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Dear reader,

Sometimes our words can not describe a state of spirit and fully hearth, as it was directly a few days before we publish this issue. About a year ago, we started with this publication with an idea that our surround will first recognize and then will accept all values we try to reach, to achieve and to offer. Many of you believed in us and as a final reward after serious and conscientious work, here it comes a new great acknowledgement: after Index Copernicus and SPORTDiscus famous bases, our journal enter through front door to scientific community – it is accepted for indexation in CAB Abstracts / ISI Web of Knowledge, world base. That is especially great result after so little time passed. We wish to thank all authorities in CAB International that recognize our efforts, our sacrificing, but also our quality. And of course, we have to thanks authors that send their excellent contributions, and without that it will be much harder to achieve. In the same time, our publisher started with new successive steps and expanded its acting, so it is now Faculty of Education but with all Kinesiological studies included. All of that is an obligation for us for further serious work and quality. Such endeavor is visible from this issue, with offer of several nice articles like: researches in sport as training cycles with young water-polo players, simulations for volleyball selection, using of royal jelly with young soccer players, information of motor abilities with young javelin throwers, planned kinesiology treatment with young footballers and research about latent morphological structure with top-level players in some sport games. Medically directed articles analyze application of neuroscience in kinesiology, training after AC ligament injury and about reaction speed with elderly persons differently engaged in physical exercise. In educational space we can offer inspired consideration of children's play as a development mean, discussion about Olympic spirit in schools, comparison of standard PE programme vs. programme with sport games, knowledge about flexibility influence on students swimming results and intervention reduction programmes for pupil's physical inactivity. APA domain is covered with analysis of attitudes about inclusion of persons with disabilities in sport. Management sphere is represented with model and algorithm for hierarchical analysis, and finally, closely methodologically oriented articles discourse about teacher's self-assessment of motor skills, and about uncertainty coefficient as a method for sport competition system optimization. As you can see, this project of our journal is still a child, but now walks entirely harmoniously. We invite all of you for cooperation, so one day it could run superiorly.

Editor-in-Chief
Assist.Prof.Dobromir Bonacin, PhD

Dragi čitatelju,

Ponekad zaista riječi teško mogu opisati stanje duha i ispunjenost srca, kao što je to bilo neposredno koji dan prije tiskanja ovog broja časopisa. Prije otprilike godinu dana pokrenuli smo ovu publikaciju s idejom da naše okruženje najprije eventualno prepozna, a zatim i prihvati vrijednosti koje se nastoje postići, ostvariti i ponuditi. Mnogi su vjerovali u nas, a kao finale ozbiljnog i savjesnog rada došlo je i novo veliko priznanje: nakon Index Copernicus i SPORTDiscus priznatih svjetskih baza, Sport Science je i na velika vrata ušao u znanstvenu zajednicu – prihvaćen je za indeksiranje u CAB Abstracts / ISI Web of Knowledge, svjetsku bazu. Ovo je posebno veliki rezultat za tako kratko vrijeme. Hvala gospodi u CAB International koja su prepoznali naš trud, naš samoprijegor, ali i našu kvalitetu. I naravno, hvala autorima koji su poslali svoje vrhunske priloge, bez kojih bi bilo teško to sve ostvariti. U isto ovo vrijeme i naš izdavač je pokrenuo nove uspješne korake i proširio djelovanje te je sada to Edukacijski fakultet ali koji uključuje i sve dosadašnje kineziološke studije. Sve nas to naravno obvezuje na daljnji ozbiljan i kvalitetan rad. Da djelujemo u tom pravcu vidi se i iz ovog broja koji nudi pregršt lijepih priloga poput: članaka o sportu kao što je trenažna ciklizacija za mlade vaterpoliste, simulacije za potrebe selekcije u odbojci, korištenje matičnog mliječa kod mladih nogometaša, informacije o motoričkim sposobnostima mladih kod bacanja koplja, kineziološki tretman mladih nogometaša te istraživanja latentne morfološke strukture vrhunskih sportaša u nekim sportskim igrama. Medicinski usmjereni članci govore o primjeni neuroznanosti u kineziologiji, treningu nakon povreda AC ligamenta i o brzini reakcije kod starijih osoba različito angažiranih tjelesnim vježbanjem. U prostoru edukacije nudimo nadahnuta promišljanja o igri djece u funkciji razvoja, raspravu o duhu olimpizma u školama, usporedbu standardnog programa s programom sportskih igara u školi, spoznaje o utjecaju gibljivosti na plivački rezultat studenata kao i interventne programe za redukciju neaktivnosti učenika. APA prostor je obuhvaćen analizom o stavovima ispitanika prema uključivanju osoba s onemogućenima u sport. Upravljačka sfera zastupljena je modelom i algoritmom za hijerarhijsku analizu, a uže metodološki orijentirani članci govore o samoprocjeni motoričkih vještina učitelja, i o koeficijentu neizvjesnosti kao sredstvu optimizacije u natjecanju. Kako vidite, ovaj projekt našeg časopisa je još uvijek dijete, ali sada već sasvim skladno hoda. Pozivamo vas sve na suradnju kako bi jednog dana moglo i vrhunski trčati.

