The American Kinesiology Association was established in 2007 to promote and enhance kinesiology as a unified field of study within the higher education system of the United States and advance its many applications. The debate about the proper name for this science has a relatively long history. Several papers addressing this subject appeared at the end of the 1980s and at the beginning of the 1990s (Ojeme, 1984; Bird, 1988; Caldwell,

1988; Piper, 1988; Vincent, Winningham, and Caldwell, 1988; Corbin & Eckert, 1989; Ojeme, 1989; Kretchmar, 1989; Newell, 1989; Vincent, 1991; Wade & Baker, 1992; Mills, 1992; Baker, Hardman, and Pan, 1996a; Baker, Hardman, and Pan, 1996). However, this discussion has not been concluded and the diversity of the terms for identifying this science has remained. There are great variations between Europe and the USA in the frequency of use of different terms in the official titles of their respective university departments and faculties in the academic field of human movement studies (Čustonja et al., 2009). Contrary to the USA, the most frequently used terms in the official names of the higher education institutions in the field of human movement studies in Europe are sport (sport sciences, sport studies, etc.) and physical education. In the USA, the most frequently used term is health. At the same time there is only one higher education institution that uses the term health in its official name in Europe. The term sport is not as frequently used in the USA. The term physical education is the second most frequently used term in the USA. There are 100 study programmes that use the term physical education alone in their names (Čustonja et al., 2009), or about 58% of all the study programmes that use the term physical education. When physical education is combined with other terms, the most commonly used terms include exercise science, health and recreation or wellness. There is only one department that combines the term physical education with the term kinesiology. Similarly, the term physical education is the second most frequently used term in Europe. In most cases (about 76%) the term physical education is combined with the terms sport or sport science(s). In Europe, 5 university departments or faculties use exclusively the term physical education (Čustonja et al. 2009). Both in Europe and the USA the term physical education is widely used as the name for higher education institutions. It is the only term that has a similar status both in Europe and the USA. This can be explained by the historical fact that physical education was the first commonly used term when the first high school and university departments or faculties in the field of human movement studies were established in Europe and the USA. Scientific understanding and appreciation of human movement studies have emerged from the field of PE which is today ever more considered as only one of the areas of human activity in which findings of the science in question are applied. The majority of PE departments in Europe and the USA were established at the beginning of the 20th century and soon after World War II with the purpose to prepare PE teachers (Čustonja et al., 2009). With the growth of fundamental scientific knowledge in the field of human movement studies, scholars realized that PE teaching was not the only area where this knowledge can be applied. Further, they realized that the term physical education is not an adequate name for a science and that, if they wanted to be recognized and appreciated by the scientific community, they

needed a more appropriate term that would better describe and define this scientific discipline. During the 1950s, 1960s, and 1970s, the divergences in terminology started. Terms like sport, sport science, exercise science, human performance, movement science, human kinetics, kinesiology, kinanthropology, health, physical culture, recreation, leisure studies and other terms or their combinations emerged in Europe and the USA in the pursuit of the best or most convenient term. Although the term physical education is still frequently used in the USA and Europe, where about 20% and 24% of all the university study programmes use this term in their names, respectively, its usage frequency has gradually decreased in recent decades (Čustonja et al., 2009). The main difficulty with the term physical education is the traditional heritage and understanding that PE study programmes are focused on the occupational preparation and therefore lacking in scientific substance. However, fundamental scientific knowledge that supports PE studies is the same as in other disciplines of the science in question and therefore physical education can be considered as a part of a bigger whole, or a branch of general science. The term sport is very often used in Europe (Čustonja et al., 2009). It has been observed that 54 study programmes, or about 44% of all the university departments or faculties, use the term sport. In most cases it is sport science(s), sport studies or just sport. About 25% of all study programmes in Europe encompassed by this investigation use the term sport science(s) (Čustonja i sur., 2009). The predominance of the term sport, like in sport science(s) or sport studies, in Europe is probably a product of social, economic and historical significance of the term sport on the old continent. Sport is a word used in almost all European languages; it is widely recognized and common in everyday use. European culture and history has become less flexible to accept a different term. Since the middle of the 1960s, the concept of sport science, based on the theory of PE, has started to emerge. Unstoppable change in social conditions and the increasing social importance of organized sport led to the implementation of academic chairs for sport science first at the universities in German-speaking countries and partly in other European countries in the 1970s. During the 1980s, the differentiation from PE was mostly finished and sport science with its theoretical framework and interdisciplinary character was established in Europe. The European social and political situation strongly influenced sport science during the 1990s. Scientists from the former East-European block countries are considered to have been dominant in scientific achievements in human movement studies in Europe before 1990s. After the fall of the communist regimes in Eastern Europe, the term physical culture, previously so popular, was widely replaced by the term sport. The foundation of the European College of Sport Science (ECSS) in 1995 was a decisive step in the process of promoting sport science as an international

discipline, at least in Europe (Müller, 2008). Nowadays the European College of Sport Science (ECSS) is the strongest and most important scientific organization in Europe in the field in question (Čustonja et al., 2009). It promotes sport science through the organization of annual international and multidisciplinary congresses on sport science; through the publication of the scientific journal the *European Journal of Sport Science*, and by supporting both the concept and the term sport science with position statements on central issues, concerns, or areas of interest. Therefore, these are the reasons why the term sport prevails in the names of European higher education institutions. However, since sport is also a form of human activity, we consider this term hardly a proper name for this scientific discipline or for a university department or a faculty.

Kinesiology as a scientific discipline

In 2009, National Science Council of the Republic of Croatia classified kinesiology as an independent scientific field in the area of social sciences. Kinesiology was listed in the official nomenclature of scientific disciplines in Croatia, next to all other affirmed disciplines, such as economy, law, sociology, psychology, political science, speech-language pathology, pedagogy, etc. Furthermore, inside the defined scientific field of kinesiology, scientific branches were determined. The classified branches of kinesiology are the following: systematic kinesiology, sports kinesiology, kinesiological education, kinesiological recreation, kinesitherapy and adjusted physical activity, and kinanthropology. The first use of the term kinesiology in the name of the Institute of Kinesiology, founded in 1967, the recognition of kinesiology as a scientific discipline and its classification as an independent scientific field mark the end of a long pursuit for the adequate name for the scientific study of human movement in Croatian academic community. Croatia seems to be the pioneer in the promotion of the term kinesiology in the European scientific and academic community. Despite the fact that only three higher education institutions in Europe use the term kinesiology in their official names, this term is used among the European academic community and it occurs in the names of journals, scientific institutions, and subject curricula. It may be concluded that the term kinesiology is increasingly recognised and accepted as the adequate term for the science dealing with an extensive scope of multidisciplinary study of human movement, regular physical activity of various duration, intensity, purpose and content, as well as its effect on the body and life of the individual and society as a whole. Kinesiology as a fundamental science finds application of its theory, concepts, developments and principles in various everyday activities, such as sport, physical education, therapeutic exercise, recreation, exercise, physical therapy, sport management, etc. Since kinesiology encompasses principles governing all these areas, the global and universal

use of the term kinesiology for both the science and the profession is only a matter of academic and scientific consensus. Kinesiology is defined as the scientific study of movement, or even more widely, as the scientific study of physical activity. The term kinesiology is an umbrella term for all the criteria designating the area of academic study of physical activity and it makes a valuable contribution to the objectivity of many current debates over the science, profession and dimensions of the related activities and their subareas.

Kinesiology as a universal term

Despite the fact that the name kinesiology meets all the above mentioned criteria, there are still several potential hindrances for the selection of the word kinesiology as the official term. First, the term kinesiology is, despite its growing popularity, still not generally as well known as the terms physical education or sport. However, the term kinesiology is becoming more frequently used in media reports. It is clear that there is still a lot of work to be done in the promotion of the term kinesiology, although major steps have already been taken. Secondly, even among physical education academics, some faculties still object the limited view of the structural and functional aspects of movement that the term kinesiology suggests and they propose the more recent term biomechanics. However, this limited interpretation of the term kinesiology is now completely abandoned and this use of the term will in time become outdated. Some faculties in this area can agree that the term kinesiology is adequate for the study of physical activity, but they reject the idea of using this term for the study of professional and performance aspects. They advocate a much more general use of the term kinesiology, which presents an unnecessary expansion of the disciplinary use of the term. First of all, even though several departments eliminated the explicit elements of professional training from their curricula, it seems that this practice will not be generally accepted in the near future. Creating separate departments on the academic level for the disciplinary, professional and performance aspects of the study of physical activity does not seem feasible. Therefore, a name that will encompass all programme orientations in the study of physical activity is to be used. Even though physical education academics often claim the word kinesiology, it is important to notice that the word kinesiology traditionally has a much wider use in terms like gymnastic kinesiology (Slowikowski and Newell, 1990) and, more recently, dance kinesiology. Next, it may be necessary to address the misconception of some academics in the area of social sciences and humanities, who consider kinesiology to be the scientific study of the biology of physical activity. Even though this interpretation may be popular in some scientific branches, the name kinesiology does not directly suggest this meaning.

Furthermore, the name kinesiology literally means “the scientific study of movement”. The expression “the study of” suggests a non-explicit orientation in the form, or one type of academic model, although some academics assume that the suffix “-ology” stresses the social study orientation. Therefore, it may be inferred that, by definition, physical education is a subordinate term to kinesiology in the same way that visual arts are a subordinate term to art. Additionally, other established fields of study with a similarly discipline-oriented name (e.g. psychology) comprise professional-oriented components (such as clinical psychology) in their curricula. There are numerous competing certified programmes within the general field of study. Whether physical education will exist independently within kinesiology or not in a certain area will depend on local decision-makers. To sum up, a universal perception of the term kinesiology can only be achieved by putting continual effort in the common presentation of its scope of study on the academic level, on the level of departments and on the level of the wider academic community. The more general view of the term is essential. Since the perception of the word is still very vague, it is possible to define the meaning of the word kinesiology more generally. It is extremely important for the field of kinesiology to have a universal description both as an academic field and a field of scientific study and for the term kinesiology to be used consistently. Another obstacle is the limiting nature of the word “education” in the term physical education, which suggests a clearly defined and accepted focus as an education model. Physical education is a well-established concept in the academic community and society as a whole and it is difficult to modify it.

Simultaneously, the terms physical exercise and sport are also well-defined (Newell, 1990a); even though the more general, so-called European interpretation of the term sport (Kretchmar, 1989) cannot logically encompass the entire field of physical activity. Furthermore, it should be recognised and noticed that the conceptual and terminology-related problems extend to subordinate fields as well (Newell, 1990b). It is therefore necessary for the academic community to harmonize the terminology so it can be extended to the subordinate fields as well. The support and understanding of numerous associations that represent the subordinate academic fields of the study of physical activity is necessary. A logical and coherent taxonomy of the academic field of physical education study is long overdue. There are a number of strong arguments supporting the introduction of the term kinesiology in primary and secondary education. Finally, the constantly changing nature of academic fields must be recognised. The general quality of the term kinesiology ensures the necessary flexibility and lends itself to successful presentation and promotion of the academic field in the 21st century.

Kinesiology in relation to other scientific fields

The current orthodox view of the scope of scientific study of kinesiology is being re-evaluated in order to allow social sciences to enter the debate over the nature and the purpose of kinesiology. An alternative vision of kinesiology’s potential has been proposed: a more scientific picture of human beings than is currently available may be produced if human beings are studied as whole selves, not as isolated physiological or psychological units. If a multidisciplinary synthesis were to be adopted, the subject, via its component disciplines, should provide a model for the reintegration of disciplines in the urgent need to study people based on a human-development rather than the performance-efficiency model. The model of the ideal science arising from physics is inadequate for many natural science models as well as for social science disciplines (Maguire, 1991). That model does not in any way exhaust the possibilities that science offer. There is only one universally accepted definition of scientific methods, which in a simple and absolute way draws a distinction between science and non-science. The current orthodox view of science is in kinesiology reflected in the ideas advocated by traditional scientific realists. The scientific method is to be found in natural science procedures, an example of which is physics. In addressing the distinction between the logic behind social sciences and the logic behind natural sciences some naive positivists describe social sciences as an underdeveloped imitation of natural sciences at best, in which the pure and eternal scientific logic is contaminated with non-scientific, socially determined ideological factors (Maguire, 1991). Sport scientists, unconcerned by the modern developments in the philosophy of science, seem to have readily accepted this model of science and retained the empirical explanations from curricula and research topics (Maguire, 1991). The first step that kinesiologists need to take in order to change that is to acknowledge that athletes must be viewed “in the round”, rather than as fragments of an entity. This observation relates not only to a critique of existing sport science practice, but also to an alternative (Maguire, 1991). A bolder and more imaginative view of the sport sciences would centre on its potential to tell us something about human beings generally, not solely relating to their performing in sport events. The existing tendency, however, is to treat individual elite athletes as machines. Highly rationalized and technologized physical and mental training methods, combined with scientifically evaluated and scheduled fitness regimes, are designed to produce maximum performance (Maguire, 1991). Hoberman (1988) has observed that modern high-performance sport is a global monoculture whose values derive in large measure from the sphere of technology. The body of the athlete has become, quite literally, a laboratory specimen whose structure and potential can often be measured in precise quantitative terms.

It is these general taken-for-granted assumptions and the outdated philosophy of science guiding sport science thinking that is seen as problematic. A more adequate and "scientific" picture of human beings than is currently available may be produced if human beings are studied "in the round", as whole selves, not as isolated physiological or psychological units. That is, if a multidisciplinary synthesis were to be adopted, it might then be possible to glimpse the fuller potential of the sport sciences. The subject, via its component disciplines, should not only contribute to the stocks of knowledge of the parent disciplines but also provide a model for the reintegration of disciplines in the urgent need to study people in their totality, be it in a sport setting or elsewhere. Such an approach would also be one step in the direction away from the drift toward the restricted "scientization of physical education discourses" to which Whitson and Macintosh directed attention McKay, Gore and Kirk (1990), the present analysis endorses the critique of "technocratic physical education" provided by McKay, Gore, and Kirk (1990), and the alternative proposed here is underpinned by a belief it shares with these writers: Science is not irretrievably flawed; it still has the potential to be a mode of enlightenment and emancipation. In the search for the "truth," be it in the natural or the social sciences, the question of objectivity repeatedly crops up (Maguire, 1991). Furthermore, the majority of authors in the field of philosophy of science argue that observations are dependent on the theory (Polany, 1973). Observations cannot simply be collected, stored, and presented as facts to be explained. Observations are always guided by some theory, no matter how simple or vague. On a continuum, there are no zero points, no absolute states of detachment or involvement, observation or theory formation. Rather, it is a matter of balances and degrees. This balance varies not only both between and within groups in the same society and between different historical periods but also with respect to what is under consideration or being experienced. (Maguire, 1991). This observation is connected to the scientization of human knowledge, a process involving a detour via detachment that resulted in greater human control over first physical, then biological, and then (though not yet to the same degree) social processes (Elias, 1987). As a consequence, it can be argued that the scientific enterprise is currently marked by a relatively high measure of autonomy—not absolute, but relative, autonomy. This is not to say that natural scientists are unaffected by values external to their craft but that these values are usually held in check by the study of broader, less time-bound problems defined by the theories and observations of generations of investigators in each field. Thus some problems of such scientists have a relatively high autonomy *vis-a-vis* the pressing social, political, and economic problems of their day (Maguire, 1991). However, this analysis was not always the case, and today it is more true for scientists working at the purer end of the

continuum. This has obvious implications for those working within the sport sciences. An overemphasis on the quest for peak performance may restrict the ability of the sport scientist to study sport in terms of a human-development model. This observation applies not only to sport scientists in Leipzig and elsewhere in the German Democratic Republic but also to western sport scientists such as those at the U.S.A. Olympic Training Centre in Colorado Springs or at the Australian Institute of Sport who have been just as keen to produce optimal performances from their countries' athletes. Despite such relative autonomy, the practice of natural scientists is also influenced by heteronomous evaluations—that is, values of powerful outsiders or values of the scientist that are more related to personal and social interests than they are to scientific concerns. Reference to the work of Kuhn (1962), Lakatos and Musgrave (1970), and Feyerabend (1975) in the philosophy of science confirms such analysis. The persistent reference in physiological and psychological research to the assumed existence of racial differences to explain patterns of sport performance illustrates another aspect of heteronomous evaluations (Bouchard, 1988; Himes, 1988). In order to avoid the trap of relativism, the answer is not to endlessly repeat the objectivity-relativity debate. Rather, the balance and blend between involvement and detachment is what varies. As stocks of knowledge have been accumulated over generations and spread to wider sections of society, scientific concepts and models have increasingly displaced magical/mythical explanations of natural processes (Maguire, 1991). Indeed, where once scientists sought to make the conceptual leap required to understand some aspect of nature, now people take for granted the recourse to scientific concepts (Maguire, 1991). This is not to suggest that involved thinking has been completely replaced by detached thinking. Indeed, in times of extreme insecurity, the dominance of the former can be so complete that the exercising of the detour via detachment is prevented. Consider, for instance, the contribution that social scientists can and have made to understanding football hooliganism (Dunning, Murphy, & Williams, 1988) and contrast this with the knowledge base on which governments and sports organizations have made decisions. People's ability to recognize and acquire new knowledge is interdependent with the substance of the knowledge they and their society already possess (Maguire, 1991). In the sense that they have developed a greater range of more object-adequate representations of the material world, the natural sciences can be said to be more "advanced" than the social sciences. One should not, however, infer that this is due intrinsically to the subject matter studied by social scientists being inherently less susceptible to investigation by methods yielding a high degree of adequacy. Given the powerful critique provided by Kuhn (1962), Lakatos and Musgrave (1970), and Feyerabend (1975), extreme caution has to be

exercised with this line of thought. Notwithstanding these problems, the general aim of both the natural and the social sciences remains the same: to find out in what ways theory-dependent data are connected with each other. There is no reason to suppose that social data are any less accessible to human understanding. By removing hypothetic-deductive nomological theories from the central place in their conception of the natural sciences, the neo-realist philosophers have been able to argue that the social sciences are sciences in exactly the same sense but not in exactly the same ways as the natural sciences. What is different and what makes the task facing social scientists more difficult is that the objects they study are also subjects, who have a consciousness and exercise free will, and that they, the researchers, form part of the patterns they are researching. Classic philosophy of science and indeed the early work of Popper (1959) have used physics, with its emphasis on universal and timeless laws, as the unique model of what "true science" should be. Sport scientists appear to have too readily accepted this model. For social scientists, this is an unattainable ideal. Nor is it an ideal worth pursuing. This model is based on what Elias (1987a) termed an "atomistic fallacy"—that the properties of composite units can always be explained in terms of the properties of their smallest component parts studied in isolation from each other. There is, however, an alternative available that is especially relevant to subjects composed of a number of disciplines (e.g., sport sciences). A "model of models," proposed by Elias (1987a), in which he places the aggregate units of observation characteristic of each kind of science along a continuum, could be used (Maguire, 1991). And as you move along the continuum away from congeries, first structure theories, then process theories become more useful than "law-like" theories. Toward this end of the continuum, it is not a matter of utilizing induction or deduction. Rather, it is more appropriate to talk of analysis and synthesis, with the latter ascending in importance as you ascend the scale. The term analysis refers to those steps in research where theoretical attention is focused on constituent parts, with the larger unit treated more as the background. The term synthesis refers to those research phases where attempts are made to construct a more coherent theoretical representation of the whole (Maguire, 1991). In chemistry, for example, structure theories emerged during the course of the 19th century. Researchers were concerned not just with the quantities of atoms constituting a substance, but also with how the atoms were connected to each other. Three-dimensional models of the structure of molecules emerged. In the biological and social sciences, it became gradually clear that some investigations require four-dimensional models. That is, there emerged process models, models tracing why one thing happens after another in a sequence of directional, though not always irreversible events, involving spatial and time

dimensions. These models are not, however, always mutually exclusive (Maguire, 1991). But whereas in the natural sciences process models involve four dimensions, in the social sciences there is a fifth dimension—experience (Maguire, 1991). This fifth dimension involves probing the experiential aspects of human thoughts, feelings, and psychological drives. The need for such five-dimensional models is an important reason why the development of consensually validated and empirically based theories in the social sciences is more difficult. In conducting research on the basis of five-dimensional models, the researcher has to exercise a process of self-distancing. In order to achieve the required degree of relative detachment, researchers must learn to observe themselves as people, observe themselves in the situation as they examine it. In addition, the idea of a structured process of change, which moves in a discernible direction but is not planned or intended by the individuals or groups involved, has yet to become widely accepted in the social sciences. Unlike processes in the biological sciences, social processes, because they involve learning and experience, are reversible. The task facing scientists is to steer a path between absolutism and relativism. One needs to recognize that most scientific knowledge is informed by involved values and that modern ideologies are informed by more factual, scientific knowledge than were the ideologies of earlier ages. When comparing the natural sciences and the social sciences, it is clear that the latter are still in the throes of establishing a measure of relative detachment (Maguire, 1991). Kinesiology, too, is very much involved in the same process, locked in as it is to disciplinary rivalry, traditional physical education concerns, national interests, and the International Olympic Committee (IOC) policy regarding the role that sport science can play in the preparation of elite athletes. The difference between the natural and the social sciences within the scientific community as a whole and within the sport sciences in particular is therefore one of degree (Maguire, 1991). Natural scientists in the sport field have to ensure that they avoid a too-involved role in such areas as peak performance and coaching and maintain a more detached perspective by viewing people "in the round." But due to their desire to be accepted by, or their actual involvement in elite sport circles and their quest for status, funding, and academic/professional advancement, they appear unwilling or unable to exercise this degree of detachment (Maguire, 1991). The dangers of the trajectory on which some sport sciences headed, namely, toward a technologized view of human beings, have been well highlighted by John Hoberman (1988). For Hoberman, sports science does not physically hybridize humans and machines. Instead, sports science treats the human organism as though it were a machine, or as though it ought to be a machine. This technologized human organism comprises both mind and body, for which there are distinct sets of strategies.

The vision of viewing people "in the round" and adopting a human-development model stands in opposition to such a trend. But, as with natural scientists, social scientists must seek to avoid the pitfalls of having to be (and inevitably being) involved in the subject matter they are researching. If sport sciences began studying people "in the round" and adopted a human-development rather than a performance-efficiency research agenda, certain consequences would flow from this decision (Maguire, 1991). Some existing areas of research would receive less priority. Other research areas currently considered crucial would be refocused. Research areas that are, at present, neglected by sport scientists would receive greater prominence. Not all areas tackled by different disciplines would, however, lend themselves to a multidisciplinary approach. The task of contributing to the stock of knowledge of the parent discipline would remain. But the examination of some areas would require rethinking (Maguire, 1991). But until the importance and value of a multidisciplinary synthesis is raised, further discussion and elaboration of the precise details of what such an approach would look like is precluded. The task of studying people "in the round" requires a collective scientific effort. The research areas chosen include the emotions, violence, drugs, and exercise and lifestyle. Other areas such as alienation, aging, and child development could be examined. Though it is not appropriate, in this context, to go into any great depth regarding Elias's (1987b) analysis of the emotions, some specific, relevant points can be made. The process sociologist's concern with human emotions centres on both characteristics of human emotions that are shared with nonhuman species and characteristics that are uniquely human and without parallel in the animal kingdom. Such an approach represents a decisive break with a long-standing tradition that induces biologists and psychologists to disregard or to blur structural differences between human emotions and those of nonhuman species. This approach seeks to avoid two opposing tendencies in the human sciences, both of which are misleading: on the one hand, ethological and some psychological approaches that stress unvarying, natural human characteristics and, on the other hand, almost all social science that treats its subject matter as something set apart from nature and is concerned with uniquely human aspects of life. For Elias (1987b), both tendencies suffer from an inability to understand the nature of processes. In contrast to these tendencies, Elias (1987b) proposed three interconnected hypotheses regarding a theory of human beings and their emotions. Elias's work on the emotions has also been complemented by research he conducted with Eric Dunning on a theory of leisure Elias & Dunning, 1986). The essence of their argument was that it is not possible to work out an adequate theory of leisure, of which sport is part, within the framework of any single human science, whether it be human physiology, psychology, or sociology.

The problems of leisure, in fact, belong to that large class of problems which, at the present stage in the development of scientific specialization, do not fit wholly into the frame of reference of any one of these sciences as they are at present constituted, but rather belong to the unexplored no-man's land between them. If sociology is considered as a science which abstracts from the psychological or the biological aspects of human beings, if psychology or human biology are regarded as sciences which can proceed on their own without taking account of the sociological aspects of people, the problems of leisure will be left out on a limb. At the present stage in the development of the scientific study of sport and leisure, disciplinary analyses suffer from the defect that they deal with aspects of people as if they in fact exist independently of each other (Vallerand, 1984). Indeed, some subdisciplines such as sport psychology further compartmentalize athletes by referring to stress and arousal in isolation from the more general issue of the emotions. Other dimensions of the emotions and sports are dealt with by "humanistic psychology" with reference to "altered states" (Murphy & White, 1978) and "peak experiences" (Gauron, 1984). In addition, there is now a growing body of literature that examines the physiological concomitants of these psychological dimensions (Glasser, 1979; Riggs, 1981). Here, multidisciplinary work examining the role of endorphins and enkephalin in the psychological experiences of sport encounters could be combined with the overall sociological analysis provided by Elias and Dunning (1986). A relative advance in the adequacy of the scientific study of sport and leisure would be gained if an overall framework within which to place both disciplinary and multidisciplinary analyses could be devised. One contribution toward this task has arguably been provided by Elias and Dunning's analysis of sport and leisure (1986). It is therefore suggested that aspects of leisure and human development require a multidisciplinary synthesis: The study of socially structured processes and emotions cannot be pursued in separate compartments. The study of leisure is one of the many instances in which it is not possible to disregard the problem of the actual relationship between phenomena on the sociological level and those on the psychological and physiological levels. Some psychologists and sociologists have employed social-learning theory as a way of considering human aggression (Smith, 1983). This theory assumes that aggression is learned like any other behaviour. Aggression is the consequence of observing and imitating others. The incidence of aggression is related both to the prevalence of aggressive acts and to the extent such behaviour is condoned and its imitation rewarded. Rejecting the catharsis thesis, social-learning theory argues that, far from channelling aggression in harmless ways, sport's aggressive acts and displays serve to normalize, heighten, and reinforce aggressive behaviour. Learning aggressive behaviour is part of the socialization process, and one of the key areas of interest

would be sport violence shown in the media (Messner, 1990; Siann, 1985). Although there is much to agree with in this approach, it was argued earlier that the steering of human conduct is always the result of an intimate interweaving of learned and unlearned processes (Maguire, 1991). Several multidisciplinary alternatives exist. Sociobiology has its devotees, but this approach, despite its name, may not be multidisciplinary in practice. Drugs and sport is one challenging issue facing sport scientists. More often than not, the issue is dealt with in a biomedical way (Goldman, 1984). Researchers are involved in a range of activities: from designing specific physiological or psychological drug programs for the needs of individual athletes, to examining the side effects of drug use or developing tests that reveal such use. When an ethical issue is raised, it is often with reference to the actions of a specific individual caught using banned performance-enhancing substances (e.g., the Ben Johnson affair). A case can be made for the need for biomedical research that examines the alleged or actual side effects of specific drugs (Maguire, 1991). A case can also be made for research that reveals the use of specific drugs. What are the ethical and social issues involved in the design, prescription, and recourse to drug use (Brown, 1980; Lavin, 1987; Simon, 1985)? The answer to this question cannot be found in the biomedical sciences, though this does not mean that researchers working in this area have not the responsibility to address these issues. For example, Simon (1985), in dismissing many conventional reasons for banning drugs in sport, argued that a ban is more ethically defensible when it involves participants in a mutual quest for excellence. That is, competitors should view themselves as under a moral obligation to their opponents. This obligation involves not only trying their best but also maintaining that the contest is a true test of worth. Such a position may overlook, however, the socioeconomic context in which elite athletes find themselves: The moral choice may not be theirs to make. In fact, the development of a coherent policy on drugs and sport is one of sport sciences most pressing needs. At present, however, the subject may be contributing, by its actions or inactions, to the trajectory Hoberman (1988) has observed elite sport is taking—that is, an experiment in human engineering. Philosophers and social scientists can, in conjunction with natural scientists, assist in the process of a critical appraisal of such a trajectory and develop a more humane sport system than currently exists. One extensively funded and researched topic in the sport sciences is exercise and lifestyle. Research that has broadened our understanding of the physiological consequences of various kinds and forms of exercise is important, though even here questions have been raised regarding the adequacy of such work. Again, problems of definition and of the interpretation of collected data arise (Hale, 1989). Questions regarding the nature of scientific craft reappear.

Important though such questions are, of more concern is that such physiological research is viewed as lopsided and one dimensional in certain respects and that it has failed to take into account the social context in which the exercise prescriptions are enacted (Featherstone, 1982; Glassner, 1989; Turner, 1984). When such research remains based on an individualistic and voluntaristic notion of health, exercise, and lifestyle, with citizens making "good" or "bad" choices, then the structural origin of illness, disease, and lack of fulfilment is overlooked. Attention to the social construction, patterning, and reproduction of these elements is required. In the study of health generally, the contribution the social sciences can make is more readily recognized and accepted. What is argued here is that the psycho-physiological parameters of exercise and lifestyle cannot be adequately studied in isolation from questions regarding existing socioeconomic and political structures. Ingham (1985), for example, argued that our recent preoccupation with our bodies is being mobilized as one solution to the fiscal crisis of the welfare state. The priority given to individual choice and lifestyle diverts attention away from the structural impediments to well-being by framing health issues in terms of personal and moral responsibilities (Maguire, 1991). Ingham's analysis of the research practice of many kinesiological and health scientists is worthy of quoting at some length: Focused on fitness, well-being, and lifestyle, such research is deemed necessary for the maximization of human potentials and, irrespective of specific features of political economy, the maximization of human potentials is a good thing. The exercise programs devised and the recommendations made by health scientists and physical educators have failed to consider how meeting these health needs is undergoing a process of commodification and how, in a consumer culture, the body is marketed, presented, and stylized in specific ways that bear little resemblance to real personal needs (Grover, 1990). Indeed, by laying emphasis on what the individual can do for his or her self, these programs and recommendations inadvertently reinforce the shift away from the state provision of health care occurring in a range of western societies (Maguire, 1991). It is necessary for researchers, when formulating their work on exercise and lifestyle, to have a sophisticated grasp of the social context within which exercise occurs and subsequently to provide critical observations on the utilization of exercise programs and healthy regimes in this wider social context (Glassner, 1989). Once more, a case is being made for a multidisciplinary human-development approach to problems the sport sciences can combine to tackle (Maguire, 1991). Several issues in the sociology of knowledge were tackled, in particular the emergence and current status of "science" and the similarities and differences between the natural and social sciences. Emphasis was placed on the importance of recognizing the diversity of approaches within

science and the need to avoid "process reduction." One task facing the sport sciences is, for example, to find out more about the way the uniquely large, unlearned human potential for learning is activated and patterned by the learning process itself. Such a move would be bold: It goes against existing vested interests, funding sources, and the status insecurity evident in the sport science community. But only in this way will a more adequate and, in that sense, more scientific picture of human beings than is currently available be produced. In the process of doing such research and disseminating the knowledge produced, the emancipatory potential of science and sport science could be glimpsed. Sport sciences, however, may be too new to make such an emancipatory move. Each discipline within the sport sciences is more or less successfully engaged in a struggle for relative autonomy. Such struggles persist in departments globally. Some disciplines, as in the sciences generally, are more established than others (Elias, 1982). As highlighted by McKay et al. (1990), some disciplines are marginalized in terms of curricula resources, time, and status. The sociology of sport, a comparative newcomer and hence an outsider in this regard, does not stand aloof from such struggles. Indeed, in its gradual integration into the sport sciences, it would be a mistake to assume that all of its practitioners would take the easy option and accept the benchmark of science expounded through physics. Sociologists, too, no doubt, will join the fray and struggle to demarcate the principles on which their social-scientific explanation of sport rests. At this stage, therefore, the degree of relative detachment required to grasp the potential of what is being proposed may not be present. In that sense, the situation within the sport sciences is not unlike the struggles that take place within the general scientific community. But this problem is compounded by the position in which sport science finds itself relative to the wider scientific community.

Structure and interdisciplinarity of kinesiology

Every science is interdisciplinary and has a certain structure.

- 1) Interdisciplinarity refers to kinesiology's relation to other sciences;
- 2) The structure of kinesiology is defined by fundamental, applied and auxiliary disciplines. Interdisciplinarity of kinesiology positions kinesiology in relation to other sciences. Kinesiology belongs to the group of anthropological sciences, a group connected with the group of methodological disciplines and the teaching methodology of kinesiology. All these sciences are interrelated and findings of one science are adopted by the other in a different form. We may conclude that no science is independent. For example, new findings in the area of pedagogy or medical science are applicable to kinesiology. Verification of these findings on kinesiological issues deepens and expands these

findings and these new findings in turn make a contribution to the original theory. The findings of medical physiology initially affected kinesiological physiology, and the knowledge on, for example, the functions of the cardiovascular system was in turn enriched by the findings of kinesiological physiology. Developments in the area of didactics were initially reflected in the teaching methodology of kinesiology, which has later become a fully developed scientific discipline with its own research methodology and which generates new findings that have application in didactics and other education-related fields.

Mraković (1997) argues that this structure is the most acceptable one from kinesiology's point of view. Such organisation of sciences is beneficial for kinesiology since it facilitates the establishment of a controlled exercise process. These scientific fields are necessary for kinesiological study of the results of a kinesiological treatment or inactivity. Due to their status of borderline sciences, kinesiological anthropology and research methodology of kinesiology can only be auxiliary disciplines of kinesiology, and teaching methodology of kinesiology an applied discipline of kinesiology. The goals of controlling the exercise process in kinesiology are as on figure 3. Basic disciplines of kinesiology include general disciplines of kinesiology and kinesiology of specific sports, as shown in Figure 2. General disciplines of kinesiology encompass systematic kinesiology, kinesiological biomechanics and non-sports kinesiology.

The general purpose of these disciplines is to study general principles of controlled exercise processes and the results of these processes; the principles of efficient movement; and the principles governing the transformation of anthropological characteristics and motor skills under the influence of physical exercise (Mraković, 1997). Kinesiology of a specific sport provides the synthesis of the principles governing the exercise processes typical for the specific sport activity or a group of relatively homogenous sport activities.

Kinesiology of sports can be divided in four categories. The first category refers to monostructural activities that involve covering a measurable distance either with one's body or a projectile. The cyclic structure of the movement prevails and the result does not depend on the cooperation among the members of a team. The second category refers to polystructural activities that involve non-cyclic activities whose aim is to symbolically defeat the opponent; the movement is performed and restricted through the contact with the opponent. The third category encompasses complex activities that involve hitting a target in space either by using a dribbled or ejected projectile; the structure of the movement is complex and can be either of cyclic and non-cyclic type; the result depends on the cooperation among the members of a team.

Finally, the fourth category refers to aesthetic activities whose goal is to achieve certain aesthetic standards by performing permitted movements; the non-cyclic movement type prevails in the form characteristic for the given sport activity. Applied kinesiological disciplines primarily refer to teaching methodology of kinesiology. Teaching methodology of kinesiology is an applied science that studies the education principles in formal education, sport, sports recreation and kinesiotherapy. Teaching methodology of kinesiology is divided into several areas: education, recreation, sport and kinesiotherapy. These disciplines study specific principles referring to the respective kinesiological system and the management of these systems in all the areas of application. The specificity of the principles is determined by the differentiation between the purpose and the application of the transformation process methods (Mraković, 1997). Auxiliary disciplines of kinesiology refer to the fundamental research areas related to kinesiology, parent sciences and various fields of human activity. This area includes kinesiological anthropology and research methodology of kinesiology. This structure of kinesiology has been established many years ago and, as such, it needs to be continually updated and expanded. Kinesiology and its disciplines constitute a homogenous research area reflecting distinct and real human needs which cannot be addressed without adopting a scientific approach (Mraković, 1997). Kinesiology places a special emphasis on planning and programming contents:

CONTROLLING THE PHYSICAL EXERCISE PROCESS

What is the subject of study in kinesiology?

The subject of study (interest) in kinesiology as a science is each controlled exercise process aimed at:

- 1) Health improvement;
- 2) Optimal development of personal characteristics, abilities and motor skills and their maintenance at the highest possible level for the longest possible period of time;
- 3) Prevention of early deterioration of certain anthropological characteristics and motor skills; Maximum development of characteristics, abilities and motor skills in competitive kinesiological activities.

Planning and programming of the controlled exercise process (Mraković, 1997)

Each controlled process consists of several factors. It is generally divided into planning and programming. The steps of a controlled cybernetic process in kinesiology are the following:

1. defining the goal of the exercise process
2. determining the subject's state
3. determining limiting factors
4. selection and distribution of exercise means

5. selection and distribution of exercise volume components
6. selection of the most adequate exercise modes; organisation and execution of a kinesiological treatment
7. periodical check
8. analysis of the effects of the exercise process

Defining the goal of the exercise process, determining the state of the subject and determining limiting factors fall into the planning phase, whereas the selection and distribution of exercise means, selection and distribution of exercise volume components, selection of the most adequate exercise modes, organisation and execution of a kinesiological treatment, periodical check, and the analysis of the effects of the exercise process fall into the programming phase of the exercise process. All the steps are closely interrelated, and the omission of one of them would undermine the entire controlled process. It is pointless to implement the programming procedure without previously defining the goal on the basis of the pre-existing state or vice versa, which is often the case in practice. It is also unacceptable to ignore the limiting factors, such as, e.g. poor material conditions etc. This means that the decisions are made intuitively and that the subject's needs cannot be properly met.

Conclusion

An overview of the body of knowledge in the field of kinesiology as a science of movement compiled to date clearly indicates that the term kinesiology is the most adequate one in the structure of sciences. In Croatia, kinesiology is considered to be an empirical, experiment-based science studying the laws, principles and patterns of controlled and directed physical exercise processes (activities) and their effects on the human body (Mraković, 1992). Kinesiology as a fundamental area of research finds its application in various areas, such as education, sport, recreation, kinesiotherapy, health and sport management, and it is positioned in relation to them as a parent science. Kinesiology studies fundamental and universal principles applicable to all branches of kinesiology. Furthermore, it can be concluded that the term kinesiology is gaining popularity and recognition as an adequate name for the science dealing with a wide area of multidisciplinary study of human movement, regular physical activity of various duration, intensity, purpose and content, as well as its effect on the body and life of an individual and society as a whole. Kinesiology as a fundamental science finds the application of its theory, concepts, developments and principles in various everyday activities. Kinesiology studies principles common to all areas of applied kinesiology – education, sport, recreation and kinesiotherapy. Thus, the global and universal use of the term kinesiology for both the science and the profession is only a matter of academic and scientific consensus.

Equating the term kinesiology with the term physical education is misleading, since physical education has a well-defined and established focus as an education model. Furthermore, the term physical education has a long tradition in the academic and wider community and it is difficult to modify its meaning at this point. The first formal use of the term kinesiology in the name of the Institute of Kinesiology that was founded in 1967, the recognition of kinesiology as a scientific discipline and its classification as an independent scientific field mark the end of a long pursuit for the adequate name for the scientific study of human movement in Croatian academic

community. Croatia seems to be the pioneer in the promotion of the term *kinesiology* in the European scientific and academic community. However, of all the proposed names, kinesiology is considered the most adequate one (Starosta, 2001). Aside from the fact that this name emphasises the independence of this academic discipline as well as its scientific status, it also defines its subject matter in a precise and explicit manner. Kinesiology and its disciplines constitute a homogenous research area reflecting distinct and real human needs which cannot be addressed without adopting a scientific approach (Mraković, 1997).

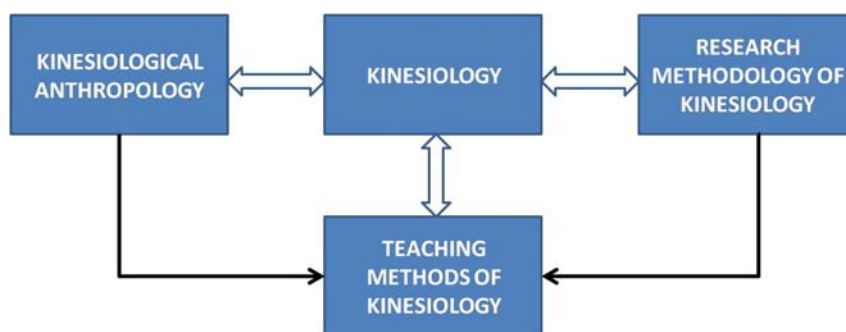


Figure 1. Kinesiology in the structure of sciences (Mraković, 1997)



Figure 2. The exercise process goals

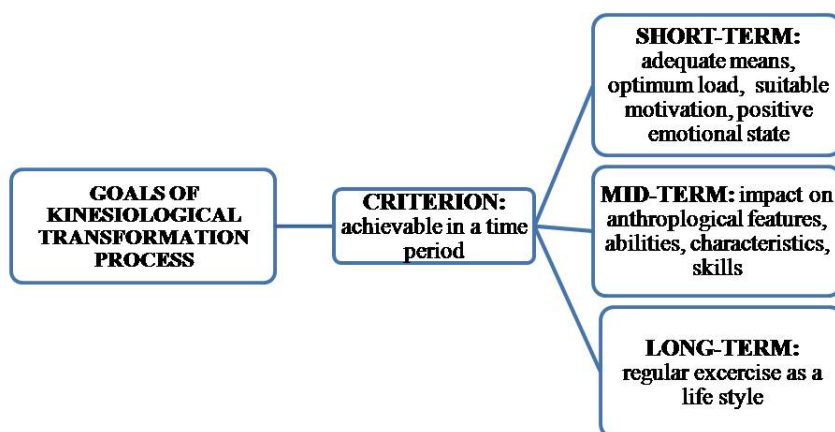


Figure 3. Exercise goals achievable in a time period

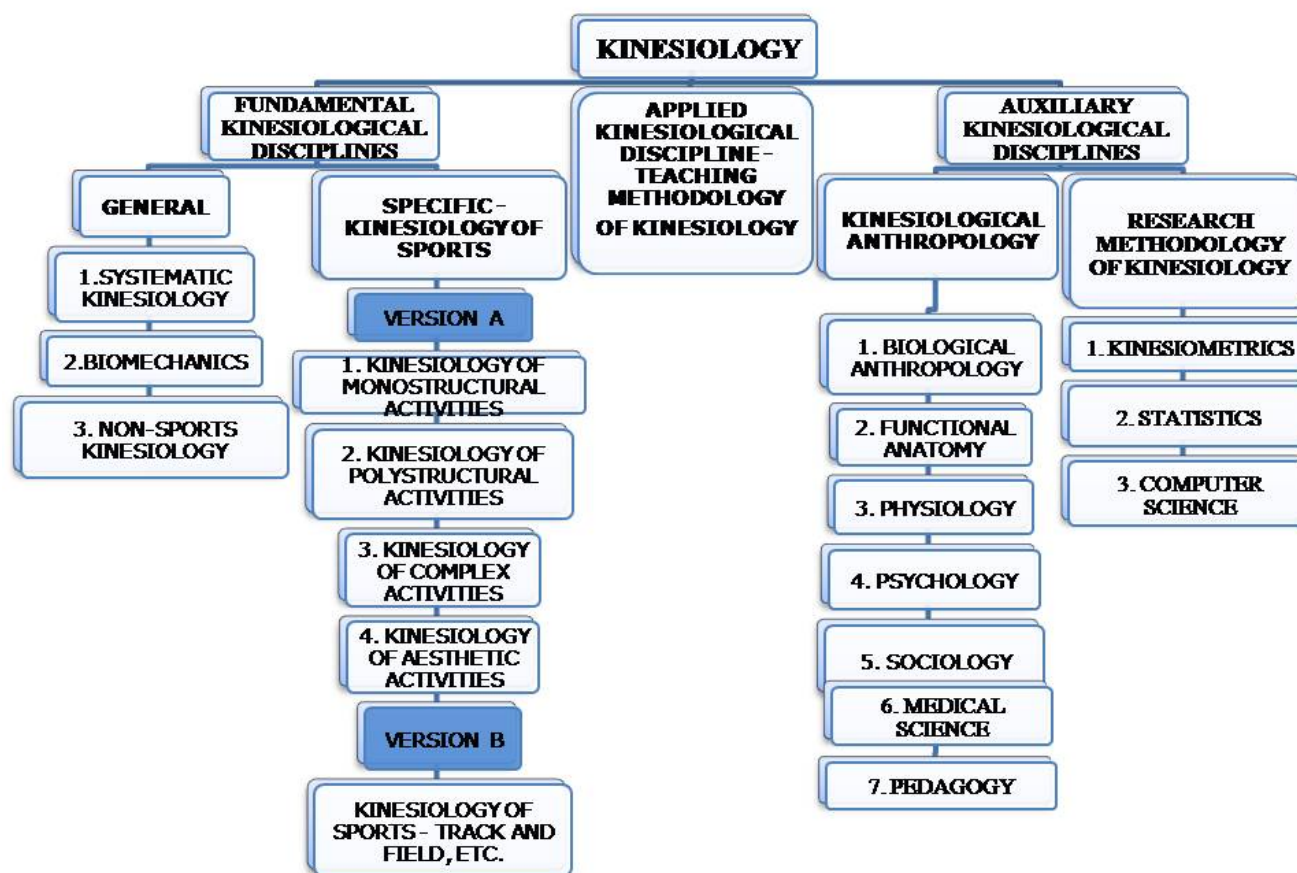


Figure 4. Internal structure of kinesiology (as revised by Mraković, 1997.)

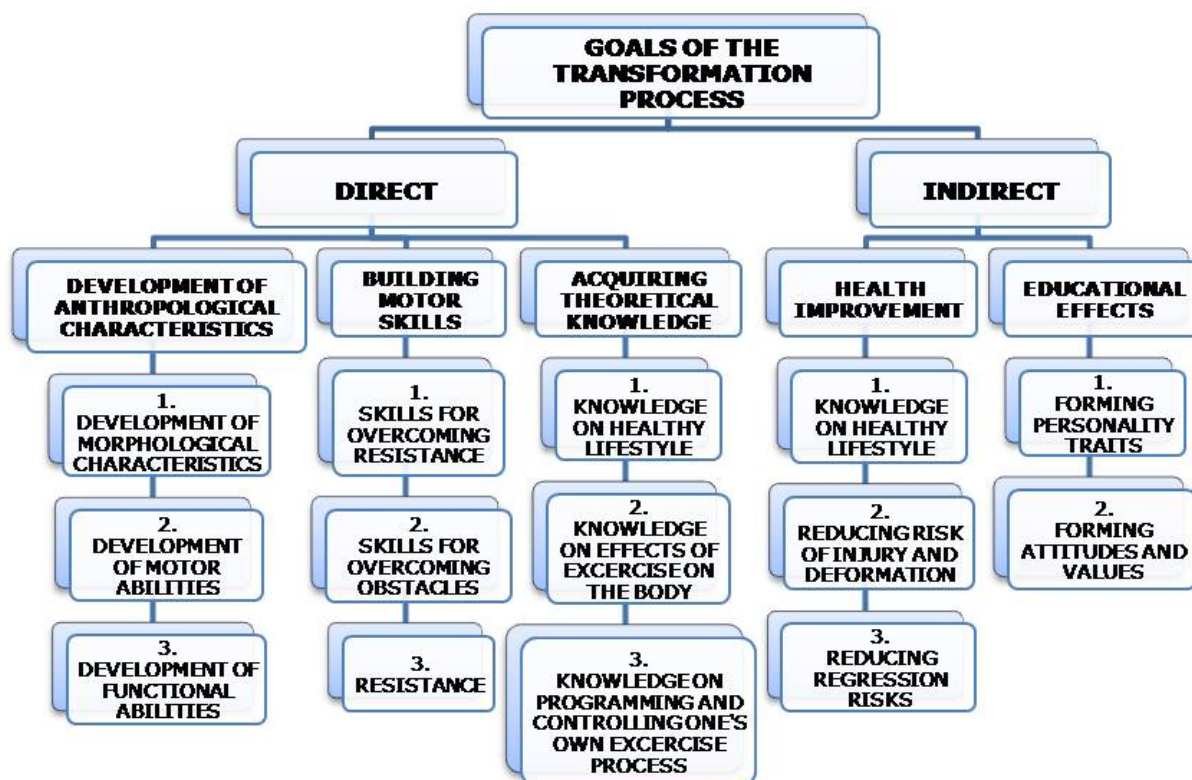


Figure 5. Transformation process goals

References

- Baker, J.A.W., Hardman, K., & Pan, D.W. (1996a). Perceptions of department titles in the United States of America and the United Kingdom. *Journal of the International Council for Health, Physical Education, Recreation, Sport and Dance*, 33(1), 58-63.
- Baker, J.A.W., Hardman, K., & Pan, D.W. (1996b). A perceptual mapping approach to determine an appropriate descriptor for our field. *European Physical Education Review*, 2(1), 75-81.
- Bird, P.J. (1988). College name change - A rationale. *Journal of Physical Education, Recreation and Dance*, 59(1), 25-27.
- Blahus, P. (1999) Measuring and modelling motor abilities as concept formation in scientific theory building in kinanthropology. *Intern. conf. Kinesiology for the 21st century*, Faculty of Physical Education University Zagreb, (pp. 43-50).
- Bouchard, C. (1988). Genetic basis of racial differences. *Canadian Journal of Sport Sciences*, 13, 104-108.
- Brown, W. (1980). Ethics, drugs and sport. *Journal of the Philosophy of Sport*, 7, 15-23.
- Caldwell, S.F. (1988). To "energize" physical education - change the dualistic term. *Journal of Physical Education, Recreation and Dance*, 59(1), 11.
- Corbin, C.B., & Eckert, H.M. (Eds.) (1989). *The evolving undergraduate major*. American Academy of Physical Education Papers #23. Champaign, IL: Human Kinetics.
- Čustonja, Z., Milanović, D., & Sporiš, G. (2009). Kinesiology in the names of higher education institutions in Europe and the United States of America. *Kinesiology*, 41(2), 136-146.
- Dally, N. (1857). *Cinesilogie ou science du mouvement dans ses rapports avec l'éducation, l'hygiène et l'therapie*. Paris: Librairie centrals des Sciences.
- Dollard, N., Doob, L., Miller, N., Mowrer, O., & Sears, R. (1939). *Frustration and aggression*. New Haven, CT: Yale University Press.
- Dunning, E., Murphy, P., & Williams, J. (1988). *The roots of football hooligan violence*. London, Routledge.
- Elias, N. (1971). Sociology of knowledge: New perspectives. *Sociology*, 5, 2-3.
- Elias, N. (1982). Scientific establishments. In N. Elias, R. Whitley, & H. Martins (Eds.), *Scientific establishments and hierarchies*. Dordrecht, Holland: Reidel.
- Elias, N. (1987). *Involvement and detachment*. Oxford, England: Blackwell.
- Elias, N., & Dunning, E. (1986). *Quest for excitement: Sport and leisure in the civilising process*. Oxford, England: Blackwell.
- Featherstone, M. (1983). The body in consumer culture. *Theory, Culture & Society*, 1, 18-33.
- Feyerabend, P. (1975). *Against method*. New York: New Left Books.
- Gauron, E. (1984). *Mental training for peak performance*. Lansing, MI: Sport Science Associates.
- Giddens, A. (1976). *New Rules of sociological method*. London: Hutchinson.
- Glasser, W. (1979). *Positive addiction*. New York: Harper & Row.
- Glassner, B. (1989). Fitness and the postmodern self. *Journal of Health and Social Behaviour*, 30, 180-191.
- Goldman, B. (1984). *Death in the locker room*. Tuscon, AZ: The Body Press.
- Grover, K. (Ed.) (1990). *Fitness in American culture: Images of health, sport and the body, 1830-1940*. Amherst: University of Massachusetts Press.
- Gruneau, R. (1982). Sport and the debate on the state. In H. Cantelon & R. Gruneau(Eds.), *Sport, culture and the modern state* (pp. 1-38). Toronto: University of Toronto Press.
- Guttmann, A. (1986). *Sport spectators*. New York: Columbia University Press.
- Hale, T. (1989, September). *Science and the search for truth*. Paper presented at the British Association of Sport Sciences Conference, Bangor University, Wales.
- Himes, J. (1988). Racial variations in physique and body composition. *Canadian Joimial of Sport Sciences*, 13, 117-126.
- Hirtz, P., Kirchner G., & Pöhlmann R. (1994), *Sportmotorik*. Univesität Gesamthochschule Kassel.
- Hoberman, J. (1988). Sport and the technological view of man. In W. Morgan & K. Meier (Eds.), *Philosophic inquiry in sport* (pp. 319-327). Champaign, IL: Human Kinetics.
- Hollis, M., & Lukes, S. (1982). *Rationality and relativism*. Oxford, England: Blackwell.
- Ingham, A. (1985). From public issue to personal trouble: Well-being and the fiscal crisis of the state. *Sociology of Sport Journal*, 2(1), 43-55.
- Kretchmar, R.S. (1989). Exercise and sport science. *Journal of Physical Education, Recreation and Dance*, 60(9), 68-69.
- Newell, K.M. (1989). Kinesiology. *Journal of Physical Education, Recreation and Dance*, 60(9), 69-70.
- Kuhn, T. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.
- Lakatos, I., & Musgrave, A. (1970). *Criticism and the growth of knowledge*. Cambridge, England: Cambridge University Press.
- Lavin, M. (1987). Sports and drugs: Are the current bans justified? *Journal of the Philosophy of Sport*, 14, 34-43.
- Maguire, J. (1991). Human sciences, sport sciences, and the need to study people „In the Round“. *Quest*, 43, 190-206.
- Mckay, J., Gore, J., & Kirk, D. (1990). Beyond the limits of technocratic physical education. *Quest*, 42, 52-76.
- Meinel, K. (1962) *Bewegungslehre (Versuch einer Theorie der sportlichen Bewegung unter pädagogischem Aspekt)*. Berlin: Volk und Wissen Volkseigener Verlag.

- Meinel, K. (1967) Motoryczność ludzka (zarys teorii czynności sportowych i działań ruchowych z punktu widzenia pedagogicznego). Warszawa: "Sport i Turystyka".
- Messner, M. (1990). When bodies are weapons: Masculinity and violence in sport. *International Review for the Sociology of Sport*, 25(3), 203-220.
- Mills, B.D. (1992). Physical Education in higher education: What should we name ourselves? /on line/. Retrieved from the address: http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/14/08/ac.pdf on October 14, 2008.
- Momirović, K. (1969). *Influence of scientific foundation of physical education on its social affirmation. In the book Theory of Physical education*. Belgrade: Yugoslav institute for Physical Education (pp, 166-133).
- Mraković, M. (1971) Kinesiology in Croatia. *Kinesiology*, 1(1), 1-5.
- Mraković, M. (1992). *Uvod u sistematsku kineziologiju*. [Introduction to kinesiology. In Croatian.] Zagreb: Faculty of Physical Education, University of Zagreb.
- Müller, E. (2008). Sport science in Europe – History and perspectives. In D. Milanović & F. Prot (Eds.), *Proceedings of the 5th International Conference on Kinesiology: Kinesiology Research Trends and Applications* (p. 32). Zagreb: Faculty of Kinesiology, University of Zagreb.
- Murphy, M., & White, R. (1978). *The psychic side of sports*. Reading, England: Addison Wesley.
- Newell, K.M. (1990a). Physical activity, knowledge types, and degree programs, *Quest*, 42(3), 243-268.
- Newell, K.M. (1990b). Physical education: Chaos out of order, *Quest*, 42(3), 227-242.
- Ojeme, E.O. (1984). Has the name Physical Education outlived its usefulness. *The Physical Educator*, 90(4), 190-194.
- Ojeme, E.O. (1989). A philosophic view of the Physical Education profession (brass ring revisited). *The Physical Educator*, 46(3), 121-134.
- Piper, R.A. (1988). P.E. recognized as a core subject: No name change necessary. *Journal of Physical Education, Recreation and Dance*, 59(4), 10.
- Polanyi, M. (1973). *Personal knowledge*. London: Hutchison.
- Popper, K.R. (1959). *The logic of scientific discovery*. London: Hutchinson.
- Renson, R. (2000). New insights into the biography and science background of Nicolas Dally (1795-1862), father of kinesiology (1857). *Kinesiology* 32(1), 5-14.
- Renson, R. (2002). Kinesiologists: raiders for the lost paradigm? In D. Milanović & F. Prot (Eds.), *Proceedings of the 3rd International Conference on Kinesiology: Kinesiology-New Perspectives* (p. 67). Zagreb: Faculty of Kinesiology, University of Zagreb.
- Riggs, C. (1981). Endorphins, neuro-transmitters and/or neuromodulators and exercise. In M.N. Sacks & M.L. Sacks (Eds.), *Psychology of running*. Champaign, IL: Human Kinetics.
- Siann, G. (1985). *Accounting for aggression: Perspectives on aggression and violence*. London: Allen and Unwin.
- Simon, R. (1985). Good competition and drug-enhanced performance. *Journal of the Philosophy of Sport*, 9, 6-13.
- Slowikowski, S., & Newell, K.M. (1990). The philosophy of kinesiology, *Quest*, 42(3), 279-296.
- Smith, M. (1983). *Violence and sport*. Toronto: Butterworths.
- Starosta, W. (2001). Science Of Human Movements – Meaning, Name, Directions Of Development. *Journal of Human Kinetics*, 6, 1-20.
- Talbot, M. (1989). *Gender and sport science*. Paper presented at the British Association of Sport Sciences Conference, Sociology of Sport Symposium, University of Birmingham, England.
- Thomas, J.R., & Nelson, J.K. (1990). *Research methods in physical activity* (2nd ed.). Champaign: Human Kinetics.
- Turner, B. (1984). *The body and society*. Oxford, England: Blackwell.
- Vallerand, R. (1984). Emotion in sport. In W. Straub & J.M. Williams (Eds.), *Cognitive sport psychology* (pp. 65-78). Lansing, MI: Sport Science Associates.
- Vincent, W.J. (1991). Kinesiology, The proper name for the discipline. *Physical Educator*, 48(3), 119-123.
- Vincent, W.J., Winningham, S.W., & Caldwell, S.F. (1988). Department name change: A rationale for kinesiology. *Journal of Physical Education, Recreation and Dance*, 59(7), 109-110.
- Wilson, B. (1970). *Rationality*. Oxford, England: Blackwell.
- Wuest, D.A., & Bucher C.A. (1991). *Foundation of physical and sport*, 11th ed. St. Louis: Mosby Inc.