Glavni urednik
doc.dr.Dobromir Bonacin

INCIDENCE OF NEUROSCIENCE ON THE PSYCHOPEDAGOGY RELATION CORPOREITY/ LEARNING

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Review paper

Abstract

The use of Positron Emission Tomography (PET), Functional Magnetic Resonance (fMRI) of Transcranial Magnetic Stimulation (TMS) and Magnetoencephalography (MEG), has allowed to study in depth the functioning of individual neurons or groups of them and has helped to further the knowledge of the central nervous system (particularly the mechanisms by which the brain produces its effects), knowledge that, in the last decade has been a real 'step' forward following the developed capacities of investigation and research through the mentioned new technologies. Nowadays, the experimental research can verify their hypothesis, live and in a non-invasive way, using animals (usually rats and monkeys) and humans (healthy and "clinical" pathologic cases). We could say that, on a theoretical level, the development of neuroscience will lead, hopefully, to revising the classic functionalist top-down model, considering the processes in their emerging complexity. For example, it is correct to state that with this, we are facing the overcoming of the primacy of the "intention" on "communication", as a philosophical mindset that is no longer ante litteram? We answer this question with a reflection that will represent a cultural nature upon which to build the entire study. But the real issue is to clarify what is "mind" for the analysts and what is "consciousness" for scholar of phenomenology and, respectively, what are the "mindset" and what an "act of conscience" is. They are in no way two synonymous.

Key words: neuroscience, neurons, knowledge, conscience

Introduction

The use of Positron Emission Tomography (PET), Functional Magnetic Resonance (fMRI) of Transcranial Magnetic Stimulation (TMS) and Magnetoencephalography (MEG), has allowed to study in depth the functioning of individual neurons or groups of them and has helped to further the knowledge of the central nervous system (particularly the mechanisms by which the brain produces its effects), knowledge that, in the last decade has been a real 'step' forward following the developed capacities of investigation and research through the mentioned new technologies. We could say that, on a theoretical level, the development of neuroscience will lead, hopefully, to revising the classic functionalist top-down model, considering the processes in their emerging complexity. David Hume in his Treatise of Human Nature, in the Anglo-Saxon area with the term 'mind', intends the collection of states of mind or functional to human beings, in opposition to the Cartesian dualism and especially to the concept of *res cogitans* as a thinking substance of an intangible nature. If Descartes supported that the essence of mind is the thought - not "this" or "that" thought, but the thought in generally without content (*Cogito*), for Hume this is totally unintelligible,

because everything that exists is particular and therefore are our different perceptions, with their insuppressible peculiarities, that constitute the mind (Ausubel, 1968). Is the scholar Daniel Dennett (Berthoz, 2000), heir of the Humana tradition that has replaced the "Cartesian theater" of the one flow of consciousness (in which all converge in an orderly and sequential way) with the theory of multiple versions that is multiple channels, in a sort of serials as a functional succession of coalitions of specialized and interconnected circuits? If we reflect and compare on the lived issue of mind-body that informs, now, the almost totality of the contemporary epistemology in the analytical research area, that intersects the cognitive science and neuroscience, we are increasingly distant, to the metaphysical concept of soul that is, in fact, more and more in disuse in the West that has philosophically produced, prepared and articulated it (Buccino et al., 2004). However, the question that we have to ask is: In what measure is a sharing between sensory-motor system of humans and robots needed, so that it is possible to create machines that communicate with us, or that reproduce, simplifying, some characteristics of the cognitive activity of human beings?

This is a radical challenge that wants to make people think. One of the primary characteristics of living bodies, in fact, is that they are autopoiesis (examples of self poetic models in morphogenetic systems have been proposed by Cummings (2001). Using this term in a classical and deep sense that has been proposed by Maturana and Varela (1980), the body can often be ill, but also often able to cure its-self, to heal. Bodies have the proprioception, the self-awareness. Bodies have physiological needs. Bodies have emotions. There is a whole inner life that makes the body a system that produced itself and allows the deployment of key characteristic of any living systems that is the maintenance of its organization, the preservation of a relational system that defines it as a systemic unit. The main principle that should be saved is that the body is a frontier, always under construction, between interoception and proprioception.

Methods

1. Embodiment and situatedness

Embodied or situated cognition? However, it is important, for us, to point out some aspects in order to understand better how to take advantage of these discoveries as well as how to avoid an inappropriate use and/or distorted cultural spreading (Gallese, 2007). If criticisms brought up by some psychologists, conceive neuroscience and in particular the techniques of the brain scanning, as a new phrenology (Cummings, 2001), appear to us immoderate and inadequate, it is still true that the evidence received through brain imaging is in correlation, and not causal. It is not enough, in our opinion, to identify which neural areas are activated to deeply understand and possibly justify mechanisms that regulate behaviors. Moreover, the risk of adopting a non critical approach of pure location functions or forms of phrenology more or less explicit is always around the corner. In other words, it is not enough to focus on showing that a specific process corresponds to a particular pattern of neural activation. It is important to consider not just the correspondences, but the underlying mechanisms not only about where, but also why (Lakoff & Johnson, 1999). Reflecting on the recent discovery on mirror neurons, which highlights the identification of a powerful mechanism that can be called, sometimes discussed, "motor simulation" (Damasio, 1994; Jeannerod, 2007; Gallese, 2007). However, this hypothesis and discovery suggests an urgent need of intermediate models of applied translation, a conversion of neurological brain structures as well as related mechanisms about phenomenological evidence, that should have the function of filters that

connect the dynamic of the body and the space where the bodies live and die: a space that we can not forget, culturally and socially perceived and constructed. Only in recent years a new perspective has emerged, the embodied, that considers not only the neural processes, but the fact that organisms have a body as well as a brain, that the mind is not something separated, but that the cognitive processes are based on sensory-motor processes. Only in recent years, in many fields the fact that cognition is not elaboration of the information, but it is movement and action has been underlined. Now, it is necessary to look whether it is sufficient to consider the body as a situated device of action or, as we think, configuring this vision according to a constructivist perspective in the educational and didactical field, a more complex element (Jeannerod, 2007). In technical terms, embodiment and situatedness, are connected. Cognition is not only embodied, but also situated, variable, contextually determined. Our body is our first setting, the first element of determination.