KINEZIOLOGIJA – SISTEMATSKI PREGLED

Sažetak

Odsutnost kretanja, kao biološke potrebe svakog živog bića, ima teške posljedice po zdravlje ljudi. Ova činjenica je iznimno važna u suvremenom svijetu obilježenom rastućom tendencijom da se zanemari kretanje. To je prepoznato od strane znanstvenika koji su generirali ogromnu količinu istraživanja za rješenje ovog problema. To je općenito vrlo napredno područje istraživanja s obzirom na kompleksnost ljudskog pokreta i činjenicu da studija razvoja načela pokreta zahtijeva interdisciplinarni pristup. Pokret se studirao u cijeloj ljudskoj povijesti, a tu je i dugogodišnja potreba za generiranjem naziva za znanstveno proučavanje pokreta u područjima obrazovanja, sporta, rekreacije i kineziterapije. Najadekvatniji izraz za znanost o kretanju je kineziologija. Riječ "kineziologija" je nastala u Europi sredinom 19. stoljeća. U Hrvatskoj, samo je došla u širu uporabu od 1967.g. U Europi prevladava uporaba riječi "sport" u smislu sportskih znanosti (i) ili sportskih studija što je vjerojatno posljedica društvenih, ekonomskih i povijesnih čimbenika koji su oblikovali značenje riječi "sport" u Europi. Termin 'kineziologija' sve je priznatiji i prihvaćen je kao adekvatan termin za znanost koja se u opsežnom okviru multidisciplinarnog studija bavi ljudskim pokretom, redovitim tjelesnim aktivnostima različitog trajanja, intenziteta, namjene i sadržaja, kao i njezin učinak na tijelo i život pojedinca i društva u cjelini. Situacija u kineziologiji ne mora nužno utjecati na širu akademsku zajednicu, međutim, taj problem odnosi se na položaj kineziologije u široj znanstvenoj zajednici i borbi za priznavanje identiteta. U strukturi znanosti, kineziologija pripada skupini društvenih znanosti. Sve ove znanosti međusobno se prepliću, pri čemu se rezultati jedne znanosti usvajaju od druge u drugom obliku. Nema neovisne znanosti. Kineziologija i njene discipline tvore homogeni istraživački prostor i odražava različite i stvarne ljudske potrebe koje se ne mogu riješiti bez usvajanja znanstvenog pristupa (Mraković, 1997).

Ključne riječi: kineziologija, definicija, sadržaj, integracija, terminologija, svrha

Received: July 18, 2012

Accepted: June 10, 2013

Correspondence to:

Assoc.Prof.Goran Sporiš, Ph.D.

Faculty of Kinesiology

University of Zagreb

10000 Zagreb, Horvaćanski zavoj 15, Croatia

Phone: 00385 (0)99 21 21 220

E-mail: gsporis@kif.hr

EFFECTS OF IN-SEASON PLYOMETRIC TRAINING ON SPRINT AND BALANCE PERFORMANCE IN BASKETBALL PLAYERS

Abbas Asadi

Roudbar Branch, Islamic Azad University, Roudbar, Iran

Original scientific paper

Abstract

The purpose of this study was to examine the effects of in-season plyometric training program on balance and sprint performance in basketball players. Twenty intermediate basketball players participated in this study and were divided into two groups; plyometric training (PL; $n = 10$) and control group (CG; $n = 10$). Plyometric training took place 2 days a week for 6 weeks including depth jump, vertical jump, and standing long jump. Star Excursion Balance Test (SEBT) and 20-m sprint were measured at pre- and post-training. The PL demonstrated significant improvement ($P < 0.05$) in 20-m sprint ($\sim 7\%$) after a 6-week of training and compared to CG. There were not significant changes ($P > 0.05$) in SEBT, but PL showed $\sim 5\%$ improvement. In conclusions, it could be concluded that a 6-week in-season plyometric program can improve sprint and balance in male basketball players. Also, this study provides support for coaches and basketball players who use this training method at during competitive phase.

Key words: basketball, quickness, postural control

Introduction

In basketball, muscular power has been considered as essential to obtain high sport performance levels (Klinzing, 1991). Moreover, balance and sprint are vital components for the success in basketball players. Two methods, plyometric and resistance training, are usually referred to in the literature as improving the most powerful strength characteristics (explosive strength) in basketball players. Several studies have demonstrated the positive effects of plyometric and resistance training for higher increases in the explosive strength indicators (Brown et al., 1986; Fulton, 1992; Matavulj et al., 2001; Wagner & Kocak, 1997). Plyometrics are training techniques used by athletes in all types of sports to increase strength and explosiveness (Chu, 1998). Plyometrics consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle and connective tissue (Chu, 1998). The stored elastic energy within the muscle is used to produce more force than can be provided by a concentric action alone (Asmussen & Bonde-Peterson, 1974). Several investigations reported that, plyometric training can contribute to improvements in vertical jump performance, acceleration, leg strength, muscular power, increased joint awareness, and overall proprioception (Harrison & Gaffney, 2001; Hewett et al., 1996; Holcomb et al., 1996). This type of exercise causes higher muscle tension compared to conventional resistance training (Asmussen & Bonde-Peterson, 1974). For this reason, plyometric exercises are widely recommended for power enhancement in jumping (Verkhoshanski, 1973). Furthermore, the bulk of research investigated plyometric training efficacy (Adams et al., 1992; Brown et al., 1986; Holcomb et al., 1996; Saez-Saez de Villarreal et al., 2008), but there were a little study that examined the effects

of plyometric training in basketball players at in-season. This is especially the case in young male basketball players, for whom there are, to our knowledge, related studies available in literature. But, in young male basketball players, the effects of in-season plyometric training especially on balance and speed performance are unknown. Therefore, the aim of the present study was to determine how balance and speed are affected by a 6-week in-season plyometric training program in young male basketball players.

Methods

Subjects

Twenty male basketball players volunteered to participate in this study and were randomly assigned to two treatment groups that performed 2 times per week plyometric training (PL; $n=10$; age 20.2 ± 1 y; height 182.1 ± 9.2 cm; and weight 78.5 ± 5.5 kg). A control group of 10 subjects (CG; age 20.1 ± 1.5 y; height 180.1 ± 7.2 cm; and weight 79.5 ± 4.5 kg) did not train plyometric training and were tested before and after a 6-week period. The subjects performed technical and tactical training 3 times a week for 90 min. The subjects were healthy, free of lower body injuries and they had no medical or orthopedic problems. Subjects were carefully informed about the experiment procedures and possible risk and benefits associated with participation in the study and signed an informed consent document before the investigation. The Institutional Review Board of the University approved the research protocol.

Plyometric training

Plyometric training was taken twice weekly for 6 weeks (on Sunday and Tuesday). Participants in the PL group performed depth jump, vertical jump, and standing long jump, respectively.

Participants in the PL group performed exercises that always began with a drop from a height (45 cm). The training protocol required 3 sets of 15 jumps separated by 2-minute rests for each exercise. Training sessions in PL group lasted 55 min; and began with a standard 10 min warm-up, 5 min of jogging, 5 min ballistic exercises and stretching; 40 min training, and 5 min cool-down. Subjects in PL group were instructed to perform exercises in each training session with maximal effort. During the training, all subjects were under direct supervision and were instructed on how to perform each exercise. During the intervention of 6 weeks, PL and CG continued their basketball training, and were not allowed to perform any other training (such as: resistance training and or plyometric training) that would impact the results.

Measurements

Star Excursion Balance Test (SEBT) is a test that incorporates a single-leg stance on one leg with maximum reach of the opposite leg. The test is consisted of 8 lines that make a 45° angle to one another. The 45° increments are from the center of the grid. The 8 lines positioned on the grid are labeled according to the direction of excursion relative to the stance leg (anterior, anterolateral, anteromedial, medial, lateral, posterior, posterolateral, posteromedial) (Kinzey & Armstrong, 1998). The diameter of the circle is 182/9 cm and it is placed on a firm surface. The width of each line is 7/62 cm. In order to reduce the learning effect each subject chooses 6 directions out of the 8 to practice (Blackburn, et al., 2000). The subject stood in the middle of the circle with the dominant leg; then with the opposite leg he reached for the furthest marked distance. Each subject was asked to touch the furthest part of the line with the most distal part of his reach foot. This was done with control and in a slow manner to ensure adequate neuromuscular control of the stance leg. The subject then returned to the original stance and the touch points that were marked during examination were recorded. Three second rest was allocated between each reach. The direction of the revolution based on the right or left reach legs was clock wise and counter clock wise, respectively (Blackburn, et al., 2000). The reach was not accepted if the leg could not touch the target line, if the subject's weight was shifted to the reach leg, if the support leg was lifted from the center, or if balance was disturbed during the reach (Blackburn, et al., 2000). Participant's legs were measured from the anterior superior iliac spine to the distal tip of the medial malleolus using a standard tape measure while participants lay supine. Leg length was used to normalise excursion distances by dividing the distance reached by leg length then multiplying by 100 (Gribble & Hertel, 2003). **20-m sprint:** The sprint running tests were performed on an outdoor track. The sprint running test consisted of 3 maximal sprints of 20-m, with a 2 min resting period between each sprint. Sprint time was recorded using hand-held stopwatch (Joerex, ST4610-2).

The subjects started the sprint when ready from a standing position start, behind the start line. On command, subjects were instructed to sprint as fast as possible through the distance. The timer stood at the finish line (Marković, et al., 2007). **Statistical analyses:** All data are presented as mean $\pm$ SD. A 2 $\times$ 2 analysis of variance (ANOVA) was used to determine significant differences between groups. In the event of a significant *F* ratio, *Tukey* post hoc tests were used for pairwise comparisons. A criterion α level of $P \leq 0.05$ was used to determine statistical significance. All statistical analyses were performed through the use of a statistical software package (SPSS®, Version 16.0, SPSS., Chicago, IL).

Results

No injuries occurred throughout the study period, and the testing and training procedures were well tolerated by the subjects. After 6 weeks of training, the PL group made significantly ($P < 0.05$) greater improvements than CG and pre-training values in sprint performance (Figure 1). The PL group improved their dynamic balance ~5%, but this change was not statistically significant ($P > 0.05$) (Table 1).

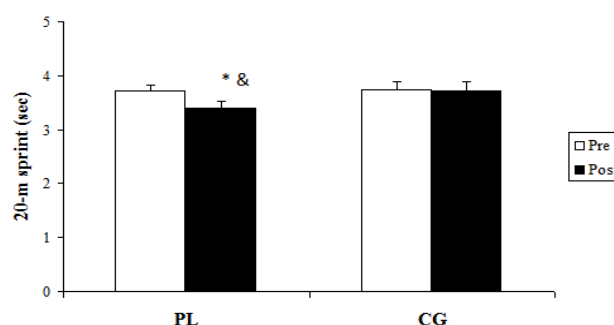


Figure1. 20-m sprint (sec) separated by group pre and post-training. Values are mean $\pm$ SD

* Significantly different ($p < 0.05$) from the corresponding baseline; & Significantly different ($p < 0.05$) from the corresponding CG; PL = plyometric group; CG = control group

Discussion and conclusion

A novel approach in this investigation was to examine the effects of in-season plyometric training on dynamic balance, and sprint in young male basketball players. Information regarding the effects of plyometric training on dynamic balance is generally lacking. The results of the present study are in line with Myer et al. (2006) and Twist et al. (2008) who reported plyometric training can improve balance performance in adults and female. Paterno et al. (2004) who used a combine dynamic balance and plyometric protocol and found that improvements in body sway measures occurred in the anterior/posterior plane. Recently, Arazi and Asadi (2011) reported changes in dynamic balance following 8 weeks plyometric training, but these changes were not statistically significant. In this study we found that PL group improved their dynamic balance ~4% (not significant).

Subjects were tested at 8 plans, and the highest improvement was observed in the anteromedial plan. These suggest that peripheral and central neural adaptations and enhancement of neuromuscular factors were induced by plyometric training, resulting in improved joint position sense and detection of joint motion. Peripheral adaptations that may have occurred because of plyometric training likely resulted from the repetitive stimulation of the articular mechanoreceptors near the end range of motion (Grigg, 1994). Central adaptation resulting from plyometric training may also improve proprioception. The novelty of this task required preparatory muscle activation (Chimera, et al., 2004). The results of this study show that in-season plyometric training can positively affect sprint performance (~7%). These findings support studies showing improvements in sprint speed after a plyometric program (Rimmer & Sleivert, 2000; Markovic et al., 2007; Saez-Saez de Villarreal et al., 2008). The factor that probably affected the obtained results for the 20-m distance was the quality of the applied training program (intensity and volume). In relation to the transfer

of plyometrics training to sprinting, it is likely that the greatest improvements in sprinting will occur at the velocity of muscle action that most closely approximates the velocity of muscle action of the plyometric exercises employed in training (Rimmer & Sleivert, 2000). It is also possible that a training program that incorporates greater horizontal acceleration would result in the most beneficial effects (Saez-Saez de Villarreal et al., 2008). In conclusion, the results of this study highlights the potential of using plyometric training at in-season of competitive phase to improve sprint and dynamic balance, especially in young male basketball players (19-20 years old). It is recommended that, coaches sometimes design plyometrics for young athletes, because this type of training can be effective for improving performance. Also, basketball players who use plyometrics to train dynamic balance should create programs that progress train intensity of the exercises based on the results of this study. Since coaches and athletes are often restricted to a short preseason, this is beneficial for coaches or athletes during competitive phase such as collegiate or logical competitions.

Table 1. Mean $\pm$ standard deviations for normalised maximum excursion distance (excursion distance/leg length $\times$ 100).

	PL (n=10)					CG (n=10)					
	Pretest		Posttest			Pretest		Posttest			~Δ%
Anterior	98.19 ±	5.05	103.02 ±	3.63		96.86 ±	5.65	97.54 ±	4.97	~5.0%	
Anteromedial	83.29 ±	8.07	88.32 ±	7.19		88.57 ±	9.42	88.54 ±	8.61	~6.0%	
Anterolateral	99.68 ±	7.15	104.04 ±	6.38		97.57 ±	4.37	97.71 ±	5.61	~4.0%	
Medial	71.41 ±	7.48	74.12 ±	6.67		79.81 ±	11.32	79.43 ±	11.45	~4.0%	
Lateral	93.3 ±	7.92	97.08 ±	5.85		91.14 ±	6.68	90.71 ±	6.5	~4.0%	
Posterior	87.6 ±	11.62	90.82 ±	10.64		86.63 ±	10.66	86.62 ±	9.72	~3.5%	
Posteromedial	80.81 ±	12.29	83.93 ±	10.73		82.69 ±	9.4	83.27 ±	10.73	~4.0%	
Posterolateral	91.64 ±	10.41	94.17 ±	10.61		92.43 ±	7.29	91.95 ±	7.87	~3.0%	

PL = plyometric group; CG = control group; ~ $\Delta\%$ = percent change in PL.

References

- Adams, K., O'Shea, J., O'Shea, K., & Climstein, M. (1992). The effects of six weeks of squat, plyometric and squat-plyometric training on power development. *J Appl Sports Sci Res*, 6, 36-41.
- Arazi, H., & Asadi, A. the effect of aquatic and land plyometric training on strength, sprint, and balance in young basketball players. *J Hum Sport Exercise*, 6, 101-111.
- Asmussen, E., & Bonde-Peterson, F. (1974). Apparent efficiency and storage of elastic energy in human muscles during exercise. *Acta Physiol Scand*, 92, 537-545.
- Blackburn, T., Guskiewicz, K.M., Petschaur, M.A., & Prentice, W.E. (2000). Balance and joint stability: The relative contributions of proprioception and muscular strength. *J Sport Reh*, 9, 315-328.
- Brown, M.E., Mayhew, J.L., & Boleach, L.W. (1986). Effect of plyometric training on vertical jump performance in high school basketball players. *J Sports Med Phy Fitness*, 26, 1-4.
- Chimera, N.J., Swanik, K.A., Swanik, C.B., & Straub, S.J. (2004). Effects of plyometric training on muscle activation strategies and performance in female athletes. *J Athle Train*, 39, 24-31.
- Chu, D.A. (1998). *Jumping Into Plyometrics*. Champaign, IL: Human Kinetics.
- Fulton, K.T. (1992). Off-season strength training for basketball. *Nat Strength Cond Asso J*, 14, 31-34.
- Gribble, P.A., & Hertel, J. (2003). Considerations for normalizing measures of the star excursion balance test. *Meas Physical Edu Exercise Sci*, 7, 89-100.
- Grigg, P. (1994). Peripheral neural mechanisms in proprioception. *J Sport Reh*, 9, 1-17.
- Harrison, A.J., & Gaffney, S. (2001). Motor development and gender effects on stretch-shortening cycle performance. *Journal of Science & Medicine in Sport*, 4, 406-415.

- Hewett, T.E., Stroupe, A.L., Nance, T.A., & Noyes, F.R. (1996). Plyometric training in female athletes. Decreased impact forces and increased hamstring torques. *American J of Sport Medicine*, 24, 765-773.
- Holcomb, W.R., Lander, J.E., Rutland, R.M., & Wilson, G.D. (1996). A biomechanical analysis of the vertical jump and three modified plyometric depth jumps. *J Strength Cond Res*, 10, 83-88.
- Kinzey, S.J., & Armstrong, C.W. (1998). The reliability of the star-excursion test in assessing dynamic balance. *J Orthopedic Sports Phys Ther*, 27, 356-360.
- Klinzing, J.E. (1991). Training for improved jumping ability of basketball players. *Nat Strength Cond Asso J*, 13, 27-32.
- Marković, G., Jukić, I., Milanović, D., & Metikoš, D. (2007). Effects of sprint and plyometric training on muscle function and athletic performance. *J Strength Cond Res*, 21, 543-549.
- Matavulj, D., Kukolj, M., Ugarković, D., Tihanyi, J., & Jarić, S. (2001). Effects of plyometric training on jumping performance in junior basketball players. *J Sports Med Phy Fitness*, 41, 159-164.
- Myer, G.D., Ford, K.R., Brent, J.L., & Hewett, T.E. (2006). The effects of plyometric vs. dynamic stabilization and balance training on power, balance, and landing force in female athletes. *J Strength Cond Res*, 20, 345-353.
- Paterno, M.V., Myer, G.D., Ford, K.R., & Hewett, T. E. (2004). Neuromuscular training improves single-limb stability in young female athletes. *J Orthopedic Sport Phys Ther*, 34, 305-317.
- Rimmer, E., & Sleivert, G. (2000). Effects of a plyometric intervention program on sprint performance. *J Strength Cond Res*, 14, 295-301.
- Saez-Saez De Villarreal, E., Gonzalez-Badillo, J.J., & Izquierdo, M. (2008). Low and moderate plyometric training frequency produce greater jumping and sprinting gains compared with high frequency. *J Strength Cond Res*, 22, 715-725.
- Twist, G., Gleeson, N., & Eston, R. (2008). The effects of plyometric exercise on unilateral balance performance. *J Sport Sci*, 26, 1073-1080.
- Verkhoshanski, T. (1973). Speed strength preparation and development of strength of athletes in various specializations. *Sov Sports Review*, 21, 120-124.
- Wagner, D.R., & Kocak, M.S. (1997). A multivariate approach to assessing anaerobic power following a plyometric training program. *J Strength Cond Res*, 11, 251-255.

UČINCI PLIOMETRIJSKOG TRENINGA ZA VRIJEME SEZONE NA SPRINT I BALANS IZVEDBU KOŠARKAŠA

Sažetak

Cilj ovog istraživanja bio je ispitati učinke pliometrijskog programa obuke na ravnotežu i izvođenje sprinta košarkaša za vrijeme trajanje sezone natjecanja. Dvadeset košarkaša srednje razine kvalitete sudjelovalo je u ovom istraživanju, a bili su podijeljeni u dvije skupine: pliometrijski trening (PL, n = 10) i kontrolnu skupinu (CG, n = 10). Pliometrijski trening je proveden dva dana tjedno kroz 6 tjedana, uključujući dubinski skok, skok uvis i skok u dalj. Uz pomoć uređaja „Star Excursion Balance Test“ (SEBT) i 20 m sprinta ispitanici su izmjereni u pre-i post fazi rada. Grupa PL pokazala je značajno poboljšanje ($P < 0,05$) u 20 - m sprintu ($\sim 7\%$) nakon 6 tjedana treninga, a u odnosu na grupu CG. Nije bilo značajnijih promjena ($P > 0,05$) u SEBT, ali je grupa PL pokazala $\sim 5\%$ poboljšanja. U zaključcima, moglo bi se reći da 6 - tjedna pliometrijski trening u sezoni može poboljšati sprint i balans kod muških košarkaša. Također, ova studija pruža podršku za trenere i košarkaše koji koriste ovu metodu treninga u vrijeme konkurentne natjecateljske faze.

Ključne riječi: košarka, sprint, posturalna kontrola

Received: March 19, 2013

Accepted: June 10, 2013

Correspondence to:

Abbas Asadi, Ph.D.

Roudbar Branch

Islamic Azad University

Roudbar, Iran

Phone: +98 91 1321 3041

E-mail: Abbas_asadi1175@yahoo.com

*

COMPARISON OF THE EFFECTS OF ACTIVE AND PASSIVE RECOVERY AFTER INCREMENTAL EXERCISE TO EXHAUSTION ON SERUM TESTOSTERONE AND PROGESTERONE LEVELS OF ATHLETES

Alireza Babai Mazreno¹, Ibrahim Salmani Nodoushan² and Nadjme Hajian³

¹ Islamic Azad University, Khorasgan, Iran

² Faculty of Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

³ Institute of Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran

Original scientific paper

Abstract

Introduction: The aim of the present study was to compare the effects of active and passive recovery after a very heavy exercise session (incremental exercise to exhaustion) on serum testosterone and progesterone levels of athletes. **Materials and Methods:** A total of 26 healthy, active sprinters participated voluntarily in the study. Exclusion factors included endocrinal, cardiac diseases and diabetes. Blood samples were drawn at three stages; baseline, immediately after an excessively heavy workout and 10 minutes after recovery on an empty stomach. Variance analysis was the statistical test used. A P -value < 0.05 was considered significant and SPSS 18 software program was used for entering the data in the computer. **Findings:** The results showed that passive recovery results in more reduction of testosterone and progesterone levels as compared to active recovery, but this difference is not significant ($P > 0.05$). **Conclusion:** It can be concluded that type of recovery and post recovery period has no effect on testosterone and progesterone serum levels of athletes.

Key words: recovery, active, passive, exercise, exhaustion, testosterone, progesterone

Introduction

One of the problems faced by athletes, especially during competition and training is return to initial levels before training or competition. This period is defined as the time required to return to the initial metabolic state. During this period, various metabolic processes take place in order to replenish the lost energy and storage. These processes are as important as the processes involved during exercise and work. Incomplete recovery processes between training sessions or competition results in an increased tiredness and reduction in ability to perform further activities. In general there are two types of recovery; passive recovery and active recovery. Active recovery is generally considered to be a bit of light practice session after heavy training or competition and it is believed that it improves recovery (Flier, 2004).

The increase in cardiac output due to passive recovery is relatively less than that due to active recovery and lesser involvement of muscles results in a lower number of messages from mechanical receptors and central orders (Karkoulas, et al., 2008). Active recovery results in more lactate uptake as compared to passive recovery (Hammes, 2003). Also, light active recovery after heavy exercise maintains adrenergic activity and catecholamine concentration (Wigernaes, et al., 2000). The testosterone that is secreted by Leydig cells present in the testes is necessary for the growth and division of fertility cells involved in sperm production (Gupta, et al., 1996). Approximately 97% of the testosterone after secretion from the testes loosely attaches with plasma albumin or more strongly with sex hormone binding globulin.

It remains in blood circulation for about half to one hour. The testosterone remains in tissues or is converted into an inactive form to be excreted later on (Gupta, et al., 1996). Tokmakidis and coworkers showed that testosterone hormone levels do not increase (Gupta, et al., 1996) or alter (Declan, et al., 2003) after a training session. Certain studies have shown that testosterone levels increase after cessation of training (Fairchild, et al., 2003) while others have reported no change in levels (Declan, et al., 2003; Crisafulli, et al., 2003; Wigernaes, et al., 2001). Progesterone is one of the steroidal hormones whose large quantities can strengthen re-absorption of sodium, chloride and water from the renal distal tubules like estrogens, testosterone and supra renal adrenal hormones. But the extraordinary fact is that progesterone causes excretion of water and sodium most of the time that is due to competition between progesterone and aldosterone as they have common protein receptors for attachment that causes the transfer of sodium ions from the epithelial tubular cells. When progesterone attaches to these receptors, aldosterone cannot attach to them. Thus, though progesterone it can result in mild increase in the re-absorption of sodium and water in the renal tubules, it antagonizes aldosterone strongly thus resulting in excretion of sodium and water from the body. It is proposed that measurement of testosterone and progesterone levels can be one of the important characteristics determining physiological pressure due to training (Fairchild, et al., 2003). Decreased levels of testosterone and progesterone are signs of increased catabolic processes.

Similarly, if this decrease is more than 30%, it is one of the important signs of Excessive Exercise Syndrome and in between is the point that the recovery period after training is incomplete (Schwane, et al., 1983). Considering the fact that the role of recovery after training has been studied in most of the studies but the relation between recovery, testosterone and progesterone has not been paid due attention to date, the authors decided to study the changes in testosterone and progesterone levels after passive and active recovery in athletes undergoing a very heavy exercise session (Bruce Max. Test).

Materials and Methods

This was a semi-experimental study with one session of Bruce Maximum test on two different occasions (days) and included 26 sprinters of the city of Isfahan who voluntarily enrolled in the study. They were divided into two groups; active recovery group (12 athletes) and passive recovery group (14 athletes). After a thorough explanation about the study and test, the consent form and questionnaire comprising of general characteristics and history of medical problems was filled. They were also asked to adhere to a normal sleep pattern (at least 8 hours sleep), day to day activities and diet during the study and abstain from strenuous bodily activity, diet supplements, drugs, coffee, cigarettes and cocoa from at least 48 hours before the test until the time of blood sample collection.

The results of the study were confidential and the reports were given to the athletes after the study. The limitations of the study were lack of control over the impulse of the population under study and also their unreported hidden medical problems. The study programs included warm up 10 minutes, Bruce Test 10 minutes and either active or passive recovery. Venous blood samples (5 ml) were drawn by two specialists (one expert and one physician) after 12 hours fasting between 7.30 A.M and 11 A.M to determine the testosterone and progesterone levels. First sample was drawn 30 minutes before start of test in the resting state, second sample immediately after Bruce Test and third sample 10 minutes after recovery.

It is worth mentioning that in order to prevent cell lysis, a German made Hettich refrigerated centrifuge with the specification of 3000 rounds per minute at 4 degrees centigrade was used for 10 minutes to separate the cells at the site and the samples were transferred on dry ice to the laboratory to be stored at -70 degrees centigrade for further analysis. The progesterone and testosterone levels were determined by DIALPLUS kit (made in U.S.A). One sided Variance analysis was the statistical test used and SPSS 18 software program was used for entering the data in the computer. A confidence level of 95% was considered for all of the samples.

Results

The results showed that none of the main effects (stages and type of recovery program) affected testosterone secretion significantly. According to the analyses, the changes in mean testosterone secretion levels in both groups were not statistically significant. The mean testosterone levels during various stages in the two groups are presented in table no.1. As shown in table 1, there was no significant difference in testosterone levels during various stages in both the active and passive recovery group. The mean progesterone levels in both the groups were higher after recovery as compared to the other stages (before and after heavy strenuous exercise). The mean progesterone levels during various stages are presented in table no.2. As shown in table no.2, there was no significant difference in progesterone levels during various stages in both the active and passive recovery group. Serum testosterone concentration (unit per litre).

Table 1. Mean, S.D., and testosterone level of blood in active and passive recovery group in 3 stages(unit per litre)

Stages	Recovery	Mean	SD	N
Before incremental exercise to exhaustion	Passive	10.60	1.25	14
	Active	9.89	2.02	12
	Total	10.27	1.66	26
After incremental exercise to exhaustion	Passive	10.62	2.81	14
	Active	10.74	2.24	12
	Total	10.68	2.51	26
After 10 minutes of recovery	Passive	10.64	2.57	14
	Active	10.42	2.72	12
	Total	10.54	2.59	26

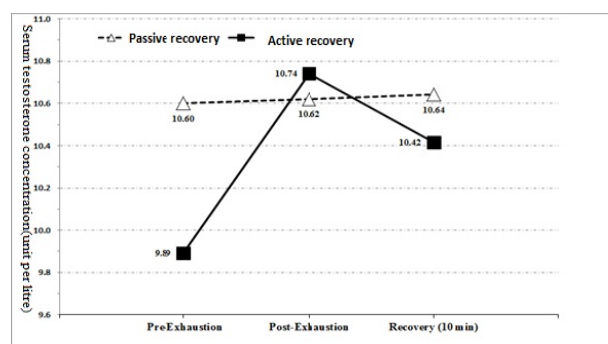


Figure 1. Mean on serum testosterone level in passive and active recovery group (before, just after, and 10 minutes after recovery)

Table 2. Mean, S.D., and progesterone level of blood in active and passive recovery group in 3 stages(unit per litre)

Stages	Recovery	Mean	SD	N
Before incremental exercise to exhaustion	Passive	.61	.41	14
	Active	.63	.37	12
	Total	.62	.38	26
After incremental exercise to exhaustion	Passive	.99	.53	14
	Active	.70	.42	12
	Total	.85	.49	26
After 10 minutes of recovery	Passive	1.08	.44	14
	Active	.94	.43	12
	Total	1.02	.43	26

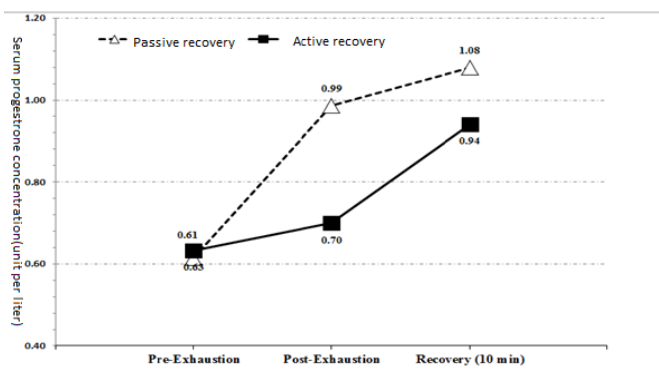


Figure 2. Mean on serum progesterone level in passive and active recovery group (before, just after and 10 minutes after recovery)

Discussion

The results of the present study showed that physical training (incremental exercise to exhaustion) has no significant effect on serum testosterone levels in athletes, but there can be an increase in progesterone levels. Also, passive recovery results in a greater decrease in testosterone and progesterone levels as compared to active recovery, but this difference is not significant. On the basis of previous studies that show that a session of exercise to exhaustion level results in increased levels of certain hormones like prolactin, cortisol and ACTH, while concentration of testosterone decreases (Carli, et al., 1992; Fotherby & Pal, 1985; Calbo, 19843; Kramer, 1988; Martelli, et al., 1987). Also, according to certain studies it is possible that testosterone concentration might increase after a training session, but its concentration decreases after 30 minutes such that it is lower than the pre exercise training levels (Freeman, et al, 2004; Tremblay, et al., 2004; Smallridge, et al., 1985). In the study by Karkoulas and coworkers in 2008 that compared a group of marathon runners who had been educated and middle aged amateur athletes, testosterone levels decreased and returned to normal levels one week after the competition (Karkoulas, et al., 2008). On the basis of a report by Keizer and coworkers after evaluation of testosterone response after weight lifting competition, it was concluded that testosterone concentration does not change significantly after competition (Keizer, et al., 1989). In the study by Semple and coworkers on marathon runners it was determined that testosterone levels decreased significantly (Semple, et al., 2001). In the study by Jurimae and coworkers regarding hormonal changes in male rowing athletes, the testosterone concentration immediately after rowing was related to the distance covered by the rowers such that there was no change in testosterone concentration during the initial two hours but the levels decreased after two hours (Jurimae, et al., 2001). In another study by Houmard and coworkers in 1990, the testosterone levels of long distance runners were evaluated and it was observed that testosterone levels did not alter

after a quiet training session and there was no change up to 4 weeks after running (Houmard, et al., 1990). In another study by Safarinejad and coworkers, the effect of severe and long distance running on testosterone levels was studied wherein the testosterone levels were lesser in those athletes who ran with more intensity (Safarinejad, et al., 2009). In the study by Keizer and coworkers, testosterone level changes were studied in athletes preparing for marathon. The levels were high even 2 days after the competition. The decrease in testosterone concentration is related to the distance covered by the athlete and can return to normal levels after rest (Keizer, et al., 1989). Tremblay and coworkers showed that testosterone hormone levels increase in response to exercise in athletes undergoing various training scenarios.

This increase was more in those exercising to the resistance level as compared to those exercising to the tiredness level. After an initial increase in testosterone concentration, there was a specific reduction in concentration level during rest that was related to the type and intensity of training. The increased levels were sustained even during rest in those exercising to the resistance level, while these changes were less in those trainings to the tiredness level (Tremblay, et al., 2005). In the study by Kraemer WJ., and Ratamess NA in 2005, the effect of the time period of exercise training on steroidal hormonal response in training men was studied. The testosterone levels increased one hour, 80 and 120 minutes after running and decreased 3 hours after rest. It was determined that more than 80 minutes of running is required to stimulate testosterone secretion. Maximum increase was 120 minutes after running. Therefore time period and intensity of exercise have an effect on hormonal response (Kraemer & Ratamess, 2005). The results of the present study are not in line with the above mentioned study. In the present study, there was no significant change in serum testosterone levels during various training stages. Buten et al., (1982) in a group study comparing young swimmers with a control group observed that progesterone level changes occurred on the 21st day. The results showed that progesterone levels were lower in the luteal stage swimmers as compared to the control group (Jurkowski, 1982). As the serum testosterone and progesterone levels did not change significantly after 10 minutes of active and passive recovery, it is proposed that more time should be allocated for recovery after training.

Conclusion

The results of the present study showed that passive recovery is responsible for a greater decrease in testosterone and progesterone levels after training as compared to active recovery, but this decrease is not significant ($P > 0.05$). Therefore, type of recovery and post recovery period has no effect on testosterone and progesterone levels of athlete.

References

- Calbo, H. (1983). *Hormonal and metabolic adaptation to exercise*. Stuttgart: Thieme.
- Carli, G., Bonifazi, M., Lodi, L., Luo, C., Martelli, G., & Viti, A. (1992). Changes in the exercise induced hormone responses to branched chain amino acid administration. *Eur j. Appl Physiol*, 64, 272-277.
- Crisafulli, A., Orru, V., Melis, F., Tocco, F., & Concu, A. (2003). Hemodynamics during active and passive recovery from a single bout of supramaximal exercise. *Eur J A Physiol*, 89, 209-216.
- Declan, A.J., Facsm, K.M., & Lauzon, C.D. (2003). Effect of active versus passive recovery on power output during repeated bouts of short term, high intensity exercise. *J of Sports Sci and Med*, 2, 47-51.
- Fairchild, T.J., Armstrong, A.A., Rao, A., Liu, H., Lawrence, S., & Fournier, P.A. (2003). Glycogen Synthesis in Muscle Fibers during Active Recovery from Intense Exercise. *Med Sci Sports Exerc*, 35, 595-602.
- Flier, J.S. (2004). Obesity wars: molecular progress confronts an expanding epidemic. *Cell*, 116(2), 337-350.
- Fotherby, K., & Pal, S.B. (1985). *Exercise endocrinology*. Berlin: De Gruyter.
- Freeman, M.E., Kanyicska, B., Lerant, A., & Nagy, G. (2000). Prolactin: structure, function, and regulation of secretion. *Physiol Rev*, 80:1523-1631.
- Gupta, S., Goswami, A., Sadhukhan, A.K., & Mathur, D.N. (1996). Comparative study of lactate removal in short massage of extremities, active recovery and a passive recovery period after supramaximal exercise sessions. *Int J Sports Med*, 17, 106-110.
- Hammes, S.R. (2003). The further redefining of steroid-mediated signaling. *Proc Natl Acad Sci USA*, 100:2168-2170.
- Houmard, J.A., Costill, D.L., Mitchell, J.B., Park, S.H., Fink, W.J. (1990). Testosterone, Cortisol, and Creatine Kinase levels in male distance runners during reduced training. *Int J Sports Med*, 11, 41-45.
- Jurimae, J., Jurimae, T., & Purge, P. (2001). Plasma testosterone and cortisol responses to prolonged sculling in male competitive rowers. *J Sports Sci*, 19, 893-898.
- Jurkowski, J.E. (1982). Hormonal and physiological responses to exercise in relation to the menstrual cycle. *Can J Appl Sport Sci*, 7(2), 85-89.
- Karkoulas, K., Habeos, I., Charokopos, N., Tsiamita, M., Mazarakis, A., Pouli, A., et al. (2008). Hormonal responses to marathon running in non-elite athletes. *Eur J Intern Med*, 19, 598-601.
- Keizer, H., Janssen, G.M., Menheere, P., & Kranenburg, G. (1989). Changes in basal plasma testosterone, cortisol, and dehydroepiandrosterone sulfate in previously untrained males and females preparing for a marathon. *Int J Sports med*, 3, S139-S145.
- Kraemer, W.J., & Ratamess, N.A. (2005). Hormonal responses and adaptations to resistance exercise and training. *Journal of Sports Medicine*, 35, 339-361.
- Kraemer, W.J. (1988). Endocrine response to resistance exercise. *Med Sci Sports Exerc*, 20(S), s152-s157.
- Martelli, G., Bonifazi, M., Lodi, L., Luo, C., Viti, A., & Carli, B. (1987). Androgen Levels in long distance runners. In: Tsopanakis, A., Poortmans, J. (eds) *Physiological biochemistry of exercise and training. Hellenic sport research institute, Athens*. (pp. 215-219).
- Safarinejad, M.R., Azma, K., & Kolahi, A.A. (2009). The effects of intensive, long-term treadmill running on reproductive pituitary - testis axis, and semen quality: a randomized controlled study. *J Endocrinol*, 200, 259-271.
- Schwane, J.A., Johnson, S.R., Vandenakker, C.B., & Armstrong, R.B. (1983). Delayed onset muscular soreness and plasma CPK and LDH activities after downhill running. *Med Sci Sports Exerc*, 15, 51-56.
- Semple, C.G., Thomson, J.A., & Beastall, G.H. (2001). Endocrine responses to marathon running. *Br J Sports Med*, 19, 148-151.
- Smallridge, R.C., Whorton, N.E., Burman, K.D., & Ferguson, E.W. (1985). Effects of exercise and physical fitness on the pituitary-thyroid axis and on prolactin secretion in male runners. *Metabolism: clinical and experimental*, 34, 949-954.
- Tremblay, M.S., Copeland, J.L., & Van Helder, W. (2004). Effect of training status and exercise mode on endogenous steroid hormones in men. *J Appl Physiol*, 96, 531-539.
- Tremblay, M.S., Copeland, J.L., Van Helder, W. (2005). Influence of exercise duration on post-exercise steroid hormone responses in trained males. *Eur J Appl Physiol*, 94, 505-513.
- Wigernæs, I., Hostmark, A.T., Kierulf, P., & Stromme, S.B. (2000). Active recovery reduces the decrease in circulating white blood cells after exercise. *Int J Sports Med*, 21(8):608-612.
- Wigernæs, I., Hostmark, A.T., Stromme, S.B., & Kierulf, P.B.K. (2001). Active recovery and Post-exercise white blood cell count, free fatty acid, and hormones in endurance athletes. *Eur J of Appl Physiol*, 84:358-366.

USPOREDBA UČINAKA AKTIVNOG I PASIVNOG OPORAVKA NAKON STUPNJEVITOG OPTEREĆIVANJA DO ISCRPLJENJA NA SERUM TESTOSTERONA I PROGESTERONA U KRVI SPORTAŠA

Sažetak

Uvod: Cilj ovog istraživanja bio je usporediti učinke aktivnog i pasivnog oporavka nakon vrlo teškog vježbanja (stupnjevito opterećivanje do iscrpljenja) na serum testosterona i progesterona u krvi sportaša. *Materijal i metode:* Ukupno je 26 zdravih, aktivnih sprintera sudjelovalo dobrovoljno u studiji. Isključenje za studiju su bili čimbenici koji uključuju endokrinološke bolesti, srčane bolesti i dijabetes. Uzorci krvi su izvučeni u tri faze, u mirovanju, odmah nakon pretjerano teških treninga i 10 minuta nakon oporavka (natašte). Za obradu je korištena Analiza varijance (SPSS-18 softver) a p vrijednost $< 0,05$ smatrana je značajnom. *Nalaz:* Rezultati su pokazali da pasivni oporavak pokazuje smanjenje razina testosterona i progesterona u usporedbi s aktivnim oporavkom, ali ta razlika nije značajna ($P > 0,05$). *Zaključak:* Može se zaključiti da vrsta oporavka i post-oporavka nema nikakvog utjecaja na razinu testosterona i progesterona u serumu sportaša.

Ključne riječi: oporavak, aktivno, pasivno, vježbanje, iscrpljenje, testosteron, progesteron

Received: October 31, 2012

Accepted: June 10, 2013

Correspondence to:

Ibrahim Salmani Nodoushan

Faculty of Health

Shahid Sadoughi University of Medical Sciences

Imam Hossein Sq., Yazd, Iran

Phone: +(98) 913 451 4020

E-mail: Email: salmani@ssu.ac.ir

DIFFERENCES AND DISCRIMINANT ANALYSIS BY LOCATION IN A1 GREEK WOMEN'S BASKETBALL LEAGUE

Eleftherios Dimitros¹, Vasiliki Garopoulou¹, Panteleimon Bakirtzoglou²
and Christodoulos Maltezos¹

¹ Department of PE & Sport Science, Aristotle University of Thessaloniki, Greece

² Organisation for Vocational Education and Training, Athens, Greece

Original scientific paper

Abstract

The purpose of the present study was to identify if and which game-related statistics are able to discriminate home and away games of women's basketball in relation with win or lose. The sample included all 242 statistical records from the games played between 2010-2011 in Greek Women's Basketball League. The game-related statistics analyzed were 2- and 3- point goal attempts (both successful and unsuccessful), free-throws (both successful and unsuccessful), defensive and offensive rebounds, assists, steals, turnovers and fouls (both committed and received). Home teams had significant increased values in successful 3-pt field-goals and assists and decreased value in unsuccessful free-throws compared with away teams ($P \leq 0.05$). In winning games the results showed significant lower values for home teams in unsuccessful free-throws and fouls received while in losing games had significant more fouls committed compared to away teams ($P \leq 0.05$). However, the game-related statistics could not discriminate the home and away teams in all, winning or losing games. Coaches of women basketball should be aware of these results in order to prepare their teams for the game. Other factors may have a role influencing the home advantage like the budget of the teams, familiarity, travel and the absence of spectators.

Keywords: women's basketball, home advantage, game-related statistics, discriminant analysis

Introduction

Home advantage is the term used to describe the consistent finding that home teams in sport competitions win over 50% of the games played under a balanced home and away schedule (Courneya, Carron 1992). Researchers all previous years dealt with whether it is an advantage or disadvantage playing at home field in sports like soccer (Clarke, Norman 1995, Pollard 2008), hockey (Bray 1999) and basketball (Gómez, Lorenzo et al. 2008). The studies about basketball have been focused in team performance by analyzing the game-related statistics (Gómez, Lorenzo et al. 2008, Sampaio, Drinkwater et al. 2010, Gómez, Lorenzo et al. 2006, Ibanez, Sampaio et al. 2008). However, all the above studies referred to men's basketball and these of Gómez et al (2006, 2007) did not study how game related-statistics can discriminate the home or away game. There is a lot of studies for home advantage which focused on women's sports (Baghurst, Fort 2008, Bray, Widmeyer 2000, Coulomb-Cabagno, Rascle et al. 2005, Gayton, Mutrie et al. 1987, Steven R Bray, Marc V Jones et al. 2002) but only, Gómez, et al. (Gómez, Lorenzo et al. 2007) investigated home advantage in women's basketball. Their research showed that the winning teams were differentiated from the losing teams by defensive rebounds, successful two point field-goals and assists. Several factors can influence the home advantage. Adams & Kupper (1994), Greer (1983) and Schwartz & Barsky (1977) showed that during booing crowd behavior conditions, the home team's performance was better than that of the visiting team.

Some studies have shown that the crowd and the home team are able to influence the referees (Boyko, Boyko et al. 2007, Balmer, Nevill et al. 2005, Sutter, Kocher 2004, Nevill, Holder 1999, Nevill, Newell et al. 1996, Lehman 1987). Bray & Widmeyer (2000) concluded that women basketball players consider that being familiarized with the facilities is the most important factor (39%) in home advantage. Other factors may include travel and familiarity (Jamieson 2010). Other studies have shown that under certain conditions the home field may be disadvantageous (Baumeister, Steinhilber 1984). Benjafield et al. (1989) reaffirmed a home disadvantage in professional basketball, baseball, and hockey, reporting that the home disadvantage was prevalent for teams who have an expectation for winning which leads to a 'choking under pressure' effect for them in closely played games (Wang, Johnston et al. 2011).

Published research focusing on the relations between game-related statistics and home and away teams' performance is reduced because available studies were conducted on samples from several years ago. The differences between winning and losing teams are probably influenced by game location which seems to configure different game tactics and strategies (Gómez, Lorenzo et al. 2008). There are no previous studies that have examined home advantage from statistical view in Greek Women's Basketball League. The main purpose of this study was to determine the performance differences between home and away teams.

Also, the goal was to investigate the game-related statistics which best allow one to differentiate the home and away teams in relation with the game result in A1 Women's League in Greece. This type of data is useful to have greater knowledge of the game.

Methods

Sample and variables

Data were collected from the Internet and specifically from Galanis Sports Data Company after permission. The sample consisted of 121 basketball games, meaning 242 statistical records for the teams engaged in games played between the 2010-2011 regular season of the Greek Women's Basketball League. All games played four periods of 10 min, with 24 sec ball possessions. The game related statistics analyzed included 2- and 3- point field- goals (both successful and unsuccessful), free-throws (both successful and unsuccessful), defensive and offensive rebounds, assists, steals, turnovers and fouls (both made and received). All records were classified according to the advantage or disadvantage of each team (home and away) and later analyzed according to the result of the game (winning and losing).

Statistical analyses

Three discriminant analyses were performed according to advantage for all games, for only winning and for only losing games. Structure coefficients higher than |0.30| were taken account for the interpretation of the discriminant functions (Tabachnick, Fidell 2007). The validation for the discriminant models was estimated using the

leave-one-out method of cross-validation (Norušis, SPSS Inc 1998). Cross-validation analysis takes subsets of data for training and testing and is required to understand the usefulness of discriminant functions when classifying new data. Each case in the analysis is classified by the functions derived from all cases other than that case (n-1). The process is repeated for each case (n times) and the percentage of correct classifications generated through averaging for the n trials. In order to identify the differences in game-related statistics between home and away in all games, in only winning and in only losing games, the Univariate ANOVAs test and t-test for independent samples were used. The statistical analyses were performed using PASW 18.0 and the level of significance was set at $P \leq 0.05$.

Results

The descriptive statistics and the differences of the game-related statistics between home and away games as well as between home and away winnings and between home and away loses are presented in Table 1. In the analysis of all games, the away teams occurred increased values compared to home teams in unsuccessful free-throws by 23.3% ($P \leq 0.05$) and lower values in successful 3-pt field-goals and in assists by 15.2% ($P \leq 0.05$) and 12.5% ($P \leq 0.05$), respectively.

In winning games the away teams had increased unsuccessful free-throws by 34.9 % ($P \leq 0.05$) and fouls received by 9.7% ($P \leq 0.05$) compared to home teams. In losing games the away teams made less fouls compared to home teams by 8.2% ($P \leq 0.05$).

Table 1. Descriptive results and differences between home and away, win and losing games. values are $x \pm s.d$

Game-related statistics	All games		Winning games		Losing games	
	Home	Away	Home (n=69)	Away (n=52)	Home (n=52)	Away (n=69)
Successful 2-pt field-goals	19.4 $\pm$ 5.1	18.9 $\pm$ 4.9	21.9 $\pm$ 4.6	21.2 $\pm$ 4.5	16.1 $\pm$ 3.8	17.1 $\pm$ 4.5
Unsuccessful 2-pt field-goals	24.4 $\pm$ 6.2	24.3 $\pm$ 5.6	23.0 $\pm$ 6.1	22.8 $\pm$ 5.0	26.1 $\pm$ 6.0	25.4 $\pm$ 5.9
Successful 3-pt field-goals*	4.6 $\pm$ 2.3	3.9 $\pm$ 2.3	5.1 $\pm$ 2.3	4.3 $\pm$ 2.5	3.9 $\pm$ 2.1	3.6 $\pm$ 2.0
Unsuccessful 3-pt field-goals	10.1 $\pm$ 3.6	9.7 $\pm$ 3.6	9.2 $\pm$ 3.3	9.0 $\pm$ 3.4	11.4 $\pm$ 3.7	10.2 $\pm$ 3.8
Successful free-throws	11.3 $\pm$ 4.7	11.0 $\pm$ 5.0	12.3 $\pm$ 4.6	13.5 $\pm$ 4.9	10.1 $\pm$ 4.7	9.2 $\pm$ 4.2
Unsuccessful free-throws*†	4.3 $\pm$ 2.7	5.3 $\pm$ 2.9	4.3 $\pm$ 2.8	5.8 $\pm$ 3.0	4.4 $\pm$ 2.6	4.9 $\pm$ 2.8
Defensive rebounds	25.6 $\pm$ 5.1	24.9 $\pm$ 6.1	27.4 $\pm$ 4.5	28.3 $\pm$ 6.0	23.3 $\pm$ 4.8	22.3 $\pm$ 4.8
Offensive rebounds	11.2 $\pm$ 4.2	10.5 $\pm$ 3.8	11.6 $\pm$ 4.3	11.3 $\pm$ 3.7	10.6 $\pm$ 4.0	10.0 $\pm$ 3.8
Assists*	13.6 $\pm$ 5.4	11.9 $\pm$ 4.4	15.7 $\pm$ 5.5	14.2 $\pm$ 4.1	10.8 $\pm$ 3.8	10.2 $\pm$ 3.9
Steals	8.9 $\pm$ 3.9	8.7 $\pm$ 3.1	10.0 $\pm$ 4.1	9.4 $\pm$ 3.5	7.4 $\pm$ 3.1	8.1 $\pm$ 2.6
Turnovers	16.6 $\pm$ 5.0	17.4 $\pm$ 4.7	16.4 $\pm$ 5.0	16.0 $\pm$ 4.1	16.9 $\pm$ 5.0	19.0 $\pm$ 4.9
Fouls committed‡	17.0 $\pm$ 3.6	16.7 $\pm$ 3.7	16.0 $\pm$ 3.2	16.7 $\pm$ 4.1	18.2 $\pm$ 3.6	16.7 $\pm$ 3.4
Fouls received†	16.5 $\pm$ 3.7	16.8 $\pm$ 3.5	16.5 $\pm$ 3.4	18.1 $\pm$ 3.5	16.5 $\pm$ 4.1	15.8 $\pm$ 3.3

* $p \leq 0.05$ vs home in all games, † $p \leq 0.05$ vs home in winning games, ‡ $p \leq 0.05$ vs home in losing games

The discriminant analyses according to team advantage for all games, as well as only for winnings and only for losing games, are presented in Table 2. Results showed that home could not be discriminated from away ($P \geq 0.05$) by the game-related statistics. However, the reclassification for this discriminant function was statistical significant (57.0%, Kappa=0.27, $P < 0.01$).

The home could not also be discriminated from away by game-related statistics both for winning ($P \geq 0.05$) and losing games ($P \geq 0.05$). However, the reclassification was statistical significant according to measure of agreement for winning (50.4%, Kappa=0.26, $P < 0.01$) and losing games (57.0%, Kappa=0.34, $P < 0.01$).

Table 2. Discriminant analysis structure coefficients (sc) from game-related statistics in all, only winning and only losing games according to advantage

Game-related statistics	All games	Win games	Lose games
Unsuccessful free-throws*†	-0.59	0.72	0.23
Assists*†	0.58	-0.40	-0.18
Successful 3-pt field-goals*†	0.50	-0.43	-0.17
Turnovers‡	-0.29	-0.10	0.37
Offensive rebounds	0.28	-0.12	-0.19
Defensive rebounds	0.22	0.25	-0.24
Unsuccessful 3-pt field-goals‡	0.22	-0.10	-0.36
Successful 2-pt field-goals	0.18	-0.05	-0.14
Steals	0.14	-0.25	0.29
Fouls received†	-0.13	0.60	-0.22
Fouls committed‡	0.12	0.26	-0.51
Successful free-throws†	0.10	0.36	-0.25
Unsuccessful 2-pt field-goals	0.02	-0.21	-0.19
Eigenvalue	0.08	0.13	0.18
Wilks Lamda	0.92	0.88	0.85
Canonical correlation	0.28	0.34	0.39
Chi-squared	18.5	14.1	18.5
Significance	0.140	0.369	0.141
Reclassification(%)	57.0	50.4%	57.0%
Kappa	0.27	0.26	0.34
Significance	0.000	0.004	0.000

*SC discriminant value $\geq |30|$ for all games according to home or away, †SC discriminant value $\geq |30|$ for home and away teams in winning games, ‡SC discriminant value $\geq |30|$ for home and away teams in losing games

Discussion

The aim of the present study was to investigate if the game-related statistics discriminate the home advantage in first division Greek Women's Basketball League. The results showed little differences in game-related statistics between home and away. Discriminant analyses showed no effect of home advantage either for all games or only for winning or losing games. This finding is in contrast with the research of Gayton et al. (1987) who found that there is a home advantage in women's basketball. However, the study of Gayton et al. (1987) included only analysis of the percentages of games won home and away. The two studies were also conducted in different eras. According to the meta-analysis of Jamison et al. (2010) the home-field advantage was significantly greater for games that took place before 1950 than for other eras like 1951–1970, 1971–1990, 1991–2007 which did not differ from each other. To the same way, it is possible to exist differences between the eras in women basketball. The results seem to be differentiated from other studies referred to men's basketball leagues. Gómez & Pollard (2011) reported the existence of home advantage in professional basketball in Europe. The gender of the players and the differences between men and women physical characteristics may contribute to different game-related statistical profile (Gomez, Lorenzo et al. 2009). Another possible factor for the absence of home advantage in women basketball is the budget of each team. So, teams with greater budget can afford more money for their roster and as a consequence best teams win the most games

home or away. Furthermore, Gómez et al. (2011) found a high home advantage in Greece for men basketball teams. They also reported that the home advantage is reduced for those teams played in capital cities compared with the rest of the country. It is noteworthy that eight of the twelve teams of the present study had their home in an area of Athens. So, for this reason the home advantage may be reduced in Greek Women's Basketball league and we agree with the hypothesis of Gómez et al. (2011) that the players are more familiar with conditions in their capital city than elsewhere in the country and maybe the disadvantage of playing away from home may be reduced when travelling to the capital. This hypothesis is supported by several studies examined travel as a factor to home advantage. For example, Snyder & Pardy (1985) found a winning percentage of 58.8% for home teams when guest teams travelled less than 200 miles, while the percentage was increased to 84.6% when guest teams traveled more than 200 miles. Similarly, Gayton & Coombs (1995) found that the home advantage of high school basketball teams is the same with this in collegiate and professional basketball suggesting that since high school basketball times do not travel like collegiate and professional teams there will be a minimum effect of travel on the home advantage. The absence of spectators in Greek Basketball games is a common phenomenon, especially in women basketball leagues and this may result to the win of the best teams. Agnew & Carron (1994) measuring the absolute crowd density, inter- versus intra-divisional rivalry and the time of year of the game at ice hockey, concluded that only crowd density was related to game outcome. Dowie (1982) found no effect of crowd size or crowd density on the home advantage in professional English soccer. Moore & Brylinsky (1993) analyzing and comparing total points scored field goal percentages and free throw percentages as performance measures from two university basketball teams showed that the performance of both teams improved in the absence of spectators. It is interesting to note the economical crisis in Greece, which may contribute to the absence of spectators and to reduced budget of each team. As a result the best teams won the games either home or away.

Conclusions

In our knowledge there is no other study investigating if the game-related statistics in basketball, especially in women can discriminate the game location (home or away) according to the result. There is evidence that the advantage in professional Greek Women's Basketball League cannot be discriminated by the game-related statistics like men's Basketball Leagues in Europe. Other factors may influence the home advantage like, the gender, familiarity, travelling, the absence of spectators and more important the budget of each team which need more investigation.

References

- Adams, R.D., and Kupper, S.J. (1994). The effect of expertise on peak performance: The case of home-field advantage. *Journal of Sport Behavior*, 17(2), 108.
- Agnew, G.A., & Carron, A.V. (1994). Crowd effects and the home advantage. *International Journal of Sport Psychology*, 25(1), 53-62.
- Baghurst, T., & Fort, I. (2008). Subjective judging and the home advantage in female collegiate Division I gymnastics. *Women in Sport & Physical Activity Journal*, 17(2), 3.
- Balmer, N.J., Nevill, A.M., & Lane, A.M. (2005). Do judges enhance home advantage in European championship boxing? *Journal of sports sciences*, 23(4), 409-416.
- Baumeister, R.F., & Steinhilber, A. (1984). Paradoxical effects of supportive audiences on performance under pressure: The home field disadvantage in sports championships. *Journal of personality and social psychology*, 47(1), 85-93.
- Benjafield, J. (1989). Is There a Home Field Disadvantage in Professional Sports Championships? *Social Behavior and Personality*, 17(1), 45-50.
- Boyko, R.H., Boyko, A.R., & Boyko, M.G. (2007). Referee bias contributes to home advantage in English Premiership football. *Journal of sports sciences*, 25(11), 1185-1194.
- Bray, S.R., & Widmeyer, W.N., 2000. Athletes' perceptions of the home advantage: an investigation of perceived causal factors. *Journal of Sport Behavior*, 23(1), 1-10.
- Bray, S. (1999). The home advantage from an individual team perspective. *Journal of Applied Sport Psychology*, 11(1), 116-125.
- Clarke, S.R., & Norman, J.M. (1995). Home Ground Advantage of Individual Clubs in English Soccer. *Journal of the Royal Statistical Society. Series D (The Statistician)*, 44(4), 509-521.
- Coulomb-Cabagno, G., Rascle, O., & Souchon, N. (2005). Players' Gender and Male Referees' Decisions About Aggression in French Soccer: A Preliminary Study. *Sex Roles*, 52(7), 547-553.
- Courneya, K.S., & Carron, A.V. (1992). The home-field advantage in sport competitions: A literature review. *Journal of Sport and Exercise Psychology*, 14, 13-27.
- Dowie, J. (1982). Why Spain should win the World Cup. *New Scientist*, 94(1309), 693-695.
- Gayton, W.F., & Coombs, R. (1995). The home advantage in high school basketball. *Perceptual and Motor Skills*, 81, 1344-1346.
- Gayton, W.F., Mutrie, S.A., & Hearn, J.F. (1987). Home advantage: does it exist in mens sport. *Perceptual and motor skills*, 65, 653-654.
- Gómez, M.A., Lorenzo, A., Ortega, E., & Olmedilla, A. (2007). Diferencias de los indicadores derendimiento en baloncesto femenino entre ganadores y perdedores en función de jugar como local o como visitante. *Revista de psicología del deporte*, 16(1), 41-54.
- Gómez, M.A., Lorenzo, A., Barakat, R., Ortega, E., Palao, J.M. (2008). Differences in game-related statistics of basketball performance by game location for men's winning and losing teams. *Perceptual and motor skills*, 106(1), 43-50.
- Gómez, M.Á, Lorenzo, A., Sampaio, J., & Ibáñez, S.J. (2006). Differences in game-related statistics between winning and losing teams in women's basketball. *Journal of Human Movement Studies*, 51(5), 357-369.
- Gómez, M.A., Pollard, R., & Luis-Pascual, J. (2011). Comparison of the home advantage in nine different professional team sports in Spain. *Perceptual and motor skills*, 113(1), 150-156.
- Gomez, M.A., Lorenzo, A., Ortega, E., Sampaio, J., & Ibanez, S.J. 2009. Game related statistics discriminating between starters and nonstarters players in Women's National Basketball Association League. *Journal of Sports Science and Medicine*, 8(2), 278-283.
- Gómez, M.A., & Pollard, R. (2011). Reduced home advantage for basketball teams from capital cities in Europe. *European Journal of Sport Science*, 11(2), 143-148.
- Greer, D.L. (1983). Spectator Booring and the Home Advantage: A Study of Social Influence in the Basketball Arena. *Social psychology quarterly*, 46(3), 252-261.
- Ibanez, S., Sampaio, J., Feu, S., Lorenzo, A., Gomez, M., & Ortega, E. (2008). Basketball game-related statistics that discriminate between teams' season-long success. *European Journal of Sport Science*, 8(6), 369-372.
- Jamieson, J.P. (2010). The Home Field Advantage in Athletics: A Meta-Analysis: home-field advantage. *Journal of Applied Social Psychology*, 40(7), 1819-1848.
- Lehman, D.R. (1987). Spectator influence on basketball officiating. *Journal of Social Psychology*, 127, 673.
- Moore, J.C., & Brylinsky, J.A. (1993). Spectator effect on team performance in college basketball. *Journal of Sport Behavior*, 16, 77-84.
- Nevill, A.M., Newell, S.M., & Gale, S. (1996). Factors associated with home advantage in English and Scottish soccer matches. *Journal of sports sciences*, 14(2), 181-186.
- Nevill, A.M., & Holder, R.L. (1999). Home advantage in sport. An overview of studies on the advantage of playing at home. *Sports Medicine*, 28(4), 221-236.
- Norušis, M.J., & SPSS INC. (1998). *SPSS 8.0 guide to data analysis*. Upper Saddle River, N.J.: Prentice Hall.
- Pollard, R. (2008). Home Advantage in Football: A Current Review of an Unsolved Puzzle. *The Open Sports Sciences Journal*, 1(1), 12-14.
- Sampaio, J., Drinkwater, E.J., & Leite, N.M. (2010). Effects of season period, team quality, and playing time on basketball players' game-related statistics. *European Journal of Sport Science*, 10(2), 141-149.

- Schwartz, B., & Barsky, S.F. (1977). The Home Advantage. *Social Forces*, 55(3), 641-661.
- Snyder, E.E., & Purdy, D.A. (1985). The Home Advantage in Collegiate Basketball. *Sociology of Sport Journal*, 2(4), 352-356.
- Bray, S.R., Jones, M.V., & Owen, S. (2002). The influence of competition location on athletes' psychological states. *Journal of Sport Behavior*, 25(3), 231.
- Sutter, M., & Kocher, M.G. (2004). Favoritism of agents – The case of referees' home bias. *Journal of Economic Psychology*, 25(4), 461-469.
- Tabachnick, B.G., & Fidell, L.S. (2007). *Using multivariate statistics*. Boston: Pearson/Allyn & Bacon.
- Wang, W., Johnston, R., & Jones, K. (2011). Home advantage in american college football games: A multilevel modelling approach. *Journal of Quantitative Analysis in Sports*, 7(3).

RAZLIKE I DISKRIMINACIJSKA ANALIZA PO LOKACIJI U A1 GRČKOJ ŽENSKOJ KOŠARKAŠKOJ LIGI

Sažetak

Cilj ovog istraživanja bio je utvrditi je li i koja igra, vezane statistike ženske košarke u vezi s pobjedom ili porazom, u stanju razlikovati igru kod kuće i u gostima. Uzorkom su obuhvaćeni podaci sve 242 utakmice između 2010-2011 grčke ženske košarkaške lige. Analizirani su pokušaji za 2 i 3 poena (uspješni i neuspješni), slobodna bacanja (uspješna i neuspješna), obrambeni i napadački skokovi, asistencije, krađe lopte, izgubljene lopte, i faulovi (počinjeni i pretrpljeni). Domaće momčadi imale su značajan rast vrijednosti u uspješnim pokušajima za 3 poena i asistencijama i manje vrijednosti neuspješnih slobodnih bacanja u usporedbi s gostujućim imovima ($P \leq 0,05$). U pobjedama rezultati su pokazali značajne niže vrijednosti u neuspješnim slobodnim bacanjima i pretrpljenim prekršajima dok kod gubitka utakmice, primjetno je značajno više počinjenih prekršaja počinjenih u odnosu na gostujuće timove ($P \leq 0,05$). Ipak, ovakva statistika nije uopće mogla doskriminirati domaće i gostujuće momčadi, u smislu pobjede ili poraza. Treneri žena u košarci trebali bi biti svjesni tih rezultata kako bi pripremili svoje timove za igru. Ostali čimbenici mogu imati ulogu i utjecati na početnu prednost kao npr. proračun timova, prisnosti, putovanja i odsutnost gledatelja.

Ključne riječi: ženska košarka, domaćin, prednost, vezana statistika, diskriminacijska analiza

Received: October 31, 2012

Accepted: June 10, 2013

Correspondence to:

Eleftherios Dimitros, MSc.

Department of PE & Sport Science

Aristotle University of Thessaloniki

54124, Thessaloniki, Greece

Phone: +(30) 69 7295 4069

E-mail: kldim4@hotmail.com

SPEED AND SPEED-STRENGTH ABILITIES OF THE REPRESENTATIVES FOR SLOVAKIA IN SHORT-DISTANCE RUNS IN THE PUPILS CATEGORY IN ATHLETICS

Ivan Čiliík¹, Martin Pupiš¹, Ondrej Ďurják¹, Ratko Pavlović² and Dobromir Bonacin³

¹ Department of PE and Sports, Faculty of Humanities, Matej Bel University in Banská Bystrica, Slovakia

² Faculty of Physical Education and Sport, University of East Sarajevo, Bosnia and Herzegovina

³ Faculty of Education, University of Travnik, Bosnia and Herzegovina

Original scientific paper

Abstract

This contribution deals with speed and speed-strength abilities of the pupils in short-distance runs in athletics. The main purpose of our contribution was to determine the performance and the correlations between the indicators of speed: accelerating speed, maximum running speed and the indicators of speed-strength: explosive power of lower limbs. We investigated speed abilities using the 50 m sprint with a standing start and speed-strength abilities by performing 10 repetitive squat jumps without the help of the upper limbs. The sample of subjects consisted of the pupils – competitors for Slovakia in the Youth category in athletics. Overall, physical demands of tested athletes were found to be average. Short-distance runners have better speed indicators than hurdle runners and long-distance runners; however, they achieve worse performance in speed-strength abilities. Contact time during the repetitive squat jumps is one of the decisive factors that significantly affect the level of speed and speed-strength abilities.

Key words: athletics, pupils, speed, speed-strength, short-distance runs

Introduction

According to some authors, 14 -15 years old children are included at the stage of specialized training (Perič 2004, Pavlović, 2008) and according to others, with whom we sympathize; children are included at the stage of basic training (Bompa, 2000; Čiliík 2004). A division as such is based on the methodological and the organizational point of view. It was also confirmed by (Millerova et al.2001; Tončev i Mihajlović, 2002) that this age is included at the stage of specialized training but they recommend the ratio of general sport training to special sport training 60:40%. So, the content of the stage is important, not the name. Competence and movement from one stage to another depends on the level of adaptive abilities and the degree of biological development. This should correspond with the sport training of an appropriate training load, racing and other external factors of training. Recently, there has increased the pressure for an early specialization which relates to including of world events in the Youth categories (World Youth Championships in Athletics, Youth Olympic Games and European Youth Championships – events for 17years old athletes or younger ones). These changes also affect the sport preparation in younger categories. Therefore, the whole long-term preparation needs to be adapted from the youngest categories and not only in older categories (14-15 years old). One of the way, how to ensure a smooth entry and movement of children between individual categories is e.g. Kids' Athletics Project. Experience and results in Slovakia but mainly in Czech shows the right way of doing it. Moreover, researches of some authors e.g. Kaplan, Válková (2009); Vindušková, Křivohlavá (2010); Švachová (2011; 2012) confirm it as well.

This project is followed by category of the youngest pupils (10-11) and younger pupils (12-13 years old). Projects in other countries have the same name and focus. The main motive is to get the children to regular training with the aim of increasing performance in older categories prospectively. In Poland, the issue of the sport preparation at this age was solved by authors e.g. Iskra et al. (2008a, 2008b), in other countries e.g. Corbin, Pangrazzi (1998), Balyi, Way (2002), Mihajlović, 2003; Balyi, Hamilton (2004), Grasso (2010), Pavlović, (2010). Performance, advanced technique and conditional preparation of the best pupils at the age of 14-15 years confirm that it is important to have a few years of training experience at this age. The training should be predominantly of a general character with a perspective performance focus. Monitoring the performance in athletics competitions is one side of talent and determining physical demands by using motor tests, which ascertain the level of selected demands, is the other side. These tests are often better indicators of demands, especially when finding out significantly genetically determined ones, therefore hardly affected by training. They show a lot about the prospect of each individual besides others e.g. somatic, technique, tactic, health, social and other factors. It is different in short-distance runs, in which a big genetic determinism of all factors affecting the performance occurs. This contribution was written with the support of GÚ VEGA 1/1158/12 Adaptive effect of training load in individual sports. The main purpose of this paper was to find out and evaluate the level and correlations of speed and speed-strength abilities in athletics. Short-distance runners representing Slovakia in the Pupils category in athletics were tested.

Methods

The testing of athletes was performed on the 27th September 2012 at the athletic stadium in Nitra during the meeting of competitors. They were tested before the international meeting of pupils from 5 countries CZE-CRO-HUN-SLO-SVK. All Slovak representatives took a part, except 2-3 athletes who had apologized themselves due to health issues. In this paper we present results achieved by pupils competing in Slovakia in short-distance runs. All of them were 15 years old, only the athlete M.K. was 14 years old. We used the following tests: 1) The 50 m sprint with a standing start: photocells were placed at the start line, in distances 20 m, 40 m and 50 m. We monitored accelerating speed 0-20 m, maximum speed 20-40 m and 40-50 m, and the overall performance during 50 m sprint. We used the 50 m sprint test as a complex indicator of running speed, accelerating speed (0-20 m) and maximum running speed (20-40 m); 2) 10 repetitive squat jumps on the jump ergometer "Myotest" (Fig. 1).

A test of repetitive squat jumps was used for the assessment of the explosive power of the lower limbs. We included the following indicators in this contribution: height of the jump – h (cm), contact time – tc (ms), reactivity (index = flight time/contact time), muscular rigidity (stiffness – indicator of muscle tension in the take-off leg) ($\text{kN}\cdot\text{m}^{-1}$) (www.verticaljumping.com). To evaluate the results, we used logical methods and correlations between individual monitored indicators of speed and speed-strength abilities.



Figure 1. The device "Myotest" (www.verticaljumping.com)

Results

Table 1. The basic somatic characteristics and indicators of speed abilities

Name	Disciplines	Body height (cm)	Body weight (kg)	50m (s)	Order	0 -20m (s)	Order	20 - 40m (s)	Order
T.P.	100m, 4x100m	175	67	6,250	3	2,974	5	2,210	3
S.V.	100m, 4x100	174	68	6,094	1	2,863	1	2,138	1
P.G.	4x100	172	63	6,229	2	2,940	2	2,204	2
P.H.	300m	181	61	6,407	6	3,061	6	2,242	4
M.Ku.	300m, 1000m	172	56	6,256	4	2,969	4	2,257	5
M.Ka.	100 and 300m hurdle	180	73	6,336	5	2,914	3	2,320	6
M.M.	100m hurdle	189	81	6,737	7	3,165	7	2,394	7

Table 2. Indicators of speed-strength abilities

Name	Body height (cm)	Order	Contact time (ms)	Order	Reactivity (index)	Order	Rigidity ($\text{kN}\cdot\text{m}^{-1}$)	Order
T.P.	28,1	6	131	4	3,62	7	50,8	3
S.V.	28,8	5	129	3	3,77	5	49,3	4
P.G.	26,4	7	112	1	4,12	2	53,8	2
P.H.	36,7	1	134	6	4,09	3	44,9	6
M.Ku.	32,7	4	132	5	3,92	4	38,8	7
M.Ka.	36,6	2	116	2	4,72	1	64,1	1
M.M.	36,5	3	148	7	3,68	6	46,2	5

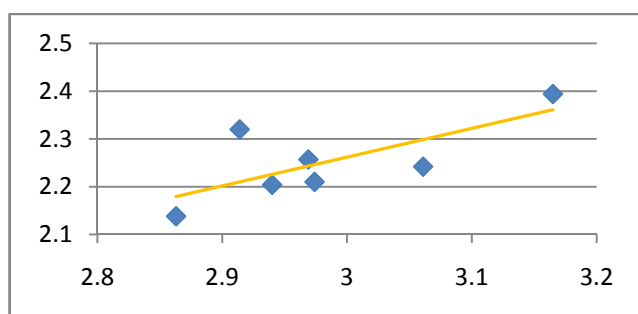


Figure 2. Correlations between accelerating speed and maximum running speed ($R = 0,72$ very strong correlation, reliability 52,2 % ; statistically sign. model)

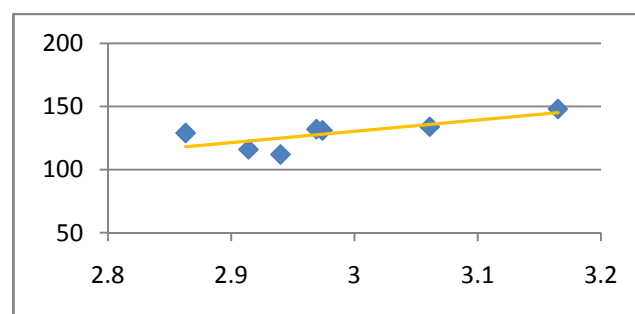


Figure 3. Correlations between the contact time and accelerating speed ($R = 0,75$ strong correlation, reliability 56,6% ; statistically significant model)

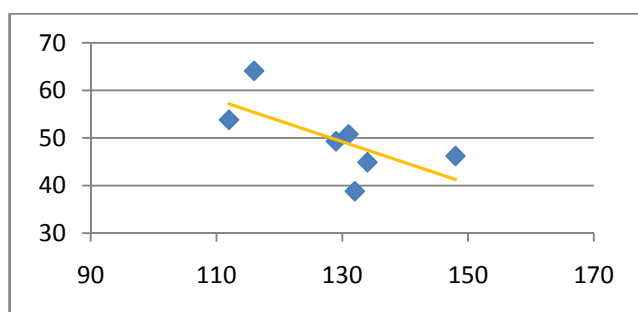


Fig. 4 Correlations between the contact time and muscular rigidity ($R = 0,66$ strong correlation, reliability 32,7%; statistically significant model)

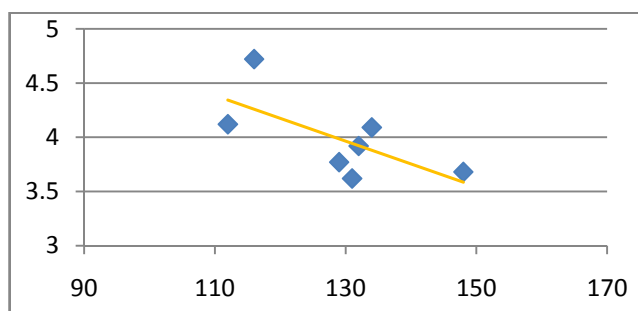


Fig. 5 Correlations between the contact time and reactivity ($R = 0,67$ strong correlation, reliability 44,9%; statistically significant)

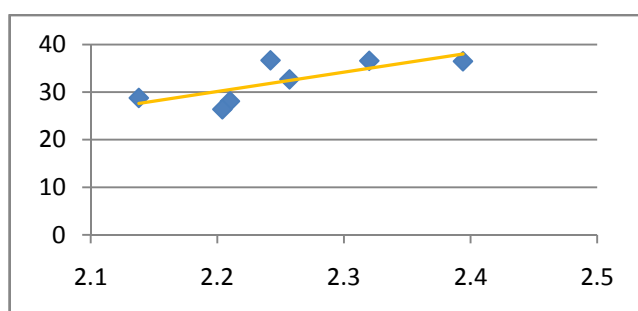


Fig. 6 Correlations between the height of the jump and maximum running speed ($R = 0,76$ strong correlation, reliability 57,6%; statistically significant model)

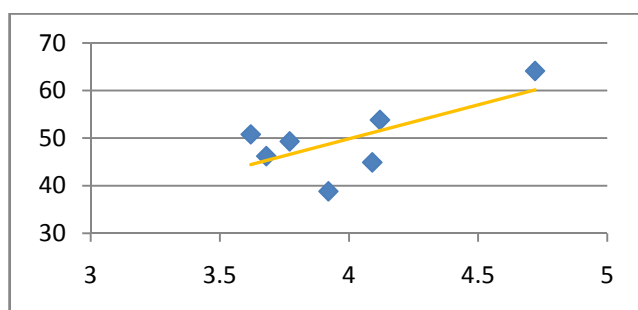


Fig. 7 Correlations between reactivity and muscular rigidity ($R=0,675$ strong correlation, reliability 45,5%; statistically significant model)

Somatic characteristics of tested athletes are suitable (Table 1). Short-distance runners at the age of 14-15 years have body height 172-181 cm.

So, these athletes are supposed to reach an adequate body height for short-distance runs in adulthood. Hurdle runners are higher (180 -189 cm) and this is necessary for hurdle races. Body weight is lower (index 6-20 cm), which gives perspective possibilities for muscle growth and the achievement of optimum height and body weight index. All three athletes have the same order of indicators of speed abilities. What refer to other athletes there are slight differences in the order. Sprinters for short distances achieve the best results, except the athlete T.P. in accelerating speed. Hurdle runners and longer sprint runners achieve lower performance in all parameters, except the athlete M.Ku. in two indicators and M.Ka. in accelerating speed. The best coefficients from all of tested athletes were reached by the athlete S.V. and good coefficients were also achieved by sprinter M.Ku., who is only 14 years old. What refer to indicators of speed-strength abilities, the best performance was achieved by hurdle runner M.Ka. (table 2). Overall, in the individual indicators this athlete took 1.-2. place and he is the best in complex indicators: reactivity and muscular rigidity. In these indicators he is significantly better to compare him with other athletes. On the other hand, short-distance runners achieve worse performance in indicators of speed-strength abilities, except the athlete P.G. We are dealing with correlations between all speed and speed-strength indicators. As shown in figure 2 – 7, we use only those indicators in which we found out statistically significant correlation. Next, we have also stated moderately strong correlation $R = 0,5$ in following relationships: correlations between the contact time and maximum running speed, correlations between the height of the jump and accelerating speed, however, these correlations were statistically insignificant. Even though, there is generally accepted relative independence between accelerating speed and maximum running speed, some relativity does exist. In our case, very strong correlation between accelerating speed and maximum running speed came out (Figure 2). In short-distance runs, the contact time during running is a limiting factor of maximum running speed. In our research we investigated the contact time during repetitive squat jumps. This indicator had proved to be important in a relation to other indicators. Strong correlation between the contact time and accelerating speed was confirmed (Figure 3). In tested subjects, statistically significant relationship between the contact time during repetitive squat jumps and complex indicators – muscular rigidity (Fig. 4) and reactivity (Fig. 5) has proved as well. Indirect relation is in both cases, it means shorter the contact time, the higher the value of muscle-tendon stiffness and reactivity index. Both correlation lines in our sample of subjects are very similar. Correlations between the height of the jump and maximum running speed showed to be statistically significant (Fig. 6). It can be explained by the confirmation of known knowledge that at maximum running speed the length of the stride, which depends on the strength when the athlete

pushes the ground and the take-off angle, is crucial despite the fact that the best athletes differ from weaker ones in stride frequency. In our study we only deal with the Youth category, however; the fact about the influence of reflective explosiveness on maximum running speed of Caribbean children at the age of 13-15 years was also stated by Babel Copaver, Hertog, Hue (2012). Reactivity and muscular rigidity are more complex indicators of speed-strength. In our sample of subjects, there is a nearly linear correlation (Fig.7). It means, with increasing level of reactivity is also growing muscular rigidity – muscle-tendon stiffness or preparedness for the take-off. Athlete, who is able to create a suitable bias, achieve better reactivity index. This ability is really important especially in reflective exercises and from athletics disciplines in jumps. However, optimum muscle bias is also important in short runs and in hurdle races it is as important as in jumps.

Discussion

Monitoring the level of speed and speed-strength abilities at this age is important in all athletics disciplines. It is particularly important in disciplines requiring speed-strength – in short-distance runs as well. Generally, there is a relatively small base of athletes in Slovakia and so the number of athletes e.g. in the Czech Republic seems to be invincible for us. For example, the authors Vindušková, Rus (2010) state the participation of about 2000 pupils when selecting children for sixth grades of sport classes. So, we must take care of young athletes more. Unfortunately, higher the number of athletes, the quality drops. This is proved by the results of our study in which the sample of subjects consisted of the best pupils. All subjects, except one of them, attained the standards in the 50m running to be selected for sprinting disciplines (Perič, 2006). However, this is only an orientation standard, as these athletes are the best in Slovakia. Then it is also important to know whether achieved performance is the result of hard work and specialized training, somatic characteristics or specific characteristics for sprinting.

Two best sprinters from all tested subjects lagged behind the standards in the 100m sprint as the criterion of selection and one of the hurdle runners lag behind the standards as well. The authors Zeličenok, Nikituškin, Guba (2000) assume that the performance of the best world runners is 11,86 s for 100 m at the age of 14,6 years in characteristic of age dynamic performance. Our athletes achieved during the international meeting only the performance at the mentioned level, respectively weaker. Even the results gained from repetitive squat jumps tests do not support high level of talent referring to the force of reflection – these athletes were overcome in three indicators by athletes competing in other disciplines. Only two athletes significantly came closer to 100ms in the length of contact with reflections.

In this group of sprinters nobody show to be a significant talent for sprinting. Above the average abilities in speed indicators were achieved by the athlete S.V. and in speed-strength indicators by the athlete M.Ka., The athlete M.Ku. can be judged with them considering the age and specialization. Anyway, we are aware of the fact that by realization of one testing we can neither solve the question of complex diagnosis of young athlete nor to determine the level of his/hers talent. However, it is important to identify the level of talent of each individual person also from the point of view of his actual and prospective specialization. Numbers of authors were dealing with questions of selecting talented athletes. Nevertheless, the identification of talented athletes and the success of training programs were rarely evaluated. Therefore, the questions dealing with identification of talented children are still topical and discussed. Correlation between speed and speed-strength abilities was confirmed in several cases. Despite of relative independence of acceleration and maximum running speed, statistically significant dependence was confirmed. From all indicators of speed-strength abilities, the length of the take-off during repetitive squat jumps showed to be the key factor which is related to all speed and speed-strength indicators, except the height of the jump. We state that the contact time in used test is equally important during running.

Conclusion

Short-distance runners have better speed indicators than hurdle runners and long-distance runners. On the other hand, short-distance runners achieve worse performance in speed strength abilities. Somatic characteristics of tested athletes are suitable. As shown by the athlete M.M., the main criterion for selecting him for hurdle-race specialization was mainly somatic characteristics and not motor performance. All in all, we evaluate the level of speed and speed-strength abilities of short-distance runners competing in Slovakia as an average. There are three athletes with more than average abilities: the athlete S.V. in speed abilities, the athlete M.Ka. in speed-strength abilities and the athlete M.Ku. in both – speed and speed-strength abilities considering the age and specialization. The performance of tested pupils does not achieve the basic recommended standards mentioned in literature, or it exceeds the standards just a little bit higher. We noted statistically significant correlations between the acceleration and the maximum running speed. Furthermore, we also found out significant correlations between the contact time and other speed and speed strength indicators, except the height of the jump. We assume, according to this, that the contact time during repetitive squat-jumps is one of the main factors which significantly influence the level of speed and speed strength abilities. Because of the small number of tested athletes, we cannot generalize the results. Therefore, there are required other measurements.

References

- Bompa, T. (2000). *Total training for Young Champions*. Illinois: York University.
- Babel, K., Hertogh, C., & Hue, O. (2012). Sprint performance changes and determinants in Afro-Caribbean adolescents between 13 and 15 years old. *Journal of Human Kinetics*, 34, 89–98.
- Balyi, I., & Hamilton, A. (2004). Long – Term Athlete Development: Trainability in Childhood and adolescence. Windows of Opportunity. Optimal Trainability. [online]. Victoria: *National Coaching Institute British Columbia & Advanced Training and Performance Ltd.* Available at: [http://www.athleticsireland.ie/content/wp-content/uploads/2007/03/balyiLTAD 2004 pdf.\(dn 2011.10.1\).](http://www.athleticsireland.ie/content/wp-content/uploads/2007/03/balyiLTAD 2004 pdf.(dn 2011.10.1).)
- Balyi, I., & Way, R. (2002). Adaptation To Training and Optimal Trainability. In: Balyi, I. – Hamilton, A. Long – Term Athlete Development: Trainability in Childhood and adolescence. Windows of Opportunity. Optimal Trainability. [online]. 2004, Victoria: *National Coaching Institute British Columbia & Advanced Training and Performance Ltd.* Available at: [http://www.athleticsireland.ie/content/wp-content/uploads/2007/03/balyiLTAD 2004pdf.\(dn 2011.10.1\).](http://www.athleticsireland.ie/content/wp-content/uploads/2007/03/balyiLTAD 2004pdf.(dn 2011.10.1).)
- Corbin, C.B., & Pangrazi, R.P. (1998). Physical activity for children: A statement of guidelines. [online]. Reston, VA: *National Association for Sport and Physical Education (NASPE) Publications*. Available at: [http://www.ed.gov./databases/ERICDigest/index/.\(dn 2002.04.29\).](http://www.ed.gov./databases/ERICDigest/index/.(dn 2002.04.29).)
- Čiliik, I. (2004). *Športová príprava v atletike*. Banská Bystrica: Univerzita Mateja Bela.
- Grasso, B. (2010). *Coordination & Movement Skill Development – The key to Long – Term Athletic Success*. [online]. Available at: [http://www.performbetter.com/webapp/wcs/stores/servlet/PBOnePieceView?storeId=10151&catalogId=10751&languageId=-1&pagename=209.\(dn 2011.09.11\).](http://www.performbetter.com/webapp/wcs/stores/servlet/PBOnePieceView?storeId=10151&catalogId=10751&languageId=-1&pagename=209.(dn 2011.09.11).)
- Iskra, J., & Paruzel-Duja, M. (2008a). *Lekkoatletyka dla dzieci i mlodziezy*. Akademia Wychowania Fizycznego im. Jerzy Kukuczki w Katowicach, Wydział Wychowania Fizycznego i Fizjoterapii Politechniki Opolskiej, Katowice-Opole.
- Iskra, J. (2008b). *Atlas cwiczen lekkoatletycznych dla dzieci i mlodziezy*. Wydział Wychowania Fizycznego i Fizjoterapii Politechniki Opolskiej, Opole.
- Kaplan, A., Váľková, N. (2009). *Atletika pro děti a jejich rodiče, učitele a trenéry*. Praha: Grada.
- Millerová, V., et. al. (2001). *Běhy na krátké tratě*. Praha: Grada.
- Mihajlović, I. (2003). Selection of children in schools for the sprint events in track and field. *Proceedings of abstracts of the XVII international interdisciplinary symposium: sports, activity physical and health of young people* (69) Novi Sad. Serbia.
- Perič, T. (2004). *Sportovní příprava dětí*. Praha: Grada.
- Perič, T. (2006). *Výběr sportovních talentu*. Praha: Grada.
- Pavlović, R. (2008). The diagnosis of characteristics and the organization and selection of future athletes. *Sport and Health*, 3(1), 77-82.
- Pavlović, R. (2010). Development characteristics, endogenous-exogenous factors of growth and development as the primary factors in routing selection and athletics. *Sport and Health*, 5(1), 138-146.
- Pavlović, R. (2010). *Atletics*. East Sarajevo: Faculty Physical Education and Sport.
- Tončev, I., & Mihajlović, I. (2002). Evaluation of the training process. *Modern Sport*, (1-2), 69-71.
- Švachová, S. (2011). Názory účastníkov projektu „Atletika pre deti“ na Slovensku. *Acta Facultatis Humanisticae Universitatis Matthiae Belii Neosoliensis*. (pp. 158–165).
- Švachová, S. (2012). Účinnosť projektu „Atletika pre deti“ v mladšom školskom veku. *Scientia Movens: sborník příspěvků z mezinárodní studentské vědecké konference*. (pp. 471–476). Praha: Univerzita Karlova, Fakulta tělesné výchovy a sportu.
- Vindušková, J., & Rus., V. (2010). Systém vyhledávání a péče o pohybově nadanou mládež v atletice. W: Perič, T., Suchý, J. et al. *Identifikace sportovních talentu*. Univerzita Karlova, Praha, (pp. 174–178).
- Vindušková, J., & Křivohlavá, H. (2010). Motivace dětí v atletických přípravkách. W: *Atletika 2010*. Univerzita Karlova, Praha, (pp. 138–143).
- Zeličenok, V.B., Nikitušin, V.G., & Guba, V.P. (2000). *Legkaja atletika: kriterii otbora*. Moskva: Tera-sport.
- * * * (2012). *Myotest review*. Available at: [http:// www.verticaljumping.com%2fmyotest_review.html](http://www.verticaljumping.com%2fmyotest_review.html) [dn. 2012.10.15).

SPOSOBNOSTI BRZINE I BRZINSKE IZDRŽLJIVOSTI KOD REPREZENTATIVACA SLOVAČKE U SPRINTU U KATEGORIJI UČENIKA U ATLETICI

Sažetak

Ovaj je prilog posvećen sposobnostima brzine i brzinske izdržljivosti učenika u sprintu u atletici. Glavna svrha i doprinos rada bio je utvrditi učinkovitost i korelacije između pokazatelja brzina: ubrzanje, brzine trčanja i brzinske izdržljivosti i eksplozivne snage nogu. Istražili smo brzinu pomoću 50 m sprinta od starta pa sve do brzinske izdržljivosti, a eksplozivnost izvođenjem 10 ponavljanja čučanj-skokova bez pomoći gornjih ekstremiteta. Uzorak ispitanika sastojao se od učenika - natjecatelja za Slovačku u kategoriji mladih u atletici. Sveukupno, utvrđeno je da su fizički zahtjevi za testirane sportaše prosječni. Rezultati su pokazali da sprinteri imaju bolje indikatore brzine od preponskih trkača i dugoprugaša, međutim, oni postižu lošije rezultate u brzinskoj izdržljivosti. Konačno, može se reći da je vrijeme kontakta ključna stvar tijekom ponavljanja čučanj-skokova i jedan je od presudnih faktora koji značajno utječe na razinu brzine i eksplozivnosti.

Ključne riječi: atletika, učenici, brzina, brzinska izdržljivost, sprint

Received: January 19, 2013

Accepted: June 10, 2013

Correspondence to:

Martin Pupiš, PhD

Matej Bel University

Faculty of Humanities (Dep. Of PE and Sport)

97404 Banská Bistrica, Tajovského 40, Slovakia

Phone: ++ 38+ 048 446 7563

E-mail: Martin.Pupis@umb.sk

COMPARISON BETWEEN AEROBIC EXERCISE AND CONSUMPTION OF GREEN TEA ON WEIGHT LOSS IN OVERWEIGHTED MEN

Sharifi Gholamreza¹, Hasanizade Reza², Ahmad Esmailzade³,
Babai Mazreno Alireza², Ibrahim Salmani Nodoushan⁴ and Nadjme Hajian⁵

¹ Department of PE and Sport Sciences, Islamic Azad University, Isfahan, Iran

² Department of Exercise Physiology, Islamic Azad University, Khorasgan, Iran

³ Department of medical science, Isfahan, Iran

⁴ Faculty of Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

⁵ Institute of Future Studies in Health, University of Medical Sciences, Kerman, Iran

Original scientific paper

Abstract

Background: Obesity and overweight are important risk factors that cause avoidable disease and death. Aerobic exercise and the metabolic mechanisms of green tea polyphenols available because it can be effective in reducing body weight. The purpose of this study compared the effects of aerobic exercise for 8 weeks and 8 weeks of green tea for weight loss, men were overweight. Methods: 82 men that are overweight has (Age: 38.91 ± 11.59 , Height: 175.08 ± 7.76 , weight: 87.4 ± 9.3 , BMI: 28.3 ± 1.05 , WHR: 1.02 ± 0.33) were randomized to two groups: aerobic exercise (12 cases) and green tea (70 cases) were divided into. 8 weeks of aerobic exercise group (three sessions per week) aerobic exercise intensity between 60 to 70 percent of maximum heart rate did and A group of green tea daily dose of 500 mg tablets of green tea was consumed. Results: The amount of BMI and WHR of the subjects was measured before and after the test. Recorded data were analyzed by paired t-test and covariance analysis. Results showed that both aerobic exercise and consumption of green tea body weight, BMI and WHR was significantly reduced ($p < 0.05$). Compared to the significant difference between aerobic and green tea consumption on body weight, BMI and WHR were observed in overweight men. Conclusion: This study showed that green tea consumption due to aerobic training can increase metabolic rate of body weight, BMI and WHR to be effective.

Keywords: aerobic exercise, green tea, overweight

Introduction

Prevalence of fatness and additional weight is increasing all around the world. Nowadays, there are more than 250 fat people all around the world that implies 7 percent of the world total adult population. Fatness and additional weight are risk factors for some diseases and metabolic disorders such as cordial and vascular diseases, blood pressure, type 2 diabetic and hyper lipid diseases. In the world, also about 300,000 people die because of fatness and its complications. Effect of fatness and additional weight on life decrease and effecting by various diseases is in extent that some life insurance companies in America take account life decrease up to two years per 2.5cm around abdomen bigger than chest around and take account one year of life decrease per each 4kg additional weight. This problem and the problems due to it have led to a progressive increase in researches in the field and quality of treatment it (Powers & Howley, 2004). Various methods are applied to prevent and/or treatment of additional weight. Using aerobic is one of these methods. In this direction, it has been indicated in a research that aerobic exercise is remarkably effective on fat metabolism of fat people with additional weight (Wolf, 2006). This indicates that fat metabolism of fat people with additional weight who were participating in aerobic increased. In a review study during 1986 to 2000 with investigation of 4 papers about 2419 adult people,

it was concluded that aerobic exercise for few times, repetition and intensity can effect on decrease in peoples' weight (Appel & Champagn, 2008). Another method is using low calorie food diet, which because of negative energy balance leads to decrease peoples weight. Although America national health institute advice limited calorie with an increase in physical exercise, most studies indicate decrease in weighing due to a low calorie diet (Cummings et al., 2002).

So, considering the performed studies can conclude that aerobic exercise and good diet are two effective methods to decrease weight. Now, various methods have been used as substituting for food diet, one of these methods is using weigh reducer industrial drugs that have been confirmed, they includes low effectiveness and undesirable complications. Various methods are applied as replacement of industrial drugs to decrease weight, one of them is using medicine plants like green tea. Green tea is consumed in various countries widely and many morphological effects have been reported for it. Green tea has been introduced as an anti inflammatory, anti oxidation, anti mutation and anti cancer (Tsuneki et al., 2004). Tablet of green tea has been studied in very few clinical researches and any one has not advised to consume in order to reduce weight absolutely (Shixian et al., 2006).

In a research, the effect of green tea on the males' weight was studied, the results indicated that the present evaluations can not support surely the role of green tea in decreasing body weight and more researches are needed (Thavanesan, 2011). In a research effect of green tea on mice's total weight with full fat diet, the results revealed that consumption of green tea decreased up to 2 percent of total weight during the 8 weeks that is was a higher rate in the experimental group in comparing with control group (Bajerska al., 2011). Since, consuming aerobic exercise and green tea is the easiest way to decrease weight in comparison with good diet and considering this matter that green tea has been investigated in very few clinical researches and any one of them has not advised to consume it in order to decrease weight, therefore it seems necessary to perform more researches to determine effectiveness rate on body weight that may have properties of weight reduction. Considering the mentioned explanations, the aim of the present study was to compare the effect of 8 week aerobic exercise and consumption of tea green on reduction of men's weight with additional weight.

Methods

Subjects

The examinations of the research include 82 men with age 18-60 with BMI between 25-30 townships of Isfahan with weight range 87.4 ± 9.3 kg and index of body mass between 28.3 ± 9.3 kg/scum that were selected intentionally, that were selected and placed in two groups of aerobic exercise (12 people) and green tea (70 people). After fulfilling the questionnaire relevant to medical history and physical activity level it was found that these persons had not any cardiac and vessel diseases, digestive disorders and also active physical exercise level. And they announced their tendency to participate in the research.

Study Design

The present study was in type of semi experimental study and contains two groups of aerobic exercise and consumption of green tea that was done via pretest and posttest for both groups. The present research is applicable, considering the time duration in cross type and using the results.

Exercise protocol

In an aerobic exercise group, the exercise program includes a 8 week aerobic exercise with intensity between 60 to 70 percent of the hearing beat as their maximum that includes three parts of the warm up (5 minutes), the main exercise program (walking for 30 to 45 minutes) and recovery (5 minutes). The control way of heart beat during exercise was in this way that by the polar digital thermometer, first the person's age was measured, then maximum heart beat was measured by formula of $\text{age} - 220$ and through that the percentage of target heart beat was obtained in every section.

The thermometers were connected to all persons one time in each several minutes sequentially. The mean time of exercise and its work intensity was increased gradually until the final week per maximum heart beat of under examination men; first and second week's activity intensity was 60-65 percentage of maximum heart beat for 30-35 minutes, then from third week until the eighth weekend, activity intensity was 65-70 percentage of maximum heart beat for 35-45 minute. The anthropometric indexes such as height, weight, BMI, WHR were measured at beginning the study (table 1).

Environmental conditions

Wet and dry bulb temperatures were taken during each trial. Wet bulb temp averaged 14.9°C and 15°C ($p=0.6273$)

Supplement

In a green tea group, the attenders consumed a tablet of green tea with dosage 500mg that contained leaf powder of green tea and 50mg caffeine with water while their stomach was empty at 10 o'clock every morning during 2 months. For each person

Statistical Analyses

Subject, aims and method of study were explained to the patients and then if they were propensity to participate in this study, conscious written testimonial was taken from them. The couplet - test was used in order to compare the data before and after study, and the covariance analysis test was used to compare the data between groups and the obtained results were analyzed via SPSS software; version 16 and the significance level were considered up to $P \leq 0.05$.

Results and discussion

The anthropometric indexes of the examinations include body weight, body mass index and WHR before and after 8 week interference have been shown in table 1. As the findings of table one indicate, 8 week aerobic exercise has effected significantly on body weight, body mass index and waist to seat ratio of men with additional weight ($P \leq 0.05$). Also, 8 week consumption of green tea tablet has effected significantly on body weight, body mass index, are waist to set of men with additional weight ($P \leq 0.05$). But, about difference between two groups of aerobic exercise and effect of consumption of green tea tablet on body weight, body mass index and waist to salt ration of men with additional weight any significant difference was not observed. The present study indicated that a 8 week aerobic exercise has effected significantly on body weight, body mass index and waist to salt ration of men with additional weight ($P \leq 0.05$). Also, 8 week consumption of green tea tablet has effected significantly on body weight, body mass index, are waist to set of men with additional weight ($P \leq 0.05$).

Table 1. The anthropometric indexes such as height, weight, BMI, WHR before and after 8 week interference

Consumption of green tea	Aerobic exercise	Group 5	
86/635± 9/517	88/400±5/327	Pre-test	Weight (kg)
85/761± 9/108	86/775±5/119	Post-test	
28/204± 1/069	28/421±1/047	Pre-test	BMI (kg/m ²)
27/935± 0/968	27/895±0/868	Post-test	
104/851±11/647	104/691±2/187	Pre-test	Waist (cm)
104/350± 2/560	103/741±1/993	Post-test	
101/810± 6/393	102/833±2/579	Pre-test	Hip (cm)
101/642± 6/350	102/433±2/325	Post-test	
1/034± 0/367	1/016±0/366	Pre-test	WHR
1/030± 0/348	1/010±0/306	Post-test	

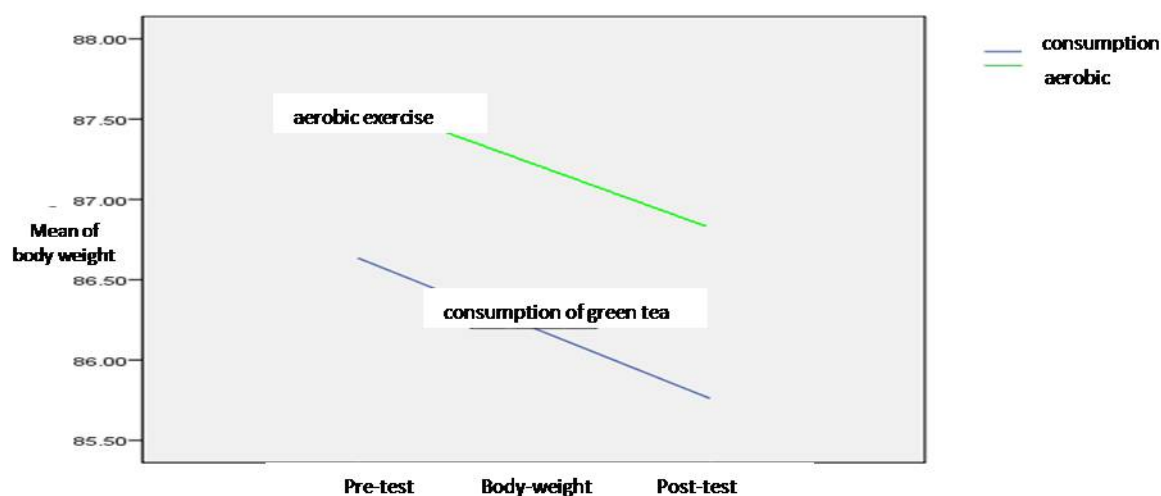


Figure 1. Difference of pre-test, post-test of aerobic exercise and effect of tablet on body weight

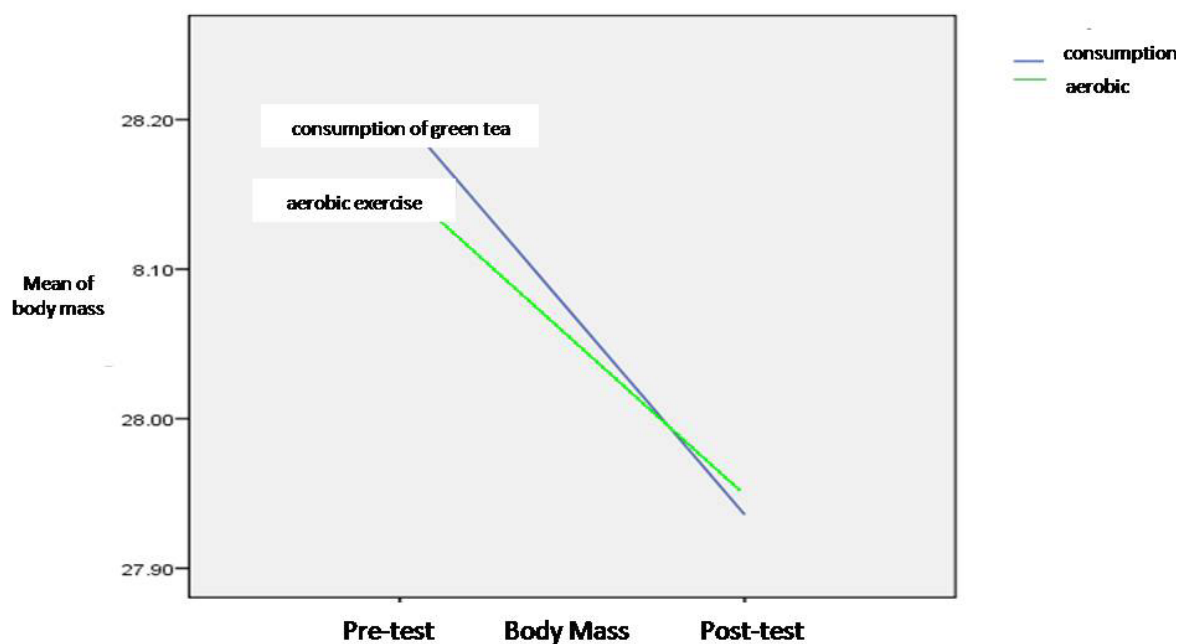


Figure 2. Difference of pre-test, post-test of aerobic exercise and effect of consumption of green tea tablet on body mass

But, about difference between two groups of aerobic exercise and effect of consumption of green tea tablet on body weight, body mass index and waist to salt ration of men with additional weight any significant difference was not observed. The results of this research are proportional to Bryant's and et al findings about the effect of aerobic exercise on body weight and body mass index and WHR of men with additional weight (Bryant et al., 2011). Investigating the results of Martin's and et al researches in which effect of aerobic exercise on the reduction of body weight was studied, it was indicated that aerobic exercise reduces body weight and MBI (Martins et al., 2010). Rakel Kali and et al investigated the costs of sport energy; effects of exercise prescription on fatness in which it was determined that aerobic exercise reduces body weight remarkably (Colley et al., 2010). Kelly and et al in their review paper concluded that it is better to do aerobic exercise with medium intensity and with 40-60% consumption of maximum energy for 30-45minutes during most days of a week that reduces body weight, BMI and WHR (Kelley et al., 2001).

Considering the above researches, it seems that aerobic exercises play an important role to reduce body weight. The metabolic mechanisms by which aerobic exercise reduces and/or keeps body weight are included: an increase in the cost of energy, increase in recalling fat through increasing activity of fat tissue, slight increase in relax metabolism after exercise, possible increase in thermogenic reaction toward food, if time of exercise is closed to time of eating food. Minimization of decrease in body net weight leads to progression of moral performance, to delay reduction of the basic metabolic rate considering feeding limitations and possibly better control of appetite (Epstein & Wing, 1980).

The results of the present research about the effect of consumption of green tea on body weight, body mass index and WHR of men with additional weight are proportional to findings of Yung Kang and et al, because after 12 weeks of aerobic exercise, body weight and also rate of blood glucose decreased significantly (Yong et al., 2010). Investigating results of Taosan's research in which effect of green tea on body fat was studied, the results indicated that present assessments can't not support surely the effect of green tea on the reduction of body weight and need more investigations (Thavanesan, 2011). This contradiction can be due to lack of consumption of green tea proper dosage, insufficient time of consumption and drinking green tea while the stomach is full, because the quotations which are poly phenol elements of green tea has the most effect on empty stomach, so the consumers of green teat should not have

digestive diseases that it is not proportional to the present research. Results of Bajreska's and et al research who studied the effect of green tea essence on total body weight of mice with full fat food diet indicated that consumption of green tea reduced significantly total body weight up to 2% and BMI was seen in the control group (Bajerska et al., 2011) that is proportional to the present research.

Considering the contradictory results of above mentioned researches, it seems that cations which are poly phenol elements of green tea make tea to produce heat via controlling the destruction of epinephrine light, this effect of quotations increases oxidation in mitochondria and reduce simultaneous production of ATP and heat is produced by this way that the final rate of metabolism is increased and it leads to decrease body weight, BMI and WHR. For possibly any research was not done about the comparison between two methods of aerobic exercise and consumption of green tea on body weight, BMI and WHR in men with additional weight, and considering the obtained findings from present research, there is not any significant difference between both methods of aerobic exercise and consumption of green tea tablet on weight and body mass index and WHR in the men with additional weight, thus its possible reasons are as the following: 1) Both methods lead to increase in the rate of body metabolism and subsequently increase in the cost of energy; 2) Both methods produce heat. Considering the above common cases, we can conclude that effect mechanism of both methods for reduction of weight is slightly similar to each other and finally considering daily duration of consumption of green tea tablet, comparing to perform aerobic exercise which is done three sections during a week, we can conclude that effect of aerobic exercise is more effective on men's weight than consumption of green tea. Therefore, contrary to wrong consumption of some people about consumption of green tea tablet as an independent therapeutic way to decrease peoples' weight, the findings of this research revealed well that consumption of green tea tablet can have few effects on peoples' weight in comparison to aerobic exercise.

Conclusion

This study indicated that both methods of aerobic exercise and consumption of green tea can effect on body weight, body mass index and WHR because of an increase in the rate of body metabolism. Thus , there is not any significant difference between effect of both methods of aerobic exercise and consumption of green tea tablet on body weight, body mass index and WHR in men with additional weight.

References

- Appel, D., Champagne, M., et al. (2008). Effects of comprehensive lifestyle modification on blood pressure control. *JAMA*, 289, 83-93.
- Bajerska, J., Wozniwicz, M., Jeszka, J., et al. (2011). Green tea aqueous extract reduces visceral fat and decreases protein availability in rats fed with a high-fat diet. *Nutrition Research*, 10, 157-164.
- Bryant, E., Caudwell, P., Hopkins, M., et al. (2011). Psycho-markers of weight loss. The roles of TFEQ Disinhibition and Restraint in exercise-induced weight management. *Appetite*, 10, 1-8.
- Colley, R., Hills, A., King, N., et al. (2010). Exercise-induced energy expenditure: Implications for exercise prescription and obesity. *Patient Education and Counseling*, 79, 327-332.
- Cummings, S., Parham, E.S., & Strain, G.W. (2002). Position of the American dietetic association: Weight management. *J Am Diet Assoc*, 102, 1145-1155.
- Epstein, L.H., & Wing, R.R. (1980). Aerobic exercise and weight. *AddictBehave*, 5, 371-388.
- Kelley, G.A., & Sharpe-Kelley, K. (2001). Aerobic exercise and resting blood pressure in older adults: a meta analytic review of randomized controlled trials. *J Gerontol A Biol Sci Med Sci*, 56, 298-303.
- Martins, C., Kulseng, B., King, N., et al. (2010). The effects of exercise-induced weight loss on appetite-related peptides and motivation to eat. *Endocrine care*, 95, 1609-1616.
- Powers, S.K., & Howley, E.T. (2004). *Exercise physiology: Theory and application to fitness and performance*. Boston Hill: MC Graw.
- Shixian, Q., VanCrey, B., Shi, J., Kakuda, Y., & Jiang, Y. (2006). Green tea extract thermogenesis-induced weight loss by epigallocatechin gallate inhibition of catechol-O-methyltransf. *J. MED. Food*, 9, 451-458.
- Thavanesan, N. (2011). The putative effects of green tea on body fat: an evaluation of the evidence and a review of the potential mechanisms. *British Journal of Nutrition*, 106, 1297-1309.
- Tsuneki, H., Ishizuka, M., Terasawa, M., Wu, J.B., Sasaoka, T., & Kimura, I. (2004). Effect of green tea on blood glucose levels and serum proteomic patterns in diabetic (deb/deb) mice and on glucose metabolism in healthy humans. *BMC Pharmacol*, 4, 18.
- Yong-Kang, M., Park, Y., Kim, B., et al. (2012). Preventive Effects of Green Tea (*Camellia Sinensis* var. *Assamica*) on *Diabetic Nephropathy*. *Yonsei MED Journal*, 53, 138-144.
- Wolf, L.D. (2006). The effects of exercise training and dietary supplementation on fat metabolism and body composition in obese women. *British Journal of Nutrition*, 19, 133-141.

USPOREDBA AEROBNE TJELOVJEŽBE I KONZUMIRANJA ZELENOG ČAJA NA GUBITAK TEŽINE KOD PRETILIH MUŠKARACA

Sažetak

Pozadina: Pretilost i prekomjerna tjelesna težina su važni čimbenici rizika koji uzrokuju bolest. Aerobne vježbe i metabolički mehanizmi polifenola zelenog čaja mogu biti na raspolaganju, jer to može biti učinkovito u smanjenju težine. **Svrha** ove studije je usporediti učinke vježbanja i uzimanja zelenog čaja kroz 8 tjedana. **Metode:** Uzorak je sastavljen od 82 ljudi s prekomjernom težinom (Dob: 38.91 ± 11.59 , Visina: 175.08 ± 7.76 , težina: 87.4 ± 9.3 , BMI: 28.3 ± 1.05 , WHR: 1.02 ± 0.33) i podijeljen u dvije skupine: aerobno vježbanje ($n=12$) i zeleni čaj ($n=70$). Vježbalo se tri treninga tjedno aerobne vježbe intenziteta 60-70 % max otkućaja srca. Druga skupina uzimala je dnevnu dozu od 500 mg tablete zelenog čaja. Rezultati su analizirani su parnim t-testom i analizom kovarijance, i pokazali su da su i kroz aerobne vježbe i konzumacijom zelenog čaja, masa, BMI i WHR znatno smanjeni ($p < 0.05$). Značajne razlike između vježbi i pijenja zelenog čaja na masu, BMI i WHR zabilježene su. **Zaključak:** Ovo istraživanje pokazalo je da pijenje zelenog čaja može povećati metabolizam tjelesne mase, BMI i WHR, i biti učinkovito.

Gljučne riječi: aerobno vježbanje, zeleni čaj, pretilost

Received: January 19, 2013

Accepted: June 10, 2013

Correspondence to:

Hasanizade Reza

Khorasgan Azad University

Department of Exercise Physiology

Khorasgan, Iran

Phone: 0311-5354135

E-mail: reza.hassanizadeh@yahoo.com

Authors' observation

Moreover, contrary to researcher's strict advices about conditions and correct and on time consumption of green tea it was impossible to fully control this variable and also the research was not done in completely experimental conditions, thus it was impossible to full control of feeding in participating men and this can effect on the obtained results. So, it is suggested that to perform a research in fully experimental conditions and full control of food diet

INTERHEMISPHERIC TRANSFER OF TRAINING IN RIGHT-HANDED SUBJECTS

Arta Dodaj¹, Anita Dodaj² and Mladenka Vukojević³

¹ Faculty of Philosophy, University of Mostar, Bosnia and Herzegovina

² Federalno ministarstvo unutrašnjih poslova, Mostar, Bosnia and Herzegovina

³ Faculty of Medicine, Mostar, Bosnia and Herzegovina

Original scientific paper

Abstract

The aim of this study was to examine the role of hemispheric (non)dominance on transfer of training in right-handed participants. The study was conducted on a sample of 20 right-handed female students from University of Mostar. Hand dominance was determined using the Annett Hand Preference Questionnaire. The participant's task was to execute skilled arm movements of different amplitudes with their right and then left hand, or with the left and then right hand. The tasks were carried out without visual control. Analysis of results showed that right-handed participants achieve shorter movement time of left hand movements, performed after the training of right hand movements, in comparison to the movement time when the left hand was the first in sequence. The result of this study confirm interhemispheric transfer of training in right handed only in one direction- from right to the left hand.

Keywords: *interhemispheric communication, cerebral lateralization, hand dominance*

Introduction

The brain contains two hemispheres associated with three commissures: corpus callosum, anterior and hippocampal commissure. Although the left and right hemispheres of the brain are very similar in appearance, they differ significantly in their functions. As for the spatial functions, previous studies have not given unambiguous results because some results suggest the important role of the left hemisphere for these functions, and some of them report of the important role of the right hemisphere. However, most of research literature suggests that the center of the movement performance (motor control) in most (right-handed) is located in the left hemisphere, and that is in left-handed probably somewhat divided into two hemisphere, where in the right hemisphere location coincides with spatial factor. Since the left and right hemispheres of the brain are associated with the commissure, then information can be transmitted through the commissural fiber from one hemisphere to another. Corpus callosum is the largest and most important structure in the transfer of information between the hemispheres. Today, most studies emphasize that it is the communication that takes place through a series of channels that are synchronized in time (Banich, 2003). All communication channels are characterized by a certain amount of autonomy and relative specialization, and can be distinguished by the type of information, the speed with which they spread and accuracy of transferred information. Researches on interhemispheric transfer of motor skills are not completely unambiguous. Some studies have found that the transfer is asymmetrical, that can only happen from the dominant hand to the non-dominant hand (Gordon, Forssberg & Iwasaki, 1994; Halsband, 1992; Laszlo, Baguley & Bairstow, 1970, Parlow & Kinsbourne, 1989), or from the non-dominant

hand to the dominant hand (Hicks, 1974; Parlow & Kinsbourne, 1990; Taylor & Heilman, 1980), i.e. only in one direction. Also, some researchers have rejected the possibility of interhemispheric transfer and given the reason that activation of one hemisphere due to the performance of a task prevents the function of the opposite hemisphere to perform the same type of task (Baizer, Kralj-Hans & Glickstein, 1999; Kitazawa, Kimura & Uka, 1997; Thut et al., 1997). However, there must be taken into account that different results are probably due to the use of different kinds of tasks and different methodological approaches. Interhemispheric interactions across the corpus callosum suggest that the performance and movement control of the both hands is carried out within the dominant (left) hemisphere. Therefore, in the dominant, right hand information about movement execution comes directly, while the left hand receives the information from the right hemisphere "indirectly" through corpus callosum. Based on this, we can expect transfer in both directions, from the dominant to the non-dominant hand and vice versa. However, because of cerebral lateralization it can be expected that the interhemispheric transfer of exercises will be different during the training with the dominant hand, and then with the non-dominant hand, and vice versa. The aim of this study was to determine the role of hemispheric (non) dominance in the transfer of training on right-handed.