2. From mirror neurons to embodied cognition

The emerging vision of concept of embodied cognition considers the cognitive processes deeply rooted in the interaction of the body with the world. This aspect, according to the reading of Margaret Wilson of the University of California, of Santa Cruz, currently holds very different versions, some of which are more controversial than others. We distinguish and value the following six options: 1) cognition is situated; 2) cognition is subject in the time; 3) we reduce the cognitive workload through the environment; 4) the environment is part of a cognitive system; 5) cognition is for action; 6) self-cognition is based on the body. Of these, the first three and the fifth appear to be partially true, and their utility is better evaluated as a range of their applicability. We state that the fourth version is very difficult. The sixth version has received less attention in literature about embodied cognition, but it may be, in fact, the best documented and most powerful of the others. It has been shown that neural networks are capable of adaptation and learning, so that an important and comprehensive study about the activity of their circuits has been prevented by the complexity of networks of mammals.

The plasticity of the networks can be defined as the modeling of the morphology and function of the networks induced mainly by experience. This process is based on the complex changes, and it depends on the activity of neurons, which modulate the capacity of neural network to transfer, to process and to store information (Gallo, 2003).

After the first period of genetically determined development, the neural circuits are continuously changed and shaped by experience (epigenetic development). Therefore, synaptic connections that are slightly used are weakened, and they disappear while those synapses that are used frequently grow stronger and eventually grow in number. Synaptic efficiency can be very varied and on a scale of variable time, from a number of factors, including previous network activity, the generation of second messengers, functional changes in pre and post - synaptic proteins, in addition to regulating the expression of genes involved in growth, in survival, and in synaptic transmission. This aspect results in changes of efficiency of synaptic transmission that can last from a fraction of seconds to minutes in the case of synaptic plasticity in the short term, up to hours, days or months in the case of synaptic plasticity in the long term.

These changes profoundly affect the processing of information between the input and output of the network, and at the end they shape the flow (Gallese, Fadiga, Fogassi & Rizzolatti, 1996). Schematizing the key points of the new neuroscience studies to reflect on the possible repetitions in the context of teaching, particularly on the relation between corporeity and learning, we can consider the following important points. 1. Studies of LeDoux sustain that the changes in synaptic connectivity underline learning and the memory represents the consolidation of these changes in the time "when the weak and strong input toward the cell are active at the same time, the stimulus weak results to be strengthened for its association with strong stimulus" (LeDoux, 2002). 2. The theory of Giacomo Rizzolatti in which it shows that mirror neurons are in a group of neurons that are selectively activated when an action is done and when we observe it while it is performed by others. The neurons observer reflects what happens in the mind of an observed person if the observer does an action (Rizzolatti & Sinigaglia, 2006). 3. The theory of Gallese on Embodied Cognition speaks about a notion of knowledge that has its roots in the states of the body and specific systems of our brain, underlining the important role of sensory-motor system in the representations and in cognitive operations (Gallese & Goldman, 1998). A study about mirror neurons, the theory on the evolution of language proposed by Rizzolatti & Arbib (1998), the discovery about audiovisual mirror neurons (Kohler et al., 2002) and a discovery about mouth mirror neurons (Ferrari et al., 2003) laying the foundations for a new research that wants to investigate the involvement of the cognitive linguistics activity in the understanding of the action.

But what does this idea mean for the world of education? And specifically, what do these neuroscientific theories imply in the dynamics of educational relations in the didactic field? In fact, the discovery about mirror neurons, helped to revisit the way of considering the relationship between action, perception and cognitive processes, and it is about this point that the meeting with didactic thought the phenomenology of perception (Merleau-Ponty, 2002). It means that when we are about to carry out an action, we are also able to predict the consequences. This type of prediction is the result of activity of the model of action. If it were possible to establish a process of motor equivalence between acted and perceived, for the activation of the same neural substrate in both situations, a direct form about understanding of others actions would be possible. It is useless to deny the significance of this relapse in within education. It is worth remembering that Alain Berthoz was a scientist who supported the proactive role of the brain, recognizing in the movement not only the physical form and dynamic of action but the instrument that approached to a 'sixth sense' for the ability to anticipate the action (Berthoz, 2000). In order to perceive an action - and to understand its meaning - therefore, is to simulate it internally. Therefore, the Neuroscience sciences, to contextualize their research, requiring the contribution of human sciences, a contribute, that with what is stated by Maurice Merleau-Ponty, we fully agree. In fact, he asserts that the need to find 'the origin of the object in very heart of our experience' (Merleau-Ponty, 2002). For the fourth point, in particular, many studies have been carried out in order to understand how the conjugation of verbs in the future and past times can be related to motor representations required driving a movement of upper limb respectively forward or backward, referring to studies conducted by Boroditsky (2000), by Richardson et al. (2003) and Buccino et al. (2004) concerning the representation of space and time (Buccino et. al., 2004). In this connection, a pilot experiment was carried out involving 18 subjects that required a decoding semantics of verbal stimuli presented acoustically to conjugate a verb in the present, in the future and in the past, and a behavioral response involving a movement of limb forward or upper. In the pilot experiment, the analysis of results was made using analysis of variance (ANOVA) considering as factors in the groups, the past, present, and future time, movement forward and backward movement, and how the factors between groups movement and time. A tendency for subjects to respond more quickly in the execution of movement forward associated with a verb of motion of the hand conjugate in the future was highlighted.

The greater reaction time for made movements by forward persons following the presentation of the verb to the future is related to the direction of the movement: the subject is facilitated when called to carry out a movement that goes in the same direction as the movement evoked spatially by the presented verb. In this experiment, the acoustic stimulus the motor priming that modulates the response, because the person hears the verb and has the time to discriminate it and understand it before it receives the stimulus of the arrow/indicator indicating the direction of movement possibly that must be done. The innovation made by the results of this experiment resides in the modulator effect on the motor response exercised by an implicit representation of the movement implied in the cognitive processing of the time in which the verb is conjugated. In fact, the stimulus presented by us explicitly does not show the reference to the direction of the movement to be carried out in response, unlike the studies conducted up until now (Buccino et al., 2004), in which the phrases-stimulus reproduced explicitly actions of movement of hand and foot directed spatially. The experimental data appear to confirm that the semantics understanding modulates the motor system in different ways depending on the experimental delivery as well as the stimulus presented to evoke it, but are in the same school of studies that confirm the involvement of the motor system not only the observation of the action, but also in the processing of presented action linguistically, in reading and listening (Gallese & Goldman, 1998).