Methods and participants

The study included 25 female students from the Faculty of Philosophy at the University of Mostar. To determine the number of trials required to learn the movements of different amplitudes there was conducted a testing which included five right-handed subjects.

These subjects had not participated in the main study. It was determined that participants needed 20 trials to learn a given movement, and this number of trials was taken in main study as a criterion of training so it was equal i.e. same for all the subjects. The main study included twenty right-handed subjects, selected from a larger group of participants on the basis of results achieved in the adapted Annett's questionnaire of hand dominance (Annett, 1998). Subjects were divided into two subgroups of ten subjects: 1) group of right-handed, which was first trained in performing arm movement with the right hand, and then performed previously trained movement with the left hand; 2) group of right-handed, which was first trained in performing arm movement with the left hand, and then performed previously trained movement with the right hand. Adapted questionnaire of the hand dominance consists of nine items, which are related to everyday activities, and subject's task was to respond with which hand they perform those activities (left or right). Tasks that are used in the study consisted of performing skilled movements with the right and left hand without visual control. The movements differed in amplitudes, which were 20, 40, 60 and 80 degrees, and were examined with computerized kinaesthetic system for testing simultaneous and individual movements of the right and left hand. The kinaesthesiometer consists of a platform and the base with a semicircular scale marked in degrees from zero to 100. The platform was designed for putting on the lower arm of the subject, which could be rotated on a small wheel, around a pivot, in a semicircular way. Red colored circle on computer served as signal for putting lower arm on a kinaesthesiometer, while green circle served as a signal for the start of movement execution. The signal also initiated two chronometers, which were connected in the circuit with two microswitches. One of the microswitches was activated by the subject at the start of the movement, and the other by the subject at the completion of the movement. Upon perceiving the green signal, subject started the movement, which stopped one of the two chronometers. When the subject thought that he completed the given movement, he pressed the second microswitch in his hand, which stopped the other chronometer. The time between green signal and the start of the movement (the first chronometer) was taken as decision-making time, while the time between the green signal and the completion of the movement (the second chronometer) was taken as the total movement time. The movement time represented the difference between total movement time and decision-making time. The movement precision was defined as the deviation of the pointer from the target number at the completion of the movement. The total movement time (ms), movement time (ms), decision-making time (ms) and deviation from the target (degrees) were recorded for each trial. Data are presented as arithmetic mean with standard deviation. Distribution of the results is normal.

Analysis of variance was used to test differences between different groups and different kinds of movements. Statistical analysis was performed in the statistical program Statistica 7.0 (StatSoft, Inc., Tulsa, OK, USA).

Results

In order to determine whether there is an interhemispheric transfer of training in a group of right-handed subjects who first performed the task with dominant hand, and then with non-dominant hand and in group of right-handed subjects who first performed the task with non-dominant hand and then with dominant hand a two-way analysis of variance with repeated measurements was conducted. There was a significant difference in the total movement time in both of these groups, group of right-handed who trained the task first with dominant hand ($F=35,13$; $df=1/4$; $p<0,01$) and group of right-handed who trained the task first with nondominant hand ($F=22,46$; $df=1/4$; $p<0,01$).

Specifically, in Figure 1 it can be seen that the total movement time was shorter for the left hand when the subjects previously trained the task with their right hand. Also, Figure 2 shows that the total movement time is shorter for right hand when the subjects previously trained the task with his left hand. However, to be able to argue conclusively about the transfer of training from one arm to another, we compared a group of right-handed while taking into account if the training sequence was performed with dominant or nondominant hand. The analysis of the results of the group of right-handed who first trained the task with the dominant hand and the group of right-handed who trained the task with dominant hand, but after training the task with non-dominant hand shows that there was no significant difference in total movement time (Figure 3) ($F=0,54$; $df=1/4$; $p>0,05$). However, the analysis of results of the group of right-handed who first trained the task with the non-dominant hand and the group of right-handed who trained the task with non-dominant hand, but after training with dominant hand found a significant difference in total movement time ($F=189,49$; $df=1/4$; $p<0,01$). The time of movement execution was shorter in a situation when a subject performed the task with non dominant hand, after training the task with dominant hand first, i.e. from right to the left hand (Figure 4). So, on the basis of these results it seems that the transfer of training appears in right-handed only from the dominant hand to the non-dominant hand, or from right to left hand. There were also significant effects of the amplitude of movement on a total movement time. These were found in the situation of movement training with the dominant hand first in sequence training ($F=28,42$; $df=3/12$; $p<0,01$), and in the situation of movements training with the dominant hand, but after training with the non-dominant hand on a total movement time ($F=39,59$; $df=3/12$; $p<0,01$) (Figure 3 and 4).

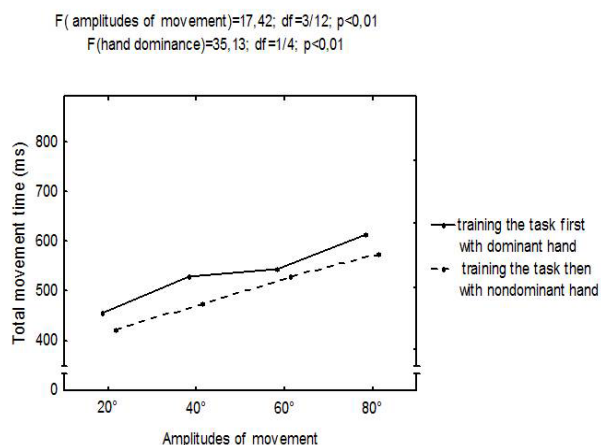


Figure 1. Effects of movement amplitudes on total movement time in a group of right handed who trained the task first with dominant, and then with nondominant hand

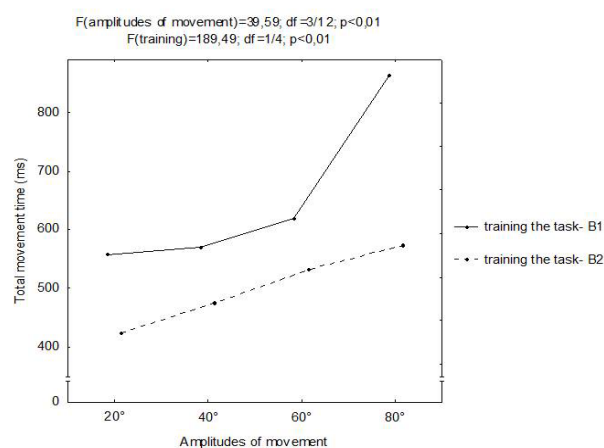


Figure 4. Effects of movement amplitudes and training task with nondominant hand on total movement time in a group of right handed

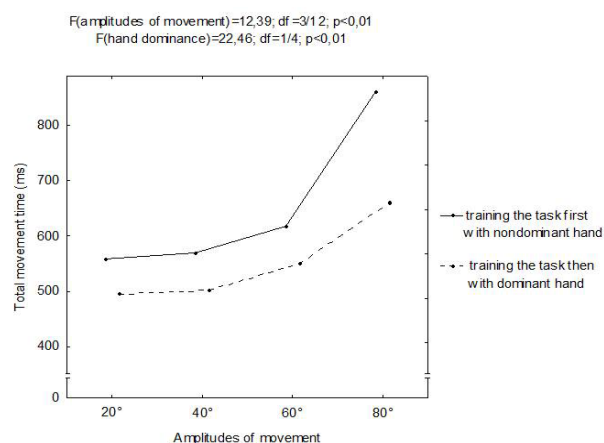


Figure 2. Effects of movement amplitudes on total movement time in a group of right handed who trained the task first with nondominant, and then with dominant hand

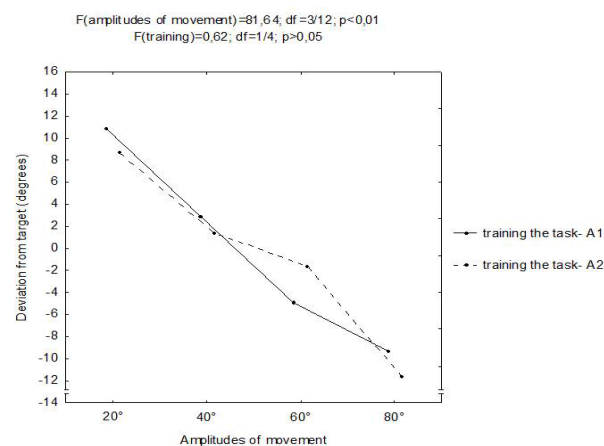


Figure 5. Effects of movement amplitudes and training task with dominant hand on deviation from target in a group of right handed

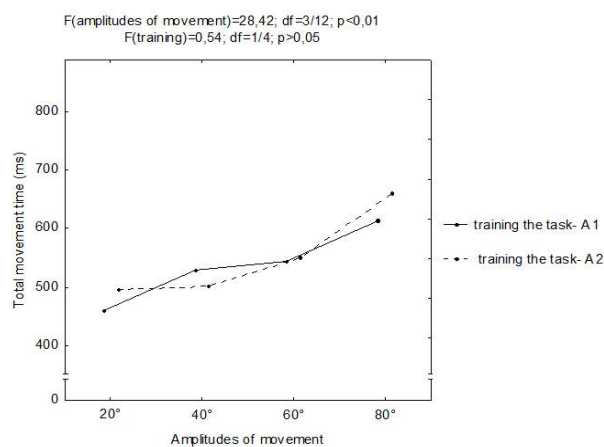


Figure 3. Effects of movement amplitudes and training task with dominant hand on total movement time in a group of right handed

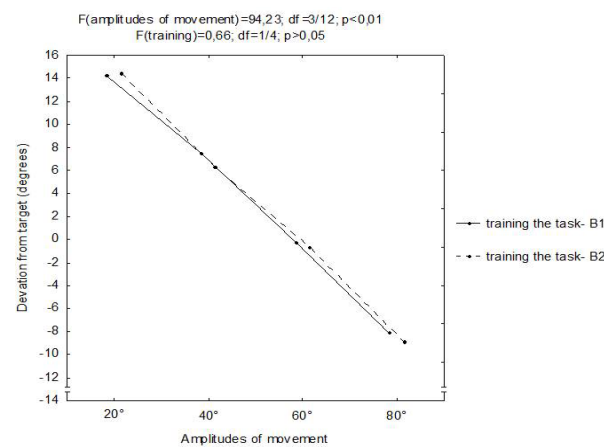


Figure 6. Effects of movement amplitudes and training task with nondominant hand on deviation from target in a group of right handed

Besides the time parameters, both groups of right-handed subjects were also compared considering their deviation from target. There were significant effects of movement amplitudes on error magnitude found for first group ($F=81,64$; $df=3/12$; $p<0,01$) and second group of right-handed ($F=94,23$; $df=3/12$; $p<0,01$). There was also found that in a situation of training movement first with one hand, and then with opposite hand there is tendency of overestimating smaller amplitude and underestimating larger amplitude (Figure 5 and 6).

Discussion

The result of this study showed that interhemispheric transfer of training in right handed exists only from right to left hand. Transfer of training from left to the right hemisphere or from right to left hand can be attributed to the superiority of the left hemisphere in the control of contralateral and ipsilateral movements in a comparison of the right hemisphere which controls only the contralateral movements (Haaland & Harrington, 1996; Kim et al., 1993). In accordance with this is the fact that those who suffered injuries of the left hemisphere have more difficulties in the reproduction of left or right hand movement compared to right hemisphere injuries, which cause difficulties only

in right hand movements (Kimura & Archibald, 1974). Movement amplitude had a significant impact on the total movement time in right-handed. Specifically, movement time increased with amplitude of movement increasing, which is logical considering that larger amplitude means also a greater distance. Thus, larger amplitude movements are more complex tasks, and induce a greater amount of kinesthetic information and their processing needs more time, which is then reflected in the total movement time. Besides the time parameters, right-handed subjects were compared considering to deviations from the target. In both groups there was a tendency for overestimating smaller amplitudes and underestimating larger amplitudes. Hollingworth (Hollingworth, 1910) called this tendency of overestimating smaller size and underestimating larger size the "central tendency error".

Conclusion

It can be concluded that the results of this study showed that there is a one-way transfer of training. However, it should be noted that in further studies is necessary to test the differences between right and left-handed subjects, as well as to equalize groups on the parameters of efficiency, since the existence of differences between groups can affect the results.

References

- Anett, M. (1998). The stability of handedness. In K. J. Connolly (Eds.), *The psychobiology of the hand*. London: MacKeith Press.
- Baizer, J. S., Kralj-Hans, I., & Glickstein, M. (1999). Cerebellar lesions and prism adaptation in macaque monkeys. *Journal of Neurophysiology*, 81, 1960–1965.
- Banich, M.T. (2003). Interaction between the hemispheres and its implications for the processing capacity of the brain. In K. Hugdahl & R. J. Davidson (Eds.), *The asymmetrical brain*. Cambridge: MIT Press.
- Gordon, A.M., Forssberg, H., & Iwasaki, N. (1994). Formation and lateralization of internal representations underlying motor command during precision grip. *Neuropsychologia*, 32, 555–568.
- Haaland, K.Y., & Harrington, D.L. (1996). Hemispheric asymmetry of movement. *Current Opinion in Neurobiology*, 6, 796–800.
- Halsband, U. (1992). Left hemisphere preponderance in trajectorial learning. *NeuroReport*, 3, 397–400.
- Hicks, R.E. (1974). Asymmetry of bilateral transfer. *American Journal of Psychology*, 87, 667–674.
- Hollingworth, H. L. (1910). The Central Tendency of Judgment. *Journal of Philosophy, Psychology and Scientific Methods*, 17, 461–469.
- Kim, S.G., Ashe, J., Hendrich, K., Ellermann, J.M., Merkle, H., Uğurbil, K., & Georgopoulos, A.P. (1993). Functional magnetic resonance imaging of motor cortex: hemispheric asymmetry and handedness. *Science*, 261, 615–617.
- Kimura, D., & Archibald, Y. (1974). Motor functions of the left hemisphere. *Brain*, 97, 337–350.
- Kitazawa, S., Kimura, T., & Uka, T. (1997). Prism adaptation of reaching movements: specificity for the velocity of reaching. *Journal of Neuroscience*, 17, 1481–1492.
- Laszlo, J.I., Baguley, R.A., & Bairstow, P.J. (1970). Bilateral transfer in tapping skill in the absence of peripheral information. *Journal Motor Behavior*, 2, 261–271.
- Parlow, S.E., & Kinsbourne, M. (1989). Asymmetrical transfer of training between hands: implications for interhemispheric communication in normal brain. *Brain and Cognition*, 11, 98–113.
- Parlow, S.E., & Kinsbourne, M. (1990). Asymmetrical transfer of braille acquisition between hands. *Brain and Language*, 39, 319–330.
- Taylor, H.G., & Heilman, K.M. (1980). Left-hemisphere motor dominance in right-handers. *Cortex*, 16, 587–603.
- Thut, G., Halsband, U., Roelcke, U., Nienhusmeier, M., Missimer, J., Maguire, R.P., Regard, M., Landis, T., & Leenders, K.L. (1997). Intermanual transfer of training: blood flow correlates in the human brain. *Behavioural Brain Research*, 89, 129–134.

MEĐUHEMISFERNI TRANSFER TRENINGA KOD DESNORUKIH SUBJEKATA**Sažetak**

Cilj istraživanja bio je utvrditi ulogu hemisferne (ne)dominantnosti u transferu vježbe kod dešnjaka. Istraživanje je provedeno na 20 dešnjakinja studentica Filozofskog fakulteta u Mostaru. Dominantnost ruke je utvrđena Annetovim upitnikom dominantnosti ruke. Zadatak ispitanika bio je izvoditi uvježbane pokrete podlakticom, lijeve i desne ruke, na kinesteziometru bez vidne kontrole. Ispitanici su trebali što brže i što točnije izvoditi pokrete čije su amplitude iznosile 20, 40, 60 i 80 stupnjeva. Obradom rezultata dobiveno je vrijeme izvođenja zadatka kraće za lijevu ruku kad je ispitanik prethodno uvježbavao zadatak desnom rukom u odnosu na skupinu koja je zadatak prvo uvježbavala lijevom pa potom desnom rukom. Dobiveni rezultati potvrđuju interhemisferni transfer samo u jednom smjeru, s desne na lijevu ruku.

Ključne riječi: *interhemisferna komunikacija, cerebralna lateralizacija, dominantna ruka*

Received: May 3, 2013

Accepted: June 10, 2013

Correspondence to:

Arta Dodaj

University of Mostar

*Department of Psychology, Faculty of Philosophy,
88000 Mostar Matice hrvatske bb, Bosnia & Herzegovina*

Phone: 00 387 63 705 618

E-mail: artadodaj@gmail.com

THE APPLICATION OF PSYCHOLOGICAL SKILLS INVENTORY FOR SPORTS AT CROATIAN COACHES AND RECREATIONAL TABLE TENNIS PLAYERS

Joško Sindik, Natalija Novokmet and Dubravka Havaš-Auguštin

Institute for Anthropological Research, Zagreb, Croatia

Original scientific paper

Abstract

The main goal of this study was to reveal the basic psychometric properties of the imported Dutch Youth Version of the Psychological Skills Inventory for Sports (PSIS–Youth), applied on Croatian samples of athletes, to establish the relationship among different psychological skills, to find the differences in psychological skills between trainers and recreational table tennis players, as well as according to the education level. Finally, we tried to predict the satisfaction with life with set of psychological skills. We have examined a total of 86 coaches of various sports in Croatia during the seminar for coaches in Croatian Olympic Academy and 86 recreational table tennis players that play in SOKAZ. The research revealed the existence of six latent dimensions of the Croatian adaptation of the PSIS–Youth (PSIS–Youth Cro). Relatively coherent set of psychological skills may reflect successful athlete. The coaches are better than table tennis players in anxiety control/ confidence, mental preparation and motivation, while recreational table tennis players are better in concentration. No statistically significant differences are found according to the education level of participants. We can successfully predict the satisfaction with life of the participants, by six psychological skills in PSIS–Youth Cro. The anxiety control/ confidence is the best and significant predictor of the satisfaction with life. PSIS–Youth Cro has to be tested on more representative samples of Croatian athletes in the future.

Keywords: athletes, factor structure, psychological skills, satisfaction with life

Introduction

A competitive mindset is advantageous to successfully compete in sports (Gould & Udry, 1994; Morgan, 1984; Orlick & Partington, 1988). Research has already supported an association between psychological skills and sports performance in general (Morgan & Pollock, 1977; Morgan 1979; May et al., 1985). In an attempt to differentiate between successful and unsuccessful competitors (to distinguish between skill position, or gender, to ascertain the effects of training, or to develop a model of the psychological profile necessary for optimal performance, attention is given toward psychological skills relevant to competition (Mahoney, Gabriel & Perkins, 1987; Meyers, LeUnes & Bourgeois, 1996; Pursley, Arredondo, Barzdukas & Troup, 1990). Mahoney, Gabriel & Perkins (1987) developed an instrument that assessed a broad range of psychological skills possessed by athletes and is sport specific. The PSIS-R5 assesses mental skill characteristics relevant to exceptional athletic performance (Cox, Liu & Qiu, 1996). Many studies use the other version of PSIS-R5 to differentiate between the mental skills in various levels of sport, from the recreational to elite level athletes (Cox & Davis, 1992; Cox, Liu & Qiu, 1996, Meyers, LeUnes & Bourgeois, 1996, Trafton, Meyers & Skelly, 1997; Ebben & Gagnon, 2012). Compared to non-elite athletes, elite athletes were more motivated to do well in their sport, more self-confident, experienced fewer problems with anxiety. Elite athletes are more internally referenced and do more on kinesthetic mental preparations. They were more focused on their own performance than that of their team and were more successful at

deploying their concentration (Mahoney et al., 1987; Mahoney, 1989). Grossarth-Maticek et al. (1990) described the importance of psychological factors as determinants of success in football and boxing. Meyers et al. (1996) reported better scores for elite rodeo athletes than non-elite ones on motivation, confidence, anxiety control and concentration, whereas in a study on Chinese track and field athletes, Cox et al. (1996) found elite athletes outscoring collegiate level athletes on confidence and anxiety control. It is not self-evident that the relation between psychological skills and performance level is similar, depending of gender and type of sport (Elferink-Gemser, Visscher & Lemmink, 2008). But the differences exist in psychological skills between individual and team sports (Mahoney et al., 1987; Cox and Liu, 1993) and between the genders (White, 1993; MacIntyre et al., 1998). Elferink-Gemser, Visscher & Lemmink (2008) and Elferink-Gemser & Visscher (2006) applied the Dutch Youth Version of the Psychological Skills Inventory for Sports with scales for motivation, confidence, anxiety control, mental preparation, team emphasis, and concentration. They found that psychological skills distinguished between more and less successful talented athletes, especially in females. In general, psychological profiles differed between males and females and between team sport athletes and individual sport athletes. However, for discrimination of elite and sub-elite youth athletes, motivation and mental preparation were useful indicators that are independent of gender and type of sport. Orlick & Partington (1988) found that among physical, technical and mental

characteristics, mental readiness provided the only statistically significant link with final Olympic ranking of Canadian Olympians. Meyers et al. (1994) found no differences in psychological skills between top-ranked, middle-ranked and bottom-ranked female world-ranked tennis players. This study concentrates on former athletes (trainers) and recreational table tennis players that were compared on psychological skills. The main goal of this study was to reveal the basic psychometric properties of the imported Dutch Youth Version of the Psychological Skills Inventory for Sports (PSIS-Youth), applied on Croatian samples of athletes. Namely, in spite of the fact that Dutch questionnaire is mainly addressed to young talented athletes, it has universal meaning. PSIS-Youth is founded on the theoretic and metric base of the PSIS R-5 (Mahoney, Gabriel, & Perkins, 1987). The other goals are: to establish the relationship among different psychological skills, to find the differences in psychological skills between coaches and recreational table tennis players, as well as to find differences in psychological skills between lower and higher educated participants. Finally, we tried to predict satisfaction with life by psychological skills.

Methods

Participants

We have examined a total of 86 coaches of various sports in Croatia during the seminar for coaches in Croatian Olympic Academy and 86 recreational table tennis players that play in SOKAZ (acronym for the Table Tennis Organization of Clubs and Actives in Zagreb, in Croat). Recreational table tennis players were examined using online survey (Survey Monkey), presented on the web: www.sokaz.hr, during the summer 2012. The average age of participants was 37 years (range 17-72 years). By gender, 135 participants were men and 37 women. In relation to their education level, 107 participants had high school education or college, while 65 participants were university graduates or had masters or doctoral degree. In terms of marital status in a sample, 74 participants were unmarried, 87 were married, while 10 were divorced. We have collected few more data about coaches. Coaches had 15 years coaching experience at average (with a range 0-45 years). On average, the coaches were more than 13 years involved in sport at the top level (range 0-52 years), while an average of 20 years engaged in the professional sports (range 0-46 years). As a coach, on average, coaches work seven years (range 0-50 years). In relation to the type of sport, the distribution of coaches was: Tae Kwon Do (n=19), riding (n=16), swimming (n=15), handball (n=12), gymnastics (n=11), mountaineering, mountain guide, football, rowing, diving, karate, jumping into the water (each n=1). After finishing sport career, 44 coaches worked as a coach in sports that are practiced at the level of athlete (the others were not involved in sport at top level). During their sport career, 47 coaches have

medals from state championships. Also, 13 coaches thought that a good coach can be the one who has not completed the appropriate coaching school, 43 thought that it only partially, 30 believe that a good coach must complete coaching education. Only a small number of trainers, i.e. 14 were members of the national cadet team, 6 of the national junior team and 12 of the national senior team. Coaches who have their own child (39 coaches have no children) are intended to include it in this sport when the time comes for 27 coaches, while only 21 do not want. Only 8 coaches thought that the senior professional athletes have to stop play competitive sports if they do not win a medal, at least at the national championships. The reasons why they stopped the career in the professional sport were: voluntary ('saturation', age) (n=23), sports injury or illness (n=40), disagreement with the club (n=17), disagreement with their coaches (n=8), critical life events (e.g. marriage, child birth, relocation, employment, etc.) (n=11), greater ambitions than the possibility of the club (n=21).

Instruments

The Psychological Skills Inventory for Sports (PSIS-R-5) consists of 5-point Likert type items, which are distributed over 6 scales (Mahoney, Gabriel & Perkins, 1987). The PSIS-R-5 has been translated into Dutch and subjected to psychometric testing (Bakker, 1995; Companjen and Bakker, 2003). The Dutch Youth Version of the Psychological Skills Inventory for Sports (PSIS-Youth) is based upon the Dutch version of the PSIS-R-5, but the formulation of questions is simpler. It contains 44 five-point Likert type items, distributed over the same 6 scales as the PSIS-R-5: Motivation (8 items), Confidence (8 items), Anxiety Control (8 items), Mental Preparation (6 items), Team Emphasis (7 items) and Concentration (7 items) (see Appendix 6.1). Correlations between scales did not exceed 0.42, supporting the PSIS-Youth as a measure of six relatively independent constructs. Internal consistency estimates for each scale were acceptably high, ranging from 0.68 on the Team Emphasis scale to 0.81 on the Confidence scale. Apart from the Team Emphasis scale, Cronbach's alpha was above the minimum level recommended for research purposes and these internal consistency estimates are in line with other studies using the PSIS-R-5 (Elferink-Gemser, Visscher & Lemmink, 2008). Pavot & Diener (1993) review evidence on the Satisfaction With Life Scale, using the 1 - 7 scale, with high internal consistency ($\alpha = 0.79$). Total score on the scale is the sum of the results of all five variables and indicates the degree of life satisfaction with higher scores indicate greater satisfaction. Sindik & Andrijašević (2012) extended the original Satisfaction With Life Scale (SWL), with additional 12 items and got three dimensions of the Extended Satisfaction With Life Scale (ESWL): *Business and social life* (8 items, $\alpha=0.86$), *Fitness* (4 items, $\alpha=0.76$) and *Life achievement* (5 items, $\alpha=0.74$).

Table 1- Factor analysis (Principal Axis Factoring, Promax rotation with Kaiser Normalization) of the PSIS–Youth on the Croatian samples of coaches and table tennis players

Items	Factors – saturation with certain variables						C	M	σ
	F1	F2	F3	F4	F5	F6			
I spend a lot of energy trying to stay calm before a meet. (AC)	,764				,404		,597	2,064	1,104
I am often panic-struck during those last few moments before I begin my performance. (AC)	,743				,433		,574	2,110	1,152
Before a meet, I worry if I will do well. (AC)	,735						,574	2,587	1,070
I get nervous, because I want to start performing. (AC)	,733						,571	2,337	1,120
The period right before a performance feels unpleasant. (AC)	,725				,465		,590	1,849	1,026
I am anxious to perform in strange places. (AC)	,717						,610	1,977	1,103
Before important meets, I feel intense anxiety. (AC)	,694	,405		,426			,569	2,413	1,164
A minor injury or a bad practice can really shake my self-confidence.(C)	,635		,409		,490		,513	2,052	1,039
When I begin to perform poorly, my confidence drops very quickly. (C)	,625				,518		,528	2,192	1,028
I have frequent doubts about my athletic ability. (C)	,589				,524		,529	2,093	1,056
It doesn't take much to shake my self-confidence. (C)	,575						,415	2,186	0,997
I am more tensed before I perform than I am during the performance. (AC)	,553						,434	3,395	1,255
My self-confidence jumps all over the place. (C)	,521				,518		,398	2,302	1,150
When I am preparing to perform, I try to imagine what it will feel like in my muscles. (MP)		,806					,679	1,919	1,202
When I mentally practice my performance, I "see" myself performing- just like I was watching a videotape. (MP)		,796					,646	2,477	1,395
When I close my eyes, I can imagine what my muscles feel like. (MP)		,790					,649	1,820	1,163
I often "rehearse" my performance in my head before I perform. (MP)		,736					,592	2,947	1,369
I prepare for a meet by making mental representations of my performance. (MP)		,702					,534	2,401	1,278
I often dream about competition. (MP)		,634	,510				,512	2,099	1,255
I want to train hard to belong to the top in my sport. (M)			,870				,779	2,738	1,485
My sport is my whole life. (M)			,802				,667	2,337	1,390
Right now, the most important thing in my life is to do well in my sport. (M)			,754				,595	2,512	1,457
I want to succeed in my sport. (M)		,470	,736			,406	,629	3,645	1,396
When my team loses, I feel badly – no matter how well I did as an individual. (TE)				,792			,639	3,372	1,280
If my teammates don't exert themselves to the utmost, I get angry. (TE)				,771			,617	3,145	1,388
I think the performance of the team is more important than my individual performance. (TE)				,747			,626	3,651	1,465
I think team spirit is very important. (TE)				,707	,461		,606	4,169	1,364
If I decline the performance level of the team, I have to be replaced. (TE)				,631			,456	3,081	1,565
I get very frustrated when a teammate is performing poorly. (TE)		,419		,551			,404	2,349	1,177
I often have trouble concentrating during my performance.(CO)	,493				,762		,621	2,035	1,014
During my performance, I am incommoded by comments of people surrounding me. (CO)	,437				,667		,471	2,174	1,211
When I am performing poorly, I tend to lose my concentration. (CO)	,440			,528	,665		,569	2,622	1,267
I can concentrate better on a difficult meet than on an easy one. (CO)	,512				,648		,499	1,977	1,054
At the beginning of my performance, I have trouble forgetting things I was doing before. (CO)					,615		,456	2,308	1,235
I experience frequent "hot streaks" in which my performance is unusually good. (CO)				,438	,491		,400	2,041	1,056
I have faith in myself. (C)						,772	,612	4,064	1,114
In most competitions, I go in confident that I will do well. (C)						,694	,514	3,523	1,095
I can usually remain confident even through one of my poorer performances. (C)						,676	,535	3,331	1,165
I am very motivated to do well in my sport. (M)			,534			,605	,567	3,948	1,083
In my sport, I want to bring out the best in myself. (M)			,552			,580	,537	4,134	1,185
Winning is very important to me. (M)			,413			,490	,346	3,576	1,266
During my performance, others distract me. (CO)				,401		,466	,442	3,209	1,330
Reliability (Cronbach's Alpha)	,916	,886	,884	,858	,837	,829	54,99%		
Eigenvalue	10,914	4,687	3,249	1,833	1,274	1,137			
Variance explained (%)	25,985	11,160	7,737	4,363	3,034	2,708			

Legend: F1= anxiety control/ confidence; F2 = mental preparation; F3 = motivation; F4 = team emphasis;

F5 = concentration; F6 = confidence

Original dimensions of PSIS–Youth: AC = Anxiety control; C = Confidence; MP = Mental preparation ; M = Motivation; TE = Team emphasis; CO = Concentration

Table 2 - Correlation between the PSIS–Youth Cro factors on the samples of coaches and table tennis players

	F1	F2	F3	F4	F5	F6
F1	1,00	**0,35	**0,42	**0,32	**0,45	-0,04
F2		1,00	**0,37	**0,37	*0,14	**0,34
F3			1	*0,14	*0,15	**0,24
F4				1	*0,36	**0,40
F5					1	-0,02
F6						1

Legend: F1= anxiety control/ confidence; F2 = mental preparation; F3 = motivation;
F4 = team emphasis; F5 = concentration; F6 = confidence

* correlation significant at $p < ,05$; ** correlation significant at $p < ,01$

Table 3. Discrimination analysis for PSIS–Youth Cro dimensions between coaches and table tennis players

Discrimination function	Eigenvalue	Wilk's λ		Canonical correlation		χ^2 (degrees of freedom)		p
	,57	,64		,60		74,78 (6)		<.01
Variables	Wilk's λ	Structure matrix	F-test (3, 1593)	p	M table tennis	σ table tennis	M coaches	σ coaches
anxiety control / confidence	,95	,67	8,64	< ,01	-0,21	0,94	0,21	0,95
mental preparation	,91	,41	15,82	< ,01	-0,28	0,89	0,28	0,94
motivation	,80	,30	42,74	< ,01	-0,43	0,87	0,43	0,84
team emphasis	1,00	-,24	,08	> ,05	0,02	0,76	-0,02	1,11
concentration	,97	-,08	5,40	< ,05	0,16	0,86	-0,16	0,97
confidence	1,00	-,03	,60	> ,05	0,06	0,93	-0,06	0,94

Legend: M= Mean; σ = Standard Deviation

Legend: F1= anxiety control/ confidence; F2 = mental preparation; F3 = motivation;
F4 = team emphasis; F5 = concentration; F6 = confidence

Table 4. Differences in the psychological skills according to participants' education level

Skill	Education level	Mean	Std. Deviation	t-test
anxiety control/ confidence	SSS, VŠS (106)	0,026	0,973	0,450
	VSS, MR, DR (65)	-0,042	0,952	
mental preparation	SSS, VŠS (106)	-0,015	0,955	-0,261
	VSS, MR, DR (65)	0,024	0,951	
motivation	SSS, VŠS (106)	0,041	0,957	0,723
	VSS, MR, DR (65)	-0,068	0,954	
team emphasis	SSS, VŠS (106)	-0,007	1,043	-0,130
	VSS, MR, DR (65)	0,012	0,769	
concentration	SSS, VŠS (106)	-0,087	0,901	-1,564
	VSS, MR, DR (65)	0,141	0,961	
confidence	SSS, VŠS (106)	-0,043	0,963	-0,762
	VSS, MR, DR (65)	0,070	0,886	

* t-test significant with $p < ,05$

** t-test significant with $p < ,01$

Table 5 - Predictive value of the psychological skills for the criteria satisfaction with life

Criteria variable	R	R ²	F	p	Predictors	β	B	t	p
Satisfaction with life	,34	,09	3,68	<,01	anxiety control/ confidence	-,32	-,34	-3,06	<,01
					mental preparation	-,10	-,11	-1,13	>,10
					motivation	,14	,15	1,57	>,10
					team emphasis	,06	,07	,62	>,10
					concentration	-,02	-,02	-,18	>,10
					confidence	,11	,12	1,19	>,10

All participants anonymously filled out ESWL. The subjects answered to the questionnaire statements using the estimation scale with a six-degree assessment ('0' means a minimal or zero degree of intensity of the estimated variable; '5' means maximal intensity).

Data analysis

First, standard descriptive statistics were calculated, for each item of the scale PSIS-Youth. To establish psychometric properties of the Croatian adaptation of the PSIS-Youth, to evaluate the latent structure of the instrument (i.e. to determine construct validity), we have used a Principal Axis Factoring method of factor extraction, with Promax Rotation and Kaiser Normalization. For factor extraction, we have combined few criteria: Scree Plot, percentage of variance explained and possibility for factor interpretability, with minimal factor saturation of ,35. Psychological skills are defined as the regression factor scores. We have used Pearson correlations for calculating intercorrelations between factors obtained (psychological characteristics), while t-test were used for comparison the differences in the psychological skills according to the education level of all participants. Discrimination analysis was used to find the differences in PSIS-Youth dimensions between coaches and table tennis players. Finally, all psychological skills were used as predictors for the criteria satisfaction with life in complete multiple regression analysis. Data processing was done using statistical program SPSS 11.

Results

For the measuring instrument (PSIS-Youth), applied on Croatian sample(s) of participants, Kaiser-Meyer-Olkin Measure of Sampling Adequacy (.846) and Bartlett's Test of Sphericity (Chi-Square = 4591,557; $p < ,01$) indicate that correlation matrix is good for factorization, too. Factor analysis (Table 1) and a scree plot of the factor structure indicated a steep drop of eigenvalues, that revealed a six-factor structure, with factors named: anxiety control/ confidence, mental preparation, motivation, team emphasis, concentration and confidence. All six components accounted for 54,99% of the total variance explained. Other data, such as descriptives and communalities, can be seen in the Table 1. However, it seems that factor structure of this preliminary adjusted instrument for Croatian population (hereinafter PSIS-Youth Cro) is very close to the original factor structure of the instrument PSIS-Youth: minimal deviations can be rather explained in items' content, much more than in cultural specificities. More specific, some aspects of the anxiety control have in fact very similar psychological background as the confidence. As indicated in Table 4, there are no statistically significant differences according to the education level of participants in six psychological skills, i.e. main mental skill characteristics relevant to exceptional athletic performance. This

result can be expected, because conative characteristics may be relative independent of the cognitive ones. On the other side, general education level probably doesn't mean much for developing specific sport psychological skills. Table 2 gives an overview in the intercorrelation matrix for the factors of the PSIS-Youth Cro, applied on the Croatian samples of coaches and recreational table tennis players. Almost all correlations have positive directions, while the most of correlations are low or very low. The highest values of correlations were found between anxiety control/ confidence and concentration, as well as between anxiety control/ confidence and motivation. The lowest values are found between anxiety control/ confidence and confidence, as well as between concentration and confidence, i.e. in cases with very low negative correlations between factors obtained. We can say that in general all psychological skills are positive correlated, but not the same: it could be said that this coherent set of psychological skills may reflect successful athlete (coach or recreational table tennis player). In Table 5, the discrimination analysis is performed in relation to the dimensions of the PSIS-Youth Cro dimensions, between coaches and table tennis players. Group centroids have the values ,754 for coaches and -,746 for tennis players. Based on the discrimination function, 83,6% of initially grouped cases could be correctly classified. The discrimination function statistically significantly differentiates personality characteristics between coaches and table tennis players. ANOVA results statistically significantly differentiate the following variables: anxiety control/ confidence, mental preparation, motivation ($p < ,01$) and concentration ($p < ,05$). On the other hand, the variables team emphasis and confidence do not show statistically significant difference. In first three of four mentioned cases, coaches have higher mean values than recreational table tennis players: they are better in anxiety control/ confidence, mental preparation, motivation. It can be explained by fact that many coaches were professional or active athletes or they coach top, professional or active athletes (so they may be more likely to have main mental skill characteristics relevant to exceptional athletic performance). On the other hand, recreational table tennis players have better concentration: that can be consequence of the special importance of this skill in the table tennis. In Table 5 we can see the predictive value of the variables using criteria satisfaction with life. The satisfaction with life could be statistical significantly predicted, with only one predictor: anxiety control/ confidence, while the other predictors do not show significant correlation with satisfaction with life. We can assume that the sport can be important social value for the coaches, as well as for recreational table tennis players. However, we can't expect that mental skill characteristics relevant to exceptional athletic performance can be strong predictors for satisfaction with life: the satisfaction with life depends about many factors outside sport issues.

Even in prediction the satisfaction with individual's sport aspect of life, these psychological skills are tiny set of factors that can have influence on it. From this point of view, the fact that anxiety control/ confidence can statistically significant predict satisfaction with life can mean that this characteristic is important not only for sport situations but in life in general, at our participants. In spite of the fact that the first aim of this study is preliminary psychometric adjustment of PSIS–Youth to Croatian population, we had found little useful information. From this study it becomes clear that psychological skills in our PSIS–Youth Cro can distinguish between coaches (as representatives of former active athletes and people who work with active athletes) and recreational table tennis players. One specific psychological skill that obtained in our research (anxiety control/ confidence) can be a good predictor for the satisfaction with life. Disadvantages of this study arise primarily from the fact that the sample of participants was convenient and extremely heterogeneous with respect to the types of sports (subsample of coaches), while the sample of table tennis players is improbable sample, too (players that fulfilled online survey). So, the possibility of generalization of the results of this study is strongly limited. Therefore, in future studies we could expand the study, including a larger sample stratified and coaches of different sports, with randomly chosen sample of recreational table tennis players.

Likewise, it may be important to compare different types of athletes in this preliminary adjusted instrument (PSIS–Youth Cro): from individual and team sports, athletes sports with different levels of the complexity, male and female athletes, etc.

Conclusion

We have confirmed the existence of six latent dimensions of the Croatian adaptation of the PSIS–Youth (PSIS–Youth Cro), which reliably interpret the space of psychological skills: anxiety control/ confidence, mental preparation, motivation, team emphasis, concentration and confidence. In general, all psychological skills are positive correlated, but not the same: this relatively coherent set of psychological skills may reflect successful athlete.

The discrimination function statistically significantly differentiates personality characteristics between coaches and table tennis players: coaches are better in anxiety control/ confidence, mental preparation, motivation, while recreational table tennis players are better in concentration. There are no statistically significant differences according to the education level of participants in six psychological skills. We can successfully predict the satisfaction with life by six psychological skills in PSIS–Youth Cro. Anxiety control/ confidence is the best and significant predictor of the satisfaction with life.

References

- Bakker, F. (1995). Ontwikkeling van tests op het terrein van de sportpsychologie in Nederland en Vlaanderen. [Development of tests for the field of sport psychology in the Netherlands and Belgium]. *Sportpsychologie Bulletin*, 6, 3-15.
- Companjen, T., & Bakker, F. (2003). Overzicht van sportpsychologische vragenlijsten in Nederland en Vlaanderen. [Outline of questionnaires for the field of sport psychology in the Netherlands and Belgium]. *Sportpsychologie Bulletin*, 14, 34-41.
- Cox, R.H., & Davis, R.W. (1992). Psychological skills of elite wheelchair athletes. *Palaestra*, 8, 16-21.
- Cox, R.H., Liu, Z., & Qiu, Y. (1996). Psychological skills of elite Chinese athletes. *International Journal of Sport Psychology*, 27, 123-132.
- Elferink-Gemser, M.T., & Visscher, C. (2006). The relative age effect in Dutch field hockey. *Journal of the Coimbra Network of Exercise Sciences*, 3, 77-80.
- Elferink-Gemser, M.T., Visscher, C., & Lemmink, K.A.P.M. (2008). Differences in psychological skills between elite and sub-elite youth athletes. *Journal of Physical Education and Sport Sciences*, 4, 95-105.
- Ebben, W.P., & Gagnon, J. (2012). The Relationship Between Mental Skills, Experience, and Stock Car Racing Performance. *Journal of Exercise Physiology*, 15(3), 10-18.
- Grossarth-Matiček, R., Eysenck, H.J., Rieder, H., & Rakić, L. (1990). Psychological factors as determinants of success in football and boxing: the effects of behaviour therapy. *International Journal of Sport Psychology*, 21, 237-255.
- Gould, D., & Udry, E. (1994). Psychological skills for enhancing performance: Arousal regulation skills. *Medicine and Science in Sports and Exercise*, 26, 478-485.
- MacIntyre, T., Mahoney, C., & Moran, A. (1998). Professional sport psychology in Ireland. *Irish Journal of Psychology*, 19, 504-515.
- Mahoney, M.J. (1989). Psychological Predictors of elite and non-elite performance in Olympic weightlifting. *International Journal of Sports Psychology*, 20, 1-12.
- Mahoney, M.J., Gabriel, T.J., & Perkins, T.S. (1987). Psychological skills and exceptional athletic performance. *Sport Psychologist*, 1, 181-199.
- May, J.R., Veach, T.L., Reed, M.W., & Griffey, M.S. (1985). A psychological study of health, injury and performance in athletes on the US alpine ski team. *Physician and Sportsmedicine*, 13, 111-115.
- Meyers, M.C., LeUnes, A.D., & Bourgeois, A.E. (1996). Psychological skills assessment and athletic performance in collegiate rodeo athletes. *Journal of Sport Behavior*, 19, 132-146.

- Morgan, W.P. (1979). Predictions of performance in athletes. In: P. Klavara & J. V. Daniel (eds.) *Coach, Athlete and the Sport Psychologist*, (pp. 172-186). Champaign, IL: Human Kinetics.
- Morgan, W.P. (1984). Selected psychological factors limiting performance: A mental health model. In: D. H. Clarke & H. M. Eckert (eds.) *Limits of human performance*, (pp. 70-80). Champaign, IL: Human Kinetics.
- Morgan, W.P. & Pollock, M. L., (1977), Psychological characterization of the elite distance runner. *Annals of the New York Academy of Science*, 301, 382-403.
- Orlick, T., & Partington, J. (1988). Mental links to excellence. *Sport Psychology*, 2, 105-130.
- Pavot, W., & Diener, E.F. (1993). Review of the Satisfaction with Life Scale. *Psychological Assessment*, 5, 164-172.
- Sindik, J., & Andrijašević, M. (2011). Relacije dimenzija Upitnika o doživljajima dnevnog napora te slobodnog vremena i brige o zdravlju za sportske rekreativce s njihovim demografskim karakteristikama. *Sportekspert*, 4(1-2), 20-25.
- Trafton, T.A., Meyers, M.C., & Skelly, W.A. (1997). Psychological characteristics of the telemark skier. *Journal of Sport Behaviour*, 20, 465-476.
- White, S.A. (1993). The relationship between psychological skills, experience, and practice commitment among collegiate male and female skiers. *The Sport Psychologist*, 7, 49-57.
-

PRIMJENA INVENTARA PSIHOLOGIJSKIH VJEŠTINA U SPORTU NA HRVATSKIM TRENERIMA I REKREATIVCIMA U STOLNOM TENISU

Sažetak

Glavni cilj ovog istraživanja bio je otkriti temeljne psihometrijske karakteristike "uvezene" nizozemske verzije Inventara psiholoških sportskih vještina za mlade (PSIS-Youth), primijenjene na hrvatskim uzorcima sportaša, pronaći korelacije između različitih psiholoških vještina, pronaći razlike u psihološkim vještinama između trenera i rekreacijskih stolnotenisača, kao i u odnosu na razinu obrazovanja. Konačno, pokušali smo predvidjeti zadovoljstvo životom pomoću skupa psiholoških vještina. Ispitali smo ukupno 86 trenera raznih sportova u Hrvatskoj tijekom seminara za trenere Hrvatske olimpijske akademije i 86 rekreacijskih stolnotenisača koji igraju u udruzi SOKAZ. Istraživanje je otkrilo postojanje šest latentnih dimenzija hrvatske adaptacije Inventara psiholoških sportskih vještina za mlade (PSIS-Youth Cro). Relativno koherentan skup psiholoških vještina može odražavati uspješne sportaše. Treneri su bolji od stolnotenisača u kontroli anksioznosti/ samopouzdanju, mentalnoj pripremi i motivaciji, dok su rekreativni stolnotenisači bolji u koncentraciji. Nema statistički značajne razlike u odnosu na razinu obrazovanja sudionika. Pomoću šest psiholoških vještina iz PSI-Youth Cro uspješno se može predvidjeti zadovoljstvo životom sudionika. Kontrola anksioznosti/ samopouzdanje je najbolji i značajan prediktor zadovoljstva životom. PSIS-Youth Cro se u budućnosti mora provjeriti na više reprezentativnih uzoraka hrvatskih sportaša.

Ključne riječi: sportaši, faktorska struktura, psihološke vještine, zadovoljstvo životom

Received: January 11, 2013

Accepted: June 10, 2013

Correspondence to:

Correspondence to:

Joško Sindik, Ph.D.

Anthropological Institute

10000 Zagreb, Ljudevita Gaja 32, Croatia

Phone: +385 (0)1 5535 122

E-mail: josko.sindik@inantro.hr

EVALUATION OF VOLLEYBALL TECHNIQUES – DIFFERENCES BETWEEN EXPERT AND NOVICE COACHES

Zoran Grgantov, Damir Jurko and Mirjana Milić

Faculty of Kinesiology, University of Split, Croatia

Original scientific paper

Abstract

Six expert and four novice coaches evaluated the technique quality of 109 young female volleyball players, whose average age was 15.4 ± 2.6 years, using the video recordings of their playing. The aim of the evaluation was to determine the differences in volleyball technique evaluation (serve, serve reception, attack and block). The conclusion, based on the descriptive indicators, was that both groups of coaches, on average, used similar evaluation marks, and those expert coaches used a wider range of marks more often than the novice coaches. In all of the volleyball technique evaluation tests, the expert reviewers had higher mutual correlations than the novice coaches. Novice coaches had somewhat lower homogeneity and congruence in the mutual object of measuring: reviewing the serve technique, serve and attack, and especially the block technique, what could be anticipated, due to the complexity of the technique element. Variance analysis determined the non-homogeneity of the expert, and especially the novice coaches, in volleyball technique elements evaluation. The obtained results indicate that volleyball technique evaluation skills should be more present in the process of volleyball experts' education. The development of these skills is the first step in the process of perfecting the techniques of volleyball elements.

Key words: female players, objectivity and homogeneity, detecting errors in technique

Introduction

According to Janković and Marelić (1995), specific motor knowledge (volleyball techniques) represents the complex of volleyball elements essential in solving concrete tactic tasks in different game situations. The technique is the most rational mode of performing a certain movement. This movement performance respects the structural and biomechanical characteristics of movement. A good volleyball elements technique is positively correlated to the game success (Thissen Milder et al. 1991, Stamm, 2004, Grgantov 2005). The aim of every sport is automatization of the correct technique, a process that requires a great number of repetitions (McGown 1994, Knudson and Morrison 2002, Grgantov 2005). This way, the player does not have to think about the correct movement performance during the game, but simply about the most useful tactical solution in the given moment. In successful technique learning, a person giving the instructions (coaches, teachers...) should present the aims of the technique, demonstrate it and give feedback (key words) during the process of learning the volleyball techniques. In the research conducted by Kounturisa and Yannisa (2007), volleyball beginners, who were given feedback concerning the attack performance during the exercise, had significantly better results after 12 one hour training sessions than the control group, who performed the exercise without the feedback. Considering the abovementioned, a conclusion can be made – giving the correct information concerning the movement, finding the key words for each volleyball skill, and finding the order of their introduction, is a demanding skill that volleyball coaches should aim to perfect.

To fully accomplish this mission, coaches should be capable of noticing every deviation from the ideal technique. An additional obstacle to this aim is the fact that, during a training session, coaches must observe the performance of a great number of players at the same time.

Problem and aim

Numerous research studies conducted on coaches in different sports (e.g., Peterson and Comeaux 1987, Woorons 2002) indicate that the knowledge of expert coaches is hierarchically organized, interrelated, causing the more immediate noticing of important movement details, dividing important from the unimportant and adjusting to the newly created situations. Therefore, it can be assumed that more expert volleyball coaches will be more uniform and compliant in the volleyball elements technique evaluation than the novice coaches (Bian 2003). Therefore, the main aim of this research was to determine whether the expert volleyball coaches differ from the novice ones in the ability to evaluate volleyball technique (serve, serve reception, attack and block).

Methods

The subject sample of this research included 109 female volleyball players, members of different clubs from County of Split-Dalmatia, County of Zagreb and County of Istra, whose average age was 15.4 ± 2.6 years. The variable sample consisted of 4 serve techniques, serve reception, attack and block evaluation tests. The tests were constructed and validated for all junior female

volleyball players' categories. A detailed description of tests, reviewer instructions and the key performance parts can be found in research by Grgantov (2005). From the total of 6 techniques used in this research 4 have been chosen, two performed while standing on the ground, and two while jumping. Attack and block, performed while jumping, are technically the most demanding volleyball elements, so it was assumed that these techniques would be more demanding for coaches to estimate. During each test, the examinees, in sequence, performed 4 repetitions of a certain technique. All the tests were recorded by a video camera. Based on the video recordings, 10 reviewers estimated the volleyball players' technique quality, using the scale ranging from 1 to 5. Six out of 10 reviewers were expert coaches, with long-standing coaching experience, while 4 reviewers attended the volleyball modules at the Faculty of Kinesiology in Split and had little or no coaching experience. All the coaches were introduced to the technique reviewing methods. With the purpose of achieving the aim of the research, basic descriptive indicators of the reviewers in the tested variables were calculated (mean and standard deviation), as well as the intercorrelations between the coaches. After this, the objectivity of the coach-reviewer was calculated, by applying the intercorrelation matrix and calculating the inter-item correlation and Cronbach alpha coefficient, separately for the expert and the novice coaches. By applying the

ANOVA procedure of analyzing the differences between the reviewers, the homogeneity of the coaches' volleyball technique estimations was calculated (separately for the group of expert coaches and separately for the novice group). The data was processed by the "Statistica for Windows" statistical package, version 7.0.

Results

Table 1 Basic descriptive indicators of the volleyball technique reviewers – mean (M) and the standard deviation (SD)

Coaches	SERVE		SREC		ATTACK		BLOCK	
	M	SD	M	SD	M	SD	M	SD
1	2.89	1.36	2.83	1.28	2.27	1.19	2.43	1.25
2	3.07	1.11	3.42	1.22	2.99	1.13	3.30	1.17
3	3.23	1.12	3.61	1.04	2.96	1.04	3.32	0.91
4	3.06	1.34	3.27	1.16	3.13	1.16	3.28	1.16
5	3.25	1.34	3.13	1.03	3.39	1.08	3.31	1.02
6	2.89	1.36	3.08	1.23	2.61	1.28	2.47	1.14
7	3.23	0.98	3.45	0.98	3.39	0.88	3.67	0.78
8	3.28	0.78	3.14	0.74	2.94	0.74	2.93	0.57
9	2.21	0.89	2.51	0.78	1.89	0.85	2.12	0.74
10	3.40	1.03	3.91	0.87	3.06	0.86	3.45	0.86

Legend: 1-10 ordinal number of the technique reviewer coaches; M - mean; SD - standard deviation

Table 2 The intercorrelation matrix of reviewers regarding the serve technique

	SERV1	SERV2	SERV3	SERV4	SERV5	SERV6	SERV7	SERV8	SERV9	SERV10
SERV1	1.00	0.77	0.76	0.82	0.80	0.77	0.54	0.66	0.79	0.77
SERV2	0.77	1.00	0.73	0.73	0.73	0.63	0.54	0.54	0.67	0.74
SERV3	0.76	0.73	1.00	0.75	0.74	0.67	0.64	0.50	0.76	0.72
SERV4	0.82	0.73	0.75	1.00	0.87	0.72	0.63	0.58	0.74	0.81
SERV5	0.80	0.73	0.74	0.87	1.00	0.66	0.62	0.52	0.68	0.77
SERV6	0.77	0.63	0.67	0.72	0.66	1.00	0.60	0.58	0.73	0.70
SERV7	0.54	0.54	0.64	0.63	0.62	0.60	1.00	0.34	0.57	0.59
SERV8	0.66	0.54	0.50	0.58	0.52	0.58	0.34	1.00	0.58	0.56
SERV9	0.79	0.67	0.76	0.74	0.68	0.73	0.57	0.58	1.00	0.72
SERV10	0.77	0.74	0.72	0.81	0.77	0.70	0.59	0.56	0.72	1.00

Legend: SERV1 – SERV10: the correlation of the coaches' serve technique evaluations

Table 3 The intercorrelation matrix of reviewers regarding the serve reception technique

	SREC1	SREC2	SREC3	SREC4	SREC5	SREC6	SREC7	SREC8	SREC9	SREC10
SREC1	1	0.69	0.67	0.75	0.64	0.72	0.68	0.59	0.60	0.72
SREC2	0.69	1	0.76	0.65	0.63	0.66	0.76	0.65	0.62	0.63
SREC3	0.67	0.76	1	0.68	0.62	0.71	0.82	0.64	0.62	0.73
SREC4	0.75	0.65	0.68	1	0.76	0.69	0.71	0.61	0.64	0.70
SREC5	0.64	0.63	0.62	0.76	1	0.65	0.63	0.53	0.50	0.61
SREC6	0.72	0.66	0.71	0.69	0.65	1	0.75	0.45	0.61	0.66
SREC7	0.68	0.76	0.82	0.71	0.63	0.75	1	0.57	0.66	0.64
SREC8	0.59	0.65	0.64	0.61	0.53	0.45	0.57	1	0.57	0.56
SREC9	0.60	0.62	0.62	0.64	0.50	0.61	0.66	0.57	1	0.61
SREC10	0.72	0.63	0.73	0.70	0.61	0.66	0.64	0.56	0.61	1

Legend: SREC1- SREC10: correlation of the 1-10 coaches' evaluation of the serve reception technique

Table 4 The intercorrelation matrix of reviewers regarding the attack technique

	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10
AT1	1.00	0.72	0.72	0.68	0.64	0.70	0.62	0.61	0.73	0.73
AT2	0.72	1.00	0.74	0.72	0.74	0.68	0.64	0.61	0.57	0.66
AT3	0.72	0.74	1.00	0.68	0.71	0.65	0.68	0.63	0.58	0.67
AT4	0.68	0.72	0.68	1.00	0.73	0.67	0.62	0.58	0.54	0.62
AT5	0.64	0.74	0.71	0.73	1.00	0.66	0.65	0.59	0.44	0.60
AT6	0.70	0.68	0.65	0.67	0.66	1.00	0.60	0.54	0.55	0.57
AT7	0.62	0.64	0.68	0.62	0.65	0.60	1.00	0.65	0.54	0.59
AT8	0.61	0.61	0.63	0.58	0.59	0.54	0.65	1.00	0.60	0.58
AT9	0.73	0.57	0.58	0.54	0.44	0.55	0.54	0.60	1.00	0.61
AT10	0.73	0.66	0.67	0.62	0.60	0.57	0.59	0.58	0.61	1.00

Legend: AT1-AT10: correlation of the 1-10 coaches' evaluation of the attack technique

Table 5 The intercorrelation matrix of reviewers regarding the block technique

	BLOCK1	BLOCK2	BLOCK3	BLOCK4	BLOCK5	BLOCK6	BLOCK7	BLOCK8	BLOCK9	BLOCK10
BLOCK1	1.00	0.63	0.71	0.72	0.64	0.66	0.50	0.34	0.72	0.61
BLOCK2	0.63	1.00	0.65	0.57	0.49	0.59	0.59	0.43	0.53	0.67
BLOCK3	0.71	0.65	1.00	0.69	0.53	0.56	0.44	0.26	0.59	0.64
BLOCK4	0.72	0.57	0.69	1.00	0.73	0.64	0.40	0.42	0.54	0.61
BLOCK5	0.64	0.49	0.53	0.73	1.00	0.58	0.36	0.23	0.43	0.52
BLOCK6	0.66	0.59	0.56	0.64	0.58	1.00	0.43	0.34	0.45	0.57
BLOCK7	0.50	0.59	0.44	0.40	0.36	0.43	1.00	0.30	0.42	0.54
BLOCK8	0.34	0.43	0.26	0.42	0.23	0.34	0.30	1.00	0.26	0.35
BLOCK9	0.72	0.53	0.59	0.54	0.43	0.45	0.42	0.26	1.00	0.48
BLOCK10	0.61	0.67	0.64	0.61	0.52	0.57	0.54	0.35	0.48	1.00

Legend: correlation of the 1-10 coaches' evaluation of the block technique

Table 1 shows the basic descriptive indicators of the reviewers, for the volleyball technique evaluation variables.

Based on the results shown in table 1, the following conclusions can be drawn:

- Both groups of coaches, on average, chose similar marks (slightly above 3). The exceptions were coaches number 1 and 6 in expert coaches, and number 9 in young experts, who seemed to be more "strict" than the other coaches.
- The expert coaches used the whole range of marks more often (higher SD values) than the novice coaches.

Tables 2-5 show the reviewer intercorrelation matrix in the volleyball technique estimation variables. Coaches 1-6 were more experienced, while coaches 7-10 were novice. By analyzing the intercorrelation matrix an observation can be made – in all of the volleyball evaluation techniques the expert coaches had higher mutual correlations than the novice ones. However, for the purpose of this research, it was more important to determine the extent to which the marks of the young coaches were congruent (correlated) with the marks of the more experienced volleyball experts, representing some form of a model value. The hardest task for the young coaches was the block technique evaluation (this variable had the lowest correlation with the expert coaches), while the other 3 techniques (serve, serve reception and attack) marks were in higher correlation with the marks of

the expert coaches. Among the novice coaches, coach number 10 had high correlation values with the expert coaches in all of the techniques, while those values were somewhat lower for the rest of the reviewers (coach number 8 had the lowest correlation). Table 6 shows the values of the Cronbach's alpha coefficients and the average reviewers' correlation – separate for the expert and the novice coaches. Besides this, table 6 shows the conducted variance analysis, containing the F-values, with the significance level of differences between the two groups of coaches.

Table 6 Values of the Cronbach's alpha coefficient (CA), average correlation between the reviewers (COR), and F-test of significance between the technique reviewers (F), separately for the expert coaches (GROUP1) and the novice coaches (GROUP2), for the volleyball technique evaluation variables.

Variables	GROUP 1 (N=6)			GROUP 2 (N=4)		
	CA	COR	F	CA	COR	F
SERV	0.94	0.75	6.13***	0.84	0.57	87.80***
SREC	0.93	0.69	18.85***	0.85	0.60	128.75***
ATTACK	0.93	0.70	42.20***	0.85	0.60	161.00***
BLOCK	0.91	0.63	45.13***	0.72	0.40	155.00***

Legend: *significant at the level of 0.05, ** significant at the level of 0,01, *** significant at the level of 0,001

Table 6 shows high Cronbach's alpha coefficient values in expert coaches, showing great homogeneity in estimating the volleyball elements technique. The correlation coefficient among the reviewers indicates the reviewers' congruence in the mutual object of measuring. These values were somewhat lower than in Cronbach's alpha, and were the lowest in block technique. The F-test values show the non-homogeneity of the expert coaches, and especially the novice coaches in evaluating the volleyball elements technique.

Discussion and conclusion

The analysis of descriptive indicators of coaches' evaluations (table 1) shows that the expert coaches use the whole range of grades more often than the novice ones. It can be assumed that the novice coaches prefer the average grades due to their lack of experience and insecurity. The novice coaches had somewhat lower homogeneity and congruence on the mutual object of measuring while evaluating the serve, serve reception and attack technique, and especially the block technique, due to the complexity of the technique element. The authors assumed that while evaluating the attack technique, the young coaches would have lower values of the coefficients observed, compared to the serve and serve reception, which are simpler. The error of this presumption can possibly be explained by the attractiveness of the attack, considered important by players and coaches alike, in training and competition, so it was logical that they were well acquainted with the correct technique and the most common deviations from the correct technique. The non-homogeneity of the "expert" coaches can partly be explained by a low measuring scale, with great difference from one grade to another. Also, different previous experience of the coaches in volleyball elements grading, and the non-existent systematic work in perfecting the evaluation technique while educating the coaches, probably contributed to the observed non-homogeneity. In this research, the reviewers were not only the means of constructing and validating the volleyball technique evaluation, rather, technique evaluation is analyzed as a coaching skill, indispensable in detecting the deviations from the ideal technique, which is an important step in the process of perfecting the volleyball technique. However, it is important to note that technique evaluation in the training process is much more demanding than the evaluation of examinees in this research (evaluation of examinees one by one, using video recording). Namely, during a training session, a volleyball coach must detect and correct the errors of more than one player at the same time (without

the possibility of repetition or slowing down the recording, as can be done on a DVD set or a video camera). Considering that there is no systematic training of volleyball coaches in players' technique evaluation in Croatia, a question can be asked: Does coaching experience guarantee the expert level of volleyball technique evaluation? The authors of this research consider that it does not, especially since it is only one of the many coaches' tasks within the sports games. Considering this, it is possible that certain coaches have good results even though they do not have a high level volleyball technique evaluation quality. Certain coaches pay much attention to the process of perfecting the volleyball technique and are real experts in the field. However, in practice one can often meet expert volleyball experts with little quality in this area, but very successful in e.g. tactical or motivational segment. The conclusion, based on the results, is that the expert coaches are somewhat more homogeneous than the novice coaches in the volleyball technique quality estimation. However, it cannot be decidedly claimed that there is a significant difference in the ability of technique quality evaluation between the groups of coaches with different experience. It would be more correct to claim that certain coaches stand out in every group (not the same ones in each of the variables), impairing the objectivity and homogeneity of the group of reviewers. To enable more reliant conclusions concerning the quality of coaches' volleyball technique evaluation, future research should use the scale of marks from 1 to 5, but with a possibility of giving halves (e.g., 1.5 or 4.5), and eventually this scale could be expanded to values from 1 to 10. Also, research should be conducted in circumstances similar to training situations (e.g., reviewers grade several players during training exercise). To gain a detailed insight into the error detecting quality of certain coaches, they should, while writing the mark, describe all the deviations from the ideal technique in a certain player, using the same prepared form, and categorize them as minor, medium or major deviations. Numerous research (e.g., Stamm 2004, Grgantov 2005) have confirmed the fact that the high quality of the overall volleyball technique is an indispensable precondition of a volleyball player's situational efficacy. In relation to this, the authors consider that during the process of volleyball experts' education, more attention should be paid to the volleyball techniques evaluation skills. These skills at the same time present the foundation of a high quality process of teaching in which usage of quality demonstration, choice of convenient exercise and other methodic processes, would result in perfection of players' technique.

References

- Abernethy, B., Thomas T.K. & Thomas T.J. (1993). *Strategies for improving understanding of motor expertise (or mistakes we have made and things we have learned!!)*. In J.L. Starkes & F. Allard (Eds.). *Cognitive Issues in Motor Expertise*, (pp.317-356). New York: Elsevier Science Publishers.
- Berliner, D.C. (1994). *Expertise: The wonder of exemplary performance*. In J. Mangieri, & C. Block (Eds.). *Creating powerful thinking in teachers and students diverse perspectives* (pp. 141-186). Fort Worth, TX: Harcourt Brace.
- Bian, W. (2003). *Examination of expert and novice volleyball coaches diagnostic ability*. Doctoral dissertation, University of Northern Iowa, Cedar Falls.
- England, E. (2002). *Differences in perception between novices and experts in judging a complex movement in ultimate frisbee*. Bachelor thesis. Stockholm University, Department of psychology.
- Gabbet, T. J., & Georgieff, B. (2006). The development of a standardized skill assessment for junior volleyball players. *International journal of sport physiology and performance* 1(2), 95-107.
- Grgantov, Z. (2005). *Identifikacija morfoloških i motoričkih sklopova odbojkašica u odnosu prema uzrastu i situacijskoj učinkovitosti* (disertacija). Zagreb Kineziološki fakultet. [Identification of volleyball players' morphological-motor structures in relation with age and situation efficiency. Doctoral dissertation. Zagreb. Faculty of Kinesiology.]
- Hoffman, S.J. (1983). *Clinical diagnosis as a pedagogical skill*. In T.J. Templin & J.K. Olson (Eds.). *Big Ten Body of Knowledge Symposium series, Volume 14: Teaching in Physical Education* (pp. 35-45). Champaign, IL: Human Kinetic Publishers, Inc.
- Janković, V., & Marelić N. (1995). *Odbojka*. Fakultet za fizičku kulturu Sveučilišta u Zagrebu. [Volleyball. Faculty for Physical education University of Zagreb.]
- Knudson, D.V., & Morrison, C.S. (2002). *Qualitative Analysis of Human Movement*. Champaign, IL: Human Kinetics.
- Kountouris, P., & Yannis, L. (2007). The effectiveness of external cues on learning spiking in volleyball. *International journal of performance analysis in sport* 7(2), 117-125.
- McGown, C. (1994). *Science of coaching volleyball*. Champaign, IL: Human Kinetics.
- Palao J.M, Santos J.A., & Urena A.Y. (2004). Effect of team level on skill performance in volleyball. *International Journal of Performance Analysis in Sport*, 4(2), 50-60.
- Stamm, R. (2004). Methods for testing individual abilities of 13 – 16 year old female volleyball players and assessment of their proficiency in the game. *International journal of volleyball research* 7(1), 50-57.

EVALUACIJA ODBOJKAŠKE TEHNIKE – RAZLIKE IZMEĐU TRENERA EKSPERATA I TRENERA POČETNIKA

Sažetak

S ciljem utvrđivanja razlika u sposobnosti procjene odbojkaških tehnika (servisa, prijema servisa, smeča i bloka) 6 iskusnijih trenera i 4 trenera početnika procjenjiva su s video zapisa kvalitete tehnike 109 mladih odbojkašica prosječne dobi 15.4 ± 2.6 god. Na osnovu deskriptivnih pokazatelja utvrđeno je da obje grupe trenera u prosjeku daju slične ocjene, te da iskusniji treneri više koriste čitav raspon ocjena od trenera početnika. U svim testovima za procjenu odbojkaških tehnika, iskusniji ocjenjivači imaju veće međusobne korelacije od trenera početnika. Treneri početnici imaju nešto nižu ujednačenost i slaganje u zajedničkom predmetu mjerenja u ocjenjivanju tehnika servisa, prijema servisa i smeča, a naročito u tehnici bloka što se i moglo pretpostaviti zbog kompleksnosti tog elementa tehnike. Analizom varijance utvrđena je nehomogenost iskusnijih trenera, a naročito trenera početnika u ocjenjivanju tehnike odbojkaških elemenata. Dobiveni rezultati ukazuju, da bi se u procesu izobrazbe odbojkaških stručnjaka, veća pažnja trebala posvetiti razvijanju vještina procjenjivanja odbojkaških tehnika. Razvijanje tih vještina predstavlja prvi korak u procesu usavršavanja tehnika odbojkaških elemenata.

Ključne riječi: mlade odbojkašice, objektivnost i homogenost, uočavanje grešaka u tehnici

Received: March 14, 2013

Accepted: June 10, 2013

Correspondence to:

Damir Jurko, Ph.D.

University of Split

Faculty of Kinesiology

Teslina 6, 21000 Split, Croatia

Phone: 00385 21 302 440

E-mail: dama1j@yahoo.com

DETERMINATION OF QUALITATIVE CHANGES OF PROGRAMMED WORK AT ATTENDEES IN BASKETBALL SCHOOL

Behudin Bajgorić¹, Žarko Bilić² and Danijela Bonacin³

¹ Ministry of education, Zenica, Bosnia & Herzegovina

² Faculty of sciences, University of Mostar, Bosnia & Herzegovina

³ Faculty of education, University of Travnik, Bosnia & Herzegovina

Original scientific paper

Abstract

The main purpose of this paper is to provide a modest contribution to the knowledge of the changes that occur at the primary school student (12-14 years), under the influence of training in the school of basketball, which are nevertheless included in regular classes, and physical and health education. This study is an attempt to determine kvantativnih changes in the space of some morphological characteristics, basic - motor and situational - motor skills under the influence of the quarterly program of basketball.

Key words: transformations, morphology, motor skills, qualitative changes

Introduction

Psychosomatic status is multidimensional and certain dimensions are interrelated in a dynamic interaction, which means that all external factors come complex. The specific structure of the movement on the parquet and rapid transformation in attack and defense, requiring the speed of basketball excitatory process in the regulation of movement and movement in order to cope in many new situations. In the training process occurring transformation motor skills, but are preceded by a learning process. However, as motor skills are not at the same level variable, and in addition are immersed in an organized system of other anthropological dimensions, very difficult to change independently individually in the desired direction. Identifying morphological characteristics and basic motor skills listed populations will facilitate entry into the specific problems identifying the impact of this area on the success of the specific motor skills in basketball. The influence of a program depends on the degree of complexity of the training unit, the connection between the volume of the transformation process, the energy and information orientation program and the circumstances in which the procedure takes place. Relationships between motor skills and motor skills (skills), are always multidimensional and complex. It is believed that a high level of motor and functional abilities as a functional morphological prerequisite for effective teaching and learning of new movement structures in all age categories.

Specific characteristics of a girl of 12-14

Period of 12-14 years in girls is often the most important period in the life of females. It is a period of rapid change and transformation in the morphology and in the psycho-motor plane. In developing the growth is not uniform, they do not grow all parts of the body equally, and constantly changing external shape and body proportions.

Growth in height and width results in a temporary no proportionality of body and limbs, which is reflected in the related bones and muscles. Significant growth of digestive, respiratory, circulatory and nervous systems.

Methods

Research subject

The subject of this research is the effects of the quarterly scheduled work on the transformation of the analyzed morphological characteristics, basic-motor and situational-motor skills in the school basketball, ages 12-14 years, which are in addition covered and regular teaching physical and health education.

Research problem

The problem in this study is whether under the influence of training programs in basketball, ie three-month program to reach kvantativnih changes in morphological characteristics, basic-motor and situational-motor abilities.

Research aim

The main objective of this study was to determine the quantitative changes in the morphological characteristics and the basic-motor and situational-motor skills, students school basketball, under the influence of programmed work. ie the transformation process.

Hypothesis

Based on the wording of the case and the research problem, research objectives and the results of previous studies, the general hypothesis of this paper could be formulated as follows: H - is expected to be a training program for a period of three months, a positive impact on the qualitative improvement of these morphological characteristics, basic motor skills and situational-motor abilities of participants in basketball school.

Compared to the general hypothesis can be set and the following specific hypotheses: H-1st It is expected that under the influence of basketball training result in significant positive qualitative changes defined in morphological characteristics. H-2nd It is expected that under the influence of basketball training result in significant positive qualitative changes defined with basic - motor skills. H-3rd It is expected that under the influence of basketball training result in significant positive qualitative changes defined with situational-motor skills.

Examinees sample

The study was conducted on a sample of 108 girls, boys aged 12 -14 years, the sports star is a selection of pioneering age.

Sample of variables

When selecting variables that are supposed to shed light on the problem set, the subject and aim of the study, we took into account that they meet basic psychometric properties (validity, objectivity, sensitivity, ...). With this choice of variables is appropriate age women, and with this objective and appropriate material and spatial conditions.

Morphological area

To assess morphological dimension subjects applied the following variables: body height, body mass, leg length, arm length, shoulder width, the width of the pelvis, arm span, hand length, hand width and length of the foot.

Motor area

For the assessment of basic motor skills were applied variables that students know because they were tested in a regular classroom. The sample of variables for assessing basic motor skills: Sprint from a standing start to 20 yards, two foot jump from place to place, two foot jump from a running start, foot tapping, envelope test, side steps, hand tapping, deep forward bend on the bench, jump with both feet long jump from place to place, sitting, hand grip and run at 20 m, back and forth with progressive acceleration.

Specific abilities

For the assessment of situational-motor abilities, players will apply the following test battery: Turning the ball around the hull 24 seconds, turning the ball around the entire body 24 seconds, throwing basketballs out of the breast with both hands, throwing a basketball above his head with two hands in step, moving into position odbranbenom sideways, forward and back for 24 seconds, moving the reversing face the basket, slalom dribbling, change of direction in dribbling, shooting a five external position for 24 seconds and dribble the racket with rubble under the basket.

Measurement methods and training programme

Research in the area of motor skills are executed in the sports hall. The temperature during the measurements was in the range of 18 to 22°C.

All measurements carried out by the same group of timekeepers and they consist of professors and teachers of physical education and basketball coaches who were previously trained for it. Tests are planned in a way that is completely off greater impact fatigue resulting preceding tests. Programmed physical training activity that is carried out in this study is multidimensional. Used the analytical and synthetic methods of work, the essence of the realization of the experimental program applied in this research is the application of situational methods. The structural part of the training is conducted according to the available theory and practice that treats methods of working age categories with players aged 12-14 years. The program of work was carried out for three months, which is 4 classes a week of training with a total of 50 units.

Data analysis

Data obtained by measuring and testing will be processed using the software system for multivariate data analysis. To identify significant quantitative changes of these morphological characteristics, basic motor skills and situational-motor abilities of participants in school basketball will apply: QDIF model global (Bonacin, 2010). In order to determine the qualitative and structural differences also will apply the most competent methods to determine the qualitative and structural differences, namely: LSDIF model, CRAMER model, QDIFF1 model and model of KRZANOWSKY (Bonacin, 2010).

Results and discussion

Results of this study included three analysis, and this work will be interpreted in such manner which leads to the determination of qualitative and structural changes in the morphological characteristics and the basic-motor and situational-motor abilities. Analysis of structural-qualitative changes involves assessing the impact of the applied program contents basketball which is reflected in positive changes in the morphological characteristics, the basic motor and situational-motor abilities of students of basketball schools aged 12-14 years. Effects of basketball are controlled by three sets of measuring instruments and a set of 10 variables to assess the morphological characteristics, a set of 12 variables to assess the basic-motor skills and a set of 10 variables to assess situational-motor abilities. The first measurement of 32 variables were obtained by three clear factors in the oblique Promax rotated position. First Promax factor describes the general motor skills and part of the so-called specific basketball movements, but students were addressed at the expense of motor skills, because in these tests was not expressed so much basketball specifics, at least not in the first measurement. Another Promax factor has 10 morphological dimensions and only dynamometer of motor variables. Explanation directs forward to student that are higher, for example has a greater mass, greater arm's length, the greater the length

of the leg, arm span, hand length, width, hands, foot length, biacromial range, bicristal range and a stronger hand grip, therefore greater weight generally produces greater force and greater result in Dynamometer. That Promax factor is obvious morphological growth and development with complete anthropometric variables and is still there. It is expected that the system is more convenient for those who have more muscle mass and growth. The third Promax factor retains specific basketball movements and describe variables whose results could not be well resolved on the basis of general motor skills and are therefore allocated as a separate factor including only those motions which are solely basketball, and that can not be subsumed under the general motor skills. This is a description of the first measurement. Relations between these factors are generally small or zero, except between the first and the third.

Table 1. Obliquely rotated factors and correlation of factors - first measurement

	PX1	PX2	PX3
1VIT	0.01	0.89	-0.06
1MAS	0.19	0.78	0.02
1DUN	0.00	0.72	-0.10
1DUR	-0.06	0.82	-0.18
1BAK	0.14	0.64	0.25
1BIK	0.07	0.72	0.11
1RRU	-0.03	0.88	-0.07
1DSA	-0.09	0.65	-0.03
1SSA	-0.07	0.72	0.06
1DST	0.01	0.81	0.02
120V	0.81	0.19	0.12
1SVM	-0.70	0.17	-0.02
1SVZ	-0.77	0.14	-0.04
1TAN	-0.55	-0.05	0.01
1TUP	0.69	0.08	0.11
1KUS	0.69	-0.08	0.02
1TAR	-0.48	-0.10	0.16
1PRK	-0.42	0.12	-0.10
1SDM	-0.75	-0.14	0.00
1PTL	-0.50	0.00	0.21
1DIN	-0.23	0.60	0.06
1SAT	-0.69	-0.16	0.00
1LT2	0.01	0.02	0.74
1LTC	-0.12	0.06	0.74
1KLF	-0.32	0.19	-0.04
1KLG	-0.19	0.23	0.39
1OS2	-0.42	0.07	0.35
1PS2	-0.52	0.06	0.16
1DFF	0.30	0.02	-0.58
1SDF	0.51	-0.06	-0.40
1PSS	0.18	-0.18	0.76
1IK2	0.12	0.00	0.70
	PX1	PX2	PX3
PX1	1.00	-0.03	-0.39
PX2		1.00	0.05
PX3			1.00

That is a connection which is not surprising because they are both motor movements, while links with morphological mostly zero. In the second measurement are also isolated three obliquely rotated Promax factors, wherein the second structure remains exactly the same. Morphological measures and tethered hands until changed relationship structures other two factors, first and third. The first is now a complete description of the general motor type, all equally focused when you take into account the signs of the variables that have the opposite orientation (who will be faster, etc.). The third factor is a complete description of situational motor characteristic for basketball. This is just ideal result because it is seen to be carried out in a particular treatment, so homogenized group capabilities. Morphological remained where they were, while the motor cleaned with general motor's skills, and basketball specific.

Table 2. Obliquely rotated factors and correlation of factors - second measurement

	PX1	PX2	PX3
2VIT	-0.07	0.90	-0.03
2MAS	0.17	0.80	-0.02
2DUN	-0.01	0.72	0.01
2DUR	-0.12	0.85	-0.15
2BAK	0.17	0.63	0.23
2BIK	0.08	0.71	0.10
2RRU	-0.05	0.89	-0.05
2DSA	0.00	0.66	-0.03
2SSA	-0.01	0.71	-0.03
2DST	0.07	0.81	0.06
220V	0.89	0.14	0.01
2SVM	-0.80	0.14	0.03
2SVZ	-0.83	0.13	0.04
2TAN	-0.57	-0.01	0.07
2TUP	0.65	0.05	-0.17
2KUS	0.62	-0.08	-0.24
2TAR	-0.40	-0.06	0.34
2PRK	-0.44	0.12	-0.01
2SDM	-0.83	-0.11	0.06
2PTL	-0.52	-0.02	0.20
2DIN	-0.36	0.62	0.01
2SAT	-0.68	-0.17	0.23
2LT2	0.09	-0.02	0.91
2LTC	-0.01	0.02	0.87
2KLF	-0.15	0.27	0.56
2KLG	-0.16	0.17	0.63
2OS2	-0.30	-0.05	0.62
2PS2	-0.21	-0.04	0.59
2DFF	0.15	0.06	-0.77
2SDF	0.28	0.02	-0.70
2PSS	-0.02	-0.02	0.87
2IK2	-0.14	0.03	0.78
	PX1	PX2	PX3
PX1	1.00	-0.11	-0.64
PX2		1.00	0.20
PX3			1.00

This means that the specific characteristics of basketball are integrated - linked to a block of properties that says that they are now in some parameters girls, but now we call them - basketball players, because they connect a set of variables in the way that we have clean, clear set. In contrast to the first measurement in the second measurement increased ratio or relationship between the first and third Promax factors. As both describe motor haul first general, and the third situational, increasing the value of the relation of these two factors can be explained by the fact that are to be cleared by type so that the first factor speaks to the type of action the general motor activity, and the third discusses situational action movements. This does not mean that they have moved away, but rather that they are linked they are clean separately. So, the first is a general motor, third situational motor, but it is certain that both better connect the integrated circuit, which is in fact the result of the work. These are real structural effects. Students have learned something new and it's so much new that no longer belongs to the general motor skills, although relies on it.

Tabl3 3. Results of LSDIF analysis

Stvarni trag matrice kvadrata razlika	=	36.58
Hi – kvadrat (funkcija traga)	=	1975.21
Stupnjevi slobode	=	32
Probabilitet	=	0.0000

One of the best, and yet simple ways to determine possible structural changes caused by some treatment, consists in analyzing the difference of correlation matrix group entity measured with the same variables in two different time points. This procedure objectively actual track position matrix of squares difference and since the matrix trail is approximately distributed by X^2 distribution, it is possible to test the significance of differences. As can be seen in Table 3, it is obvious that in the analyzed samples has been serious changes, and could possibly argue that the structure in two different states is not sufficiently similar. The actual track is very high, so the trace function with a significant probability of error of less than 0.0000. This situation tells us directly that the described treatment effect on multiple ways, and certainly to the restructuring of global mechanisms responsible for the regulation of morphological and motor manifestations of the girls in this study. Certainly at this point it is difficult to say whether these changes just desirable, but if it is assumed that the girls went intense and eventful transformation process, then surely all these stimuli are applied to act solely and exclusively on quantitative adaptation possibilities, but certainly and a good part of the tasks and their effects was focused on the complex interactions set of capabilities and features. This result warns us directly and otherwise transformational processes can not and must not be viewed only through the "progress" in certain quantitative indicators, fitness and similar

isolated parameters, because a change in interactions certainly occur after even a brief transformation process, if sufficiently intense and corresponding total volume of labor. LSDIF analysis, although it can not provide information about the details of these changes but it is unavoidable and important in determining whether global the structural changes occurred or not. As can be seen, they are serious. Of possible analyzes that provide information about local changes, it could be used several methods, but Trg1 proved quite enough power for explication of local and global parameters that define the details of already recognized figure established structural changes.

Tabela 4. Results of Trg1 structural changes

	DGS	e2	h2
AVIT	0.97	0.94	0.06
AMAS	0.99	0.98	0.02
ADUN	0.90	0.81	0.19
ADUR	-0.90	0.82	0.18
ABAK	-0.66	0.43	0.57
ABIK	0.26	0.07	0.93
ARRU	0.25	0.06	0.94
ADSA	-0.39	0.15	0.85
ASSA	0.84	0.71	0.29
ADST	0.11	0.01	0.99
M20V	-0.68	0.46	0.54
MSVM	0.09	0.01	0.99
MSVZ	-0.59	0.35	0.65
MTAN	-0.07	0.01	0.99
MTUP	0.16	0.03	0.97
MKUS	0.45	0.20	0.80
MTAR	-0.31	0.10	0.90
MPRK	-0.33	0.11	0.89
MSDM	0.51	0.26	0.74
MPTL	0.25	0.06	0.94
MDIN	0.49	0.24	0.76
MSAT	0.04	0.00	1.00
OLT2	0.28	0.08	0.92
OLTC	-0.53	0.28	0.72
BKLF	-0.37	0.14	0.86
BKLG	0.37	0.14	0.86
KOS2	0.34	0.12	0.88
KPS2	0.03	0.00	1.00
SDFF	0.47	0.22	0.78
PSDF	0.67	0.45	0.55
SUM		8.20	21.80
%		27.34	72.66

(DGS = similarity measures diagonal elements, e2 = variability similarities, h2 = variability of the difference)

Finally, the data in Table 4. show us that the transformation process really sparked a series of changes that simply must be located within the area of structural transformation. It is clear that only a small number of variables remained structurally intact, and that the most because it is a variable with a large genetic disposition that is not possible at all to change in a short interval (height, weight, leg length, arm length, biacromial range, hand width), mostly with bone growth and bone segments.

However, in the space of motor and specific motor abilities, the changes that have occurred are extraordinary, almost, one might say, dramatic. Totally, 72.66 % of all properties schoolgirl underwent changes, without any risk, can be described as structural. Among them, especially leading KPS2 (Movement with reversing face to the basket), mSATA (running at 20 m there - here with progressive acceleration), OLT2 (Turning the ball around the hull 24 seconds), MTAN (foot tapping), MTUP (Envelope test), MPTL (sit- lying), MTAR (hand tapping), but almost all other variables from the motor and specific motor area. There were even joined some variables from the morphological characteristics of ABIK (pelvic width) ARRU (Wingspan), ADSA (Fist length). Athlete function system is one of the most complex at all, and the one of most complex dynamical systems. It is complex and complicated because it consists of a series of a numerous interconnected subsystems (bone , muscle , heart – vessel, respiratory, nervous, endocrine, etc.) and dynamic because it is able to change its state affected by a number of external operations. Conditions of complex dynamic systems, such as the human body, determines the state of the subsystems that form an integral part. Inside the human's body we can different: working cells, which directly generate the necessary functions in a complex organism, such as movements, exchange of materials, mechanical connection subsystems and regulatory cells which appear as an upgrade work cells and carry out the function of accepting and processing information (Bonacin, et al., 2008; 2012).

Since the body of Man is a complex dynamic system, as a rule, it can not be described in every detail. Such situation attempts to analyze the body of man piecewise – subsystems, and then based on that try to form a 'big picture', can be found in physiology, particularly in education. However, such a complex system, such as a human, can not be seen as a simple collection of specific subsystems and components. There are four types of regulatory systems (Amosov, 1964) and higher levels are mixed in lower work only when unforeseen situations arise, or on the occurrence of a flood of information, which exceed the capabilities of a lower level of regulatory systems. Structural - qualitative changes obtained in this project were presented and they are currently a final state . Many questions for which there has been a change - the transformation is not easy to answer a particular questions that come from? What, how and why, provide some of the answers, what is to be led to the condition that the girls are so structurally changed especially in motric and situational mobility area. So these questions open up next to many a new wide area methodical knowledge and actually make the methodology of teaching methods. The answers to these questions in part related to the planning and programming of the training process, the preparation of trainers, methodical forms of organization of work, working methods, scope and

intensity of the work load and dosing in the training process, selection and adaptation to exercise, access to exercise performance that is sure to exercise in performed slowly or too fast and whether such a practice is detrimental to precision, smoothness or physiological effect, correct technique and demonstration exercises , the order and content of exercises, training and methodological approaches in homogeneous and heterogeneous groups, the maximum optimum use of available space and the rational use of sports equipment, incentives to work and the development of competitive spirit, theoretical knowledge of modern educational basketball, individual, group and collective monitoring and checking the development of athletes in the anthropological venues (morphological, functional, cognitive, conative, social, motor and situational - motor). The basis of qualitative changes largely are based on a set of different structures of movement which correspond to maximum transformation process, so the basketball program in its content includes movable structure (technical elements), practice means (motor movements that are performed and applied for the development and improvement of properties and abilities) , the volume of training load, the intensity of work activities and situational basketball activities in defense and efficiency in attack, as well as theoretical and practical importance of the interaction between the coaches and basketball players and basketball players themselves. Movement patterns as kinesiology operator occupy a special place in the global agenda, and they are characterized by a large number of repetitions of specific dominant elementary basketball technique, appropriate movement structures trained by hierarchic importance and possibilities of their receipt, with effectively changing, developing and improving the general movement which in turn correspond to the maximum transformational process. The changes that have occurred in variable KPS2 (Movement with reversing face the basket) and other variables of motor skills and situational variables motor skills are definitely expected, because basketball as sports games and basketball program requires a wide variety of intensive motor movement but certainly in great accordance with specific basketball movements both in defense and in attack. Movements have to be of dosed volume and intensity of work and is generally applied on high and submaximal intensity, with a lot of movement and change of direction in the attack and less in defense and a lot of change of direction in the defense and to a lesser offense. In defense movement we can find dominated lateral and diagonal movement in attitude, movement back and forth with a lowered center of gravity of the body that gives us balance and safety techniques in attitude and movements of the arms and legs incorporated into coordination dimension.

The program offered abundant exercises specific basketball movements and tasks that are certainly contributed to the several changes.

Those changes are:

- Basketball stands;
- The lateral movement;
- Depth of movement;
- Combined movements in taking defenders;
- Movement for the defense of the blocks and jump angle;
- Developments in the attitude and coordinating the work of the arms and legs;
- Fast moving and setting up the body for quick response cutting balls;
- Developments in obstruction (closing) players;
- Preparation of movement and explosion at defense jumps;
- Developments and prepare fight for a position in which dominates the strength (power players);
- Developments in running a counter-attack and preparing for explosive movement jump and implementation;
- Movement and prepare to win the ball and offensive jump.

The program of motion will lead to higher overall endurance and speed endurance is certainly what we obtained indicate changes in variables MŠAT (running at 20 m back and forth with progressive acceleration). All these movements of special interest attaches to the ball no matter if it is in close or not. Basketball continually and on the whole field requires intensive movement and ball handling skills as the ability to manipulate fine player and ball in motion OLT2 (Turning the ball around the trunk). Speed of players without the ball, mostly covering developments in counterattack while movement in defense mainly represented short explosive specific basketball movements as KOS2 (Movement in defense position laterally back and forth) and MKUS (side steps).

Manipulation of ball has mastered the ability to situational basketball technique that its meaning and use of places in situational solutions for the games and heavy loads and they are definitely present during the entire match OLTC (Turning the ball around the entire body) and in three levels: the overhead in height above the hips to the head and below the hips. For basketball added it is characteristic velocity of ball (transition) with short and long pass but very explosive and mostly accurate belt BKL (throwing basketballs out of the breast with two hands), BKLG (Throwing a basketball above his head with both hands from the steps). Given the relatively small size of the field and with a belt - adding it can cover the entire field, so that's probably the reason why the basketball as sports game has a specific attraction for a large number of young population. Certainly it should be noted that basketball players must have significant explosive ability of the body especially the muscles of the upper and lower extremities, including the weight and volume of a ball that is in a relation to the ball in other sports much heavier and larger. Obtained changes are significant and suggest that all variables are applied to a large extent involved in the hypothetical mechanism of specific basketball movements. Basketball specific movements are certainly the result of basketball training and its implementation, which has always been the goal in this game.

In this sense, the obtained result was expected and welcome, it certainly confirms that the programmed basketball treatment that has been realized in this study had important and significant effect.

Conclusion

The first or initial measurement can gain an insight into the relation of individual manifest variables used in the present study. It is obvious that these variables from subspace (morphology, motility and situational motor) show mutually expressed connection, which is the expected situation. Also, beyond these basic subspace, it is possible to register a marked connection, which tells about the connection of whole segments of the anthropological status of girls (morphology and motility, morphology and situational, motor and situational).

In the second and final measurement is noticeable that almost all morphological variables are almost identical to what is normal for a relatively short time of three months is not possible at all to get by any means some dramatic changes. In basic motor variables were not so, but the size of the diagonal elements are around 0.80-0.90, which means that there are shifts because many variables among themselves do not show such a great similarity between the first and second measurements. Situational - motor space caused the most important effects and is actually desirable and expected. Somewhat smaller effects are achieved in other situational- motor variables but still enough to be said in general that the morphological variables remained virtually the same, the basic motor changes are achieved, but what is essential and what is most important is that the situational made make changes and actually were the real goal of this treatment. The resulting changes are significant and suggest that all variables are applied to a large extent involved in the hypothetical mechanism of specific basketball movements. Basketball - specific movements are certainly the result of basketball training and its implementation, which is really the goal of this research.

In this sense, the obtained result was expected and welcome, it certainly confirms that the programmed basketball treatment that has been realized in this study had significant effect. The general conclusion which follows from the analysis of qualitative changes in the morphological characteristics and the basic - motor and situational - motor skills after a three-month scheduled work can be formulated as follows: Quarterly programmed basketball program has caused significant changes in the structure of the morphological characteristics (4 variables), a significant change in structure - basic motor skills and caused significant changes in the structure of situational- motor abilities.

References

- Bajgorić, B. (2007). *Efekti programiranog rada na transformaciji morfoloških obilježja, bazičnih motoričkih sposobnosti i situaciono-motoričkih sposobnosti kod polaznica košarkaške škole.* /Magistarski rad/, Sarajevo: Fakultet sporta i tjelesnog odgoja.
- Bala, G. (1986). *Kvantitativne metode u fizičkoj kulturi.* Novi Sad: Fakultet za fizičku kulturu.
- Blašković, M. (1982). Analiza pouzdanosti i faktori valjanosti situaciono motoričkih testova u košarci. *Kineziologija*, 14(5).
- Bonacin, D. (2004). *Uvod u kvantitativne metode* [Introduction to quantitative methods. In Croatian.]. Travnik: Edukacijski fakultet.
- Bonacin, D., Bilić, Ž., & Bonacin, Da. (2008). *Uvod u antropološku analizu* [Introduction to anthropological analysis. In Croatian.]. Travnik: Edukacijski fakultet.
- Bonacin, D., Bilić, Ž., & Bonacin, Da. (2012). *Uvod u kineziološku analizu* [Introduction to kinesiological analysis. In Croatian.]. Travnik: Univerzitet u Travniku.
- Findak, V. (1999). *Planiranje, programiranje, provođenje i kontrola procesa vježbanja.* Kineziologija za 21.stoljeće, Zagreb: Fakultet za fizičku kulturu.
- Hadžikadunić, M. (1998). Uticaj programiranog vježbanja na neke antropometrijske karakteristike motoričke i funkcionalne sposobnosti, *Homosporticus*, 1, 9-16.
- Malacko, J. (2000). *Osnove sportskog treninga.* Beograd: Sportska akademija,
- Mikić, B. (1999). *Testiranje i mjerenje u sportu.* Tuzla: Fakultet za fizičku kulturu.
- Milanović, D. (1996). Kineziološka dijanostika bazičnih i specifičnih sposobnosti sportaša, Zbornik radova treće konferencije o sportu Alpe – Jadran, Rovinj, 1996. (pp.26-29; 35-39).
- Milanović, D., Jukić, I., & Dimitros, I. (1994). Uticaj programiranog treninga na promjene u motoričkim sposobnostima mladih košarkaša. *Kineziologija*, 4(1-2), 33-43.

ODREĐIVANJE KVALITATIVNIH PROMJENA PROGRAMIRANOG RADA S POLAZNICAMA ŠKOLE KOŠARKE

Sažetak

Osnovna svrha ovog rada jeste da pruži skroman doprinos u spoznaji promjena koje se dešavaju kod učenika osnovne škole (12 - 14 godina), pod utjecajem treninga u školi košarke, a koje su pored toga obuhvaćene i redovnom nastavom tjelesnog i zdravstvenog odgoja. Ovo istraživanje predstavlja pokušaj utvrđivanja kvaliativnih promjena u prostoru nekih morfoloških karakteristika, bazično - motoričkih i situaciono - motoričkih sposobnosti pod utjecajem tromjesečnog programa košarke.

Ključne riječi: transformacije, morfologija, motorika, kvalitativne promjene

Received: May 11 2012

Accepted: June 10, 2013

Correspondence to:

Behudin Bajgorić, Ph.D.

Ministry of education

Zenica, Zije Dizdarevića 12B, Bosnia & Herzegovina

Phone: +385 (0) 061/105-066

E- mail behudin.bajgoric58@yahoo.com

EXTREME LOADINGS OF LOCOMOTOR SYSTEM IN THE RUNNING

Milan Čoh

Faculty of Sport, University of Ljubljana, Slovenia

Review paper

Abstract

Walking and running are natural way of human motion. Today running is effective aerobic exercise to maintain vital human functions, mostly cardiovascular and breathing functions. Modern human's lack of movement results in numerous health problems and generally reduce the quality of his life. The impact of regular physical exercise on the body is proven beyond any doubt; but we can also see the growing negative effects of physical exercise, which are typically a result of the unadjusted and too demanding exercise programs. Walking and running are human's the most effective and health activities, but running can have large load on joints, bones, tendons, ligaments and muscular system. The negative effects of physical exercise are manifested in the form of overload which often leads to injuries. Running injuries and their development takes place at the beginning relatively unnoticed, obvious symptoms with pronounce consequences for the runner occur relatively late.

Key Words: *biomechanics, running, technique, extreme loadings*

Introduction

Running as a physical activity is genetically determined. The basic running structural unit is double step. Within the cycle running cycle alternates support and flight phase. Support phase begins at the moment when the foot strikes the surface and ends when the foot leaves the ground. Moment of leaving foot from support delimits both phases. When foot touches the ground with heel is the first support, and when the take off is done with finger is called last support. Between a supporting phase is the flight phase. The distance between the two phases defines the stride length. In addition to the frequency step is the most important step length parameter of running. Step length and step frequency are in inverse proportion and are individually conditioned. They depend on runner's characteristics and capabilities. At higher frequency is smaller stride length and vice versa. Parameter stride length depends on the morphological characteristics of runners, especially the length of the lower extremities, from the ground reaction force, contact time and take off angle. The average stride length of the recreational runner is 100 to 150 cm, a top runner 150 to 220 cm. Frequency step, which is manifested by the number of steps per unit time depends on the intra and inter muscular coordination and operation of the central nervous system that regulates the movement of agonist and antagonistic muscle groups (Mero, Komi, Gregory, 1992; Novacheck, 1997; Komi, Nicol, 2000). The relationship between length and step frequency steps is largely automated and fixed in locomotor central nervous system (Enoka, 2003). Human running technique is very individual and independent with stage of training.

The mechanics of running

Maximum load on human body is created the first and last support phase (Figure 1), vertical reaction force is between 2000 to 2500N, during sprint

even up to 3500 N (Cavagna, Komarek, Mazzoleni, 1971; Mero, Komi, Gregor, 1992, Škof, Strojnik, 2007). Gait reaction forces are three times smaller (Novacheck, 1997). The main difference between walking and running is flight phase, which do not exist in walking. During walking the human body is always in contact with one foot on the ground. The foot is one of the most loaded segments of the locomotor system during running. The foot has 26 bones of different shapes and features, 19 muscles and more than 100 ligaments. In the course of 10 km, the foot strikes the ground about 5,000 times, the average stride length of 2 m. With average runner's mass (70 kg) and regarding to the number of steps, we can conclude that the total absorption reaction of surface forces for each foot is 3430 kN. This force is then transmitted to the knee and hip joint. Undoubtedly, these burdens are on the borderline of human adoptive capacities. Runner's reaction force depends on the running technique, how foot is placed on ground in the moment of the first contact (Figure 2). We differentiate three types (Novacheck, 1997, Hasegawa et al., 2007, Lieberman et al., 2009, Daoud et al., 2012): with heel (RFS rear-heel foot strike), mid foot (MFS mid-foot strike) and fingers (FFS fore foot strike). Hasegawa et al., (2007) found that 75% of marathon runners use RFS (Figure 3), 24% MFS and only 4% FFS. Which of the run models are the most effective researches up to date did not give a single answer (Lieberman et al., 2009). Superior results were achieved during the marathon runners with all three types. Placing foot is closely related to the function of modern running shoes, which are constructed according to the latest knowledge of biomechanics and functional anatomy of the foot. The basic task of running shoes is the mechanical protection of the feet, partial neutralization of reaction forces and injury prevention. Rear – foot strike means in terms of burden "shock" to the ankle, knee and hip joint.

Reaction force in this case is oriented in the opposite direction of motion of body center of gravity. In part, this force is absorbed by running shoes sole, which must be appropriately thick and elastic. In terms of biomechanics of running a more efficient technique is to place foot in the first contact to the front outside part (Figure 4). In this mode, the foot like a spring partially neutralizes the reaction force. Contact with the front foot, however, requires proper coordination and activation of agonist and antagonist muscles (m. tibialis and m. gastrocnemius medialis and lateralis). M. Gastrocnemius muscle provides necessary preactivation needed for proper foot stiffness (Komi, Nicol, 2000). When are muscles activated 50 milliseconds before touchdown, less energy is lost than a passive setting foot on the heel. Efficiency and economy of running is not only dependent on the production of chemical energy, but also on the amount of mechanical - elastic energy that is generated in the eccentric phase (the first phase of foot contact with the ground). Economic running technique is combination of efficiency of chemical and elastic energy. According to researches (Mero, Komi, Gregor, 1992; Komi, Nicol, 2002; Enoka 2003) the proportion of chemical energy and, elastic energy is 75:25 %. During evolution walk and run have helped man to survive in raw nature. The man ran and walked barefoot for about four million years. Only in the modern era has started using shoes. Running shoes are little more than sixty years old, which is in context of the history of time. Running shoes have changed the technique of running. Barefooted man ran through the front foot and by exploiting the elasticity of muscles, tendons and ligaments (Lieberman et al., 2009). Today's modern runner sets foot on the heel and exploits the elasticity of the lower part of running shoes. The basic functions of running shoes are absorption of impact forces at the feet with ground, stabilization of ankle and foot and provide a good grip (friction). It is important that the front part of the sole is rigid enough, which prevents excessive foot supination and plantar fasciitis development.

Extreme loadings in the running

Despite the fact that running is one of the most effective and healthy human motor activity, it can also have high impact on locomotor system, especially for joints, tendons, ligaments and muscle system of lower extremities (Hartmann, Mester, 2000; Halson, Jeukendrup, 2004; Mujika, 2009). The negative effects of sports training show as "collateral damage" in the form of various injuries. The first type of injury is acute one that occurs immediately with the known mechanism of injury and place. The second type chronic injuries are primarily due to overload of the motor system, in particular segment of the lower extremities. Chronic injury is taking place in the beginning usually completely unnoticed, obvious symptoms with noted consequences for the runner occurs relatively late.

First signs of chronic injuries are attributed to bad warm up, excessive load, unfavorable external influences; runner continues with sports activity, problems are not heavy and there is no sign of injury (Urhausen, Kindermann, 2002). To the difficulties which are associated with overload syndrome runners react late or too late. On muscle, tendon, ligament, cartilage, bone, nerve and blood vessel is continuous load which can cause micro-trauma and micro-stress. The most common external causes of overload syndrome are: improper motor preparation, running technique, rapid changes in the intensity of training, inadequate configuration of the terrain, frequent one-sided load, inadequate rest and recovery, inadequate climatic conditions and inadequate equipment. The internal causes of overload syndrome may be genetic or acquired. In general the morphologic characteristics of the body manifest different level of asymmetry. The reason may be also the biochemical change in the organism. Important role play age and gender as well. It is important to identify and analyze causes and act accordingly. The entire process of eliminating both external and internal causes of overloading the motor system requires a team approach with work-oriented specialists. These are coaches, physiotherapists, masseurs, doctors, orthopedic surgeons. Kinesiology profession and science can play a key role in early identification and prevention of the occurrence of overload syndrome. This applies to all those athletes, who use running in their sport (weather monostructure or polystructur). Achilles tendon is undoubtedly the most critical part in runners (Figure 5). Painful Achilles tendon may remove athlete from training for several months. Achilles tendon is a thick fibrous bundle which connects muscle gastrocnemius lateralis and medialis, and soleus with heel. Tendinopathy is one of the most common injuries in runners. Tendinopathy means painful and swollen Achilles tendon accompanied by reduced functionality, which can cause tendinitis (inflammation) or paratenonitis (inflammation of the fascia). Tendinopathy occurs approximately 2-6 cm above tendon insertion.

Tendon pain occurs due to the high forces and long-lasting load. With tendinopathy microscopic tears occur in tendon and fascia. On tendon scar tissue begins to accumulate. The basic function of the Achilles tendon is the transmission of force generated by muscle to bone, besides it also works as shock-absorber against external forces and prevents muscle's damage. This feature requires appropriate elasticity, flexibility and tensile strength. Achilles tendon load in sprint can reaches 9 kN and 2.6 kN with slow running (Urhausen, Kindermann, 2002; Lieberman et al., 2009). At peak forces tendon can partly or totally breaks. Tendon partly can break up the first degree (when are interrupted 5% to 50% fibers) and the second degree (when are interrupted 50% to 80% fibers). Point of complete rupture occurs when tendon extends 10% to 20% of initial length.

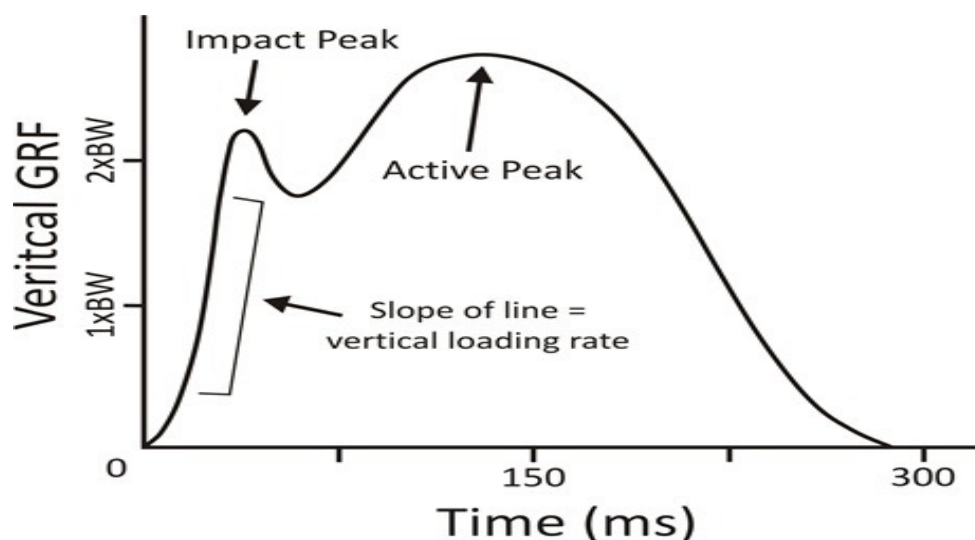


Figure 1: Vertical ground reaction force in the touch-down (Impact Peak) and take-off phases (Active Peak) (<http://www.google.si/imgres?q=site+foot+biomechanics+running>)

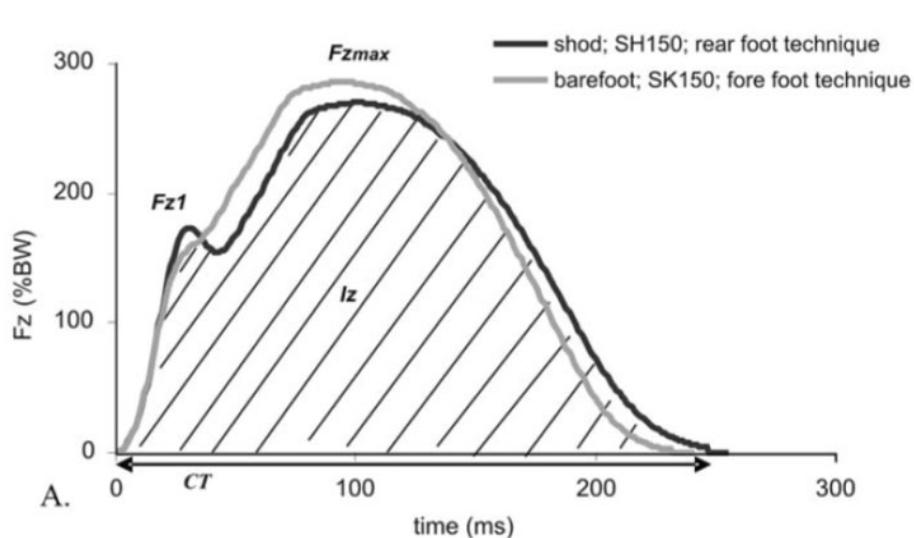


Figure 2: The differences in the development of the ground reaction force – the rear foot and fore foot techniques (<http://www.google.si/search?num=10&hl=sl&site=img&tpbm>)



Figure 3: Over 70 percent of marathon runners use the heel-strike technique.

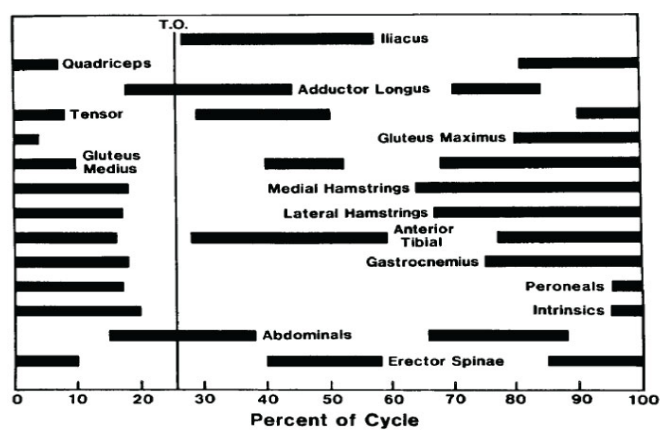


Figure 4: EMG activation of muscles in the phase of running stride ((<http://thebodymechanic.ca/2011/02/02/running-biomechanics/>))

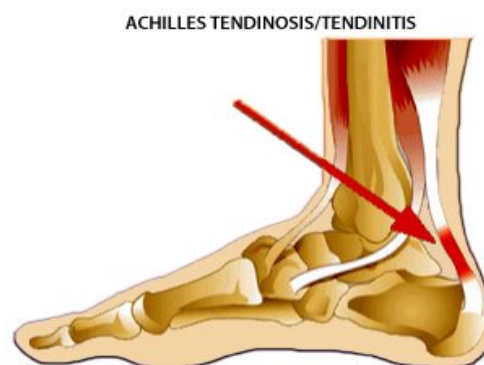


Figure 5: Tendinopathy is one of the most common injuries sustained by elite and recreational runners. (<http://www.google.si/imgres?q=achilles+tendinosis&um=1&hl=sl&sa=N&tbo=d&biw=1280&bih>)

Conclusion

In the recreational sport running and walking are the most common aerobic sports activities. Running is an integral part of many competitive sports. Walking and running are natural forms of exercise, one of the most appropriate ways of maintaining good physical fitness and wellness. There is ample evidence that walking and running reduces stress, lowers blood pressure and total blood cholesterol levels. These are all important reasons for the popularity of walking and running as a regular form of recreation, which in recent

years continually growing. Nevertheless running have indisputably proven positive impact on human, in recreational and competitive sport we have noticed growing negative effects of wrong sport training, which usually results from unadjusted and to demanding exercise programs.

Many injuries are also associated with different running content. Running can have also high load, especially for joints, ligaments, tendons and muscles of the lower extremities.

References

- Auersperger, I., Ulaga, M., & Škof, B. (2009). An expert model for determining success in middle-distance running = Ekspertni model uspešnosti za teke na srednje proge. *Kinesiol. Slov*, 15(2), 5-15.
- Cavagna, G.A., Komarek, L., & Mazzoleni, S. (1971). The mechanics of sprint running. *Journal of Physiology*, 217, 709-721.
- Daoud, A., Geissler, F., Wang, F., Saretsky, J., Daoud, Y., & Lieberman, D. (2012). Foot strike and injury rates in endurance runners: a retrospective study. *MedSci Sports Exerc*, 44(7), 1325-1334.
- Halsen, S., & Jeukendrup, A. (2004). Does overtraining exist? An Analysis of overreaching and overtraining research. *Sports Med*, 34(14), 967-981.
- Hartmann, U., & Mester, J. (2000). Training and overtraining markers in selected sport events. *Medicine and Science in Sports and Exercise*, 32(1), 209-215.
- Hasegawa, H., Takeshi, Y., & Kramer, W. (2007). Foot Strike Patterns of Runners the 15 km Point During An Elite Level Half Marathon. *Journal of Strength & Conditioning Research*, 21(3), 880-893.
- Enoka, R. (2003). *Neuromechanics of human movement*. Champaign, IL: Human Kinetics.
- Komi, P., & Nicol, C. (2000). Stretch-shortening cycle fatigue. U: McIntosh, B. and Nigg, B.(ed), *Biomechanics and Biology of Movement*. Champaign (IL): Human Kinetics.
- Lieberman, D., Venkadesan, M., Werbel, W.A., Daoud, A., D'Andrea, S., & Pitsiladis, Y. (2009). Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature* 463, 531-535.
- Mujika, I. (2009). *Tapering and peaking for optimal performance*. Champaign, IL: Human Kinetics.
- Mero, A., Komi, P., & Gregor, R. (1992). Biomechanics of Sprint Running. *Sport Medicine*, 13(6), 376-392.
- Novacheck, T. (1998). The biomechanics of running, *Gait and Posture*, 7, 77-95.
- Škof, B., & Strojnik V. (2007). The effect of two warm-up protocols on some biomechanical parameters of the neuromuscular system of middle distance runners. *J. strength cond. res.*, 21(2), 394-399.
- Urhausen, A., & Kindermann, W. (2002). Diagnosis of overtraining. What tools do we have? *Sports Med*, 32(2), 95-102.
- Zatsiorsky, V., & Kraemer, W. (2006). *Science and Practice of Strength Training*. Champaign IL: Human Kinetics.

EKSTREMNO OPTEREĆENJE LOKOMOTORNOG SISTEMA KOD TRČANJA

Sažetak

Hodanje i trčanje su prirodni način ljudskog kretanja. Danas je trčanje učinkovita aerobna vježba za održavanje vitalnih funkcija, naročito kardiovaskularnih i dišnih funkcija. Suvremenom čovjeku nedostatak kretanja rezultira brojnim zdravstvenim problemima i općenito smanjuje kvalitetu života. Pozitivan utjecaj tjelovježbe je dokazan izvan svake sumnje, ali mi također možemo vidjeti rastuće negativne učinke tjelovježbe, koji su obično posljedica neprilagođenih i prezahtjevnih programa vježbanja. Hodanje i trčanje su tipično ljudske i najučinkovitiji zdravstvene djelatnosti, ali trčanje može prouzročiti veliki teret na zglobovima, kostima, tetivama, ligamentima i mišićnom sustavu. Negativni učinci tjelesne vježbe se očituju u obliku preopterećenja što često dovodi do povreda. Ozljede u trčanju i njihov razvoj odvija se na početku relativno nezapaženo, a očiti simptomi s vidljivim posljedicama javljaju se relativno kasno.

Ključne riječi : biomehanika, trčanje, tehnika, ekstremna opterećenja

Received: January 24, 2013

Accepted: June 10, 2013

Correspondence to:

Prof. Milan Čoh, Ph.D.

University of Ljubljana

Faculty of sport

1000 Ljubljana, Gortanova 22, Slovenia

Phone: +386 (0)520 7700

E- mail: Milan.Coh@fsp.uni-lj.si

SPORT PEDAGOGY APPLIED TO THE KNOWLEDGE OF THE MARRIAGE OF SPORTS AND TRAINING OF THE PERSON

Francesco Perrota and Angelo Pannelli

Department of Education, University of Macerata, Italy

Review paper

Abstract

The sport in Italy involving tens of thousands of young people with passion and dedication to train, play and compete under the constant guidance of coaches and instructors. You make a reflection, because the sport is not education per se, as also all other human activities. Being based on the difference physical and athletic that is increasingly enhanced and emphasized in the race, the sport is not for everyone and anyone who has had experience of racing knows that the important thing is not to participate, but that the very structure of the sport expected to looking for the win and you play to win. The task of the instructors, coaches is to move slightly accents where you practice sport at youth level: youth sport has its dynamics and its specificity if he wants to be educational, and therefore must be something more and something different from only sport. Then it should be possible for a coach or a trainer working for the practice of a sport education, focusing on the material elements of the sports event, such as the rules of the game, materials, field, opponents and turn them into option education.

Key words: sport, pedagogy, growth, value of sport, motor skills, integration, lifestyle

Introduction

The sport in Italy involving tens of thousands of young people with passion and dedication to train, play and compete under the constant guidance of coaches and instructors .. You make a reflection, because the sport is not education per se, as also all other human activities. Being based on the difference physical and athletic that is increasingly enhanced and emphasized in the race, the sport is not for everyone and anyone who has had experience of racing knows that the important thing is not to participate, but that the very structure of the sport expected to looking for the win and you play to win. The task of the instructors, coaches is to move slightly accents where you practice sport at youth level: youth sport has its dynamics and its specificity if he wants to be educational, and therefore must be something more and something different from only sport, then it should be possible for a coach or a trainer working for the practice of a sport education, focusing on the material elements of the sports event, such as the rules of the game, materials, field, opponents and turn them into option education. From this basic idea, it should be noted that the technical aspect covers approximately 50% of the work required to build and manage a team at youth level in an engaging and educational. Do not understand why then work in the field should be for 99.9% of an exclusively technical. Also because we firmly believe to have personally experienced that a team of guys with whom he has worked seriously on the size of the team spirit, the changing climate, the management of emotions is even more ready to absorb the technological and especially to play better. . Education through sport, it is a strong message that should be disseminated by the small team in a small town to

a big club in a big city. Many, like us, share it and put it into practice every day, on the fields of the province or in gyms disputed by the minute. We would like to show some evidence of reflection for those who love the sport, and those who despise him not knowing, but preserves the love for young people and curiosity about a world which mobilize massively their emotions.