Results and discussion

1. Neuroscience and Psychopedagogy compared. Learning takes shape.

The mirror neurons map the observed actions on the same neural circuits that control the execution and allow active, therefore, an internal representation, a sort of "embodied simulation" of a particular act real, concrete, be it socio-behavioral, and the language (Gallese, 2005). This would be the neurophysiological evidence that human beings are naturally social, and in this direction should be explained to some disorders such as autism: it might be, in fact, the presence of lesions within the mirror system to not allow the subject to get in touch with the world around town, even from the point of view of language delay. The recent contributions of neuroscience in educational and teaching are beginning to consider the body as an integral part of the time learning as "the mind must not only move from one physical Cogito not in the realm of biological tissues, but must also be correlated with a whole, possess a brain and a body of integrated and full interaction with a physical

and social environment" (Damasio, 1994). Referring to embodiment and corporeity, the dialogue between psychological studies, research, cognitive neuroscience and construction of mathematical models on the one hand, and phenomenology, cultural studies and semiotic language of the other, could now envisage a new era: the creation of intermediate models, as the study of spatial-temporal patterns by which we humans perceive ourselves in a relationship and coordination of body and space between body and objects (Lakoff & Johnson, 1999). We could say with a slogan: neither bottom-up nor top-down, but levels that are the result of a continuous reciprocal translation. Inputs from a stimulating environment can affect in a decisive manner on synaptic formation because, even if they are billion neurons that characterize the adult human brain connected in a specific way, there are, in fact, connections which are ordered and well defined and what is achieved, says Elisa Frauenfelder¹³, is a sort of "Neural Darwinism: the cells are assembled, creating sets, groups of cells, which are repeated thousands of times and tend to compete to acquire the ability to transmit as many replicas of themselves, thus entering into the law of evolution" (Frauenfelder, 2002). In a broader sense, this plasticity is identified with the capability of learning, through mechanisms of synaptic connection and disconnection. The phenomenon of sprouting, which literally means bud, explains how the number of synapses may increase during the first years of childhood, and especially thanks to an environment rich in stimuli, in addition to the presence of critical periods defined by their sensitivity to external stimulation during which the synapses increase (Frauenfelder, 2002). Another element to be considered in the study of the relationship corporeity/learning is to ensure that the emotions affect learning and cognitive processes. From a biological perspective, a part of our brain that is the limbic region and is home to emotivity "is related to the environment through the afferent nerve pathways, which convey to the brain sensations and perceptions and is integrated into the cerebral cortex". Between emotional processes and learning there is a deep connection, since it is usually in an emotional relationship". The educational relationship is existential presence of the educator to the student (Goleman, 2006). Through the paradigm of embodied cognition, then, you tend to learn how to interact as though each other, which allows you to create models of the self / other. According to the model of classical cognitive science, however, the sensory systems, the data of the world, then interpreted and understood by most as cognitive systems.

In this light, the motor system does not represent more than a tool for translating movement in the responses prepared by the cognitive system.

2. Neuro-scientific paradigms and pedagogic codes in the education through the body

Regarding the controversial relation between mind and brain and its undue reductivism, philosophically debated especially in the analytical research of the Theory of Mind, in the last decade has been, as already mentioned, the neurophysiology to make great steps forward and indirectly confirm the phenomenological analysis of Husserl, Stein and Merleau-Ponty about subjectivity and un-subjectivity, up to the point to formulate the need to formulate "phenomenologizing the cognitive neuroscience, rather than naturalizing the phenomenology [...]. A better dialogue between neuroscience and phenomenology is not only desirable but necessary. Future neuroscience research will increasingly focus on those aspects of human experiences and try to give more personal characteristics for the experiences of the individual subject" (Gallese, 2006, b). According to Maurice Merleau-Ponty, eyesight, motility and sexuality are functions that "cannot be connected between each other and to the outside world by causal relationships, but they are all involved in a single drama. "The body is not, therefore, an object, a thing or a fact, and for the same reason, the conscience that we have of it is not just a thought. Whether it is considering the body of others or our own, there is an only way to know the human body: living it, making ours the drama that goes through it" (Merleau-Ponty, 2002). Living it, means also relating to other bodies. The contact, the encounter with others, given thanks to the objectification of otherness: the Leib. Through the presence of many experiences, which flows, we have consciousness; it discloses the significance of the intersubjective relationship, thanks to the medium of the living body. Leib is an essential medium of relation, through a subtle game of perception and apperception that allows the seizing of the body, psyche and spirit of others ego¹⁴. Considering in depth, this aspect regarding the educational science field, the reading of signs that the body expresses in interpersonal relations denotes also a strong connection between emotional intelligence and body-kinesthetic intelligence, this interaction is not limited to a mere interdependence, but expresses an opportunity for cognitive constructions. It should be put before the need of a body that shows coherent signals with a message to be communicated, in the work of the interlocutor, is natural to analyze meticulously whether if the motor semeiotics of the subject addressed and reinforced the