Material and methods

Sport, education of the person.

Sport is synonymous with competition, conflict, rivalry, leadership and challenge to the last breath with the dominance of its competitive, more crucial to enhance the values related more to the fight and the contrast between the contenders that meeting, the comparison and the discovery of self and other. Meeting, discussion and discovery that underlie the growth and formation of the person, a pedagogy capable of driving the subject for the construction and sharing of basic rules of social life, to discover and experience the values of tolerance, loyalty, solidarity, fraternity and belonging. A purpose and an educational path are the two concepts that travel in harmony with each other, allow us to understand how their own body, movement and sport promotes awareness of self, environment and possibilities of movement, and also contribute , the formation of the personality of the student through knowledge and awareness of one's bodily identity. In the common meaning today want to sport a physical activity that is carried out on at least three different levels of emotional investment: for competition, for fun, as a healthy activity. These levels are anthropologically and psychologically acceptable if they occur together and integrated with each

other, without the prevalence of a reason other. In particular, the speech that we intend to do, a redefinition is necessary just because we want mark the meanings of education and training, being men, that sport still can be expressed even if, in my opinion these meanings are covered masked and modified by many influences pollutants. Sport, for us, is as a vehicle for growth and, as a metaphor of shared challenge and tension to success, the shared objective, the importance of the role, respect and the ability 'to manage the skills that are here now joined training of a sports team and make a unique team. Success is not only given dale technical skills, but the ability to use these skills for the good of their own and their team, such as: - Sense of belonging to a group; - Discovery of values; - Development of problem solving skills and proactivity; - Acceptance of the challenges and the ability to learn from mistakes; - Management of emotions (fear, shyness, aggressiveness) and expansion of self-esteem. The sports training as well conducted in children and adolescents can get some results. Starting from the basic idea that sport is an activity specifically psychomotor activity, that is, that necessarily combines physical condition with psychological cognitive and emotional skills, and as such are tied to experiences that are then conditioning on subsequent behavior. The purpose of a sport training in childhood can be summarized as follows: - Build a harmonious development of the individual through the expression of personal skills both physical and mental, through compensatory mechanisms of deficiencies and inconveniences; - Establish a habit to finalize a healthy competitiveness in a complementary relationship with the cooperation and sharing; - Increase self-esteem as a basic element of personal safety starting from the concrete bodily ego involved and built in attachment dynamics - Contain finalize in a constructive relational aggression both physiological and reactive; - Enable the ability to ask, understand and follow the rules of the game. This can be achieved through an educational relationship that tends not only to train both the body and the mind in that specific discipline, but also to facilitate an awareness of what you do and what happens, but also of bodily sensations and emotions. This element of awareness is essential for the formation because it is the essential basis to develop a sense of the limits and possibilities that builds the critical sense which is the correct expression of a mature personality and balanced. Fundamental to conclude this speech is to try to define what is meant by educational relationship, because a relationship of this kind is needed to give meaning and return to sport training in children and adolescents. The concept of education has had in the history of thought, and several different definitions, always in tune with the ideologies historically and culturally determined. With the emergence of psychology and pedagogy that although human sciences, have agreed to also be based on an epistemological

status of science, things have changed in the sense that the measure of the method and often the content of education are no longer ideologically arbitrary. This ultimately means that a good education should take into account the developmental level of the student and the quality of the relationship between the teacher and teaching. And 'now established that the children, and those in children in general, have shown a sensitivity and a chance to learn different depending on age, in close relationship to the level of cognitive and emotional maturation and in relation to meaningful relationships on which they depend in much of the motivation to learn. Teachers in the school should educate children and adolescents in sport. I personally believe that educating means helping each other to come out, to manifest, to be brought about by its potential. Children need to play, as a top priority in their lives. through the game to learn how to live. the other is not required, are not adults. it is important to give to the children the experience of moving, fun gameplay related. In addition, today's children live in the house paradoxically, where you created a fake reality that makes up the real one, move, for example, in front of an instrument called wii fit that simulates reality. The child thinks of walking, because the video before he throws a tree-lined avenue, a meadow, clouds, obstacles, but in reality really has not moved, has not breathed the air outside, has not run out , nor has come really a way. Therefore, we need to return to the street game, but where this is not possible, the experience of the sport played out, as a group, makes up beautifully to it, I remember from our childhood. The European Union and the World Health Organization have identified promotion of education "LIFE SKILLS", one of the priorities of educational policies and interventions to promote among the younger generations and adults, such as: - Problem Solving, address and solve everyday problems in a constructive way, - Critical Thinking and Creative Thinking, analyze the situation in detail, exploring alternatives and finding original solutions, - Effective communication, express yourself in a manner appropriate to the situation and the interlocutor, both verbal and non-verbal level - Empathy, recognize, discriminate, share the emotions of others - Managing emotions and stress management, recognize and regulate their emotions and states of tension - Effectiveness staff, to effectively organize a series of steps in order to cope with new situations, trials and challenges - Effectiveness collective system of values and beliefs shared by a group about the ability to achieve common goals.

Conclusion

For us, education means, basically, propose a target and accompany him to his pursuit, train, educate, fatigue, perspiration. With regard to propose a target and accompany him to his pursuit, we must help children to appreciate diversity, to overcome the fear of becoming, to have courage, to design the game as inner

wellbeing besides physical, to be comfortable in the group, appreciating the contribution of all, without exception, not to give up in the face of difficulties. With regard to the objective dell'allenare, we must train the children to be able to face the difficulties, so that they can solve them, because you can risk life and you can go forward, fall thanks to them, to get up and continue the race.

The error must not be seen in a negative way, but positive, as it is the cornerstone of all progress and any improvement, then, err means progress, life such as sports, proceeding to problems and errors, and only at the end, through mistakes, you can improve its performance.

Train children and adolescents to overcome the errors mean give them strength from within, so as to give them a good reason to always face the inevitable difficult situations that arise in their lives. Goal of any sound education is to ensure that children acquire the inner strength to get back in the game, not give in to despair. With regard to the education effort and sweat, we must educate and modulate the experiences that require waiting, the realization of its objectives, in order to bring the kids to build their own making, or better, to grow and not be afraid because children and adolescents the capture and adapt accordingly. Our task will be to help children to form their future, so that we can grow adolescents ready to compete in adult society.

References

- Agosti, E. (1989). *La preparazione psicologica dell'atleta*. Roma: S.d.S. CONI.
- Antonelli, F. (1977). *Psicologia dello sport*. Roma: Società Stampa Sportiva.
- Baggi, S., & Cappellini, S. (1991). *Corso pratico di training autogeno*. Roma: De Vecchi Editore.
- Ballanti, G. (1991). *Analisi e modificazione del comportamento insegnante*. Roma: Giunti e Lisciani.
- Ballanti, G. (1991). *Modelli di apprendimento e schemi di insegnamento*. Roma: Giunti e Lisciani.
- Ballanti, G., & Fontana, L. (1989). *Discorso e azione nella pedagogia scientific*. Roma: Giunti e Lisciani.
- Berti, A., & Bombi, A. (1985). *Psicologia del bambino*. Roma: Ed. Il Mulino.
- Bortolotti, A. (1989). *Tecniche di autodistensione*. Roma: La casa verde.
- Bruner, J.S. (1982). *Il Conoscere*. Roma: Ed. Armando.
- Calligaris, A. (1991). *Elementi di psicologia dell'allenamento sportive*. Roma: Società Stampa Sportiva.
- Cratty, B.J., & Pigot, R.E. (1988). *Psicologia dello sport*. Roma: Società Stampa Sportiva.
- De Landsheere, G. (1990). *Come si insegna*. Roma: Giunti e Lisciani.
- Dussault, G., Leclerc, M., Brunelle, J., & Turcotte, C. (1991). *L'analisi dell'insegnamento*. Roma: Armando.
- Farne, M., Calderaro, G., & Pozzi, U. (1980). *Il training autogeno di J.H. Schultz*. Roma: Giunti Barbera.
- Ghirelli, G. (1989). *Il gruppo sportivo: elementi di psicologia sociale*. Roma: S.d.S. CONI.
- Hanggi, R. (1989). *Elementi di psicologia dello sviluppo*. Roma: Società Stampa Sportiva.
- Kappas, J.G. (1984). *L'autoipnosi nello sport*. Roma: Edizioni Mediterranee.
- Levi, S. (1983). *I problemi dello sviluppo*. Roma: Giunti Barbera.
- Lodispoto, A. (1972). *Tecniche di rilassamento e training autogeno*. Roma: Fiap.
- Leontjev, L.V. (1970). *Psicologia e pedagogia*. Roma: Editori Riuniti.
- Mascellani, A. (1982). *Igiene mentale e sport*. Roma: AIPS FMSI.
- Moates, D.R., & Schumacher, G.M. (1983). *Psicologia dei processi cognitive*. Roma: Il Mulino.
- Most, P.H. (1983). *Psicologia dello sport*. Roma: Masson.
- Muzio, M. (1983). *Aspetti psicologici dell'età evolutiva*. Roma: Centro Studi e Ricerche Fidal.
- Muzio, M. (1988). *Psicopedagogia dello sport*. Roma: Edi Ermes.
- Norman, D.A. (1981). *Memoria e attenzione*. Roma: Franco Angeli Editore.
- Oliverio, A. (1986). *Biologia e comportamento*. Roma: Zanichelli.
- Oserov, P. (1984). *Sviluppo psicomotorio degli atleti*. Roma: Società Stampa Sportiva.
- Petter, G. (1984). *Lo sviluppo mentale nelle ricerche di Jean Piaget*. Roma: Giunti Barbera.
- Piaget, J. (1967). *Lo sviluppo mentale del bambino*. Roma: Einaudi.
- Pieron, M. (1989). *Metodologia dell'insegnamento dell'educazione fisica e dell'attività sportive*. Roma: SSS.
- Porzi, S. (1996). *Rapporto tra componente psicologica e prestazione*. Roma: Centro Studi Fidal.
- Rosa, K.R. (1975). *Cos'è il training autogeno*. Roma: Sugarco.
- Saibene, F., Rossi, B., & Cortili, G. (1986). *Fisiologia e psicologia degli sport*. Roma: Mondadori.
- Schultz, J.H. (1977). *Il training autogeno*. Roma: Feltrinelli.
- Sonato, R. (1993). *Combattere ansia, stress e insomnia*. Roma: La casa verde.
- Sonato, R. (1993). *Terapie e tecniche naturali per combattere ansia, stress, insomnia*. Roma: La casa verde.
- Thomas, K. (1984). *Autoipnosi e training autogeno*. Roma: Edizioni Mediterranee.
- Traetta, T.E. (1988). *Tecniche d'intervento psicosomatico applicate allo sport*. Roma: Società Stampa Sp.
- Tubi, V. (1983). *Eutonia e training autogeno*. Roma: Società Stampa Sportiva.
- Wallon, H. (1974). *L'origine del carattere nel bambino*. Roma: Editori Riuniti.
- Weiner, I.R., & Elkind, D. (1973). *Lo sviluppo umano, mentale e fisico, individuale e sociale*. Roma: AAE.
- * * * (1992). AA. VV. *L'allenatore vincente*. Roma: Società Stampa Sportiva.
- * * * (1996). AA. VV. *Scienze sociali per operatori sportive*. Roma: S.d.S. CONI.
- * * * (1982). AA. VV. *Sport, sviluppo umano, socializzazione – Atti Convegno*. Roma: S.d.S. CONI.

SPORTSKA PEDAGOGIJA PRIMJENJENA NA SPOZNAJU 'ŽENIDBE' SPORTA I USAVRŠAVANJA OSOBE

Sažetak

Sport u Italiji uključuje desetke tisuća mladih ljudi sa strašću i predanošću za trening, igru i natjecanja pod stalnim vodstvom trenera i instruktora. Moguće je napraviti svoj image, jer sport nije obrazovanje po sebi, baš kao i sve druge ljudske aktivnosti. Budući se temelji na razlici, fizičkoj i atletskoj, treba sve više jačati i naglašavati razlike u natjecanju, pa dakle sport nije za svakoga, I svatko tko je imao iskustvo utrke zna da nije važno sudjelovati, već da se po samoj strukturi sporta očekuje potraga za pobjedom, i igra se na pobjedu. Zadatak instruktora, trenera je da postavi jasan naglasak kako ćete vježbati na svojoj razini: sport mladih ima svoju dinamiku i specifičnost ako nastoji biti edukativan, ali svejedno treba biti nešto više i nešto drugačije od samo sporta. Tada postaje moguće da trener radeći na praksi sportske edukacije, fokusiran na materijalne elemente sportskog događaja, poput pravila igre, materijala, polja, oponenta i pretvori sve to u opciju obrazovanja.

Ključne riječi: sport, pedagogija, rast, vrijednost sporta, motorika, integracija, životni stil

Received: April 25, 2013

Accepted: June 10, 2013

Correspondence to:

Assoc.Prof.Francesco Perrotta, PhD.

Univesity of Perugia

Faculty of Sports Science

06100 Perugia, P.zza. Università 1, Italy

Phone: +075 5851

E-mail: francescoperrotta@msn.com

MOVEMENT REGULATION OF THE GLIDE KIP IN GYMNASTICS

Thomas Heinen¹, Katrin Apitius¹, Farhang Mirzaie¹,
Marc Nicolaus¹ and Pia Maria Vinken²

¹ University of Hildesheim, Institute of Sport Science

² University of Hanover, Institute of Sport Science

Original scientific paper

Abstract

Successfully performing the glide kip in gymnastics depends on how the feet can pass the ground below the bar. The aim of this study was to examine the perceived size of the space between the bar and the ground operating as an informational source in the regulation of the glide kip in gymnastics. It was hypothesized that parameters that are spatially related to this informational source should vary as a function of the distance between bar and mats. To test this hypothesis, N = 13 gymnasts were asked to perform glide kips, while the size of the space between the bar and the mat was systematically manipulated. Results revealed that the distance of the tiptoes to the ground was regulated in an invariant manner based on the perceived space between the bar and the mat during the glide phase. Regulating the distance of the tiptoes may serve as a visual reference in the performance of a glide kip in a constrained movement situation. It is stated that knowledge about relationships between informational sources in the environment and the resulting regulatory processes in gymnasts may help coaches to develop specific training programmes for the acquisition of complex skills.

Key words: visual perception, constraints, artistic gymnastics, complex skill performance

Introduction

In gymnastics the glide kip is a fundamental skill for beginners and also an important skill for expert gymnasts when performing compulsory and optional routines in training and competition (Arkaev & Suchilin, 2004). Successfully performing the glide kip primarily depends on how the feet can pass the ground below the bar, since the space available below the bar significantly constraints the skill. This is especially true, if the kip is performed on the lower bar of the uneven bar apparatus or on a lowered high bar apparatus which is a typical training aid in gymnastics (Turoff, 1991). Skilled gymnasts are thought to perceive relevant environmental information directly and use that information to regulate their movements (Raab, de Oliveira, & Heinen, 2009).

However, the question arises, on which informational source(s) this regulation is based on when performing gymnastics skills in environmentally constrained movement situations? The aim of this study therefore was to examine the perceived size of the space between the bar and the ground operating as an informational source in the regulation of the glide kip in gymnastics. Comprehensive work has been done regarding the biomechanical analysis of the glide kip in gymnastics (e.g., Brüggemann, 1994; Reid & Kopp, 1983; Mooney, 1977). For instance, coordination profiles of the body joints and segments together with the trajectory of the center of mass were analyzed in order to gain a better understanding of the mechanisms of the kip movement. Lately, even complex simulation models utilizing and examining different optimization approaches when performing a glide

kip have been developed in the mentioned context (e.g., Dareru, Joo, & Miyazaki, 2000; Yamasaki, Gotoh, & Xin, 2010). However, research has thus far neglected the role of visual information in the performance of a glide kip in gymnastics. Research on human locomotion and obstacle avoidance as well as on human grasping tasks highlight the role of visual information in (end point) trajectory formation and control (Jeannerod, Arbib, Rizzolatti, & Sakata, 1995; Patla, 1997).

Visual information about the environment is integrated with information due to self-motion in order to plan and adjust the movement kinematics based on the circumstances of the movement situation (Raab et al., 2009), and recent theoretical approaches argue that athletes in general use the information that can directly guide their action (Withagen & Michaels, 2005). From the outlined perspective, the main aim of the current study was to examine the role of the space between the bar and the ground in the regulation of the glide kip in gymnastics. It was hypothesized that the perceived size of the space between the bar and the mat not only constraints kip performance but is also a relevant informational source for performing a glide kip. Parameters that are spatially related to this informational source, such as the distance of the tiptoes to the ground, should vary as a function of the distance between bar and mats. To test this hypothesis, gymnasts were asked to perform glide kips in a constrained movement situation, while the size of the space between the bar and the mat was systematically manipulated.

Methods

Participants

$N = 13$ female gymnasts (age: 15 ± 2 years, body weight: 40 ± 8 kg, body height: 159 ± 0.12 cm, average training: 8 ± 2 years). Gymnasts reported to participate in the regional championships. At the beginning of the experiment, the gymnasts gave their informed written consent. The experiment was carried out in accordance with the ethical guidelines and the approval of the university's ethical committee. The gymnasts were not explicitly informed about the experimental manipulation to ensure that they remained in principle naive to the experimental conditions.

Task and Measures

The experimental task was a glide kip on a high bar apparatus simulating the lower bar of women's uneven bars. Figure 1 presents a stick-figure sequence of the experimental task. The high bar was adjusted to a height of 1.70 meters from the ground and standard gymnastics mats of different heights were put below the bar. Each mat had a length of 1.58 meters. From an upright stance in front of the bar, the gymnast placed her hands on the bar and slightly bended her knees for a small initial jump prior to the glide phase of the kip. The glide phase comprised the downswing and the sweep towards the turning point at the end of the glide phase. The glide phase is usually characterized by an extension of the hip angle whilst the shoulder angle remains extended. At the end of the glide phase the gymnast flexes her hips and brings her toes towards the bar. Immediately before the toes would contact the bar, the gymnast performs a coordinated action of extending and blocking the hips whilst pushing the arms actively towards the bar (kip phase). This kip maneuver enables the gymnast to reach a support position (cf., Mooney, 1977).

Experimental Protocol

The gymnasts had to perform $n = 4$ glide kips in each of three experimental conditions, and in the baseline condition for a total of 16 kips (Figure 2). In all conditions the high bar was set at a height of 1.70 meters from the ground. In the first condition (*baseline condition*), a stack of standard gymnastics mats was put under the bar giving an approximate height of 0.22 meters from the ground. In the second condition, the mats on the backside of the bar were lowered to a height of 0.11 meters (*lowered mat condition*) whilst in the third condition the mats on the back side of the bar were elevated to a height of 0.33 meters (*elevated mat condition*). The fourth condition comprised an elevated stack of mats of 0.33 meters height in front of and behind the bar (*elevated base condition*). Each gymnast began with performing the four kips in the baseline condition. Following this, the remaining three experimental conditions were presented to the participating gymnasts in a blockwise and randomized order.

Kinematic Analysis

A digital video camera recorded the glide kip. The optical axis of the camera was adjusted to the plumb line from the bar to the mats beyond the bar. The camera was placed 15.00 meters away from the bar, ensuring that the complete skill could be recorded. The camera thus captured visual field of approximately 3.40 meters width. The visual field was calibrated by means of a 3.00×2.00 meter calibration frame (Enoka, 2002). The camera operated with a sampling rate of 120 Hertz (temporal error: ± 0.00833 s) and at a spatial resolution of 640×480 pixels (spatial error: ± 0.005 m). A reflective marker was attached to the right toe. The horizontal and vertical coordinates of this marker were extracted from the videotaped sequences using the movement analysis software Simi Motion© version 8.5 (Simi Reality Motion Systems, 2012). From the position data of the marker the distance of the tiptoes to the mat was calculated.

Procedures

The experiment was conducted in three phases. All participants were tested individually. In the first phase the gymnast arrived at the gym and completed the informed consent form. The gymnast was informed about the general purpose and the procedure of the study. In particular, the gymnast was told that she takes part in a study on the kinematics of the glide kip on the uneven bars. Afterwards the gymnast was given a 20-minute individual warm-up phase. At the end of the warm-up the gymnast was allowed three practice trials in which the bar height and the mat level height were set to the values of the baseline condition. This was done to ensure that gymnasts' motor system was adjusted to the particular apparatus used in our study (Enoka, 2002). The second phase took place after the three practice trials were completed. The gymnast was asked to perform four glide kips in the baseline condition and in each of the three experimental conditions for a total of 16 glide kips. The experimental conditions were presented in a blockwise fashion. The order of the three blocks was randomized for each gymnast. The gymnasts were not explicitly informed about the experimental manipulation to ensure that they remained in principle naive to the experimental conditions. After performing four kips in each condition, the gymnast was asked to take a short 5-minute break in the locker room. During this period the mats were rearranged according to the gymnasts' individual experimental protocol. When performing the glide kips in each condition, breaks were allowed as requested. There was no time pressure during the experiment. After the 16 glide kips were completed, the gymnast was given a 20-minute individual cool-down phase. A manipulation check was conducted by asking the gymnast if she had perceived any experimental manipulation during the experiment, and if she performed the glide kips different due to that perception. All gymnasts indicated that they had perceived the different situation of the mats below the bar.

However, none of the gymnasts reported having performed the glide kips differently. After the manipulation check the gymnast was debriefed.

Data Analysis

First, the time courses of the distance of the tiptoes to the ground were averaged and time-normalized for all trials of each gymnast and each condition. For the time-normalization the beginning of the glide phase was set at 0% and the end of the pike phase was defined as 100% of the time-course (Figure 3). Second and given that regulative processes may occur at several parts in the time-course, significant events in the time course of the experimental condition (initial values, local minima) which were related to the main hypothesis of this study, were subjected to the statistical analysis. In particular and in order to assess differences in distance of the tiptoes to the ground between the experimental conditions, *t*-tests for paired samples were calculated, and a significance criterion of $\alpha = 5\%$ was defined for all reported results (O'Keefe, 2003).

Results

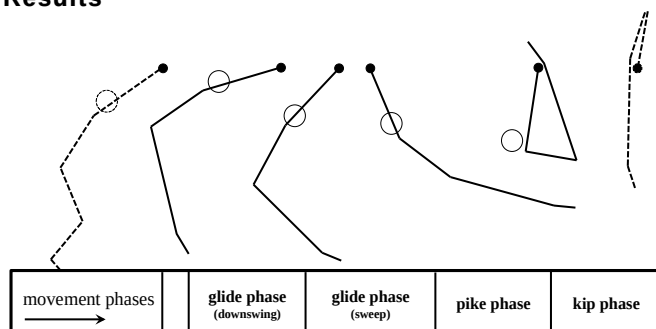


Figure 1. Stick-figure sequence and corresponding movement phases of the glide kip in gymnastics (cf., Mooney, 1977)

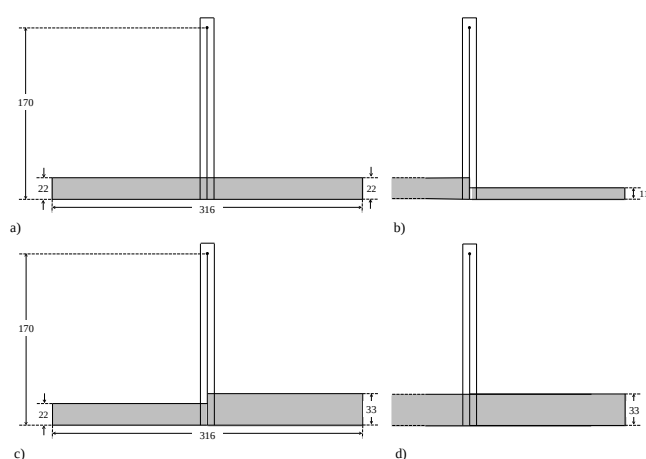


Figure 2. Illustration of the four conditions realized

Illustration of the time-normalized course of the distance of the tiptoes to the ground in the baseline condition (BL) and the three experimental conditions (LM = lowered 2nd mat, BL = baseline, EM = elevated 2nd mat, EB = elevated base, cf., Figure 2).

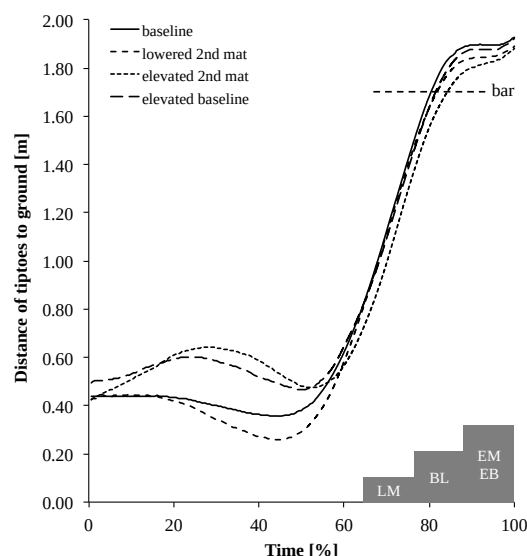


Figure 3. Illustration of the time-normalized course

Notes: The grey rectangles in the Figures' lower right hand corner illustrate the height of the mats below the bar. For better readability the standard deviations were omitted from the Figure. A time of 0% indicates the beginning of the glide phase and a time of 100% indicates the end of the pike phase (cf., Figure 3). Illustration of the four conditions realized in this study: a) baseline condition, b) lowered 2nd mat, c) elevated 2nd mat, d) elevated base. **Note:** Gymnasts always started on the left side of the bar while grasping the bar (cf., Figure 2). It was expected that the perceived size of the space between the bar and the mat is a relevant informational source for performing constrained swinging in gymnastics in general, and for performing the glide kip in particular. It was argued that parameters that are spatially related to this distance, such as the distance of the tiptoes to the ground, should vary as a function of the distance between bar and mats. Figure 3 presents the time-normalized course of the distance of the tiptoes to the ground in the *baseline condition* and in the three experimental conditions. It can be seen that in the *baseline condition* and the *lowered mat condition* tiptoes are continuously lowered from the beginning of the glide phase (= 0%) towards approximately 50% of the time course (end of the glide phase). They are raised afterwards continuously toward the end of the pike phase (= 100%). In the *elevated mat condition* and in the *elevated baseline condition*, the tiptoes are initially raised (25-30% of the time-course). They are then lowered towards the end of the glide phase and they are raised again towards the end of the pike phase. Complementary to the description of the time-course, two particular and statistically significant results should be emphasized here. First, at the beginning of the glide phase (= 0% in the time-course) there were significant differences in the distance of the tiptoes to the ground between the *elevated baseline condition* (mean: 0.49 ± 0.06 m) and the remaining three conditions (mean: 0.42 ± 0.06 m), $t(12) = 2.225$, $p = .046$, Cohens $d = 0.65$.

However, when normalizing the average distance of the tiptoes to the height of the mat, the significant difference disappeared, indicating that the distance of the tiptoes to the ground is regulated based on the perceived space between the bar and the mat already at the beginning of the glide kip. On average gymnasts exhibited a distance between the tiptoes and the mat of 0.20 ± 0.06 meters. Second, towards the end of the glide phase there were significant differences in the minimal distance of the tiptoes to the ground between the *baseline condition* (0.35 ± 0.05 m) and the *lowered mat condition* (0.26 ± 0.05 m), $t(12) = 7.280$, $p < .05$, Cohens' $d = 2.08$, between the *baseline condition* and the *elevated mat condition* (0.476 ± 0.05 m), $t(12) = 6.918$, $p < .05$, Cohens' $d = 2.00$, between the *baseline condition* and the *elevated base condition* (0.464 ± 0.05 m), $t(12) = 5.767$, $p < .05$, Cohens' $d = 1.66$, between the *lowered mat condition* and the *elevated mat condition*, $t(12) = 14.268$, $p < .05$, Cohens' $d = 4.11$, and between the *lowered mat condition* and the *elevated base condition*, $t(12) = 12.115$, $p < .05$, Cohens' $d = 3.46$. However, when normalizing the average distances of the tiptoes to the height of the stack of mats behind the bar, the significant differences disappeared, indicating that also the glide phase is regulated based on the perceived space between the bar and the mat. On average, gymnasts exhibited a minimal distance between the tiptoes and the mat of 0.14 ± 0.05 meters towards the end of the glide phase.

Discussion and conclusion

The main goal of this study was to investigate the role of the perceived space between the bar and the mat in the regulation of the glide kip in gymnastics. This goal was approached by asking gymnasts to perform glide kips while the size of the space between the bar and the mat was systematically manipulated. It was hypothesized that the perceived size of the space between the bar and the mat not only constraints kip performance but is also a relevant informational source for performing a glide kip. Taking the results of the current study together, it becomes apparent that gymnasts utilize the perceived space between the bar and the mat as an informational source to control the glide kip in

gymnastics. The distance of the tiptoes to the mat seems to be regulated in an invariant manner already prior to the beginning of the glide phase since the average tiptoes-mat distance was invariant between the experimental conditions. The same pattern of results emerged for the distance of the tiptoes to the mat during the glide phase. Taken together, this result is in line with studies aiming at examining the role of different informational sources on movement kinematics (cf., Heinen, Jeraj, Thoeren, & Vinken, 2011). It can thus be argued that visually perceiving the space between the bar and the mat guides the performance of the glide kip in gymnastics. Regulating the distance of the tiptoes to the mats in an invariant manner may therefore serve as a visual reference in the performance of a glide kip in a constrained movement situation (Davids, Button, & Bennett, 2008; Raab et al., 2009). An advantage of utilizing vision in the glide kip is that it may enable the gymnast to make small corrections throughout the glide phase, which may enable her to reach an adequate piked position prior to the kip phase. In this sense it may also enable the gymnast to adjust the glide phase in every trial to accurately perform the pike and kip phase with an optimal movement quality. However, setting the height of the bar is still common training practice in gymnastics.

Gymnasts typically start from the same position and the same height when performing glide kips on the uneven and/or parallel bars. This, however, ignores the potential effects of a variable training schedule, which could potentially equip the gymnast with the necessary experience to adjust for changing environments in training and competition (Schmidt & Wrisberg, 2008). Therefore, the coach should encourage learners to practice the glide kip under varying conditions. This can easily be achieved by practicing the kip on bars of different heights together with different initial positions. It is stated, that gymnasts regulate the glide kip in a constrained movement situation on the basis of the visually perceived space between the bar and the mat. Knowledge about relationships between informational sources in the environment and the resulting regulatory processes in gymnasts may help coaches to develop specific training programs for the acquisition of complex skills.

References

- Arkaev, L.I., & Suchilin, N.G. (2004). *How to create champions. The theory and methodology of training top-class gymnasts*. Oxford: Meyer & Meyer Sport.
- Brüggemann, G.P. (1994). Biomechanics of gymnastic techniques. *Sport Science Reviews*, 3, 79-120.
- Buneo, C.A., Jarvis, M.R., Batista, A.P., & Andersen, R.A. (2002). Direct visuomotor transformations for reaching. *Nature*, 416, 632-636.
- Davids, K., Button, C., & Bennett, S. (2008). *Dynamics of skill acquisition: A constraints-led approach*. Champaign, IL: Human Kinetics.
- Heinen, T., Jeraj, D., Thoeren, M., & Vinken, P.M. (2011). Target-directed running in gymnastics: the role of the springboard position as an informational source to regulate handsprings on vault. *Biology of Sport*, 28, 215-221.

- Jeannerod, M., Arbib, M.A., Rizzolatti, G., & Sakata, H. (1995). Grasping objects: the cortical mechanisms of visuomotor transformation. *Trends in Neurosciences*, 18(7), 314-320.
- Mooney, C.M. (1977). *A cinematographic analysis of a glide kip on the uneven parallel bars*. Unpublished Thesis. Texas: Texas Tech University, USA.
- Nakawaki, D., Joo, S., & Miyazaki, F. (2000). Multi-model based analysis of a gymnastic movement on the horizontal bar. *Journal of the Robotics Society of Japan*, 18(1), 59-65.
- O'Keefe, D.J. (2003). Colloquy: Should familywise alpha be adjusted? Against familywise alpha adjustment. *Human Communication Research*, 29(3), 431-447.
- Patla, A.E. (1997). Understanding the roles of vision in the control of human locomotion. *Gait & Posture*, 5(1), 54-69.
- Raab, M., de Oliveira, R.F., & Heinen, T. (2009). How do people perceive and generate options? In M. Raab, H. Hekeren, & J.G. Johnson (Eds.), *Progress in brain research: Vol. 174. mind and motion: The bidirectional link between thought and action* (pp. 49-59). Amsterdam, NL: Elsevier.
- Reid, J.G., & Kopp, P.M. (1983). A force-torque analysis of the kip on the horizontal bar. *Canadian Journal of Applied Sport Sciences*, 8(4), 271-275.
- Schmidt, R.A., & Wrisberg, C.A. (2008). *Motor learning and performance* (4th ed.). Champaign, IL: Human Kinetics.
- Turoff, F. (1991). *Artistic gymnastics. A comprehensive guide to performing and teaching skills for beginners and advanced beginners*. Dubuque, IA: Wm. C. Brown Publishers.
- Vickers, J.N. (2007). *Perception, cognition, and decision training. The quiet eye in action*. Champaign, IL: Human Kinetics.
- Withagen, R., & Michaels, C.F. (2005). The role of feedback information for calibration and attunement in perceiving length by dynamic touch. *Journal of Experimental Psychology: Human Perception and Performance*, 31(6), 1379-1390.
- Yamasaki, T., Gotoh, K. & Xin, X. (2010). Optimality of a kip performance on the high bar: an example of skilled goal-directed whole-body movement. *Human Movement Science*, 29, 464-482.
- * * * (2012). *Simi Motion version 8.5*. Germany: Unterschleissheim.

REGULACIJA POKRETA KLIZNE SKLOPKE U GIMNASTICI

Sažetak

Uspješno izvođenje klizne sklopke u gimnastici ovisi o tome kako stopala mogu proći tlom ispod šipke. Cilj ovog istraživanja bio je utvrditi opaženu veličinu prostora ispod između šipki i tla operativno kao informacijski izvor u regulaciji klizne sklopke u gimnastici. Pretpostavljeno je da će parametri koji su spoznajno povezani s ovim izvorom informacija varirati u funkciji udaljenosti između šipki i strunjače. Kako bi testirali ovu hipotezu, N = 13 gimnastičara je zamoljeno da izvedu sklopku, dok je prostor između šipki i strunjače bio sistematski mijenjan. Rezultati su pokazali da je udaljenost od prstiju do tla manipulirana na nepromjenjivi način temeljeno na procjeni prostora između šipki i strunjače za vrijeme klizeće faze. Regulacija udaljenosti od prstiju može služiti kao vizualna referenca u izvođenju klizne sklopke u situaciji ograničenja pokreta. Zaključeno je kako znanje o relacijama između informacijskog izvora u okruženju i rezultirajućeg procesa regulacije u gimnastici može pomoći trenerima da razviju specifične trenažne programe za usvajanje kompleksnih vještina.

Ključne riječi: vizualna percepcija, ograničenja, gimnastika, izvođenje složenih vještina

Received: February 15, 2013

Accepted: June 10, 2013

Correspondence to:

Thomas Heinen, PhD.

University of Hildesheim

Institute of Sports Science

31141 Hildesheim, Marienburger Platz 22, Germany

Phone: +49 (0)51 21 883 592

E-mail: thomas.heinen@uni-hildesheim.de

VALUES OF SPEED AND AEROBIC CAPACITY PARAMETERS AS INDICATORS OF PHYSICAL FITNESS IN U18 AND U19 SOCCER TEAMS AT THE BEGINNING OF THE PRE-SEASON PERIOD

Jaroslav Teplan, Tomáš Malý, František Zahálka and Lucía Malá

Faculty of Physical Education and Sport, Charles University in Prague, Czech Republic

Original scientific paper

Abstract

The aim of this study was to evaluate and to compare the current situation in terms of intermittent training by two elite Czech U18 and U19 team categories before the start of the pre-season period. The U18 category consisted of 17 players (age: 17.6 ± 0.3 years, body weight: 71.1 ± 5.7 kg, body height: 178.2 ± 6.9 and body fat: $10.3 \pm 1, 4\%$) and the U19 category consisted of 14 players (age: 18.3 ± 0.2 years, body weight: 74.9 ± 6.5 kg, body height: 181.5 ± 6.3 and body fat: $10.6 \pm 1.6\%$). Speed parameters were assessed using 5 and 10 m acceleration tests and maximum speed test at 20 m (flying start). For monitoring and evaluating aerobic parameters, the Yo-Yo intermittent recovery test 1 (Yo-Yo IRT1) was used. In the 5 and 10 m tests, no significant differences were found. However, a significant difference was detected in maximum speed at 20 m ($p = 0.04$). The difference in the maximum covered distance between the teams was not significant ($t_{29} = 0.60$, $p = 0.56$). Furthermore, no significant differences were observed at the maximum heart rate ($p = 0.66$), decrease in heart rate during 1 minute after the test ($p = 0.78$) and maximum oxygen consumption ($t_{29} = 0.59$, $p = 0.56$). Insignificant differences could be caused by long-term inactivity of players in the transitional period. For objectification of the results of our investigative conclusions, it would be appropriate to follow both teams throughout the duration of the competitive period.

Key words: soccer, field test, youth, aerobic parameters, Yo-Yo IRT1

Introduction

Soccer player's performance cannot be evaluated separately as factors of physical fitness, techniques, tactics and psychological factors. During the match, these factors constantly interact and mutually form an individual player's game performance (Bangsbo, Mohr, Poulsen, Gomez, & Krustup, 2006), which is important for achieving the superior aim, which is team performance. Soccer puts demands on the player in terms of physical fitness, namely strength and power, speed, agility, balance, stability, flexibility and adequate level of endurance (Bloomfield, Polman, & O'Donoghue, 2007; Malý, Zahálka, Malá, Buzek, Teplan & et al., 2012).

When assessing qualitative physical activities during the match, the most important are those performed at high intensity. High intensity is the main factor distinguishing players at the highest level (professional players) from players at the lower level (semi-professional and amateur players). High intensity actions include acceleration and maximum speed which are constantly repeated during the match (Little & Williams, 2006). Soccer is a sport characterised by intermittent load with the prevalence of aerobic energetic system. During the match, approximately 85 % of maximum heart rate (HR_{max}) occurs on average with the maximum heart rate around 98% HR_{max} (Bangsbo, 1994). In the second half, fatigue starts to appear and the amount of high intensity activities accordingly decreases. Simultaneously, the level of fine motor skills is lowered (physical and game skills).

The game performance of a player is to a large extent composed of actions without a ball (defensive – moving in the block, closing down the player, covering the space among each other, etc.; offensive – moving into free spaces and behind defenders, etc.). Sliwowski, Rychlewski, Laurentowska, Michalak, Andrzejewski & et al. (2011) suggest that only 2 % of the match is composed of player's performance with a ball. The prevalence of aerobic metabolism is primarily related to the length of the soccer match (90 minutes at least) and the total distance run by the player (Da Silva, Dittrich, & Guglielmo, 2010). In competition matches, high demands are put on the player's performance which is determined by a direction, typology, intensity and total distance run. These demands are also put on young players so that they could be successful and competitive in their age category (Da Silva, Dittrich, & Guglielmo, 2010). Players are differently loaded throughout the annual training cycle (pre-season, pre-competitive, competitive and transition period). Load intensity also varies during the weekly micro-cycle. Therefore, it is important to understand the requirements of training periods during the year and respect the demands and specificities of the match in order to prepare soccer players. For optimization and regulation of the training process, it is necessary to know the character of the match (physiological, functional, psychological and skill requirements). In the pre-season period, physical and skill-related activities, which closely relate to the match, should be developed.

The course of the game is variable and the player should be prepared to manage and quickly react to changing game situations (Silva, Santhiago, Papoti, & Gobatto, 2008), which are associated with the level of competition, the team's tactics, the style of the opponent's game and pitch quality. At the beginning of the pre-season period, players' functional state and current fitness capacity should be detected by means of diagnostics. Consequently, the results should be implemented into the training process in order to plan the physical load of each player.

For optimization or improvement of special physical preparedness for the match, it is inevitable to create specific test batteries by means of which we can monitor the course and feedback on the load during training sessions and matches, as well (Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007). One of the most important field intermittent tests described over the last decade is Yo-Yo IRT1. Yo-Yo IRT1 was created for assessment of the ability to repeatedly perform actions in high intensity at short distance (Bangsbo, Iaia, & Krstrup, 2008), which is a typical feature of a soccer match (Young, Newton, Doyle, Chapman, Cormack & et al., 2005).

Another important test for examining physical fitness include acceleration and maximum speed tests since the authors (Faude, Koch, & Meyer, 2012) found that linear sprint is the most frequent action leading to scoring a goal in professional soccer. Most of these sprints are performed without a ball and therefore the linear sprint should be a part of fitness training and testing. The aim of our study was to evaluate and compare the current state of physical fitness (aerobic and anaerobic demands) in two elite Czech U18 and U19 soccer teams of before the pre-season period.

Methods

Subjects

The research group consisted of U18 and U19 soccer players who play in the highest competitions in their age categories. Both teams belong to the same club in which the same conception of trainings is set. Throughout the weekly micro-cycle, players undergo five training sessions and one competitive match. The U18 category group was formed from 17 players (age: 17.6 ± 0.3 years, body weight: 71.1 ± 5.7 kg, body height: 178.2 ± 6.9 cm and body fat: 10.3 ± 1.4 %) and the U19 group consisted of 14 players (age: 18.3 ± 0.2 years, body weight: 74.9 ± 6.5 kg, body height: 181.5 ± 6.3 cm and body fat: 10.6 ± 1.6 %).

For more accurate data processing, we did not include goalkeepers in this study because their physical performance significantly differs from the other players and simultaneously these components do not primarily determine their performance. All players were instructed in a test protocol before the measurement.

Methods of data collecting and processing

Field testing was carried out before the summer pre-season period and after 4 weeks' transition period without regulated individual programme. Measurements were performed on artificial surfaces of the second generation. The temperature during testing was 23°C and humidity 60 %. Prior to measurements, 15 minutes warm-up guided by an assistant coach was performed, which consisted of jogging (4 min), stretching (4 min), passing the ball (4 min) and 6 sprints at 10 m (3 min). During the whole training session, players' HR was recorded by Polar RS400 heart rate monitors (Polar, Kempele, Finland). To perform speed tests, photocells (BROWER Timing System, USA), which recorded time with an accuracy of 0.01 second, were used.

Acceleration test

Acceleration was assessed by a 10 m test (A10) (Little & Williams, 2005; Wilson, Newton, Murphy, & Humphries, 1993), when at 5 m (A5) a lap time was recorded. The players started from a stationary position 0.1 m behind the photocells. They completed 2 trails, the better of which was assessed. The ratio of rest and load interval was 16:1. The 10 m test's reliability detected in senior players by average intra-class correlation coefficient was ICC = 0.81 (Mirkov, Nedeljkovic, Kukolj, Ugarković, & Jarić, 2008) and in young professional players aged 17-19 years average ICC = 0.91 (Jullien, Bisch, Largouet, Manouvrier, Carling & et al., 2008).

Maximum speed test

Maximum speed was assessed using a 20 m flying sprint test (M20) which evaluates the ability to sprint at a short distance (Little & Williams, 2005). The player completes 20 m at maximum speed after a 10 m run-up. The players completed 2 trails, the better of which was assessed. The ratio of rest and load interval was 16:1. The maximum speed test's reliability in senior players was ICC = 0.93 (Mirkov et al., 2008).

Aerobic capacity test

For monitoring and evaluation of aerobic parameters, Yo-Yo IRT1 was used according to Bangsbo (1994), Krstrup, Mohr, Amstrup, Rasgaard, Johansen & et al. (2003) a Bangsbo et al. (2008). The test includes basic actions frequently occurring in a match (reaction, acceleration, deceleration and turning) (Teplan, Malý, Zahálka, Hráský, Kaplan & et al., 2012a). It puts high demands on aerobic metabolism and thanks to this test we can assess aerobic capacity parameters such as total covered distance, VO_{2max} (obtained from a prediction equation), HR_{max} and HR decrease for a period of 1 minute after the test. Yo-Yo IRT1 consists of repeated runs at 20 m according to an audio signal which is reproduced from a CD player. After completing 2x20 m, a 10 second active rest interval follows (walking, jogging) at 2 x 5 m. The test is terminated if a player does not manage to reach the 20 m distance (audio signal) in a row or is fatigued.

We recorded total distance run and for 1 minute after the test we monitored HR decrease. Thereafter the measurement was finished. We tested 8 players at once in one measurement. We tried to motivate players to maximum effort and competition between each other. During the test, each player has its own area which was 2 m wide and 25 m long (20 m for test run and 5 m for active rest) (Figure 1). The total test time did not exceed 20 minutes for one group. During the measurement, there were two examiners at both sides of the tested area in order to control the achieved distance (marked by a cone) at a given time. Yo-Yo IRT1 is, in terms of acceleration in individual runs, designed as follows: four runs (2x20m) at speed of 10 – 13 km.h⁻¹ (0 – 160 m), seven runs at 13.5 – 14 km.h⁻¹ (160 – 440 m) and afterwards the speed is increased after completion of eight runs by 0.5 km.h⁻¹ (i.e. after 760, 1080, 1400, 1720 m, etc.) up to exhaustion. The maximum distance which can be achieved is 3640 m (Castagna, Impellizzeri, Belardinelli, Abt, Coutts & et al., 2006). To assess VO_{2max} we used a prediction equation¹ according to Bangsbo et al. (2008): ¹ VO_{2max} (ml.kg⁻¹.min⁻¹) = distance (m) × 0.0084 + 36.4

warm-up	acceleration	maximal speed	Yo-Yo IRT level 1
0-15 min	15-25 min	25-35 min	35-80 min

Figure 1. Time course of the measurement



Figure 2 Illustration of Yo-Yo IRT1

Statistical analysis

For statistical processing of the research data, we used methods of descriptive and inductive statistics. The arithmetic mean was used to identify the measure of position and standard deviation to characterise variability. The difference between the compared means in the monitored parameters was assessed by means of t-test for independent samples.

Compliance of the variances of the compared groups was evaluated by Levene's test. The significance of a difference between means of the compared group was assessed at the level of $p \leq 0.05$. The size of the observed effect between the monitored groups was assessed by Cohen's „d” coefficient. This was calculated as a difference of means of the compared parameters and divided by the pooled standard deviation (1) (Thomas & Nelson, 1996). The coefficient was further classified as follows: $d=0.20$ – small effect, $d=0.50$ – moderate effect and $d=0.80$ – large effect) (Cohen, 1992).

$$d = \frac{x_1 - x_2}{s}, \quad s_p = \sqrt{\frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{n_1 + n_2 - 2}} \quad (1)$$

Results are presented in tabular and graphical presentation. Statistics was processed using SPSS IBM ® ver. 20 software.

Results

Average values and standard deviations of the monitored parameters are listed in Table 1. In acceleration tests at 5 and 10 m, no significant difference was found between U18 and U19 groups. However, in 20m flying sprint, a significant difference in favour of the older category was detected ($p=0.04$). Players of the U18 category ran more on average in Yo-Yo IRT1 by 60 m (3.4 %) than those from the U19 group but this difference was not significant ($p = 0.56$). Younger players showed higher variability in the achieved performance when compared to the older category. Values of maximum heart rate were comparable. The difference in these values was, however, insignificant ($p = 0.66$). Heart rate recorded in the period of 1 minute after the test decreased in the U18 players by 29.7 beat.min⁻¹ and in the U19 category by 26 beat.min⁻¹. Similarly, this difference was not statistically significant ($p = 0.78$). Moreover, the level of maximum oxygen consumption in the observed groups was not statistically significant, either ($p=0.56$).

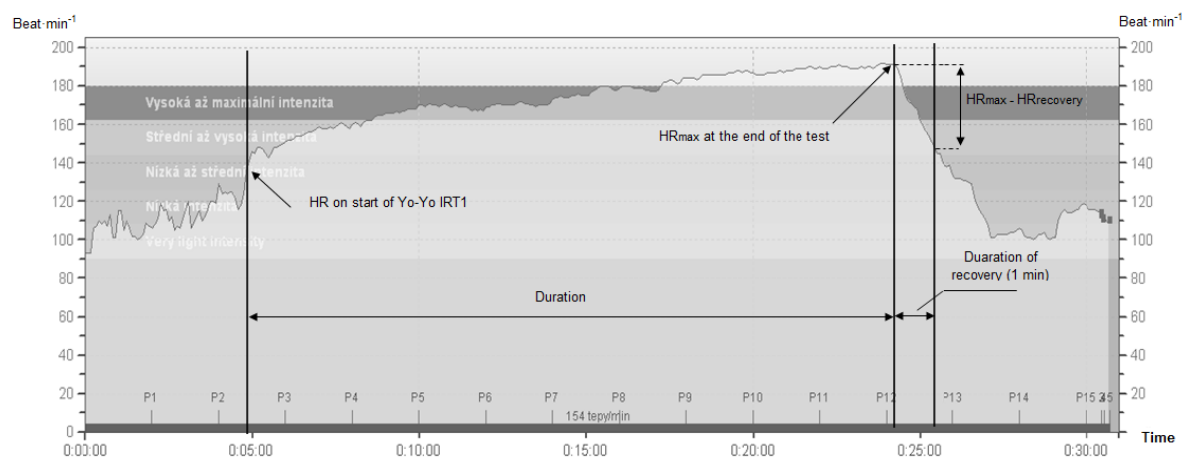


Figure 3. Illustration of a physiological curve during Yo-Yo IRT1 recorded by Polar RS400 heart rate monitor (Teplan, Malý, Zahálka, Hráský, Kaplan & et al., 2012b)

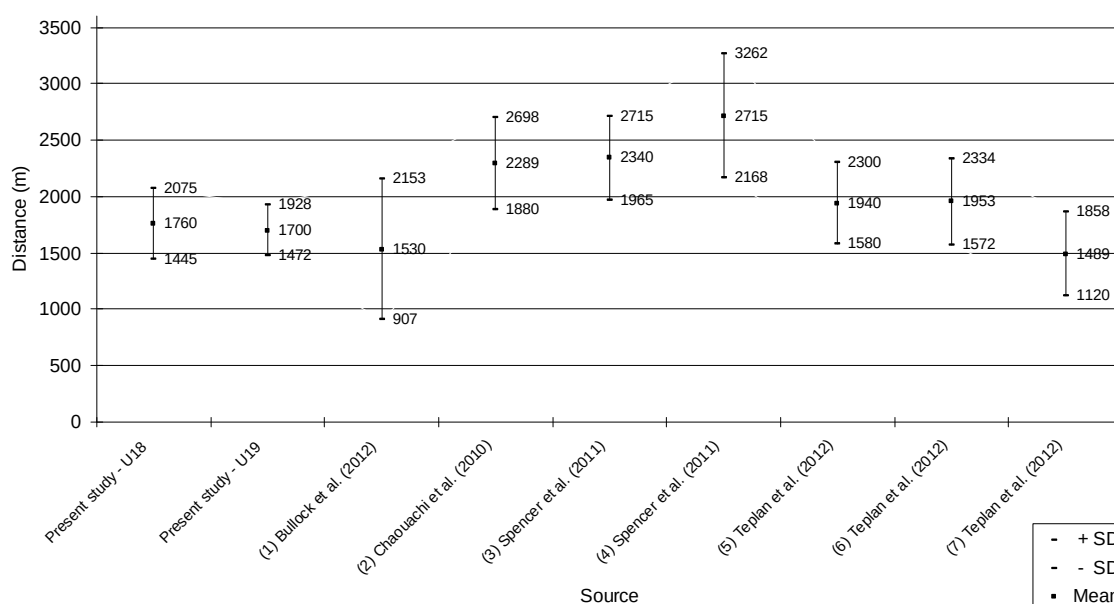


Figure 4. Comparison of performance in Yo-Yo IRT1 test with other studies

Note: (1) $n = 42$, age = 18 ± 4 , level = amateur; (2) $n = 23$, age = 19 ± 1 , level = elite; (3) $n = 16$, age = U17, level = high trained; (4) $n = 8$, age = U18, level = high trained; (5) $n = 14$, age = $16,5 \pm 0,3$, level = national team; (6) $n = 16$, age = $16,4 \pm 0,3$, level = best league team; (7) $n = 14$, age = $16,6 \pm 0,4$, level = worst league team

Table 1. Results of speed parameters and Yo-Yo IRT1 between two teams from elite competition before the pre-season period

Tests	U18		U19		t	d
	Mean	SD	Mean	SD		
Sprint 5 m (s)	1.05	0.06	1.05	0.03	0.07	0.03
Sprint 10 m (s)	1.81	0.09	1.80	0.05	0.16	0.13
20 m flying (s)	2.41	0.07	2.34	0.04	3.17**	1.20
Yo-Yo (m)	1760.00	314.64	1700.00	227.77	0.60	0.22
HRmax (beat.min ⁻¹)	193.53	10.68	192.07	6.58	0.45	0.16
Recovery 1 min (%)	14.23	7.93	13.50	6.31	0.28	0.10
VO2 max (ml.kg.min ⁻¹)	51.18	2.64	50.68	1.91	0.59	0.21

Note: ** - $p < 0.01$

Discussion

The pre-season period in soccer is usually much shorter (several weeks) in comparison to a long competitive season (several months) and often includes a higher number of training sessions (Tessitore, Meeusen, Cortis, & Capranica, 2007). However, climatic conditions of each country have to be considered as they influence the annual training plan (programme). Soccer competitions are not identical in different countries in terms of a number of pre-season periods (1 or 2), number of matches, character of the competition (spring-autumn, autumn-spring), etc. In the Czech Republic, players undergone two pre-season and transition periods during the season which remarkably influences their functional state in terms of activities performed at high intensity. At the beginning of the pre-season period, coaches usually prepare training sessions focused on development of aerobic capacity and various forms of field and laboratory tests in order to detect players' fitness capacity. (Brink, Nederhof, Visscher, Schmikli, & Lemmink, 2010) mention that regular testing of players provides information on their individual changes in game

performance in the course of time and prevent decline in aerobic capacity (90 % of performance). The purpose of testing at the beginning of the pre-season period is not only to observe the current fitness capacity and performance but it also has a health prevention character (e.g. muscle imbalances, muscle asymmetries, etc.).

In a soccer match, the most crucial skills are those related to power production capacity of neuromuscular system (e.g. sprint, fast duels against opponents) (Requena, Badilo, Villareal, Erelina, García & et al., 2009). The players have to be able to produce maximum speed (acceleration) in the range from 1.5 to 105 m during the game (Bangsbo, 1994). Elite players are able to perform approximately 30 – 40 sprints at different distances during the match (Mohr, Krustup, & Bangsbo, 2003). 75.8 % of sprints in the match are shorter than 9 m (Vigne, Gaudino, Rogowski, Alloatti, & Hautier, 2010) and 96 % of sprints are under 30 m (Valquer, Barros, & Sant'anna, 1998). Svensson & Drust, 2004 suggest that physical predispositions for maximum speed runs and ability to quickly accelerate can play a decisive role in the final result of the match.

However, players only rarely achieve maximum speed during the match and therefore start and acceleration phases are important factors for the players' performance (Jovanovic, Sporiš, Omcen, & Fiorentini, 2011). The results of the 5 m and 10 m acceleration tests before the pre-season period in U18 and U19 categories did not reveal any significant difference. This fact can be caused by neuromuscular system inhibition in both categories which occurred in the transition period (significant reduction of physical activity). Speed abilities are determined by genetic predispositions and this could be also reflected in our measurement. To verify this theory, it would be appropriate to carry out testing after pre-season period or during the main season. A significant difference between the two categories was found in the maximum speed test at 20 m. Maximum speed is determined by running stride frequency and length which interact (Čoh & Babić, 2010). The running stride length is, to a certain extent, determined by anthropometric parameters (Čoh, Tomažin & Rausavljevic, 2007). Maximum speed at 20 m was the only parameter observed before the pre-season period in which there was a significant difference between both categories. However, this difference could be caused by higher average body height of the players (U19>U18). Yo-Yo IRT1 is one of the most important tests for team sports of intermittent character of load because there is a high correlation between Yo-Yo IRT1 and the number of activities performed at high intensity ($r = 0.73$, $p = 0.003$) (Bangsbo et al., 2008). Castagna, Impellizzeri, Cecchini, Rampinini, & Barbero-Álvarez (2009) revealed high correlation in young soccer players ($r = 0.77$, $p < 0.001$) and Krustup et al. (2003) in adult soccer players ($r = 0.71$, $p < 0.05$). No significant relationship was observed between total run distance and Yo-Yo IRT1 ($r = 0.42$, $p = 0.14$) (Castagna, Impellizzeri, Cecchini, Rampinini, & Barbero-Álvarez, 2009; Krustup et al., 2003). Most of these studies focused on Yo-Yo IRT1 implementation during the main season. Teplan, Malý, Zahálka, Hráský, Malá & et al. (2012c) found out that performance achieved in Yo-Yo IRT1 can divide more and less successful teams (according to their position in table). The most important and the most informative parameter in Yo-Yo IRT1 evaluation is total run distance. The average performance of a team which participates in international competitions is 2420 m. Teams which attempt to achieve the highest possible place in the table achieve 2190 m on average and average players in national competitions run approximately 2030 m. The shortest distance is achieved by semi-professional teams whose distance covered is around 1810 m (Castagna et al., 2006; Krustup et al., 2003; Mohr et al., 2003). U18 and U19 players in comparison to adult players at both international and national levels are significantly behind before the pre-season period (U18: 27.3 % or 19.6 %, respectively; U 19: 29.8 % or 22.4 % respectively). Figure 4 shows the results of our study compared to the results of other studies

dealing with similar age categories. Total run distance ≥ 2320 m is a good indicator and predisposition for performance in repeated sprints (Chaouachi, Manzi, Wong, Chaalali, Laurencelle & et al., 2010). Young players in U18 and U19 categories participate in the training process with adult players and therefore it is essential to prepare them in high quality of physical fitness capacity. When young players progress to adult category, it is necessary that players are able to cope with the demands of matches and training sessions (Reilly, Bangsbo, & Franks, 2000). When developing physical fitness abilities, pressure has to be exerted on fitness coaches so that technical and tactical skills are developed simultaneously (Teplan et al., 2012a). Values of VO_{2max} calculated from a prediction equation are lower than values obtained from multistage running tests on a treadmill up to maximum effort in laboratory conditions (Bangsbo et al., 2008; Krustup et al., 2003). Values of VO_{2max} can be influenced by different levels of matches (the highest competitions in comparison with lower level competitions), training regimes and season within the annual training cycle. Players with high aerobic capacity are able to play at high intensity during the match (Reilly, Bangsbo, & Franks, 2000). Yo-Yo IRT1 evaluates not only aerobic load but also recovery processes after each completed section (2×20 m). Therefore, more accurate assessment of VO_{2max} is by multistage running test up to maximum effort in laboratory conditions (Bangsbo et al., 2008; Castagna et al., 2006). The main reason and principle of the test usage is the ability to repeat intensive activities (Krustup & Bangsbo, 2001; Krustup et al., 2003). Moreover, Yo-Yo IRT1 provides more sensitive measurement of changes in player's performance caused by intermittent load than VO_{2max} (Young, Newton, Doyle, Chapman, Cormack & et al., 2005). Players with higher values of VO_{2max} have greater glycogen stores which are necessary for energy release in actions performed at high load intensity or in sprints (Bangsbo & Mizuno, 1988). It also influences speed of regeneration processes after matches or intensive training sessions (Bangsbo & Mizuno, 1988). Barbero-Álvarez, Barbero-Álvarez, & Granda (2007) stated that at the beginning of pre-season period, professional players ($n=9$) underwent Yo-Yo IRT and their mean VO_{2max} was $55.3 \pm 1.3 \text{ ml.kg}^{-1}.\text{min}^{-1}$. Similarly Krustup et al. (2003) tested professional soccer players at the beginning of the pre-season period ($n=10$) and the measured mean value of VO_{2max} was $51.3 \pm 1.1 \text{ ml.kg}^{-1}.\text{min}^{-1}$. When we compare our results with the study by Krustup et al. (2003), we can see similar values (U18: $51.2 \pm 2.6 \text{ ml.kg}^{-1}.\text{min}^{-1}$ and U19: $50.7 \pm 1.9 \text{ ml.kg}^{-1}.\text{min}^{-1}$). In indirect testing of VO_{2max} on a treadmill or in field testing, the relationship between HR and intensity is linear up to sub-maximum speed (George, Fisher, & Vehrs, 2002); simultaneously, it provides HR_{max} intervals which can be useful for aerobic training (Motta & Angelino, 2009). HR gradually increases during the test and reflects gradual increase of oxygen consumption (Krustup et al., 2003).