significance of the information that should be transmitted (Watzlawick, Beavin & Jackson, 1967). So, how much and how are they connected, dependent, causally linked to the talent of a clever and what are the conditions and contexts where this bond can possibly be fed and driven to succeed? Gardner defines the body-kinesthetic intelligence as an ability of the body expressing, governing itself, manipulating things, orienting with precision, consistently and effectively respond to the motor difficulties that will occur in the most different ways. But if life, what we are, is it the result of biochemical changes of synapses, (Le Doux, 2002) is the result of our experiences, therefore, of our heritage of knowledge, why should the body not be culture (input), emotion (processing), intelligence (output)? On this postulate there is the cognitive relationship between emotional and body-kinesthetic intelligence and the body cannot be the best cultural vehicle that we have! Awareness of the mechanism of these processes helps human beings to intervene constructively in the complex field of education; where human variables is beyond basic search and points of reference. Clarity and awareness of emotional and bodily interaction as cognitive development, express, therefore, thanks to new neuro-scientific contributions, new frontiers in the field of teaching and supply alternative modality that the community requests us nowadays (Paloma, 2004). The organization of the training action, therefore, must be based on appropriate teaching strategies so that individuals are able to learn with maximum efficiency and build up conceptual networks that allow a construction of a systematic organization of stable knowledge, but open, for this reason capitalizable, of real networks of knowledge, "creating conditions of possibility, both cognitive and affective-motivational, understanding what is new, of a self-learning" (Domenici, 1999). From the perspective of perception and reading that Domenici has about the construction of knowledge, it is interesting to reflect on the influence of new research on embodied cognition. For example, about the full sharing of the need to make the methodological procedures innovative in order to make knowledge a significant aspect, the emotional and empathetic involvement of the pupil, bodily speaking, determines the genesis of new knowledge that becomes more easily grafted on to those already owned (Ausubel, 1968). Knowledge, therefore, must be "systematic, namely represent an organic and consistent set and have a structure within which each element is equipped of senses ... stables, in the sense that they should be able to endure over time, which should facilitate the prevalent use of the functional memory or rather semantic relative to the episodic or

mechanic one, ... of basic, not only in the traditional sense of knowledge, but rather and above all of their recent evolution; ... capitalizable, which allow more than others to whom possess them to use them as intellectual picklock of penetration and mastering of more knowledge" (Domenici, 1999). The suggestion to make the construction of knowledge possible, validated by Domenici, and offered by Antinucci: "there is another way to learn, that does not happen only through the interpretation of texts or through mental reconstruction. It happens, however, through the perception and the motor action on reality. Perceiving an object or an event with eyesight, hearing, touch, intervening on it with my action and that makes a change in my perception, a change that is a function of what I have done and the nature of the object. Since the action is inherently known to me, because I have produced it, the differential perception - the reaction that I see - produces the knowledge of the other term, the nature of the object. This learning is called motor-perceptive, because it is based on experiential cycles of action-perception" (Gallo, 2000). Considering these scientific principles, the basis on which to reflect for new teaching protocols, the commitment of our research group, in this sense, is to exploit the latest neuro-scientific studies on the relationship between corporeity and learning, starting from a scientific paradigm that serves as a theoretical framework to reach the table of experiences proposed and to the spectrum of educational activities that, through the body, respect and enhance the many dimensions of the person. From this perspective, "intelligence is a bio-psychological potential, inducing to assert that there are not general cognitive architectures, but different cognitive architectures. Each of these *formae mentis* works in a "relatively independent way from the others" and is structured and emerges only in contact with certain symbolic-cultural systems, "during daily life these intelligences typically work together in a harmonious way, and their autonomy can therefore be invisible. But when you put on one's appropriate spectacles, the distinctive nature of all understanding will emerge with sufficient (and often surprising) clarity" (Gardner, 1983, p. 29). Research in the field of bio-neuro-science today provides possible interpretations on the processes of growth and on the directions of development of individual potential evolutions in different environmental and the neuro-didactics, giving attention to both the complexity of the individual dimension of human system as bio-dynamic entity in training, that to the consideration of the issues involved in the development of the living reality, follows a heuristic approach and synergistic that do not predefine its goals, but

rules them from time to time, which does not intervene but leads, that does not prescribe but interprets, expressing the own desire to know and respect the person in the complexities of the dynamics of interaction and development (Sibilio & Paloma, 2004). But if the context impact on our education and society today, ready to quantify the amount of experiences, at the cost of going to the detriment of their quality, what has happened to our nervous system over recent years? The diversity and high frequency of environmental stimuli has induced over the years, our brain to revisit the receiving, analyzing, processing and synthesis system, focusing attention and the scientific interest on creativity (Gallese & Goldman, 1998). The concept of mental flexibility, seen as an easiness of adjustment that has, however, a contrast in inflexibility. Most of creative thinking, in fact, requires an organization of ideas according more inclusive patterns. For this reason, a capability of synthesizing is necessary. In opposition, it is possible to think that there is an analytical capacity; this is the reason why symbolic structures must be broken frequently, before building more up (Beaudot, 1969). In defined situational contexts (Gallese et al., 1996), actions with the body and through movement, mean as a link between technical conduction and interactive-symbolic, may represent a tool that contributes to the acquisition of mental flexibility remodeling, in this way the perspective view of life under the scientific and cultural outline. We are therefore facing a circular system that is self-conditioned; the nervous system collects information and the related processing and result of a mix between genetic predisposition of neural cells and the building of new functional connections to the responses to achieve. If this is true, it means that in order to make our processes of life creative, the following is necessary:

1. Awareness and personal recognition valence of daily availability for spending of the creativity in the midst of the relational life;
2. Solicitation stimulus and the related functional perception to the construction of creativity forms.

The body and movement, in our opinion, may, through a series of targeted interventions, to create circumstances and contexts for the "construction" of creative minds, the result of games for the solicitation of motor problem solving. In this concept, it is important to be familiar with the reading of the scholar Pierre Parlebas, that to the term socio-motility, intends the research of an action that shows a behavior, and that behavior makes clear a communication. According to Parlebas "a motor action involves emotions and fantasies of the person that plays, touching conscious and non-conscious plans.

The body that plays is between education of the body, of affections and mind, at the same time using a unique and original form of communication. The action during the game has its significant communication and specific language. A person who plays put in action behaviors that lead to communicational needs and social symbols" (Parlebas, 1989). From this interpretation, it is possible to grasp how the motor activity itself, through the use of the body, requires a cultural deepening and a coherent semantic self-elevation, able to combine to the implicitly shown techniques in the disciplines, methodological and educational elements based on the communication. The technique combination and the communication can be made in connection through the Lateral Thinking of Edward De Bono (1969). Attention to how, therefore, and not only to what, capable of upsetting the traditional educational paths through a reading that is not only in a performative biomechanical key but above all relation communicative. Going deeper into the matter and examining the characteristics of the motor action through the body, the person has to:

- select, interpret the feedback information for self-regulation (feedback);

- make assumptions (advances) on the situation and generate appropriate actions.

This means that, in the circumstances activities (e.g. sports team), the person, other than following "technical" rules to optimize the performance, requires a considerable estimation-motor capacity. This is strongly linked to the ability of interpreting and integrating different internal and external, abstracts and contingent, symbolic, physical and interpersonal levels of information. About this context, the motor action through the body is inserted on two basic levels:

1. socio-relational, referring to an interpersonal and socio-cultural context collocated to a symbolic- interactive level;

2. operational, where there is the intelligent adaptation of the movement to the situations and their manipulations in achieving a goal, is collocated in a strategic and tactical level (Nanetti, Cottini & Busacchi, 1996).

The first aspect, socio-relational, is collocated on a symbolic-interactive level and is represented by an elaboration of the sensorial information that is bound to a semantic dimension and to its rules, so the feed-back belongs to the symbolic categorization level and in alternative to the sensory-perceptive. Gathering a meaning both on expressive and communicative level and exactly:

- on the expressive level, the motor action is configured as complex bodily signals (gestures, postures) that transmit messages, often unconsciously related to attitudes and emotional states.

- on the communicational level, it is a strategy that, in agreement or disagreement with the word, intentionally influences the recipient.

The cultural domain that affects the socio-relational is called socio-motility.

Motor conductions of those who act in a particular activity and / or physical discipline through the body "can be considered as signs where the signifier is the observable behavior and the meaning is the corresponding tactical project" (Parlebas, 1989).

At the moment of the action, the subject releases observable indices by other participants: orientation of the body, position of the supports etc.). Such constellation of signs gives a decoding based on very complex cognitive processes. The motor semeiotics, semeiotricity, was established to describe the complex system of signs directly associated to motor behaviors and differs according to this, a reading semeiotricity of the natural environment (natural indices) and a coding and decoding of the same motor behaviors. Low semeiotricity activities are those that take place in a highly predictable context (cyclic motor patterns) and are characterized by motor stereotypes. High semeiotricity activities are performed in unpredictable environmental situations (motor creative games engines and team games), which continuing sensory-motor and symbolic information decisions, should result in motor adaptation decisions. The second operational level, is collocated in a strategic and tactical level, and is present when the motor action assumes the operational meaning to achieve a target in spatial-temporal, complex and changeable situations.

The adjustment of the motor action to the changing of the situational context requires the collection of motor elastic maps that allows the person to produce, transform and adapt the movements according to the needs of the moment. Such capability requires a mindset which clearly shows the need to always have the "field" cleared of symbolic crystallized structures (Robazza & Bortoli, 1990). If it is therefore, reasonable to think that being creative means acting in opposition to logic, it is understandable even if something happens to make a mistake. Acting creatively means using a logic that does not influence the choices of the subject according to the life styles, according to past experiences, according to the principles and values of the context, but according to the need expressed by the present circumstances. Psycho-pedagogical sciences have enabled and then built up, through empiric experiences and through validated research, a solid bridge between the motor activities and educational and training values, recognizing to the body, a fundamental role of the development of children.

Activism by Dewey and Montessori, and the cognitive approach by Bruner and sensory-motor by Piaget, pluralism by Gardner, emotional approach by Goleman, the metacognitive approach by Ausbel and Novak, have contributed to the enhancement of kinesthetic body-dimension as a basis for all learning and to the recognition of several independent *formae mentis* but interacting, to the revaluation of an emotional mind able to affect our rationally action and the communication of our emotions, that have affirmed, indirectly, a revaluation of the motor games, of the various forms of games through the body as tools for training and opportunities for personal expression of subjects (Sibilio, 2007). With the contribution of neuroscience today, it is possible to decline scientific theories that explain the hidden and intriguing physiological and biochemical mechanisms of the nervous system and build up new protocols of intermediation for the contextualization of these processes in the world of human sciences.

Conclusions

As previously mentioned, recent studies in neuro-bio-psycho-physiological, through neural Darwinism by Edelman, the contributions by Damasio and LeDoux, Rizzolatti, Berthoz, have provided interesting answers to science on cognitive and emotional mechanisms, on the analysis of the movement and the surprising anticipation and simulation abilities of our brain, opening new horizons in teaching and education. The value attributed to games and to motor activities makes them as an ideal breeding-ground for the development of the body and action, a 'positive transfer' for the access to knowledge, opening new horizons of the educational doing and new opportunities of teaching. The neuro-didactics approach by Hebb, gives the opportunity to reflect about what is already genetically present in each person, and its adaptability, by seeking a possible harmony between what is innate and how much environment and intentionality are able to determine. Teaching using the body and movement to find a new balance between research and innate characteristics of stimuli are able to penetrate and engage emotionally conditioning system mnemonic. The body becomes the subject for interactive problem solving, for the reworking of alternative or complementary approaches of knowledge, a real engine to support the teaching, "a learning environment in which you can follow a complex route where you can open spaces' knowledge, the know-how and skills' through a participatory learning" (Sibilio, 2002). This wonderful wave of enthusiasm that is manifested in us through cultural reflections on the mechanisms of our deep-mind and their