HR depends on maximum capacity of each player with respect to his individual rhythm of adaptation and neuro-vegetative functions which increase or compensate the loss of fluids, electrolytes and acid-base balance occurring during training session or match (Mishchenko & Monogarov, 2000). Soccer match has a character of intermittent load in which high intensity periods alternate with low intensity periods (Teplan et al., 2012a) during which HR does not drop below 65 % HR_{max} in elite players (Bangsbo, Gibala, Krstrup, González-Alonso, & Saltin, 2002). After completion of Yo-Yo IRT1 we can observe HR_{max} with standard deviation 99 ± 1 % or similar to HR_{max} achieved on a treadmill, respectively (Krstrup et al., 2003). The number of high intensity actions decreases towards the end of the match (Bangsbo, 1994; Mohr et al., 2003).

Amount of actions performed at high intensity in soccer is one of the elements deciding a successful or unsuccessful result. Krstrup et al. (2003) add that elite players perform more high intensity actions than players at a lower level. Actions implemented at high intensity are interspersed with low intensity periods during which speed of recovery processes is important. During the match, high intensity activities are followed by short rest which is, however, not sufficient for full recovery (Barbero-Álvarez, Soto, & Granda, 2004; Dogramaci & Watsford, 2006). The recovery process is mainly determined by previous load (Bompa, 1999) and speed of recovery process is important for maintaining high physical fitness (Tessitore et al., 2008). Krstrup et al. (2003) also recorded recovery speed during 1 minute after test completion in professional players.

They found out that HR decreased by 39 $\text{beat} \cdot \text{min}^{-1}$ (21 %). In comparison to our results we can state that professional players were better prepared in terms of recovery after physical load at the beginning of the pre-season period.

Conclusion

Based on results of our study we can conclude that in U18 and U19 players there were no significant changes in parameters of acceleration speed (5 and 10 m), aerobic capacity which was manifested by total run distance, HR_{max} , VO_{2max} and recovery over a period of 1 minute after test completion. Insignificant differences could have been caused by reduced physical activity during the transition period (4 weeks off) after the last match. The only parameter which revealed a significant difference was maximum speed at 20 m flying sprint. All monitored parameters are only a predisposition for successful game performance of a player in the match. The importance of diagnostics is clearly confirmed. It should not be used randomly; on the contrary, it has to provide clear results implemented in modification of training process. Regular planning and insertion of tests throughout the year is an important component of monitoring and affecting player's sport performance. For further optimization of the results, it would be appropriate to continue with the research directed to measuring both teams throughout the whole year (preferably at the beginning of the pre-season period, before the main season, in the middle of the main season and at the end of the season) in order to determine changes in physical fitness of both teams during the year.

References

- Bangsbo, J. (1994). The physiology of soccer: with special reference to intense intermittent exercise. *Acta Physiologica Scandinavica*, 15, 1-156.
- Bangsbo, J., Gibala, M., Krstrup, P., González-Alonso, J., & Saltin, B. (2002). Enhanced pyruvate dehydrogenase activity does not affect muscle O₂ uptake onset of intense exercise in humans. *American Journal of Physiology*, 282, R273-R280.
- Bangsbo, J., Iaia, M., & Krstrup, P. (2008). The Yo-Yo Intermittent Recovery Test: A Useful Tool for Evaluation of Physical Performance in Intermittent Sports. *Sports Medicine*, 38, 37-51.
- Bangsbo, J., & Mizuno, M. (1988). *Morphological and metabolic alternations in soccer players with detraining and retraining and their relation to performance*. Paper presented at the Science and Football: Proceedings of the First World Congress of Science and Football, Liverpool.
- Bangsbo, J., Mohr, M., Poulsen, A., Gomez, P.J., & Krstrup, P. (2006). Training and testing the elite athlete. *Journal of Exercise Science and Fitness*, 4, 1-14.
- Barbero-Álvarez, J.C., Barbero-Álvarez, V., & Granda, J. (2007). Perfil de actividad durante el juego en futbolistas infantiles. *Apunts. Educación Física y deportes*, 90, 33-41.
- Barbero-Álvarez, J.C., Soto, H.V.M., & Granda, V.J. (2004). Effort profiling during indoor soccer competition. *Journal of Sports Sciences*, 22, 500-501.
- Bloomfield, J., Polman, R., & O'Donoghue, P. (2007). Physical demands of different positions in FA Premier League soccer. *Journal of Sports Science and Medicine*, 6, 63-70.
- Bompa, T. (1999). *Periodization Theory and methodology of training*. Champaign: Human Kinetics.
- Brink, M.S., Nederhof, E., Visscher, C., Schmikli, L., & Lemmink, K.A.M.P. (2010). Monitoring load, recovery, and performance in young elite soccer players. *Journal of Strength and Cond Research*, 24, 597-603.
- Bullock, W., Panchuk, D., Broatch, J., Christian, R., & Stepto, N.K. (2012). An integrative test of agility, speed and skill in soccer: Effects of exercise. *Journal Science and Medicine in Sport*, 15, 431-436.

- Castagna, C., Impellizzeri, F.M., Belardinelli, R., Abt, G., Coutts, A., Chamari, K., et al. (2006). Cardiorespiratory responses to Yo-Yo Intermittent Endurance Test in nonelite youth soccer players. *Journal of Strength and Conditioning Research*, 26, 326-330.
- Castagna, C., Impellizzeri, F.M., Cecchini, E., Rampinini, E., & Barbero-Álvarez, C.J. (2009). Effects of intermittent-endurance fitness on match performance in young male soccer players. *Journal of Strength and Conditioning Research*, 23, 1954-1959.
- Cohen, J. (1992). Statistics a power primer. *Psychology Bulletin*, 112, 115-159.
- Čoh, M., & Babić, V. (2010). Biodynamic characteristic of maximum speed development. *Facta Universitatis, Physical Education and Sport*, 8, 141-148.
- Čoh, M., Tomažin, K. & Rausavljevic, N. (2007). Differences in morphological and biodynamic characteristics of maximum speed and acceleration between two groups of female sprinters. *Biology of Sport*, 24, 115-128.
- Da Silva, J.F., Dittrich, N., & Guglielmo, L.G.A. (2010). Aerobic evaluation in soccer. *Revista Brasileira de Cineantropometria e Desempenho Humano*, 13, 384-391.
- Dogramaci, S.N., & Watsford, M.L. (2006). A comparison of two different timing methods for time-motion analysis in team sports. *International Journal of Performance Analysis in Sport*, 6, 73-83.
- Faude, O., Koch, T., & Meyer, T. (2012). Straight sprinting is the most frequent action in goal situations in professional football. *Journal of Sports Sciences*, 30, 625-631.
- George, A.G., Fisher, D.J., & Vehrs, P.R. (2002). Test y pruebas físicas. *Ed Paidotribo*, 5, 112.
- Chaouachi, A., Manzi, V., Wong, D. P., Chaalali, A., Laurencelle, L., Chamari, K., et al. (2010). Intermittent endurance and repeated sprint ability in soccer players. *Journal of Strength and Conditioning Research*, 24, 2663-2669.
- Jovanović, M., Sporiš, G., Omrcen, D., & Fiorentini, F. (2011). Effects of speed, agility, quickness training method on power performance in elite soccer players. *Journal of Strength and Conditioning Research*, 25, 1285-1292.
- Jullien, H., Bisch, C., Largouet, N., Manouvrier, C., Carling, C.J., & Amiard, V. (2008). Does a short period of lower limb strength training improve performance in field-based tests of running and agility in young professional soccer players? *Journal of Strength and Conditioning Research*, 22, 404-411.
- Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., et al. (2003). The Yo – Yo Intermittent Recovery Test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise*, 35, 697-705.
- Little, T., & Williams, A.G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *Journal of Strength and Conditioning Research*, 19, 76-78.
- Little, T., & Williams, A.G. (2006). Effects of differential stretching protocols during warm-ups on high-speed motor capacities in professional soccer players. *Journal of Strength and Conditioning Research*, 20, 203-207.
- Malý, T., Zahálka, F., Malá, L., Buzek, M., Teplan, J., & Gryc, T. (2012). The level, dependance and structure of speed indicators in young elite soccer players. *Medicine & Science in Sports & Exercise*, 44(5), S400.
- Mirkov, D.M., Nedeljković, A., Kukolj, M., & Ugarković, D. (2008). Evaluation of the reliability of soccer-specific field test. *Journal of Strength and Conditioning Research*, 22, 1046-1050.
- Mirkov, D.M., Nedeljković, A., Kukolj, M., Ugarković, D.J., & Jarić, S. (2008). Evaluation of the reliability of soccer-specific field tests. *Journal of Strength and Conditioning Research*, 22, 1046-1050.
- Mishchenko, V.S., & Monogarov, V.D. (2000). Fisiología del deportista. *Ed Paidotribo*, 5, 171-216.
- Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high - standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences*, 21, 519-528.
- Motta, A.D., & Angelino, A.A. (2009). Heart rate contribution in soccer players during the competition period. *Revista Argentina De Cardiología*, 77, 27-32.
- Rampinini, E., Coutts, A., Castagna, C., Sassi, A., & Impellizzeri, F.M. (2007). Variation in top level soccer match performance. *International Journal of Sports Medicine*, 28, 1018-1024.
- Reilly, T., Bangsbo, J., & Franks, A. (2000). Anthropometric and physiological predispositions in soccer. *Journal of Sport Sciences*, 18, 669-683.
- Requena, B., Badillo, J.J.G., Villareal, E.S.S., Erelina, J., García, I., Gapeyeva, H., et al. (2009). Functional performance, maximal strength, and power characteristics in isometric and dynamic actions of lower extremities in soccer players. *Journal of Strength and Conditioning Research*, 23, 1391-1401.
- Silva, A.S.R., Santhiago, V., Papoti, M., & Gobatto, C.A. (2008). Hematological parameters and anaerobic threshold in Brazilian soccer players throughout a training program. *International Journal of Laboratory Hematology*, 30, 158-166.
- Sliwowski, R., Rychlewski, T., Laurentowska, M., Michalak, E., Andrzejewski, M., Wieczorek, A., et al. (2011). Changes in aerobic performance in young football players in an annual training cycle. *Biology of Sport*, 28, 55-62.
- Spencer, M., Pyne, D., Santisteban, J., & Mujika, I. (2011). Fitness determinants of repeated-sprint ability in highly trained youth football players. *International Journal of Sports Physiology and Performance*, 6, 497-508.
- Svensson, M., & Drust, B. (2004). Testing soccer players. *Journal of Sports Sciences*, 23, 601-618.

- Teplan, J., Malý, T., Zahálka, F., Hráský, P., Kaplan, A., Hanuš, M., et al. (2012a). The level of aerobic capacity in elite youth soccer players and its comparison in two age categories. *Journal of Physical Education and Sport*, 12, 129-134.
- Teplan, J., Malý, T., Zahálka, F., Hráský, P., Kaplan, A., & Malá, L. (2012b). Level of an aerobic capacity of soccer U17 category teams with different succes. *Studia Kinanthropologica*, 13, 37-44.
- Teplan, J., Malý, T., Zahálka, F., Hráský, P., Malá, L., & Heller, J. (2012c). The level and differences of aerobic capacity in three different young soccer teams in the U17 category. *Sport Science*, 5, 43-48.
- Tessitore, A., Meeusen, R., Cortis, C., & Capranica, L. (2007). Effects of different recovery interventions on anaerobic performance following preseason soccer training. *Journal of Strength and Conditioning Research*, 21, 745-750.
- Tessitore, A., Meeusen, R., Pagano, R., Benvenuti, C., Tiberi, M., & Capranica, L. (2008). Effectiveness of active versus passive recovery strategies after futsal games. *Journal of Strength and Conditioning Research*, 22, 1402-1412.
- Thomas, J., & Nelson, J. (1996). *Research methods in physical activity*. Champaign, IL: Human Kinetics.
- Valquer, W., Barros, T.L., & Sant'anna, M. (1998). *High intensity motion pattern analyses of Brazilian elite soccer players*. Paper presented at the IV World Congress of Notational Analysis of Sport, Porto.
- Vigne, G., Gaudino, C., Rogowski, I., Alloatti, G., & Hautier, C. (2010). Activity profile in elite Italian Soccer Team. *International Journal of Sports Medicine*, 31, 304-310.
- Wilson, G.J., Newton, R.U., Murphy, A.J., & Humphries, B.J. (1993). The optimal training load for the development of dynamic athletic performance. *Medicine and Sci in Sports and Exercise*, 25, 1279-1286.
- Young, W.B., Newton, R.U., Doyle, T.L., Chapman, D., Cormack, S., Stewart, G., et al. (2005). Physiological and anthropometric characteristics of starters and non-starters and playing positions in elite Australian Rules football: a case study. *Journal of Science and Medicine in Sport*, 8, 333-345.

VRIJEDNOSTI PARAMETARA BRZINE I AEROBNOG KAPACITETA KAO POKAZATELJI TJELESNE KONDICIJE U18 I U19 NOGOMETNIH MOMČADI NA POČETKU RAZDOBLJA PREDSEZONE

Sažetak

Cilj ovog istraživanja bio je ispitati i usporediti trenutnu situaciju u smislu povremenih treninga po dvije elitne Češke momčadi U18 i U19 kategorijama na početku razdoblja predsezone. U18 kategorija sastojala se od 17 igrača (dob: $17,6 \pm 0,3$ godina, tjelesna težina: $71,1 \pm 5,7$ kg, visina tijela: $178,2 \pm 6,9$ i tjelesna mast: $10,3 \pm 1,4$ %), a kategorija U19 sastojala se od 14 igrača (dob: $18,3 \pm 0,2$ godina, tjelesna težina: $74,9 \pm 6,5$ kg, visina tijela: $181,5 \pm 6,3$ a tjelesna mast: $10,6 \pm 1,6$ %). Pparametri brzine su ocjenjeni na 5 i 10 m ubrzanja i maksimalnim testom brzine na 20 m (leteći start). Za praćenje i vrednovanje aerobnih parametara, primjenjen je Yo-Yo isprekidani test oporavka 1 (Yo-Yo IRT1). U testovima 5 i 10 m nema značajne razlike. Međutim, uočena je značajna razlika u maksimalnoj brzini na 20 m ($p = 0,04$). Razlika u maksimalnom rađenoj udaljenosti između ekipa nije bila značajna ($T29 = 0.60$, $p = 0.56$). Nadalje, nisu zabilježene značajne razlike ni maksimalnog broja otkucaja srca ($p = 0.66$), smanjenje broja otkucaja srca tijekom 1 minute nakon testa ($p = 0,78$) ni maksimalne potrošnje kisika ($T29 = 0.59$, $p = 0.56$). Neznatne razlike mogu biti uzrokovane dugotrajnom neaktivnošću igrača u prijelaznom razdoblju. Za potpuno objektivizaciju rezultata i ovih zaključaka, bilo bi uputno slijediti obje momčadi tijekom trajanja natjecateljskog razdoblja.

Gljučne riječi: nogomet, terenska ispitivanja, mladi, aerobik parametri, Yo - Yo IRT1

Received: December 3, 2012

Accepted: June 10, 2013

Correspondence to:

Jaroslav Teplan, MSc

Charles University in Prague

Faculty of Physical Education and Sport

16252 Praha 6-Veleslavín, J. Martího 31, Czech

Phone: +420 2201 72288

E-mail: teplan@ftvs.cuni.cz

SPEED AND COORDINATION IMPROVEMENT BY MEANS OF AGILITY TRAINING AT SCHOOL P.E. LESSONS

Jaromír Šimonek

Constantine the Philosopher University, Nitra, Slovakia

Original scientific paper

Abstract

The work deals with the possibilities of development of complex motor ability – agility – in the school conditions. A cross-experimental study was used to obtain relevant research data. Two groups – one experimental and the other reference one were randomly selected to apply the special programme of agility exercises during two 3-month-long periods during the school year 2011/12. The special programme was implemented in experimental groups during 15 minutes at each P.E. lesson 2-times a week during 3 months. After three months the experimental and reference groups were mutually exchanged and the programme was implemented in the former reference groups. The former experimental group did not do any special programme. Positive changes on the .01 level of statistic significance were found in both experimental periods under the influence of the programme of exercises. In both reference groups in reference periods stagnation or decrease in the level of agility and acceleration were recorded. Based on the research we recommend the verified programme of exercises for teachers of P.E. and trainers in sport games.

Key words: speed, coordination, agility training, school Physical Education, sport preparation

Introduction

One of the main tasks of school physical education lessons is to develop the qualities of children in the critical periods of their development. Besides traditional motor abilities which are developed in school are speed, endurance, flexibility and strength. Life situations and specially situations in sport performance require highly coordinated and effective movement depending mostly on the level of development of coordination abilities and conditional factors, which can be creatively applied in permanently changing situations. Development of motor abilities is an inevitable part of everyday teaching process. The most frequently mentioned key abilities for sport games are: speed and agility. Agility, being a complex motor ability, includes several partial subabilities.

It expresses the ability of a person to intensively and effectively change the direction of movement of his body parts in compliance with the game actions, the ability to accelerate quickly, to stop and change the direction of movement. Verstegen & Williams (2005) denoted the term „agility“ by the complex of 10 components: coordination, body core, biomechanics, speed, intensity, energy, energy systems development, elasticity, power, dynamic balance and mobility (flexibility). Hirtz (1985) describes coordination abilities as „cooperation of central nerve system and skeletal muscles within some aimed movement process“ Quality of coordination depends principally on the processes of movement control and the connected nervo-muscular processes, as well as on the level of analysers. Especially in the period of puberty, they play an important role at the creation of coordination basis – prerequisites for the development of physical fitness and acquisition of motor skills.

Coordination abilities form an important role, which is, however, very often a little appreciated part of motor prerequisites of a man for motor activity. Factorial analysis considering 30 indicators of *coordination abilities* applied in school population aged 7-18 years, which was realized by Raczek and Mynarski (1992) approved of five elementary, the so-called primary coordination abilities (I.). Each of the primary abilities, subject to authors Waskiewicz-Juras-Raczek (1999), is then structured into subabilities (II.). Coordination abilities rarely exist isolated and represent a moaic of individual – manysidedly mutually interconnected abilities. Kirchem (1992) states that the terms „skill and agility“ used before, are not able to explain the complex of coordination abilities and to describe their structure. On the other hand we consider the term „agility“ a complex ability including several dependent qualities (Verstegen & Williams, 2005). Abilities are highly genetically determined, however, when influenced in the critical periods of children's growth there can be reached rather high accruals (Hirtz, 1985; Broďáni & Šimonek, 2010, etc.).

Aim

The aim of our research was to find out the course of changes of the level of agility and speed in 10-11-year-old schoolers and find consequences for the teaching practice.

Methods and sample

In order to follow the level of agility and acceleration speed in 10 to 11-year-old pupils, attending regular classes in Slovak basic and secondary 8-year schools with 2 P.E. lessons per

week, the method of testing these motor abilities was used. Agility was tested by the standardized test „Illinois Agility Test“, which finds out the level of reaction speed, acceleration, movement frequency and change of direction of movement of the tested person (fig. 1). The tested sample of male children was randomly divided into two groups – one experimental (A; $n=18$) and one control group (B; $n=17$). In the first experimental period a special 20-minutes-long program of exercises aimed at developing partial abilities of agility (reaction and acceleration speed, spatial orientation, frequency of movements, dynamic strength and dynamic balance) was implemented in P.E. lessons which were held twice a week during 3 months. The reference group conducted classical contents of lessons (gymnastics, sport games). In the second 3-month-long experimental period, the originally experimental group started to conduct the classical content of education and the reference group became the experimental group with the special program devoted to agility development. In order to mine scientific research data, the following statistical methods will be used: Wilcoxon's test and Mann-Whitney's test.

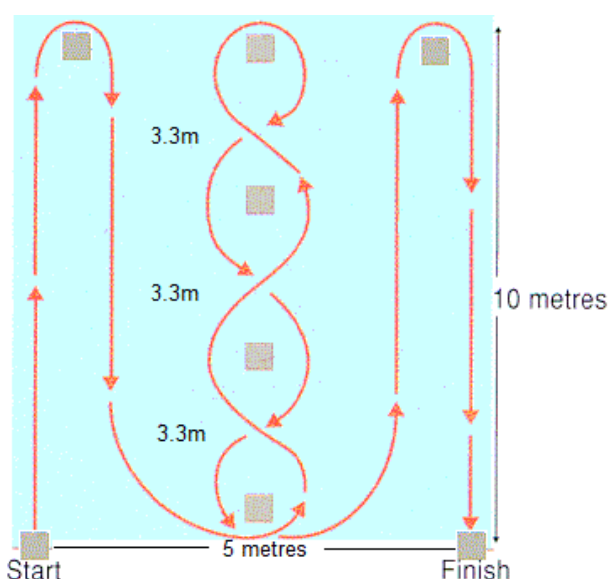


Fig. 1 Illinois Agility Test

Results and discussion

After 6 months of experiment and having performed the Agility test, the results were analyzed and depicted in graphs and tables. The results have shown the following consequences and suggestions: Experimental group „A“ recorded in the first experimental period (A1 – A2) an improvement in the test from 22.08 to 21.15 s (-0.93 s), which represents 0.01 % level of statistical significance. Parallely we recorded the performance of the referential group „B“ (period B1 – B2) which improved slightly from 22.77 to 22.09 s (-0.68 s), which was statistically significant only on 0.05% level.

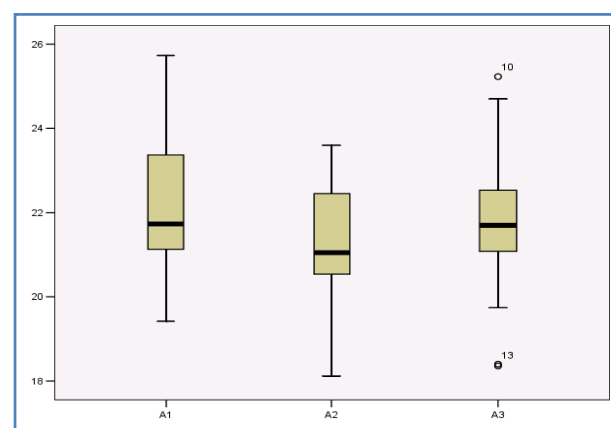


Fig. 2 Statistic data of Group „A“

Table 1. Descriptive statistics – „A“ group

„A“ / No.	Pupil	Input measurement	Partial measurement	Output measurement
1	G.R.	22.30	21.05	22.15
2	S.T.	22.40	21.62	21.90
3	P.C.	21.68	20.68	21.35
4	F.R.	21.13	20.54	20.21
5	K.I.	23.99	23.20	24.64
6	P.L.	21.20	20.98	21.08
7	K.N.	23.37	22.97	23.17
8	F.L.	25.14	23.32	24.70
9	S.L.	22.64	22.45	22.53
10	M.O.	25.73	23.60	25.23
11	L.E.	23.45	22.14	22.45
12	H.R.	19.71	18.12	18.36
13	H.A.	20.80	18.15	18.40
14	U.H.	19.42	19.98	21.20
15	P.O.	21.73	20.96	21.70
16	L.I.	21.60	21.58	21.63
17	K.O.	20.20	19.14	19.74
18	M.I.	21.02	20.29	20.38
	Mean	22.08	21.15	21.71
	Median	21.73	21.05	21.70
	Min	19.42	18.12	18.36
	Max	25.73	23.60	25.23

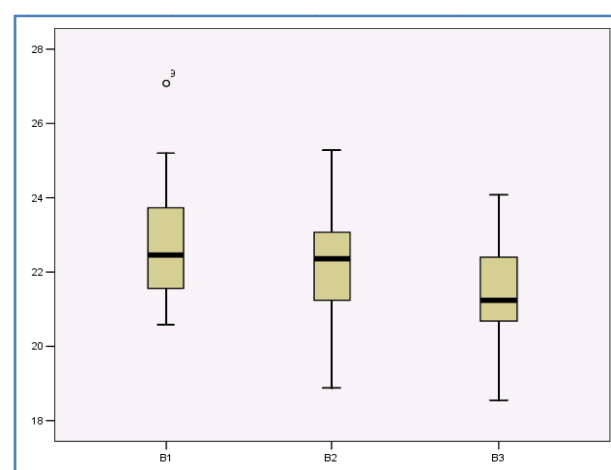


Figure 3. Statistic data of Group B

In the second period of experiment, the experimental factor was implemented in the reference group „B” (cross-experiment period B2 – B3) which reached an improvement from 22,09 s into 21.35 s (-0.74 s), which represents a 0.01 % level of statistical significance. The originally experimental group „A”, now the reference group (period A2 – A3), recorded a decrease in the performance in the test from 21.15 s into 21.71 s (0.56 s), which represents 0.01 % level of statistical significance (Fig 2 and 3, Tab. 1 and 2).

Table 2. Descriptive statistics – Group „B”

„B” / No.	Pupil	Input measurement	Partial measurement	Output measurement
1	M.A.	24.79	23.89	23.52
2	S.Z.	23.91	23.07	21.97
3	C.I.	21.80	22.09	21.37
4	K.R.	22.30	23.33	22.40
5	B.U.	22.48	22.55	21.38
6	H.A.	22.97	22.94	22.91
7	V.A.	23.73	22.91	21.24
8	K.U.	21.56	21.24	20.74
9	L.E.	27.08	25.28	24.08
10	V.A.	21.43	21.40	20.68
11	G.R.	20.58	18.88	18.55
12	B.A.	20.96	19.92	19.69
13	F.Ü.	22.50	20.10	19.45
14	L.U.	21.25	19.79	19.08
15	M.T.	22.04	21.77	21.11
16	K.O.	25.20	24.06	23.53
17	G.Ä.	22.46	22.36	21.23
	Mean	22.77	22.09	21.35
	Median	22.47	22.23	21.29
	Min	20.58	18.88	18.55
	Max	27.08	25.28	24.08

Table 3. Significance testing

	Mann-Whitney U	p-value	
A<>B Input	115.5	0.32	NS
A<>B Partial	105	0.17	NS
A<>B Output	123	0.46	NS
	Wilcoxon Signed	p-value	
A 1st Ex	3.38	0.00	$p < .01$
A 2nd	3.20	0.00	$p < .01$
	Wilcoxon Signed	p-value	
B 1st	2.67	0.02	$p < .05$
B 2nd Ex	3.62	0.00	$p < .01$

Conclusion

Our special program of exercises had a positive impact on the level of speed and agility of children aged 10-11. The hypothesis was thus proved. In both experimental periods both experimental groups recorded statistically significant increase in the level of coordination on 0.01% level of statistic significance. On the other hand in groups where exercises were not conducted the level of speed and agility stagnated or decreased.

Based on the results obtained, we can recommend the use of special agility exercises during the lessons of Physical Education at school for the development of speed and agility in pupils aged 10-11 years of age. The special experimental programme is with the author on request.

References

- Brodáni, J., & Šimonek, J. (2010). *Structure of Coordination Capacities and Prediction of Overall Coordination Performance in Selected Sports*. Oradea: Editura Universitatii din Oradea. 110 s.
- Hirtz, P. et al. (1985). *Koordinative Fähigkeiten im Schulsport*. Berlin: Volk und Wissen Verlag.
- Kirchem, A. (1992). *Diagnostik motorischer Fähigkeiten und Auswirkungen einer Forderung der Bewegungskoordination im ausserunterrichtlichen Schulsport*. Erlensee: SFT-Verlag.
- Raczek, J., & Mynarski, W. (1992). *Koordynacyjne zdolności motoryczne dzieci i młodzieży. Studia nad motorycznością ludzką*. Katowice: AWF.
- Šimonek, J. (2006). *Model of development of coordination abilities in the long-term sport preparation in volleyball*. Oradea: Editura Universitatii din Oradea. 95 s.
- Verstegen, M., & Williams, P. (2005). *Core performance*. 1st ed. New York: Rodale.
- Waskiewicz, Z., Juras, G., & Raczek, J. (1999). The structure of space orientation and motor adjustment – computer supplemented diagnosis system. *Gymnica*, 2, 19-25.
- Willardson, J., et. al. (2009). The effect of different rest intervals between sets on volume components and strength gains. *Journal of Strength and Conditioning Research*, 22, 145-152.

POBOLJŠANJE BRZINE I KOORDINACIJE KORIŠTENJEM TRENINGA AGILNOSTI NA NASTAVI TJELESNOG I ZDRAVSTVENOG ODGOJA

Sažetak

Rad se bavi mogućnostima razvoja složene motoričke sposobnosti – agilnosti, u školskim uvjetima. Cross-eksperimentalna studija koristila je za dobivanje relevantnih istraživačkih podataka. U dvije skupine - eksperimentalnu i kontrolnu, ispitanici su slučajno selektirani za primjenu posebnih programa vježbi agilnosti tijekom dva 3-mjesečna razdoblja školske godine 2011/12. Proveden je poseban program u eksperimentalnim grupama tijekom 15 minuta na svakom TIZO satu 2-puta tjedno tijekom 3 mjeseca. Nakon tri mjeseca su eksperimentalne i referentne skupine međusobno razmijenjeni i program se provodio u bivšim referentnim skupinama. Bivša eksperimentalna skupina nije provodila nikakav posebni program. Pozitivne promjene na 0,01 razini statističke značajnosti pronađene su u oba eksperimentalna razdoblja pod utjecajem programa vježbi. U obje referentne skupine u promatranom razdoblju stagnacije zabilježeni su učinci smanjenja razine agilnosti i ubrzanja. Na temelju istraživanja preporučujemo ovjereni program vježbi za nastavnike tjelesnog odgoja i trenere u sportskim igrama.

Ključne riječi: brzina, koordinacija, trening agilnosti, školsko vježbanje, sportska priprema

Received: March 5, 2013

Accepted: June 10, 2013

Correspondence to:

Prof. Jaromir Šimonek, PhD

Constantine the Philosopher University

SK - 949 74 Nitra, Tr. A. Hlinku 1, Slovakia

Phone: +421 37 6408 111

E-mail: jsimonek@ukf.sk

Acknowledgements:

This article was elaborated with the support of the grant scheme KEGA No. 029UKF-4/2011 Model Programmes of Activities Focusing on the Prevention and Remedy of Lifestyle Diseases in Adolescents.

THE INFLUENCE OF MORPHOLOGICAL CHARACTERISTICS ON EFFECTIVENESS OF TEACHING SAILING

Goran Oreb, Nikola Prlenda and Josip Kolega

Faculty of Kinesiology, University of Zagreb, Croatia

Original scientific paper

Abstract

The aim of this research was to determine the extent to which morphological characteristics influence learning of basic sailing techniques on balancer keel boats (Elan 19) in the population of adult beginners. The research was conducted on the sample of 135 regular students of the Faculty of Kinesiology, University of Zagreb, as a part of Water sports – Sailing classes. Morphological characteristics were measured in the premises of the Faculty of Kinesiology immediately before conducting practical part of the class. Criteria variables consisted of marks that examinees were given through standard procedure of knowledge assessment on Water sports-Sailing exam. The exam and lesson were conducted on Elan 19 sailboat type. The effectiveness of examinees was assessed on 1 to 5 scale. The knowledge of examinees was assessed on four technique elements: tacking, jibing, heading up and bearing away on positions: helm, main sail and jib. To determine basic morphological characteristics of the examinees, four anthropometric measures were selected: body height (ATV), body mass (ATM), body fat percentage (% fat) and total fat (Kg/fat). Results of regression analysis on twelve variables have singled out one statistically significant correlation ($R=0,21$) of body mass to the criterion variable heading up on jib position with only 4% of total variance. Further, through factor analysis two new variables are extricated, achieved sailing technique knowledge on jib and main sail position, and achieved knowledge on helmsman position. Also, through regression analysis was determined that in those variables no influence of morphological characteristics on final result exists either. On the basis of achieved results it is concluded that in teaching basics of sailing to adult beginners, the differences in basic morphological characteristics will not influence the amount of knowledge achieved.

Key words: morphological characteristics, sailing school, sailing

Introduction

Sailing is a skill of managing a sailboat. Although it may seem as an easy sport, to navigate a sailboat in any direction regardless of the wind direction, overcoming often troubled water conditions, severe wind or other difficulties in the process, is anything but easy. As a sports branch it includes great static and dynamic strains in different conditions. Also, success in sailing depends on a number of morphologic, functional, motor, cognitive and conative dimensions, as on the specific conditional, technical, tactic and theoretical preparedness. Constant changes of conditions and situations are leading to the continuous shifts of energy processes and that makes sailing one of the most demanding sports branches. Former researches in the sailing field, especially in determining important morphological characteristics which are influencing effectiveness, are very few. As a reason for such a low number of researches Allen and De Jong (2006) are mentioning uniqueness of sailing which, unlike most of other sports in which conditions are very similar, such as football, tennis etc., covers very wide spectrum of changes concerning weather conditions, place where the competition is held (area near to the coast, open sea, lakes, rivers etc.) which makes this sport very demanding for researching and complicates possible result comparisons with other sports. They also conclude that that very diversity of the sport leads to the number of differences in physiological strains,

injuries, defining of optimal training etc. Results of basic morphological characteristics compared to the effectiveness in demonstration of basic sailing techniques should answer the question how much are these characteristics influencing the amount of acquired knowledge in the population of adult beginners. Until now, researches in sailing and similar sports, such as windsurfing, are showing the importance of morphological characteristics for the result of the competitor (Vogiatzis et al., 1995; Legg et al., 1997; Vogiatzis et al., 2001; Mendez-Villanueva and Bishop, 2005; Zuban, 2006; Bojsen-Moller et al., 2007; Cortell-Tormo et al., 2010; Farley et al., 2012) and also for the success of the recreational sportsman (Oreb et al., 2009; Ošlak-Kranjc, J. 2011; Prlenda et al., 2012). But, how much are such measures influencing adult beginners in learning basic techniques of sailing on balancer keel sailboat (Elan 19) and in the area that offers possibility to adjust to the weather conditions due to the indented coastline in the area where the lessons are conducted (Korčula – Croatia)?

Methods

The research was conducted on the sample of 135 regular students of Faculty of Kinesiology, on the University of Zagreb, as a part of the Water sports – Sailing class. The main condition students had to fulfill to become a part of the sample was that

they never before tried sailing as a motor activity. Morphological characteristics were measured on the premises of the Faculty of Kinesiology immediately before the practical lessons. Evaluation was made after practical part of Water sports – sailing class was finished. Criteria variables consisted of marks given to the examinees through the standard procedure of knowledge evaluation on the Water sports – Sailing exam. The exam and lessons were conducted on the sailboats type Elan 19. Efficiency of examinees was evaluated on the 1 to 5 scale by experienced educated examiners in the field of sailing. Knowledge evaluation is related to the four elements of sailing which are part of every sailing school: tacking, jibing, heading up and bearing away on positions: helm, main sail and jib. Every examinee was given one mark for the each of four sailing elements on each sailing position, which means that every examinee was given twelve marks in total. To determine basic morphological characteristics of the examinees, four anthropometrical measures were used: body height (ATV), body mass (ATM), body fat percentage (% fat), total body fat (Kg/fat). Standardized procedure for anthropometric characteristics measuring was conducted according to International biologic programme-IBP (Mišigoj-Duraković, 2008.). Percentage of body fat and total body fat was assessed using the Omron BF 300 device. Data was processed through „Statistica vr. 8 for Windows“. As a part of descriptive statistics, main measure of central tendency was calculated (arithmetic mean) and also dispersion measures (standard deviation, minimum and maximum). In order to determine influence of morphological characteristics on the level of achieved knowledge in sailing, regression analysis was used. Collected data was processed through factor analysis too, with the aim of isolation of the factor that represents knowledge of sailing. To determine the number of significant factors Scree test was used. Statistically significant level was tested on significance level $p < 0.05$.

Results and discussion

It is evident from the results that all the students were successful in mastering basic technique elements necessary for independent performance, since the lowest mark was 2. Beside mark span indicator in Table 1. it is also clearly evident that the lowest marks were achieved by the examinees in elements bearing away-jib and jibing- main sail (3,51 and 3,57), while the highest average marks were achieved in elements tacking- main sail and heading up - helm (4,04 and 3,91). Lower result in element bearing away – jib can be explained by wind conditions, in other words, strong or low wind can influence final performance of any sailing element in a considerable level. In this case, wind was low, which ensures more confidence to the beginners, but makes bearing away limit harder to assess, since changes in the sail are less visible to the beginner.

Table 1. Descriptive statistic parameters – criterion variable

	N	Min	Ma	M	SD	Skew	Kurto
HeadH	135	2,0	5,0	3,91	0,85	-0,41	-0,42
HeadMS	135	2,0	5,0	3,88	0,81	-0,29	-0,45
HeadJ	135	2,0	5,0	3,84	0,84	-0,07	-0,90
TackH	135	2,0	5,0	3,59	0,95	0,01	-0,95
TackMS	135	2,0	5,0	4,04	0,72	-0,18	-0,68
TackJ	135	2,0	5,0	3,62	0,81	0,05	-0,57
BearH	135	2,0	5,0	3,80	0,98	-0,26	-1,03
BearMS	135	2,0	5,0	3,64	0,95	-0,05	-0,96
BearJ	135	2,0	5,0	3,51	0,95	0,17	-0,91
JibeH	135	2,0	5,0	3,68	0,94	-0,15	-0,88
JibeMS	135	2,0	5,0	3,57	0,98	-0,07	-0,98
JibeJ	135	2,0	5,0	3,60	0,82	-0,12	-0,47

(N – number of respondents; Min – minimum value; Max – Maximum value; M – sample mean; SD - standard deviation; Skewness – Coefficients of skewness; Kurtosis – Coefficients of kurtosis) HeadH – heading up helm; HeadMS – heading up main sail; HeadJ – heading up jib; TackH – tacking helm; TackMS – tacking main sail; TackJ – tacking jib; BearH – bearing away helm; BearMS – bearing away main sail; BearJ – bearing away; JibeH – jibing helm; JibeMS – jibing main sail; JibeJ – jibing jib

Except that, somewhat lower marks in element jibing on main sail position can be explained by a little shorter training period, considering that that element is, according to the programme, the last to be learned in sailing school. Values of coefficients of skewness on tests: heading up-helm (-0,41), heading up - main sail (-0,29), heading up - jib (-0,07), tacking- main sail (-0,18), bearing away - helmsman (-0,26) show that results of examinees in mentioned sailing skill elements are grouping in the higher value domain. Reason for that can be in selected examinee population, who are students of Kinesiology faculty, and to whom mentioned elements didn't present greater problems. On the other hand, values of coefficients of skewness for elements tacking- helm (0,01), tacking - jib (0,05) and bearing away - jib (0,17) are positive, which makes distributions slightly positively asymmetric, i.e. they show that mentioned elements are in the lower value domain.

Table 2. Descriptive statistic parameters – predictor variable

Morphological characteristic	N	Min	Max	M	SD	Skew	Kurt
BODY HEIGHT (cm)	135	153,5	199,0	176,0	8,5	0,02	-0,3
BODY MASS (kg)	135	48,0	109,2	73,5	12,1	0,20	-0,2
% BODY FAT	135	4,7	32,0	14,7	5,1	0,03	-0,1
Kg/FAT	135	3,5	28,7	10,7	4,2	1,10	2,3

(N – number of respondents; Min – minimum value; Max – Maximum value; M – sample mean; SD - standard deviation; Skewness – Coefficients of skewness; Kurtosis – Coefficients of kurtosis)

According to the results in Table 2. large result spans are noticeable in all four morphological characteristics. Looking at height, the difference between examinees is 45,5 centimetres.

Knowing that sailing lessons are conducted on smaller sailboats with balancer keel on which examinees are restricted by moving space, it will be interesting to examine the results of regression analysis which should answer the question in what extent does such a difference in height influence the amount of achieved knowledge in sailing. Similar differences are visible in other measures too, so between the lightest and the heaviest examinee the difference of 61,2 kg can be noticed. Percentage of body fat differs 27,3 % , while per kilogram that difference amounts to 25,2 %. Also, standard deviation results show that such results are not under influence of individual examinees, but that the results are generally quite dispersed.

Table 3. Regression analysis of predictor variables and criterion variable

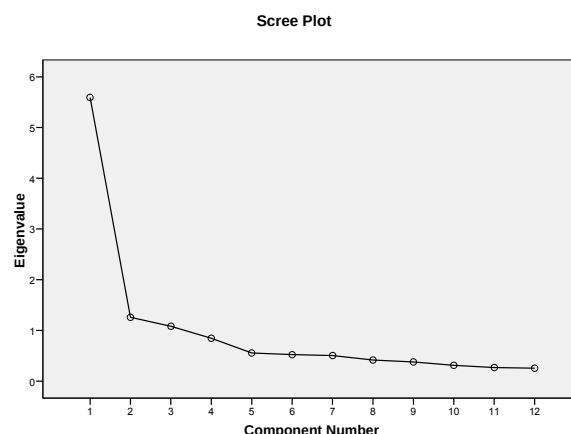
Morphological characteristic	B	SE	β	p
BODY MASS (kg)	0,02	0,01	0,23	0,01
Kg/FAT	-0,02	0,02	-0,08	0,41

Heading up - jib ($R=0,21$; $R^2=0,04$; Adj. $R^2=0,032$; $p<0,05$) (R – Multiple correlation coefficient; R^2 – Determination coefficient; Adjusted R^2 – Corrected determination coefficient; p – probability); B – Beta coefficient; SE – Standard error of estimate; β – Beta standardized partial contribution; p – predictor

After descriptive statistics, regression analysis of all twelve variables with anthropometrical characteristics was conducted. The results have singled out one statistically significant correlation ($R=0,21$) of predictor variables (body mass) to criterion variable Heading up - Jib (Table 3). Predictor group explains 4% of the variance (R^2), with the level of significance of 0,05. Although correlation of body mass and jib position in the heading up element is very low, it is easily explainable. It is known that during the heading up it is necessary to pull in the jib sheet, so greater body mass is surely making jib trimming easier.

Table 4 . Distinctive matrix values of variable correlations

Component	Eigenvalue	% Total Variance	Cumulative %
1	5,59	46,61	46,61
2	1,26	10,50	57,12
3	1,08	9,02	66,14
4	0,85	7,06	73,20
5	0,56	4,63	77,82
6	0,52	4,36	82,18
7	0,50	4,20	86,38
8	0,42	3,47	89,86
9	0,38	3,16	93,02
10	0,31	2,60	95,62
11	0,27	2,24	97,86
12	0,26	2,14	100,00



Graph 1. Scree test – method for determining statistically significant factors

Factor analysis was used to calculate the matrix of the main components (factors) on the basis of marks achieved by the examinees in four sailing technique elements and in three different sailing positions (Table 4). On the basis of distinctive values calculated through Cattels scree test, two statistically significant factors are extracted ($\lambda=5,59$; $\lambda=1,26$), which explain 57,12% of the total variance. With the mentioned proportion, first two statistically significant factors are explaining results in assessment of achieved knowledge amount in four different sailing technique elements on three different sailing positions.

Table 5. Varimax projections of variables on two extracted factors

Sailing technique elements	Factor 1	Factor 2
HeadH	0,23	0,73
HeadMS	0,77	0,14
HeadJ	0,51	0,54
TackH	0,25	0,76
TackMS	0,67	0,15
TackJ	0,47	0,47
BearH	0,19	0,86
BearMS	0,65	0,26
BearJ	0,69	0,29
JibeH	0,22	0,77
JibeMS	0,62	0,40
JibeJ	0,68	0,21

HeadH – heading up helm; HeadMS – heading up main sail; HeadJ – heading up jib; TackH – tacking helm; TackMS – tacking main sail; TackJ – tacking jib; BearH – bearing away helm; BearMS – bearing away main sail; BearJ – bearing away; JibeH – jibing helm; JibeMS – jibing main sail; JibeJ – jibing jib

Analysis of Varimax rotation results shows that positive projections on first factor are found in sailing technique elements demonstrated by the crew, in this case on jib and main sail position (Table 5.), while the second factor is mostly explaining sailing technique elements evaluated on helmsman position.

Results obtained suggest that the first factor is behaving like a component of achieved knowledge on jib and main sail position, while the second factor indicates the amount of achieved knowledge on the helmsman position.

Table 6. Regression analysis of predictor variables and new criterion variable

Morphological characteristic	B	SE	β	p
BODY HEIGHT (cm)	-0,01	0,02	-0,12	0,51
BODY MASS (kg)	0,00	0,03	-0,05	0,88
% BODY FAT	-0,10	0,12	-0,49	0,41
Kg/FAT	0,11	0,15	0,46	0,48

Acquired knowledge of sailing technique on jib and main sail position ($R=0,12$; $R^2=0,01$; Adj. $R^2= -0,016$; $p=0.757$); ((R – Multiple correlation coefficient; R^2 – Determination coefficient; Adjusted R^2 – Corrected determination coefficient; p – probability); B – Beta coefficient; SE – Standard error of estimate; β – Beta standardized partial contribution; p – predictor

Table 7. Regression analysis of predictor variables and new criterion variable

Morphological characteristic	B	SE	β	p
BODY HEIGHT (cm)	0,02	0,02	0,18	0,30
BODY MASS (kg)	0,00	0,03	0,04	0,91
% BODY FAT	0,03	0,11	0,14	0,81
Kg/FAT	-0,06	0,15	-0,27	0,67

Acquired knowledge of sailing technique on helmsman position ($R=0,20$; $R^2=0,04$; Adj. $R^2= 0,011$; $p=0.243$); (R – Multiple correlation coefficient; R^2 – Determination coefficient; Adjusted R^2 – Corrected determination coefficient; p – probability); B – Beta coefficient; SE – Standard error of estimate; β – Beta standardized partial contribution; p – predictor

After factor analysis, regression analysis of morphological characteristics and two new variables achieved by factor analysis (acquired knowledge of sailing technique on jib and main sail

position, and acquired knowledge on helmsman position) was carried out (Table 6. and 7.). Like in other elements, in two new variables no correlation was formed between morphological characteristics and efficiency in demonstration of basic technique elements. It can be concluded that in conducting basic sailing school with adult beginners, there will be no difference in the amount of acquired knowledge, not even when big differences in morphological characteristics (Table 2.) exist. The reason for such a result can be in using of optimal sailboats for mentioned population, which are reducing these differences by their simplicity and stability. Also, obtained result can be due to the quality and suitability of class programme to the population of students who were subject to it.

Conclusion

The basic goal of this research was to determine correlation between morphological characteristics and efficiency in teaching sailing. Data were processed using regression analysis, and on the basis of obtained results it can be concluded that morphological characteristics had very little influence on the amount of acquired sailing skills knowledge, regardless of great differences in anthropological characteristics of observed examinees. The only significant difference was determined in the element heading up – jib and body mass, which can be explained by the fact that it was easier to the examinees with higher body mass to pull up the jib, and it ensured better concentration for the right performance of the assignment in the end. Obtained results can be explained by the fact that examinees were training their skills on balancer keel boats and the fact that they were trained according to the programme that was completely adjusted to that population. On the basis of the aforementioned reasons, it can be assumed that morphological characteristics could not have significant influence on final result, respectively, in this case, better mark on the exam.

References

- Allen, J.B., & De Jong, M.R. (2006). Sailing and sports medicine: a literature review. *Br J Sports Med*, 40, 587-593.
- Bojsen-Moller, J., Larsson, B., Magnusson, S.P., & Aagard P. (2007). Yacht type and crew-specific differences in anthropometric, aerobic capacity, and muscle strength parameters among international Olympic class sailors. *Journal of Sports Sciences*, 25(10), 1117-1128.
- Cortell-Tormo, J.M., Perez-Turpin, J.A., Cejuela-Anta, R., Chinchilla-Mira, J.J., & Marfell-Jones, M.J. (2010). Anthropometric profile of male amateur vs professional formula windsurfs competing at the 2007 European Championship. *Journal of human kinetics*, 23, 97-101.
- Farley, O., Harris, N.K., & Kilding, A.E. (2012). Anaerobic and aerobic fitness profiling of competitive surfers. *J Strength Cond Res*, 26, 2243-2248.
- Legg, S.J., Miller, A.B., Slyfield, D., Smith, P., Gilberd, C., Wilcox, H., & Tate, C. (1997). Physical performance of elite New Zealand Olympic class sailors. *Journal of sports medicine and physical fitness*, 37, 41-49.
- Mendez-Villanueva, A., & Bishop, D. (2005). Physiological aspects of surfboard riding performance. *Sports Med*, 35(1), 55-70.
- Mišigoj-Duraković M. (2008). *Kinanthropologija, biološki aspekti tjelesnog vježbanja*. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.

- Oreb, G., Kostanić, D., & Oreb, I. (2009). Povezanost nekih morfoloških dimenzija s uspješnosti u obuci jedrenja na dasci. Zbornik sažetaka sa 5. Kongresa i 6. međunarodne naučne konferencije Crnogorske sportske akademije, Tivat 2009.(pp. 98-103). Podgorica: Crnogorska sportska akademija.
- Ošlak-Kranjc, J. (2011). *Povezanost motoričkih i morfoloških obilježja i uspješnosti u jedrenju na dasci.* (Magistarski rad). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
- Prlenda, N., Oreb, G., Cigrovski, V. (2012). Utjecaj nekih antropoloških obilježja muškaraca i žena na proces stjecanja znanja jedrenja na dasci. *Hrvatski športskomedicinski vjesnik*, 27(2), 89-94.
- Vogiatzis, I., Spurway, N.C., Wilson, J., & Boreham C. (1995). Assessment of aerobic and anaerobic demands of dinghy sailing at different wind velocities. *J of sports medicine and physical fitness*, 35(2), 103-107.
- Vogiatzis, I., De Vito, G., Rodio, A., Madaffari, A., & Marchetti M. (2002). The physiological demands of sail pumping in Olympic level windsurfers. *European Journal of Applied Physiology*, 5, 450-454.
- Zuban, M. (2006). *Povezanost antropometrijskih obilježja, motoričkih i funkcionalnih sposobnosti s uspjehom u natjecateljskom jedrenju klase optimist.* (Diplomski rad). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.

UTJECAJ MORFOLOŠKIH KARAKTERISTIKA NA UČINKOVITOST U NASTAVI JEDRENJA

Sažetak

Cilj istraživanja bio je utvrditi koliko morfološka obilježja imaju utjecaj kod odraslih početnika prilikom usvajanja osnovne tehnike jedrenja na brodu s balansnom kobilicom (Elan 19). Istraživanje je provedeno na uzorku od 135 redovnih studenata Kineziološkog fakulteta Sveučilišta u Zagrebu, u sklopu nastave iz kolegija Sportovi na vodi – Jedrenje. Morfološka obilježja izmjerena su u prostorijama Kineziološkog fakulteta neposredno prije provođenja praktičnog dijela nastave. Kriterijske varijable sačinjavale su ocjene ispitanika dobivene standardnim postupkom procjene znanja na ispitu iz kolegija Sportovi na vodi-jedrenje. Ispit i poduka održani su na jedrilicama tipa Elan 19. Uspješnost ispitanika procjenjivana je na skali od 1 do 5. Procjenjivanje znanja ispitanika utvrđeno je na osnovu demonstracije četiri elementa tehnike: letanje, kruženje, prihvaćanje i otpadanje na pozicijama: kormilo, glavno jedro i flok. Za utvrđivanje osnovnih morfoloških obilježja ispitanika odabrane su četiri antropometrijske mjere i to: visina tijela (ATV), masa tijela (ATM), postotak masnog tkiva (% Masti) i ukupna količina masti (Kg/Masti). Rezultati regresijske analize na dvanaest varijabli izdvojili su jedinu statistički značajnu povezanost ($R=0,21$) tjelesne mase sa kriterijskom varijablom prihvaćanje na poziciji floka sa svega 4% ukupne varijance. Nadalje, faktorskom analizom izdvojene su dvije nove varijable, usvojeno znanje jedrilčarske tehnike na poziciji floka i glavnog jedra i usvojeno znanje na poziciji kormilara. Isto tako regresijskom analizom utvrđeno je da niti kod ovih varijabli nema utjecaja morfoloških obilježja na konačan rezultat. Na osnovu dobivenih rezultata zaključuje se kako prilikom provođenja osnovne škole jedrenja s odraslim početnicima razlike u osnovnim morfološkim obilježjima neće utjecati na količinu usvojenog znanja.

Ključne riječi: morfološka obilježja, škola jedrenja, jedrenje

Received: March 13, 2013

Accepted: June 10, 2013

Correspondence to:

Prof. Goran Oreb, PhD

University in Zagreb

Faculty of Kinesiology

10000 Zagreb, Horvaćanski zavoj 15, Croatia

Phone: +385 (1) 3658 666

E-mail: goreb@kif.hr

WHAT KIND OF APPROACH TO SOMATOTYPE DETERMINING IN KINESIOLOGY?

Mislav Lozovina¹, Vinko Lozovina¹ and Dobromir Bonacin²

¹ Faculty of maritime studies, University of Split, Croatia

² Faculty of Education, University of Travnik, Bosnia & Herzegovina

Review paper

Abstract

The aim of this paper was to determine actual systematic position for human morphological definitions. It is well known that such a job is very serious and even more complex. So, first of all we have to rearrange basics, include all possible significant ideas and try to reach frontiers in this complicated area. We are in that work app. 30 years, and still are looking for new universal concept. We hope this article will help others to establish strong and sustainable concept, a theory for better praxis and transformation processes.

Key words: morphological characteristics, somatotype, kinesiology, conceptual approach

Introduction

In kinesiology are particularly significant problems relating to the relationship between morphological and psychomotor characteristics because it is the foundation on which rests the practical application of kineziological knowledge in the areas of education, recreation, physical training, and agonistics. In each kinesiology activities in terms of the work involved all psychomotor performance in various mutual ratios are responsible for the implementation of energetic components (ultimately measured with mixture of anaerobic-aerobic capacity) and information components (efficiency techniques tactics and strategy) in a given activity.

In relation to the IT component, and for the efficient performance of all the techniques that are operational tactics and strategies in a sport, coordination is ultimately responsible for the proper and orderly execution of the required movement structures. There are no movement structures, even if it consisted of a single movement, which is not influenced by a complex mechanism for the regulation of complex motion. These mechanisms are described in Hošek (1972), Kurelić et al. (1975), Viskić-Štalec (1974) and Hošek-Momirović (1976) and define them as: a mechanism for regulating the movement or in the narrow sense of a mechanism for structuring movements. For complex integrative and coordinating function responsible array of devices are located cortically and sub-cortically in the CNS, which allow effective psycho-motor response to a specific stimulus or in accordance with ones intention. Coordinating function of the CNS and the visual decoding, analysis and transformation of information in an optimal kinetic structure will become less effective if there are disturbances caused by inappropriate structure of effectors system.

If the ability to zone CNS (as by Bernstein, Anokhin and Čhaidze) be defined as external and internal control circuit optimally developed disturbances caused by inappropriate characteristics effectors system, it is possible to incorporate such information element in the system for analysis and transformation which will certainly produce the most efficient kinetic output. However, the complex structure of effectors system in different kinetic

situations will produce so many different noises that it is virtually impossible to identify all information at the same time and in a very short time to integrate the appropriate kinetic programs. In doing so, the biggest obstacle produces exactly morphology effectors system that is in its functional definition directly subordinate to biomechanical principles, which provide a maximum of precisely aligned with the morphological structure of the body. As the biomechanical principles by definition and in all cases constant, are the most efficient implementation of the kinetic program it is always directly caused by the efficiency and flexibility of control devices and their ability to identify and absorb the information emitted by the morphology effectors system as the data that needs to be integrated into the final output program.

Complete neutralization of noise produced by the morphological structure is not possible while the kinetic programs, which can not always be in absolute agreement with the movement patterns which is influenced by the morphological structure of the body, need to be the closest to appropriate biomechanical solutions. Coordination in the literature is defined as the ability to effectively solve complex psychomotor problems and so has the meaning defined as motor intelligence (Fleishman, 1946). Similarly, in terms of intensive interactive relationship between cognitive and motor skills, coordination, interprets and describes Mejovšek (1976).

If this is true, it is possible to assume that people with near equal intellectual abilities may differ in structure and level of coordination abilities, because as the generator of these differences appear different morphological structure of effectors system that influenced biomechanical laws and produce different kinetic effects. While the motor dimensions in a situation of one type of body structure can directly interfere with the realization of the same angular physique, in another situation, the motor dimension can be extremely favorable. Hence arises the need for defining and analysis of morphological complexes present in each sport activities especially as subsets of the population from which they are drawn and selected in the activity in which they are located.