meanings that are in the daily actions of each of us faces, but at the same time, with the concealed attempt to scientific paradigms rules behavior according to a process biologization of life. This should not frighten us, but simply alert. It is an undisputable fact that these new contributions to neuroscience today - and will even more in the future - provide strong evidence of correlation of the phenomena of life, including education. In this context, in fact, you start to value and use from time to time, the various forms of analog communication, to guide and support, involving the body, gestures, that is where knowledge, our report education in a variety of cognitive forms, creating a learning environment where you enhance skills and abilities potential vicariate and formative, open windows on the world of hardship, disability and, more generally, on how to build success training will give the world the possibility of a total rethinking of educational practices that start with subjectivity, the individual needs of the person from his body-knowledge indivisibility. An approach that should be read as a result of a circle conditioner, now validated scientifically on an international level, which is self and self-respecting subjective interaction between genetics and environment, biology and psychology, between neurology and science education (Sibilio, 2003). And 'our customary end a relationship with a question mark, that is, opens a small gap of a reflective on the subject. The study and analysis of this research was interesting, as already mentioned in the 3rd paragraph, the interpretation that in multiple 21st century is attributed to embodied cognition. Margaret Wilson, it enriches the literature of the concept of embodied cognition, thus opening new horizons for thought and interesting cultural comparisons on relapse in training. She, in her article Six Views of Embodied Cognition, presented the six versions of scientific-cultural concept, commenting in a critical-constructive and assigning values and meanings. In brief:

1. Cognition is situated. The cognitive activity takes place in the context of a real environment and involves, with relevance, the perception and action. (eg Chiel & Beer, 1997; Clark, 1997; Pfeifer & Scheier, 1999; Steels & Brooks, 1995; Beer, 2000, Port & van Gelder, 1995; Thelen & Smith, 1994; Wiles & Dartnall, 1999).

2. Secondly, knowledge is subject to time. We are "the mind on the hoof" (Clark, 1997), and cognition must be understood in terms of how it works under the pressures of real-time interaction with the environment. It is often said that agents located must meet the restrictions of real time or time passing (eg Brooks, 1991b; Pfeifer & Scheier, 1999, van Gelder & Port, 1995).

3. Thirdly, we reduce the workload through the cognitive environment. Due to the limitations on our ability to process relevant information (eg about the limits on attention and working memory), we use the environment to reduce cognitive load. Do you maintain that the environment or manipulate information for us and we collect this information only in accordance with the requirements of knowledge (Kirsh & Maglio, 1994).

4. Fourth, the environment is part of the cognitive system. The information flow between mind and world is so dense and continuous that, for scientists who study the nature of the cognitive, the mind is not only a significant unit of analysis (eg Beer, 1995; Green & Moore; Thelen & Smith, 1994; Wertsch, 1998; see Clark, 1998).

5. Fifth, knowledge is for action. The function of the mind is to guide the action and cognitive mechanisms, such as perception and memory, must be included on their last contribution to the behavior appropriate to the situation (Grafton, Fadiga, Arbib, & Rizzolatti, 1997;

Murata, Fadiga, Fogassi, Gallese, Raso, & Rizzolatti, 1997).

6. Sixth and finally, self-knowledge is based on the body. Even when decoupled from the activity of the mind is confined in the mechanisms that have evolved through the interaction with the environment, i.e. the mechanisms of sensory processes and motor control (Glenberg, 1997; Grush, 1996, 1998; Dennett, 1995; Stein, 1994).

Wanting to summarize, we might say that neuroscience began to reveal the treasures contained in our mind and to explain the origin of our behavior more complex and evolved. Probably the future will give great surprises in the training, but we can and must now rely on two important pillars: the certainty that our identity is defined by the relationship with our fellow creatures and the environment and confirmation that our behavior, subjects and objects of neural plasticity are closely related to the earliest experiences of our life (Wilson, 2002).

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UČESTALOST PRIMJENE NEUROZNANOSTI U PSIHOPEDAGOŠKIM ODNOSIMA: TJELESNOST / UČENJE

Sažetak

Korištenje Pozitronske Emisione Tomografije (PET), Funkcionalne Magnetske Rezonance (fMRI) Transkranijalne Magnetske Stimulacije (TMS) i Magnetoencefalografije, je omogućilo detaljnu studiju funkcija pojedinačnih ili grupa neurona, i pomoglo je u proširenju znanja o centralnom nervnom sistemu (posebno o mehanizmima pomoću kojih mozak funkcionira). To znanje je u posljednjoj deceniji bilo pravi korak naprijed s obzirom na razvoj istraživačkih mogućnosti kroz nove tehnologije. Danas eksperimentalna istraživanja mogu potvrditi hipotezu, na živim bićima i bezopasno po zdravlje, koristeći životinje (obično pacove i majmune) ili ljude (zdrave osobe i 'kliničke' patološke slučajeve). Možemo reći da, na teoretskom nivou, razvoj neuroznanosti će voditi revidiranju klasičnog vrh-dno modela, uzimajući u obzir procese u svoj njihovoj kompleksnosti. Na primjer, može se reći da s ovim, mi se suočavamo sa savladavanjem primata 'namjere' za 'komuniciranjem', kao filozofskog sklopa koji više nije ante litteram. Na ovo pitanje odgovaramo osvrto na koji će predstavljati kulturnu prirodu na kojoj ćemo graditi cijelu studiju. Ali pravi problem je razjasniti šta je 'um' za analitičara, a šta je 'svijest' za naučnika fenomenologa; i u skladu s tim, šta je 'mentalni sklop' a šta je 'čin savjesti'. Oni ni na koji način nisu sinonimi.