Conceptual problems associated with the determination of morphological taxons

The concept of morphological taxons is derived from the concept of somatic or constitutional type. The concept of somatotype is to be operationalized in several different ways. The most commonly used operationalization is based on the assumption that relates different characteristics are not the same in different segments of the human population and that it is therefore possible to identify morphological structures that are defined in different rule opposite intensity development of specific groups of morphological characteristics and those related to general and specific development skeleton, the amount and distribution of body fat and the amount of active muscle mass. A 'pregnant' morphological forms are experiencing significantly more intense than poorly differentiated, which are generally closer to the expected, in the creation of the theory of observation and is taken as the basis for the construction of various constitutional and typological theories including Kretschmer (1921) a long time been used in anthropological research. Very similar concept, which can be operationalized, and much closer to the notion of type or taxons, common in biological taxonomy, is offered by Jardine and Gibson (1971). Their operationalization of the concept of morphological types was based on the assumption that the area bounded measures morphological characteristics can be divided into a relatively small number of subspace defined existence of zones of high density and relatively small-scale concentrated around such a large number of centroid how many so defined subspaces, where the zone defined by a large density points separate zones of little or no density. Such logic is equivalent to the logic that is based on morphological characteristics of human populations can be divided into a relatively small number of distinct subpopulations. Centroids of these subpopulations are treated as represents of morphological types or morphological taxons.

Sheldon (1939; 1954) offered following concept of defining morphological types or taxons based on the logic that some genetic factors influence the quantity and quality differentiated development of morphological characteristics and that it is therefore acceptable to the concept of constitution and it is derived from the concept of constitutional type. Each taxonomic theory is based on the assumption of the existence of distinct types of collision (conflict) with the fact that in no matter how defined human population morphological system is or at least the anthropometric characteristics are multivariate normally distributed, and therefore all the anthropometric measures are normally distributed or distributed so as to allow to treat them as if they were normally distributed. Multidimensional hyper-ellipse that define anthropometric measures of a population or a representative sample of it, in any meaningful way is not possible to divide in the smaller number of equally dimensioned hyper-ellipse that are mutually far enough. That is why it is not possible to accept the classical notion of morphological type. Distinct taxons are not the only form that can be reduced to a general concept of taxons. Vectors of entities can be projected onto any number of vectors, orthogonal or placed in any other suitable relationship.

This means that it is possible to choose such vectors so that the extreme positions on either end of any of them associated with projections close to the common origin of all the other so selected vectors. This concept is known as the concept of polar taxons defined in the work of Cattell (1966) and is close to Sheldon's understanding of the fundamental constitutional variables, and is acceptable for real properties anthropometric variables.

Methodological problems associated with determining the morphological taxons

Except for classic indirect taxonomic procedures, based on the functions of distance or similarity, which is the purpose of the separation of a set of entities on a number of distinct subsets, methodological problems associated with the determination of polar taxons can be divided into several groups.

Problems associated with the type of data on which to perform taxonomic operations

Polar taxons can specify operations over three types of data. The simplest way to determine the polar taxons is to act on the data obtained by measurement. The analysis can enter as raw, standardized or transformed into a suitable metric (transformation into image or Harris metrics). If the overall variance is significant for determining the morphological taxons and if expected to be measured by units which are expressed anthropometric measures important for defining taxonomic circuits and if it is expected that the anthropometric dimensions are commensurable (standardized and measurable) taxonomic data analysis procedures are best performed over the original non-standardized data. As the anthropometric variables commensurable only for some segments of morphological space, it is necessary to do some operations of commensurable standardization. Sometimes it is useful to apply anthropometric measures given to the importance of which is proportional to their variance in the common area and inversely proportional to their variance in 'unique (anti-image) space in order to avoid ' unique variance of the measures involved in the formation and morphological taxons made representative in the universe of morphological characteristics.

In the first case it is reasonable to transform data to standardized and sometimes non-standardized variables in image form, and the second is to transform anthropometric variables into Harris form which eliminates the problem of the original units. Often anthropometric variables have special significance for the determination of morphological taxons. In these cases, the variables obtained by measurement have to be transformed into a suitable system of latent anthropometric dimensions. Number of such transformation is unlimited. As a suitable system of latent dimensions of which are performed taxonomic procedures, can be used a principal components system whose number is based on estimates of their generalization, their representativeness and the actual dimensionality of latent space. These components can be derived from standardized and non-standardized measures, transformed in the image or Harris form and as such commonly can not be treated within concepts of polar taxons.

As a basis for taxonomic procedures it may be used the components transformed into a suitable orthogonal or orthogonal parsimonious system as a set of anthropometric measures in latent space. If the system is un-orthogonal, dimensions have to be executed by the subsequent orthogonalisation, usually by least-squares. Parsimonious system can be determined on the basis of any methods belonging to the generalized parsimax criterion and sufficient degree of ease when oblique transformation achieved from oblimin technique or one of two standard types of orthoblique techniques. In varimax orthogonal transformation there are the most of the group orthomax procedures. Factor values obtained by conventional factor model because of its indeterminacy are not suitable for taxonomic procedures. Details of which are performed taxonomic procedures can be used to determine the measure of similarity or distance between the entities. Taxonomic procedures can be applied over so transformed the basic data. Among the similarity measures for taxonomic purposes may be used scalar product vector of entities defined in any metrics of original variables or defined after transforming the original data into a suitable system of latent dimensions. If such similarity measures apply using scalar products of standardized entities vector (correlation coefficients between the entities) on the outcome of taxonomic procedures will affect only structural but not quantitative similarities. Determination of polar taxons based on the distance function is not normal procedure but such approaches are possible. As a measure of distance is usually taken Euclidean spaces or Mahalanobis distance between the entities, but this distance can be expressed in another L_n metric. As a measure of distance can be used coefficients similarity profile, metric distance function, or any other measure suitable for this purpose (Momirović, 1972).

The problems with number of taxons definition

Number of taxons can be fixed in advance if there is a valid theoretical basis but on the basis of information obtained by previous research which is little, it is not likely. Valid theoretical concepts which permit the implementation of this strategy has little even when taxonomic procedures applied to the data that belong only to the segment of morphological space. The problem of determining the number of polar sensitive taxons in each taxonomy is because a solution depends on the nature of data on which to perform taxonomic operations and mathematical models lay in the basis of which the taxonomic algorithmic procedures are prepared. When used as a basis for determining taxonomic operations of anthropometric measures, transformed into any metrics, number of taxonomic variables is defined according to the criteria for assessing the significance of the main components of which may be severe or less severely penalizing. Since it is not reasonable to produce more taxonomic variables than there are major components with non-negative coefficients of generalizability, the number of such components is also the upper limit of the number of polar taxons. Reasonable number of taxons may be lower if the sample is representative in anthropometric dimensions space, or sufficient because then the possible number of taxonomic variables limited to as much as is sufficient to exhaust the variance in common (image) space.

Dimensions simply exhaust real variance in joint subspace of original anthropometric dimensions and those dimensions are transformed in image form. As the number of latent dimensions determined by the number of significant principal components, the number of species on the basis of certain latent anthropometric variables can be determined in the same manner. As the eigen-values of the matrix of scalar products of entities equal eigen-values of the matrix of scalar products of the variables, the same procedure to determine the number of morphological taxons can be applied when the similarity measures base to perform taxonomic operations. The problem of determining the morphological taxons becomes more complex when the taxonomic operations conducted over the distance measures. In this case the number of species is defined as the minimum number of dimensions along which one can perform some operations of multidimensional scaling (Szirovica, Momirović, Hošek, & Gredelj, 1972).

Problems associated with the choice of an algorithm to determine the taxons

Problems of determining any and any type of taxons are generally not realized at the level of the algorithm at all, for the simple reason that the algorithm is contained already prepared a logical concept that is implemented in the chosen method of determining types regardless of mathematical procedures, or a mathematical procedure is already integrated into the logical procedure. However, although at first glance the foregoing logic polar taxons is viable, it also holds the germ of inconsistencies, because the assumption of real existence of ellipsoid or hyper-ellipsoid data, already in the beginning it is clear that the ellipsoid is "stretched" by the prolonged axis, which means that it is "stretched" the whole set of any kind of data collected, and then it does not mean anything other than polarization, or in terms that we are interested in - precisely distinct taxonomization, regardless of whether or not a full set is hyper-normally distributed. On the other hand, the polarization in the set of normally distributed data (a latent dimensions such still are) very seriously brings us into question any consideration of possible distinct position taxons, and thus of course, to the question of their existence at all. Having said this it is clear that the problems of universal taxonomy are not resolved, and that such problems do not belong to informatics area et all.

The results of some recent studies of morphological types (historical overview)

According to the authors (Albonico, 1970; Lozovina, 1983), the first attempts to classify people into constitutional types dating back to the distant past. So Hypocrite (460-390 BC) hypothesized the existence of four structural elements in the structure of the body of a man whose qualitative variations in people differ from one another. Galen, developing Hypocrites hypothesis based on the domination of one of the existing elements, forms a theory that there are four temperaments (sanguine, choleric, phlegmatic and melancholic). Halle and Rostan (1826) on the basis of its own anthropological study hypothesized the existence of constitutional types, which are called: vascular, muscular and nervous. From these early beginnings to the present in the literature can be found numerous and very different

types in the same anthropological space, depending on the criteria on which they are based. So there are many social, phylosophical, psychological, morphological and within the latter sports and psychomotor. In his work "Mensch-Manschen typen" Albonico (1970) provides a vertical view the most significant effort to determine the morphological types from the beginning until today. Here we should mention just a few of these studies have historical significance and which provided the largest contribution to the scientific study of these problems. Research of Siguada (1908) and his followers Chaillon and Mc Aulifa, whose common view that the only external environment main generator forming the constitution and not hereditarily, as claimed by most other authors, has resulted in work in which the authors distinguish four basic types of relative to the dominant muscular, respiratory, gastrointestinal and cerebral systems by defining them as : 1) tipus muscularis - developed limbs , a large mass of skeletal muscle, rectangular face with a vertical as well as the long side, the approximate equality between the upper (cerebral) medium (respiratory) and lower (digestive) fuselage , 2) Tipus respiratorius - diamond- look middle part of the face, long and wide nose, protruding eyeballs, trapezoidal shape of the hull (with a base turned above), wide and broad chest with sharp epigastria angle, poorly pronounced belly, 3) Tipus digestivus - prominent belly, short and wide chest with a blunt epigastria angle, conspicuously developed lower segment faces, 4) Tipus cerebialis - whole body gives the impression of slimness, developed forehead, triangular face (with the base facing up It is difficult to discern why these authors attribute their constitutional types of exogenous origin when the basis of their analysis is skeletal construct, which is not and can not deny hereditarily. The next author who deserves to be ranked with history important persons is Kretschmer (1921) who classified its types, at reasonable, easily and what is most important, by measurable criteria. He distinguishes three basic types: leptosome, athletic and picnic, with the possibility of occasional appearances so called dysplastic type. It is obvious that he is an author who takes into account both the skeletal, muscular and adipose components, and for this reason it have today many respects. As defined by the pure types, Kretschmer connects them with some psychological dimensions. Connecting them with pathological personality traits, he talks about schizoids at leptosomes, and cyclothymiacs in picnic types. With regard to mental illness suggests a greater likelihood of schizophrenia in leptosome types, genuine epilepsy in athletics and maniacal - depressive states in picnic types (Lozovina, 1983). Leptosome type is characterized by considerable longitude body, long limbs, a narrow chest, and a long and thin muscles. Athletic is defined by a strong skeleton, developed and strong muscles, a well-developed and strong limbs, broad thorax and relatively narrow pelvis. Picnic type is defined with poorly developed structure, weak to moderately strong muscles, a relatively wide pelvis, a considerable body weight, thick neck, short, wide and thick trunk with a pronounced belly and short and thick limbs. Athletic is characterized with trapezoidal shape of the hull, broad shoulders and a relatively narrow pelvis, extremities that are appropriate with large hands and feet and a powerful muscle relief of entire body.

The author, whose work is also very important is Conrad (1941), who attempted to establish the principle factor that underlies the formation of constitutional types. Starting from the premise that there are certain, probably genetic, the criteria for the formation of different constitution, the author has created three theories in which there are possible standards of growth and development of the body, or primary, secondary and tertiary options for forming types: 1) The theory of the primary variant unites two different growth trends: a) conservative tendencies of growth relates to the types in which the growth and development resulted in a relatively small proportional shifts during development, when in adulthood retained body proportions from early childhood (infantile form). The same trend is evident in both psychological maturity of this type whose character set defined primeval innocence, simplicity, immediacy and sociability, and b) The progressive tendency of growth is defined types whose development is accompanied by a relatively large proportional shifts with finite strong deviation in the form of the body from the physical form of a child. Character structure of this type is marked as shisotic and means guys who are focused on the analysis itself. Conservative trend growth with morphological point of view the author identifies with picno-morph guy, a progressive tendency to increase with leptomorph type; 2) The theory of secondary variants unites the two tendencies of growth that occur independently of the primary variants and are defined as: a) type with hypoplastic tendency of growth corresponding asthenic type of which is characterized by a short beard, pulled inward, poorly expressed the frontal lobe, narrow shoulders, bent back, poorly formed end parts of the limbs and a relatively low height. With this type it is possible to perceive the presence of the conservative tendencies of growth, b) type with hyperplastic tendency of growth suits Kretschmer's athletic type. With this type we can notice very prominent frontal lobe, in contrast to its rear, broad shoulders and a relatively long limbs. Such a structure, according to the authors, based on increased impetus to growth, that type occurs after puberty in those areas at that time and still allow for the possibility of growth. It refers to the skeletal and muscular system; 3). The theory of tertiary variant refers to pathological changes that accompany the growth and development of the body and result in dysplastic and dismorphic type (Lozovina, 1983). Entirely new principle in the study of constitutional types introduced Sheldon (1939), started from the hypothesis that certain organ systems, as well as branches of three developmental sheets (endoderm, ectoderm and mesoderm) show different trends of growth and development. According to the dominance of one of the three components, it is possible to distinguish three types: 1) Endomorph type characterized by the curvature of the contours of the body, a considerable body weight, short and thick neck, broad torso, expressed fat especially in the belly, short and thick limbs, 2) Mesomorph type characterized by a strong skeleton, developed and powerful muscles, long and muscular neck, wide and protruding chest, narrow waist, strong extremities and well developed, 3) Ektomorph type characterized by high growth, slim physique, broad forehead on a small face, pointy nose, long and slender neck, narrow chest, long limbs with a thin and graceful musculature.

Since most people represents a combinations of endomorph, mesomorph and ektomorph type, Sheldon has developed a labeling system of mixed types with three numbers that vary 1-7, the size of which speaks of the presence of each of the three basic characteristics of the type. Number 1 indicates the absence of the appropriate characteristics of type traits. Numbers 2-7 are saying about the appropriate level of quality. Markers like '7 - 1 - 1' indicates a person of pure endomorph type, '1 - 7 - 1' pure mesomorph type, and label '4 - 4 - 4' person pure mixed type. Aware of the high interconnectedness of morphological characteristics, which on the basis of the embryonic origin of the projects a three-dimensional coordinate system, Sheldon becomes the initiator of a new approach to typology. His hypothesis is that virtually no real clean guys who would by definition exclude the presence of other types of structural elements of the beginning of the idea of continuous multimodal distribution structure morphological dimension. Based on the theory of the existence of Sheldon endomorph, mesomorph and ectomorph type Brozek (1950) has been thoroughly elaborated labeling Sheldonovich types and set out the criteria for morphological structure of individual parts to the labeling system that could even declare endomorph, mesomorph or ectomorph. The whole body is examined by the author in five regions: a) head and neck, b) thoracic part of the trunk, c) arms shoulders and hands, d) abdominal part of the hull, and e) legs and feet. For each of these regions the author stated detailed characteristics (Lozovina, 1983). Somatotyping techniques are used to assess body shape and composition. Somatotype is defined by quantifying shapes and composites of the human body and it is expressed with three figures represent endomorph, mesomorph and ectomorph component, always in the same order and it evaluates each component. Ratings 3-5 are moderate and considered to be low, 5 ½ to 7 are high and 7 ½ and over are very high (Carter & Heath, 1990). The rating is based on phenotypic characteristics and the concept of geometric proportion of the human body, and the technique is applicable to both genders from children to adulthood. Heath-Carter somatotyping is today the most widely used method. There are three ways to determine the somatotype: 1) Anthropometric method, in which anthropometry is used to evaluate the criteria somatotype, 2) Photoscopic method, in which the marks are made on the basis of standardized photographs, and 3) Anthropometric plus Photoscopic (combined) method, which combines anthropometry and ratings of photographs.

Measurement techniques

Ten anthropometric variables are needed to calculate the anthropometric somatotype: height, body weight, four skin folds (triceps, subscapular, supraspinale, medial calf), two of the bones (humerus and femur biepicondylar) and two on the scope of the extremities (arm flexion and relaxed recumbent). Detailed descriptions are given by Carter and Heath (1990). Further adjustments and improvements are given in Ross and Jones (1991), Carter (1996), Carr and Carter (1999), Duquet and Carter (2001) and Isak Manual (2001).

Reliability of measurements

The advantages of anthropometry are lost unless the measurements are accurate and reliable (i.e. precise).

It is essential to learn precise measurement techniques and accurate calculations. Although at first sight anthropometry appears easy to the beginning investigator, obtaining a high level of skill and reliability requires training under a criterion anthropometrist and considerable practice. Although calculation of the Heath Carter is an objective procedure, the validity of the rating depends on the reliability of the measurements used. Investigators should report test-retest reliability of the measurements. In comparisons of distributions of two independent measures on the same subjects, that means should not differ significantly, and the Pearson product moment (r) should be above 0.90. Specifically, height and weight should have test retest values of $r = 0.98$. Girths and diameters should have r 's between 0.92 and 0.98. For skinfolds r 's between 0.90 and 0.98 are reasonable. Currently, many anthropometrists use the technical error of measurement (TEM) for evaluating the consistency, or precision, of the measures on a given variable. The TEM is the square root of the sum of the differences between those measures and two squared, divided by twice the number of subjects (Cameron, 1984; Norton and Olds, 1996). The TEM provides an estimate of the measurement error that is in the units of measurement of the variable. This value indicates that two thirds of the time a measurement should come within $\pm$ of the TEM. The TEM can be converted to a percentage of the mean of the total number of measures (grand mean). This allows comparisons among measures or for groups of variables. Generally, the TEM for skinfolds should be about 5%, and that for breadths and girths 1%, and for height about 0.5%. The equations are as follows: $TEM = (\sum d^2 / 2n)^{0.5}$, and $\% TEM = 100 (TEM / \text{grand mean})$. Calculating the memory somatotype There are two ways to calculate the memory somatotype: a) Enter the data onto a somatotype rating form b) Enter the data into equations derived from the rating form. The Heath Carter Somatotype Rating Conducted 16 steps in calculating the order Mesomorphisch, Ectomorphisch and Ectomorphisch components. The second method of obtaining the memory somatotype is by means of equations into which the data are entered. Endomorphy = $-0.7182 + 0.1451 (X) - 0.00068 (X^2) + 0.0000014 (3X)$ where $X = (\text{sum of triceps, subscapular skinfolds and supraspinale}) \text{ multiplied by } (170.18 / \text{height in cm})$. This is called height - corrected endomorphy and is the preferred method for calculating endomorphy. The equation to calculate mesomorphy is: $\text{Mesomorphy} = 0.858 \times \text{humerus breadth} + 0.601 \times \text{femur breadth} + 0.188 \times \text{corrected arm girth} + 0.161 \times \text{corrected calf girth} - \text{height } 0.131 + 4.5$. Three different equations are used to calculate ectomorphy according to the height - weight ratio: 1) If HWR is greater than or equal to 40.75 then: $\text{Ectomorphy} = 0.732 \text{ HWR} - 28.58$; 2) If HWR is less than 40.75 but greater than 38.25 then $\text{ectomorphy} = 0.463 \text{ HWR} - 17.63$; and 3) If HWR is equal to or less than 38.25 then $\text{ectomorphy} = 0.1$. The preceding equations, derived from data used by Heath and Carter (1967), use metric units. The equation for endomorphy is a third degree polynomial. The equations for mesomorphy and ectomorphy are linear (when the HWR is below 40.75 a different equation is used for ectomorphy). If the calculation equation for any component is zero or negative, a value of 0.1 is assigned.

That as the component rating, because by definition ratings can not be zero or negative. Because the somatotype is a three - number expression, meaningful analyzes can be conducted only with special techniques. Somatotype data can be analyzed by both traditional and non-traditional descriptive and comparative statistical methods. Although descriptive statistics are used for each of the components, comparative statistics should be made in the first instance using the whole (or global) somatotype rating. This, is followed by analysis of separate components. Here are some definitions: somatopoint (S) = A point in three - dimensional space determined from the somatotype which is represented by a triad of x, y and z coordinates for the three components. The scales on the coordinate axes are component units with the hypothetical somatotype 0-0-0 at the origin of the three axes. Somatotype attitudinal distance (SAD) = The distance in three dimensions between any two somatopoints, calculated in component units. Somatotype attitudinal mean (SAM) = The average of the SADS of each somatopoint from the mean somatopoint (S) of a sample. The U.S. Represents the "true" distance between two somatopoints (A and B). The U.S. is calculated as follows: U.S. $A, B = \sqrt{[(\text{endomorphy } A - \text{endomorphy } B)^2 + (\text{mesomorphy } A - \text{mesomorphy } B)^2 + (\text{ectomorphy } A - \text{ectomorphy } B)^2]}$ Where A and B are two individuals, two different times for one individual, or two means . The SAM is calculated by dividing the sum of the SADS from their mean somatopoint by the number of subjects. These equations are used in the calculation and analysis of somatotype data. Items 1 and 2 are for calculating and plotting the somatotype. Items 3 - 6 are for analysis of the whole somatotype. Item 7 suggests methods for comparisons by components. To identify the contributions of the three - somatotype components to possible differences between samples, we can use standard MANOVA designs or Discriminant Analysis. For quantitative analysis of the longitudinal change in somatotype components use MANOVA techniques with and within - subject design. To assess the relationship over time for a component use interage partial correlations for one component while holding the other two constant. Somatotype - Calculation and Analysis V 1.1. Monte Goulding, Sweat Technologies, Mitchell Park, South Australia. It is a new comprehensive user - friendly PDF platform program designed to calculate individual and group somatotypes , somatotype data import from, and export to other files. Reports show statistics, somatoplots, categories and comparisons of individuals and / or groups. HC_StypeCalculation - 03.xls is a simple program for calculating the Heath - Carter somatotype from anthropometry, useful for individual or group data. No plotting or analysis. LifeSize. V1.0 for Windows (or Mac), (1999), by Olds & Norton is a memory profiling and analysis program. It is a tool which assists in the collection and analysis, has a database containing norms for somatotype, body fat and skinfolds for the general population and specific sporting groups. B.O.R.I.S. (2002) -Alexander is a CD-Rom software program in Spanish for memory evaluation, including somatotype. Although this approach to determining somatotype is modern and more objective of all previous typology, it is questionable why the authors specify for exactly this methodology because this way

of calculating the morphological characteristics allow the occurrence of errors and a significant loss of information. It is undisputed that the latent space much better define a number of originally measured anthropometric variables, such as index values themselves have a greater loss of important information in defining latent morphological dimension and it could declare a huge lack of Heat-Carter method for determining somatotype. An objective approach based on experimental data and of factor - analytic methods in the study of morphological dimension was introduced by Spearman (1927). The results concluded that there exist "type-factors" that can be understood in terms of taxonomic and appear alongside mandatory isolated general anthropometric factors. Similar results find Raes & Eyseek (1945), as well as representatives of the British school, using orthogonal factor procedures. Their U.S. counterparts Thurstone (1946), Howells (1951) and Heath (1952) have come up with very similar results using oblique factor solutions (Lozovina, 1983; 1986; Lozovina , et al., 2004; 2008; Lozovina, 2012). Authors Eyseek & Rees (1945) argue that the human body can be seen as a rectangle, and it can be defined by latitude and longitude. To estimate the length there are taken measures of arm and leg length and height, while for estimating the width, the width of the chest, circumference of chest and pelvic width. Multiplying the length and width overtaking the overall size of the body, dividing the length of the width given to the relationship that was the shape of the body, i.e. talked about whether the body is relatively short or long. On the basis of such analysis the authors performed two indices of physical material on which was represented by the size and shape of body composition. Anthropometrics often compare the dimensions of the two parts of the body or body size are compared with some general measures that describe it or place body size in relation to other functions such as the psychomotorics, energy outputs, techniques, tactics and strategies in the sports competition and more. Such comparative studies are called Allometric. In biology allometrics refers to changes in the relative size of body parts and correlated with changes in overall size (Julian Huxley and Georges Teissier, 1936 by Norton & Olds, 1996). If there exists the independent variable x, which is in relation to body size or body shape (X = body weight or height) and is put in relation with the dependent variable y (Y = skin folds, basal metabolic rate or locomotion) and determine any relationship between these variables, did we step towards a theoretical model where on our theoretical knowledge and choice of appropriate statistical and mathematical procedures depends how well the variable x predict variable y!? The model does not decide mechanically but chooses the one that best fits the concept of the research and the logic of nature phenomena we study. *N* the anthropometric surveys, there are three models commonly in use: 1) Ratio model expressed by the equation: $y = kx$, where k is a constant. For example, the length of the limbs are considered constant fraction of body height within ethnic subpopulations, and once the bone growth has to stop; 2) regression model, expressed by the equation $Y = a + bx$, where a and b are constants. For example, the relation between stroke volume and body mass, Tanner (1949) determined by the equation : $MV = 0.32 * \text{Mass} + 79.5$; and

3) Power model or general allometric equation as refer by Huxley (1932) and Teissier (1931) which suggests that the proportional relations can best describe the general function expressed by the equation $Y = BXA$, or by logarithm of both sides $\ln y = \ln a + b \ln x$, where x is the size of a part of body size or general measures of body size (height and weight), and y is the size another part of the body or a body function. When $a = 0$, y is equal to b , which is the case when the dimensionality of one part of the body is dependent on the total dimensionality. example the size of red blood cells in mammals is equal regardless of the size of the mammal. So mouse and horse red blood cells have a similar size.

When $a = 1$ size of the two parts of the body (or the size of the body and the whole body) is in a linear relation, for example length legs still growing just as the growth and overall height. When $a = 2$ body part size increases with the square of body size. The cross-sectional area of muscle and body surface area are examples of body characteristics which increase approximately with the square of height. When $a = 3$, the body characteristics increases with the cube of body size. Volume would be expected to increase with approximately cube of height. When $a = -1$, y decreases as x increases inversely. The mean height of sprinters increases as the sprint distance increases from 50 to 400 m. Over longer distances, acceleration is much less important than in short sprints (Norton & Olds, 1996). What is obvious is that the people have basically the same shape. similarity of comparative anthropometry makes it possible and easier. Certainly there are exceptions to this rule, and then we talk about morphological aberrations incurred for any reason, but always remains the possibility of comparing two individuals of different shapes and forms. A large number of differently dimensioned body characteristics can be presented as different sized cubes. If the leg length (L) doubles size will quadruple (L^2) and the volume will grow eight times (L^3). Similarly, human lengths, girths and breadths generally increases linearly with height, surface areas increase with the square of height, and masses and volumes increase with the cube of height.

This process can not run indefinitely. From a technical point of view, machines, including biological, such as animals or human-machines if are becoming bigger must be functionally adapted. Already Galileo reasoned that if the length of the muscle and bone grows quadratic and cubic volume, the critical point will be reached when the bones and muscles are no longer able to support the weight of the body. In addition bone mass grows at a relatively greater rate than body mass. This represents a structural response to functional demands which "breaks the allometric rule". There are interesting parallels between allometric relation to animals and correspondent allometric changes in objects made by hand of man. Mc Mahon & Bonner (1983) by Norton & Olds, (1996) determined that steel nails show a systematic relationship between the length and diameter. This relation is a consequence of the planning and has already created a system error in the trial- period of several thousand years. Because the bones are cylindrical, same relation can be attributed to them as a cylindrical object under the influence of compressive forces.

Mc Mahon (1983) by Norton & Olds (1996) proposed a system of elastic similarity with logic that the size and shape of the animal forces have undergone some important criteria, of which are inertia and gravity force most responsible. Geometric system and similarity together, is applicable in the real human anthropometry on a wide number of variables that describe the body size but do not always provide the expected results, which in turn opens up the possibilities of new research of which is maybe most interesting research result by Muftić (1992; 1996). On the ex-Yugoslav population, most important anthropological research was performed by Škerlj. In the area of physical education a number of papers to date refers to the study of anthropometric parameters of students in a relatively lesser athletes specialties. Research of manifest and latent morphological and anthropometric dimensions and factor analysis began in 1960 as research in the area of reliability and validity of measurement instruments. Momirović et al. (1960) analyze the interdependence measure of body fat, and this study determined the general factor of subcutaneous fat.

Viskić (1963) according to Lozovina (1983) analyzed the factor structure of body weight. There are three factors, and defines them as dimensionality of the skeleton, the volume of muscle and subcutaneous adipose tissue. Momirović et al. (1966) studied the effect of latent anthropometric variables on the orientation and selection of top athletes. This analysis identified four latent anthropometric factors which the authors named as: longitudinal dimension of the skeleton, transversal dimensionality of the skeleton, volume and subcutaneous adipose tissue. The assumption is based on morphological characteristics of human populations that can be divided into relatively small and limited number of strictly distinct subpopulations, found no justification even when, for the purpose of identifying these subpopulations, were used a very fair anthropometric, mathematical and statistical procedures. For these reasons, it was recently rejected the criterion of strictly distinct groups, and in today's research is based on the hypothesis that each participant takes a relatively stable position in each of several multivariate continuous distributed taxonomic variables. Such studies are based on taxonomic and component models. These procedures belong to the family of data processing TAXOBL algorithms, and some of them have been applied in studies by "Zagreb school." So Hošek, Medved, Stojanović and Momirović (1997) in Morphotax modification of Taxobl procedures analyzed extraction and try to identify the optimal number of taxonomic variables (polar taxons) using a space of 23 manifest anthropometric variables. They found five taxon variables and identified five morphological mechanisms within which the authors identified as types M, K, D, R and E. polar variables marked with an M - morphological structure defined by body volume which is based on mesomorph structure. Variable marked with K - morphological structure also defined by volume, but basically that is the general adiposity. With D it is marked morphological structure defined distinct skeletomorphy. With R it is defined structure in whose base lies adiposity, while the structure of the E -type is defined by a specific set of morphological characteristics obtained after extraction of the previous four taxon variables.

Why model of "Zagreb school" and not Heat-Carter somatotyping model?

Although the Heat-Carter somatotyping model for a number of years in use worldwide, authors of this paper believe that the model of the "Zagreb School" with 24 anthropometric measures that are designed to detect latent dimensions (longitudinal dimensionality of the skeleton, transversal dimensionality of the skeleton, circular dimensions and subcutaneous adipose tissue) far more efficiently and better provides usable data for further analysis.

And for the reason that in apparent area operates with originally measured variables, not the index value as it is the case in determining somatotype in Heat-Carter method. Furthermore, the latent space is very well covered by the original anthropometric variables with high coefficients of participation,

virtually in all previous studies. Respecting the fact that they are mostly all anthropometric measures normally or approximately normally distributed (except make some measures of subcutaneous adipose tissue) in the analysis of latent space we can use taxonomic analysis algorithms that are not based on an analysis of the differences and similarities that certainly gives more options in defining and clarifying polar taxonomic variables as is the case when you use Morphotax model taxonomic analysis, although Uditax procedure is very interesting (Bonacin, 2008). Therefore, the authors recommend just such an approach in the study of the anthropometric and morphological characteristics of the athletes, and of course a production of some new research techniques and scientifically approved algorithms.

References

- Albonico, R. (1970). *Mensch-Mencshen Typen*. Basel: Press.
- Battinelli, T. (1990). *Physique and fitness: the influence of body build on physical performance*. New York (NY): Human Sciences Press.
- Bonacin, D. (2010).
- Bonacin, D., Bonacin, Da., & Bilić, Ž. (2009). Uditax – model of distinct taxons based on distance maximization of representative entities. *Acta Kinesiologica*, 3(2), 50-53.
- Bonacin, D., Bilić, Ž., & Bonacin, Da. (2008). *Uvod u antropološku analizu* [Introduction to anthropological analysis. In Croatian.]. Travnik: Edukacijski fakultet.
- Bonacin, D., Bilić, Ž., & Bonacin, Da. (2012). *Uvod u kineziološku analizu* [Introduction to kinesiological analysis. In Croatian.]. Travnik: Univerzitet u Travniku.
- Borms, J., & Hebbelinck, M. (1984). Review of studies on Olympic athletes. In: Carter J.E. (ed.) *Physical structure of Olympic athletes. Part II: kinanthropometry of Olympic athletes*. Medicine and Sport Science Series, XVIII. Basel: S. Karger, (pp. 7-27).
- Carter, J.E. (1970). The somatotypes of athletes – a review. *Hum Biol.* 42, 535-569.
- Carter, J.E., & Ackland R.T. (1994). *Kinanthropometry i Aquatic Sports*. Champaign: Human Kinetics.
- Carter, L. (1996). Somatotyping. In: K. Norton and T. Olds (Eds.), *Anthropometrica, Chapt. 6*, (pp. 147-170). Sydney: University of New South Wales Press.
- Hauspie, R.C., Vercauteren, M., & Susanne, C. (1997). Secular changes in growth and maturation: an update. *Acta Paediatr Suppl*, 423, 420-427.
- Hošek-Momirović A. (1978). *Povezanost morfoloških taksona sa manifestnim i latentnim dimenzijama koordinacije*, /Disertacija/. Zagreb: Fakultet za fizičku kulturu.
- Johnston, F.E. (1995). *Environmental constraints on growth: extent and significance*. In: Hauspie R, Lindgren G, Falkner F, (eds). *Essays on auxology presented to James Mourilyan Tanner*. London: Castlemead Publications. (pp. 402-413).
- Katch, F.I., & McArdle, W.D. (1973). Prediction of body density from simple anthropometric measurements in college-age men and women. *Hum Biol.* 45, 445-454.
- Ljung, B.O., Bergsten-Brucefors, A., & Lindgren G. (1974). The secular trend in physical growth in Sweden. *Ann Hum Biol.* 1, 245-256.
- Lozovina, V. (1986). *The characteristic of water polo players in the morphological space*. In: Reilly T, Watkins J, Borms J, editors. *Kinanthropometry III*. London: E & FN Spon, (pp. 215).
- Lozovina V. (1983). *Utjecaj morfoloških karakteristika i motoričkih sposobnosti u plivanju na uspješnost igrača u vaterpolu*, /Disertacija/. Zagreb: Fakultet za fizičku kulturu.
- Lozovina, M., Lozovina, V., & Pavičić, L. (2012). Morphological changes in elite male water polo players: Survey in 1980 and 2008. *Acta Kinesiologica*, 6(2), 85-90.
- Lozovina, V., Pavičić, L., & Lozovina, M. (2003). Analysis of Indicators of load during the game in activity of the second line attacker in water polo. *Coll Antropol.* 27, 343-351.
- Lozovina, V., & Pavičić, L. (2004). Anthropometric Changes in Elite Male Water Polo Players: Survey in 1980 and 1995. *CMJ*, 45(2), 202-205.
- Lozovina, V., & Lozovina, M. (2008). Morphological optimisation, overlap zones and secular trend in selection pressures. *Acta Kinesiologica*, 2(1), 33-41.
- Malina, R.M. (1991). Research on secular trends in auxology. *Anthropol Anz.* 48, 209-227.
- Malina, R.M., & Bouchard, C. (1991). *Growth, maturation, and physical activity*. Champaign: Human Kinetics.
- Meredith, H.V. (1976). Finding from Asia, Australia, Europe, and North America on secular change in meanheight of children, youths, and young adults. *Am J Phys Anthropol.* 44, 315-325.

- Momirović K. (1972). *Metode za transformaciju i kondenzaciju kinezioloških informacija*. Zagreb: Institut za kineziologiju.
- Muftić, O. (1992). *Harmonical Method of Man's Figure Drawing, XI International Anthropological Conference / Zagreb*.
- Muftić, O. (1994). Method of Man's Figure Drawing, *Coll. Antropol.* 18(Supl.1), 27-32.
- Norton, K., & Olds T. (1996). *Anthropometrica*. Sydney: University of New South Wales Press.
- Norton, K., & Olds, T. (2001). Morphological evolution of athletes over the 20th century: causes and consequences. *Sports Med.* 31, 763-783.
- Pavičić, L., Tomany, E., & Lozovina, V. (2000). A study of anthropometric differences among elite water polo players with different team role assignments. *Proceedings of the 2000 Pre-Olympic Congress* (pp. 503). Brisbane: Australian SC.
- Szirovica, L., Momirović, K., Hošek, A., & Gredelj M. (1978). Morphotax: Algoritam i program za taksonomsku analizu u prostoru multivarijatno raspoređenih varijabli, *Informatica*, 78.
- Stojanović, M., Vukosavljević, R., Momirović, K., & Hošek, A. (1975). Image analiza strukture antropometrijskih dimenzija. *Kineziologija*, 5(1-2), 206-228.
- Tanner, J.M. (1986). *Growth as mirror of the condition of society; secular trends and class distinction*. In: Demirjian A, editor. *Human growth: a multidisciplinary review*. London: Traylor & Francis, (pp. 3-34).
- Tanner, J.M. (1966). The secular trend towards earlier physical maturation. *Belg Tij Geneesk.* 44, 524-539.
- van Wieringen, J.C. (1978). *Secular growth changes*. In: Falkner F, Tanner JM, editors. *Human growth: a comprehensive treatise*. 2nd ed. Vol 3. Postnatal growth. New York (NY): Plenum Press, (pp. 307-315).
- Vujović, D., Lozovina, V., & Pavičić, L. (1986). *Some differences in anthropometric measurements between elite athletes in water polo and rowing*. In: Reilly T, Watkins J, Borms J, (eds.) *Kinanthropometry III*. London: E&FN Spon (pp. 27-33).
- Vukosavljević, R., Grginčević, M., Momirović K., & Stojanović M. (1977). Kanoničke relacije skeletalnih dimenzija i mjera potkožnog masnog tkiva, *Kineziologija*, 7(1-2), 7-13.
- Weiner, J.S., & Lourie, J.A. (1969). *Human biology: a guide to field methods*. IBP handbook No. 9. Oxford: Blackwell Sp.
- * * * (2001). *ISAK. International Standards for Anthropometric Assessment*. Underdale: International Society for the Advancement of Kinanthropometry.

KAKO PRISTUPITI ODREĐIVANJU SOMATOTIPOVA U KINEZIOLOGIJI?

Sažetak

Cilj ovog rada bio je utvrditi aktualno sustavno stajalište za definiciju morfoloških dimenzija čovjeka. Poznato je da je takav posao vrlo ozbiljna, pa čak i jako složena zadaća. Dakle, prije svega moramo preurediti osnove, uključiti sve moguće značajnije ideje i pokušati prijeći granice u ovom kompliciranom području. Mi smo u tom "poslu" oko 30 godina, i još uvijek u potrazi za novim univerzalnim konceptom. Nadamo se da će ovaj članak pomoći drugima uspostaviti jak i održiv koncept, teoriju za praksu boljih transformacijskih procesa.

Ključne riječi: morfološke karakteristike, somatotip, kineziologija, konceptualni pristup

Received: August 10, 2012

Accepted: June 10, 2013

Correspondence to:

Prof.Vinko Lozovina, PhD

University in Split

Faculty of maritime Studies

21000 Split, Domovinskog rata 8, Croatia

Phone: +985 (0)21 393 500

E-mail: lozovina@pfst.hr

PREVENTION AND TREATMENT OF 'TENNIS ELBOW'

Jelena Gudelj and Zdenko Kosinac

Split, Croatia

Review paper

Abstract

'Tennis elbow' is overuse injury caused by frequent repeated contraction of hand and fingers extensors resulting chronic stress muscles and tendons. The main symptom is pain that occurs on the outside of the elbow, but can be felt in the upper arm or the outer side of the forearm. The diagnosis of tennis elbow using computed tomography (CT), ultrasound, arthroscopy, magnetic resonance imaging (MRI) and clinical diagnosis, which is the basis and most important diagnostic method. Depending on the stage of disease and treatment is different. Great importance is given to kinesiotherapy, especially stretching exercises. Except stretching exercises, kinesiotherapy also include isotonic and isometric exercises. Indications for operative treatment is the existence of symptoms for more than six months, despite adequate treatment conducted non-operatively.

Key words: tennis elbow, prevention, non-operatively, operative treatment

Introduction

Tennis is played by millions of people of all ages around the world. It is a sport that is very interesting, exciting and usually do not cause serious medical problems. In the elbow, however, problems arise. Inflammation and degenerative changes in the elbow resulting in the medial and lateral humeral epikondil. Epicondylitis humeri is entenzitis that appears on the same starting point extensor hands and fingers on the lateral epikondil humerus, which is called the lateral (radial) epicondylitis (Grisogono, 1989). Inflammation of the lateral epicondyle, or more often referred to as a "tennis elbow" is one of the injuries of which suffer most sports and recreation (tennis) and pitchers (baseball) and cricket players, javelin throwers, handball players, etc. (dactilografi, shoemakers, dentists). Despite the name "tennis elbow", professional tennis players are an absolute minority, only 5 % of the total number of people with inflammation of the lateral epicondyle. Lateral epicondylitis (tennis elbow) occurs 7-10 times more than the median, is more common in men, usually occurs in middle aged between 30-50 years. The first description of symptoms suggestive of lateral epicondylitis gave back 1873rd the German doctor Runge & Morris (1882). Describing the symptoms of tennis introduces name tennis arm (Engl. lawn tennis arm), while a year later Major changed the name for tennis elbow, which is held to this day. Lateral epicondylitis is one of the most popular and also the most common overuse injuries of the locomotor system in humans, manifested by pain in the outer part of the elbow. Appears at the starting point caput commune extensor hands and fingers on the lateral epikondil. Damage of mioentensial apparatus is caused by repeated muscle contractions. The causes of pain are microscopic rupture tendon insertions. The pain occurs in the elbow and forearm. Because of injuries is reduced vascularization in the affected tendon perch and nervous endings are irritated and resulting inflammation. Repetition of movement can lead to a complete tendon rupture.

Etiopathogenesis of lateral epicondylitis

The disease is one degenerative process resulting from fatigue due to hamstring injuries, weaknesses and likely changes due to poor blood circulation. Regardless of the type of tissue response to injury is inflammation, which includes a number of changes in the final core networks, blood and connective tissue. Inflammatory reaction is a very complex reaction in which involved different types of cells, a number of enzymes, many physiologically active substances and other. Changes nerve causes severe pain in the area of the damaged tendon or her handle the often subtle morphological changes. There comes to perineuritisa flange nerve sheath that subsequently compressed nerve.

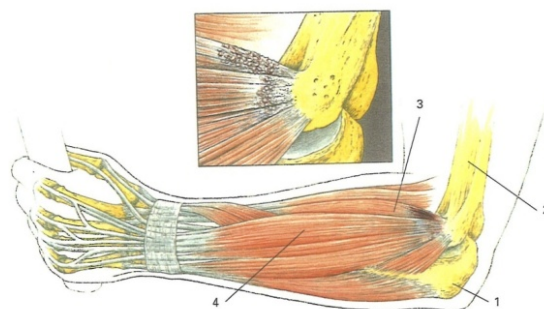


Figure 1. Changes that occur in the tendons due to lateral epicondylitis

(1. Ulna, 2. Humerus; m. extensor carpi radialis brevis; 4. m. extensor digitorum communis)

Changes in the tendon can be seen in edema and necrosis of the tendon, and after only a short time in the damaged area accumulate inflammatory cells (Figure 1). The inflammatory phase of the regeneration of damaged tendons supplements with the growing binder, in the beginning of cellular which eventually becomes richer collagen fibers. Blood vessels multiply, but over time their number is decreasing. The scar is different than normal tendon irregularity layout and structure of bundles of collagen fibers, and it is often found more blood capillaries.

Changes tendon insertions can be seen in edema and hemorrhage, sometimes there is a tear of the tendon or bone, connective scar bronchial often degenerates, so most of the tendons, and often the periosteum, becoming almost acellular and imbued with a homogeneous mass of hyaline. These scars often spread to surrounding tissue structures by changing their appearance. Changes nerves causes severe pain in the area of the damaged tendon or her handle the often subtle morphological changes. There comes to perineuritis a flange nerve sheath that subsequently compressed nerve (Renström & Peterson, 2002). Risk factors for lateral epicondylitis can be divided into two groups: the use of inadequate equipment and the performance impact improper technique. Causal role play racket and his posture, tension mat on it, the size and weight of the racket, the width of the handle, the weight of the balls and hitting her mid racquet, type of terrain, the intensity of impact players. Performing impact improper technique (backhand shot) leads in connection with the development of lateral epicondylitis. Concentric contraction that occurs when the shot incorrectly performed shortens the muscles in order to maintain the tension needed to stabilize the wrist. As a result of shortness muscle maximum load occurs at the ends of the muscle or tendon. This creates a certain force that is transmitted along them to their starting point at the lateral epikondilus humerus. Such repeated contractions resulting in chronic stress of mioentessal apparatus, which therefore reduce vascularization and irritated nerve endings and the resulting aseptic inflammation.

Aim

The main objective of this paper is to highlight the benefits and importance of preventive measures in the development of "tennis elbow". Likewise, the goal of this paper is to describe the current methods of treatment of tennis elbow due to the stage of disease and therapeutic procedures in the treatment of tennis elbow.

Prevention of 'tennis elbow'

Prevention of sports injuries, generally the primary task of a sports coach, a sports doctor and the athlete. More than half of the injuries can be avoided by proper dosing load to prevent fatigue and muscle fatigue in athletes. To ensure and implement prevention, ie to reduce the risk of overuse injuries, it is essential to know the risk factors and their possible effect and negative effect on the development of overuse injuries. From a theoretical point of view can be distinguished: general preventive measures and specific preventive measures. General preventive measures include: stretching as a leader in the prevention and treatment and strengthening - strengthening the muscles of the forearm to stabilize the wrist. Preventive measures for playing tennis are properly playing (technique) and avoiding asymmetric training techniques.

According to Peterson (2002), while playing tennis should pay attention to the following items: 1) good footwork, so that the player is properly set up to the ball, 2) the ball should be in the right place at the right time to hit the racket, 3) on impact should be applied throughout the shoulder and body as when hitting the shuttle on the racket would not be disrupted paths, 4) it is very important foundation courses, which should be slow to reduce the speed of the balls, 5) the ball should be light; wet balls or balls with too little air pressure becomes severe, and 6) the right equipment - the racket should be selected individually, taking into account the technique of playing, 7) Great so. "sweet spot" (center of the racket hitting the surface area on which generated the smallest torsion -twisting on impact balls). Hit balls out of the surface increases the vibrations.

Treatment of 'tennis elbow'

Treatment can be nonsurgical and surgical.

Nonsurgical treatment

The objectives of non-operative treatment are: 1) Relieve pain and inflammation control mioentessal appliances; 2) Enhancing healing of mioentessal appliances; 3) Control further action; 4) Increase muscle strength and endurance of the muscles; 5) Restoring the proper range of motion; and 6) Restore maximum functional ability, and 7 Prevention of repeated movements on mioentessal apparatus (Kosinac, 2008; Grisogono, 1989). Treatment is important to start as early as possible, at the appearance of the first symptoms. Here are the most common and mistaken, because the first symptoms are usually not paid sufficient attention and continues with the activity unchanged intensity. Treatment is divided into three phases: 1) The first stage is the most important holiday of the working and sporting activities. The patient should avoid movements that cause pain, but it has to perform active movements of the rest of the limb to avoid stiffness and other complications. At this stage in the account comes Cryotherapy several times during the day. Cryotherapy reduces the pain lowering conductivity sensory nerves, reduces inflammation and the island of vasoconstriction and lowers levels of a chemical reaction. If the present endemic, it is necessary to raise the grip of your hand. It is recommended that you wear a brace for the wrist that held his fist in the forward position of the 200, which tendon release excessive tension, and allows full mobility of the fingers and elbow, 2) The second phase is characterized by the absence of pain at rest, or the appearance of increased pain when performing movements due to the increased load. At this stage continues cryotherapy and starts with the individual program of physical training. Of great importance are stretching exercises for increasing the length mioentezijskog apparatus at rest can be reduced by stretching and during the execution of certain movements. In addition to stretching exercises, at this stage, complementing the isotonic and isometric exercises.

From electrotherapy procedures used high-voltage galvanic stimulation current that creates the piezoelectric effect which helps healing of mioentesimal appliances, improves its vascularity, and in some patients has an analgesic effect. In the second week can apply electrotherapy procedures : ultrasound, laser, magnetic therapy and analgesic power. When all provocative movements become painless, the patient returns to his daily activities. during these activities must wear inelastic forearm cuff deflation which has the function of secondary insertions of muscles which relieves tendon insertions on the lateral epikondilu (Figure 1); 3) In the third stage the patient is fully returned to their daily activities and sports. It is recommended to continue to carry out stretching and strengthening the affected muscles. In severe physical activities necessary to implement adequate preparation (warming) the affected muscle group, and if necessary apply cryomassage. To prevent recurrence in cases with professional disease etiology should reduce the weight of the working tool (racket) or frequency provoking stereotyped movements, and if it is not possible to increase the number and length of rest during operation to allow for relaxation of muscles and reduce the risk of re-injury. The use of corticosteroid injections should be delayed as long as possible and limited to cases that do not respond to nonsurgical treatment. Usually injected up to three injections deep in Manila recess which is sub-tendon positioned (Figure 2).



Figure 1. Forearm supporter

The downside is that steroid injections as the organism adapts over time, so the answer to the injection weaker and increases the risk of possible complications (subcut atrophy, weakening the surrounding tissue). The next day, after the injection, pain can be intensified, but by the next day pain decreases. Exercise 1: Stretching exercises of extensor muscles: the patient performs the movement can easily be seen from the 90°, then completely extends elbow and palmar inflecting hand while pressing the other hand increase the palmar flexion fists up to the occurrence of pain (Fig. 3). At this point, the maximum painless stretching patient keep stretching 15:25 s exercise should be repeated 4-5 times a day, 2 sets of 10 reps, but always only to the occurrence of pain. Exercise 2: Placing the patient in the position of full forearm pronation on the table so that his hands hanging over the edge of the table in this position performs the extension and flexion of the hand (Figure 4).

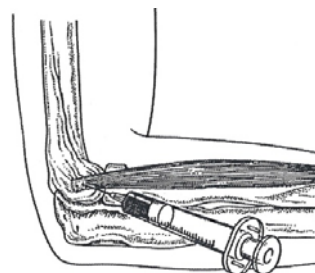


Figure 2. Application of corticosteroid injections

Example exercises for tennis elbow:

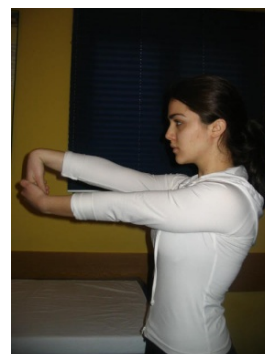


Figure 3. Stretching of extensor muscles



Figure 4. Fist extension



Figure 5. Fist extension against resistance



Figure 6. hands extension with small weights



Figure 7. Fingers extension



Figure 8. Extension of the fingers against resistance



Figure 9. Extension of the fingers against resistance



Figure 10. Padded hand grip

In the beginning, these movements are performed slowly, so that at the end of palmar flexion accommodates up to 6, and at the end of extensions to 3. Exercise 3: When the previous movements cease to be painful, the patient gradually increases the speed of execution and the external resistance. Resistance is achieved by a small weight or resisting physical therapists in the opposite direction of the movement that the patient performed (Figure 5). Exercise 4: The initial position is the same as in the previous exercise. Resistance is achieved by a small weight (Figure 6). Exercise 5: The patient is in a sitting position, and forearms and hands were laid on the ground in full pronation, while the fingers off base flexion in MCF joints per 900. The patient performs the movement extension of the fingers (Figure 7). Exercise 6: The patient was in the same position as in the previous exercise, only the resistance applied to the dorsal side of the fingers in the direction of flexion (Figure 8). Exercise 7: Elastic rubber is placed around the fingers and thumb, which are collected in the form of the tower (Figure 9).

The same exercise can be performed with an elastic band that is placed around the fingers and thumb, alternately making loops. Exercise 8: Position arm to the horizontal position (900), the elbow in extension. In a handful put blades, the patient alternately increased and decreased hand grip (Figure 10).

Surgical treatment

Indications for surgical treatment are the persistence of symptoms for more than six months with the inability to return to normal work and leisure activities despite adequately conducted nonsurgical treatment. Operative treatment is also carried out for recurrent cases where they diagnosed degenerative and calcification changes in muscle-tendon structures with the aim of removing the damaged tissue section affected muscle.

The operation proved to be always a part of musculus extensor carpi radialis brevis, and in 35 % of cases musculus extensor digitorum communis (Niethard, et al., 2009). The downside of surgery is a rehabilitation treatment extended, and success is not always satisfactory. After the surgery elbow is immobilized for a week with steal rail in a position of 900. Exercises for strength and durability on resistance usually begins three weeks after the surgery. In 85% of cases it is achieved the disappearance of pain and restoration of the previous power. Studies have shown recurrence of 18-66 %. The amount of pain before treatment allows most reliable prediction of recovery: the greater the pain, the greater the likelihood of treatment success. After the surgery should take 8-10 weeks before they started to play tennis again.

Discussion

Tennis elbow can be a big problem for players. The pain can be so intense that the disabled injured while performing work activities, or it may interrupt the sport. Because of the lengthy delay in sports activities it often lead to hypotrophy extensor muscles and the islands of the affected areas, and can lead to a decrease in joint mobility and mild degree of calcification. When we talk about prevention of tennis elbow, it is necessary to consider in detail the external and internal factors that participate in the realization of sporting activities, as well as their interactions, and the mechanisms of formation and the situation in which it comes to sports injury. Technically correct play is the most important preventive measure, while the asymmetric training techniques be avoided or reduced to necessarily play. Prevention of injury involves a series of measures such as: stretching exercises, strengthening, massage and other forms of activities that contribute to easier and faster recovery of the players. For early detection, diagnosis and appropriate treatment of overuse injuries is important knowledge of etiopathogenesis.

The first step in treatment is certainly absolute rest and abstinence from basic sports activities that led to the disease condition until symptoms are present (minimum recovery period is 7-10 days). Experience shows that the disease can be kept, so that treatment can extend sometimes months to complete resolution of all symptoms. It is important to emphasize that the pain in the elbow should not be underestimated or ignored, because in most cases they will not disappear by themselves. The basis of treatment is a stretching exercise affected muscle group, and after stretching exceeds the static and dynamic strengthening exercises with and without resistance. Physical procedures are used to reduce pain and improve circulation. A particular problem is the return of the sport or competitive activity after treatment. If this return so quickly and without a certain protection, the recurrence of pain is more than probable. When they return, it is advisable to continue to carry out activities that will help prevent injuries. It takes at least 5 to 10 minutes 'warm up' arms and shoulders gently moving and stretching before starting the activity. In addition, it is recommended to change the racquet, as to reduce the stress on the structure of the elbow and the forearm muscles to put the corset that their pressure on the muscles reduce their maximum power, and thus relieve elbow.

References

- Grisogono, V. (1989). *Sports Injuries*. Johan Murray (pp. 268-276).
Kosinac, Z. (2008). *Kineziterapija sustava za kretanje, 3ed* [Kinesitherapy of locomotor system. In Croatian.]. Zagreb: Gopal (pp. 298-303).
Kuprian, W. (1987). *Sport et physiothérapie*. Paris, New York: MASSON(pp. 223-227).
Niethard, F.U., Pfeil, J., & Biberthaler, P. (2009). *Duale Reihe orthopädie und unfallchirurgie. 6. Ed*. Berlin: Thieme Verlag (pp, 457-458).
Renström, P., & Peterson, L. (2002). *Verletzungen im Sport. Prävention und Behandlung. 3. Ed*. Berlin: Verlag (pp, 162-167).

Conclusion

Epicondylitis lateralis humeri is the damage that occurs in the lateral epicondyle of the humerus, or in the grips forearm extensor muscle groups. The disease is one degenerative process resulting from fatigue due to hamstring injuries, weaknesses and likely changes due to poor blood circulation. Basic movement that causes overtraining is an extension of elbow flexion with simultaneous dorsal hands flexion and forearms supination from pronation position. The problem in the treatment of overuse injuries are daily load during training, which can lead to chronic stages. Proper selection of therapeutic procedures as well as early initiation of treatment will lead to a reduction of inflammatory conditions and alleviate.

However, for long-term success of therapy and avoidance of chronic changes necessary to educate athletes and coaches. Therefore, great attention is paid to prevention. More than half of the injuries can be avoided by proper dosing load to prevent fatigue and muscle fatigue. Good effect in preventing tennis elbow can be achieved: by changing the tennis equipment, sports mastered techniques and adequate fitness and trained coach with enviable knowledge of the basics of anatomy, physiology and kinesiology methodology.

PREVENCIJA I LIJEČENJE 'TENISKOG LAKTA'

Sažetak

'Teniski lakat' je sindrom prenaprezanja koji nastaje zbog čestih ponavljanih kontrakcija ekstenzora šake i prstiju koje rezultiraju kroničnim naprežanjem mioentezijskog aparata. Glavni simptom je bol koja se pojavljuje na vanjskoj strani lakta ili vanjskoj strani podlaktice. U dijagnostici teniskog lakta koristimo kompjutoriziranu tomografiju (CT), ultrazvučnu dijagnostiku, artroskopiju, magnetsku rezonanciju (MRI) te kliničku dijagnostiku koja je osnovna i najvažnija dijagnostička metoda. Ovisno o stadiju bolesti liječenje je različito. Velika važnost pridaje se prevenciji i kineziterapiji koja obuhvaća vježbe istezanja, izometrijske i izotoničke vježbe. Indikacije za operativno liječenje je postojanje simptoma više od 6 mjeseci, unatoč adekvatno provedenom neoperativnom liječenju.

Ključne riječi: teniski lakat, prevencija, neoperativno liječenje, operativno liječenje

Received: April 15, 2013
Accepted: June 10, 2013
Correspondence to:
Prof. Zdenko Kosinac, PhD
21000 Split, Croatia
Phone: +385 (0)21 547 103
E-mail: zkosinac@gmail.com