Ključne riječi: neuroznanost, neuroni, znanje, savjest

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THE EFFECT OF INSTABILITY RESISTANCE TRAINING ON NEUROMUSCULAR PERFORMANCE IN ATHLETES AFTER ANTERIOR CRUCIATE LIGAMENT INJURY

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Original scientific paper

Abstract

The study evaluates effects on static and dynamic balance, speed of step initiation and the soccer kick after instability resistance training in athletes after ACL injury. A group of 14 soccer players (age 21.8 ± 3.4 y, height 182.2 ± 5.6 cm, and weight 76.7 ± 4.8 kg) underwent two months after rehabilitation a combined resistance and balance exercises (in duration of 30 min) for a period of 12-weeks (4-5 sessions/week). Postural stability was evaluated under both static and dynamic conditions (wobble board and antero-posterior / medio-lateral tilted platforms) during bipedal and one-legged stance. The COP velocity was registered at 100 Hz by means of posturography system FiTRO Sway check based on dynamometric platform. Speed of step initiation and the soccer kick was measured using FiTRO Dyne Premium. Pre-training measurements showed the non-injured-to-injured leg percent differences of 15.7% for static and 24.5% for dynamic balance. Following the training there were no changes in static balance on both legs (from 18.2 ± 3.3 mm/s to 15.8 ± 2.8 mm/s), on non-injured leg (from 41.3 ± 8.8 mm/s to 38.2 ± 7.8 mm/s), and on injured leg (from 49.0 ± 8.9 mm/s to 43.2 ± 7.7 mm/s). Likewise, the dynamic balance did not change while standing on both legs (from 95.2 ± 19.0 mm/s to 86.7 ± 17.8 mm/s) and on non-injured leg (from 112.3 ± 25.0 mm/s to 101.2 ± 21.8 mm/s), however a significant ($p \leq 0.01$) improvement on injured leg has been found (from 148.7 ± 22.8 mm/s to 118.0 ± 20.0 mm/s). In addition, the COP velocity significantly ($p \leq 0.05$) decreased during bipedal stance on M-L tilted platform (from 134.2 ± 20.1 mm/s to 110.6 ± 18.2 mm/s) but not on those A-P tilted (from 120.6 ± 19.7 mm/s to 104.7 ± 18.0 mm/s). Furthermore, mean run-out speed significantly ($p \leq 0.05$) increased on injured leg (from 347.4 ± 42.3 cm/s to 385.3 ± 38.8 cm/s) but not on non-injured leg (from 378.1 ± 42.1 cm/s to 371.8 ± 47.1 cm/s). However, no changes in mean kick-off speed on injured and non-injured leg have been found (from 474.0 ± 38.5 cm/s to 515.6 ± 43.3 cm/s and from 475.9 ± 40.7 cm/s to 499.5 ± 37.6 cm/s). It may be concluded that resistance exercises performed on unstable surfaces represent an effective means for the improvement of dynamic balance under various conditions and speed of step initiation in athletes after ACL injury. However more specific exercises should be implemented into training program in order to improve sport-specific skills like the kick-off speed.

Key words: athletes, ACL-injury, instability resistance training

Introduction

Traumatic injuries of the knee joint leading to anterior cruciate ligament (ACL) tears are frequent in sport. After conservative treatment some of the individuals return to their preinjury functional level, whereas others present with functional instability. Among the variables that might be related to the presence of functional instability caused by ACL deficiency, deficits in proprioceptive mechanisms have received considerable attention. In most of the studies (e.g., Barrack et al., 1989; Corrigan et al., 1992; MacDonald et al., 1996; Roberts et al., 1999) a reduction in proprioceptive acuity in individuals with ACL injuries has been demonstrated. In particular, higher threshold of perception of passive motion in individuals with ACL rupture when compared to healthy controls (Roberts et al., 1999) and when compared injured and non-injured legs of individuals with

ACL damage (Barrack et al., 1989; MacDonald et al., 1996) has been found. In addition, repositioning errors have been documented as a result of ACL injury (Barret, 1991; Corrigan et al., 1992). On the other hand, a few studies failed to demonstrate these deficits in individuals with ACL injury (Friden et al., 1998; Good et al., 1999). Fonseca et al (2005) proved that individuals with good functional and muscular performance did not present proprioceptive deficits measured through tests of position sense and threshold of detection of passive movement. It may be assumed that a decline in functional and muscular performance could also lead to a reduction in proprioceptive acuity. It is therefore important to continue in rehabilitation after conservative treatment in order to maintain or even improve the performance.

Currently, instability resistance exercises in combination with sport-specific drills used to be applied in post-rehabilitation period when training is carried out in the playing field or gym. These exercise programs should be designed to match particular sport activity in order to achieve the improvement in sport-specific neuromuscular performance. The aim of the study was to evaluate effects on static and dynamic balance, speed of step initiation and the soccer kick after instability resistance training in athletes undergoing rehabilitation after ACL injury.

Methods

Subjects

A group of 14 soccer players after ACL injury (age 21.8 ± 3.4 y, height 182.2 ± 5.6 cm, and weight 76.7 ± 4.8 kg) volunteered to participate in the study. All of them were informed of the procedures and of the main purpose of the study.

Study setting

Subjects underwent, two months after conservative treatment, a combined resistance and balance exercises (in duration of 30 min) for a period of 12-weeks (4-5 sessions/week) (Fig. 1). Professional instructor was involved to provide individually designed training programs.

The intervention included besides balancing and strengthening exercises, and forward and side-by-side run-out movements, also soccer-specific drills.

Diagnostic equipments

Postural stability was evaluated under both static and dynamic conditions (wobble board and antero-posterior / medio-lateral tilted platforms) during bipedal and one-legged stance. The COP velocity was registered at 100 Hz by means of posturography system FiTRO Sway check based on dynamometric platform. Subjects were instructed to minimize postural sway by standing as still as possible. Speed of step initiation and the soccer kick was measured using FiTRO Dyne Premium. Subjects were asked to either run-out or kick-off as fast as possible. The best result of three trials performed with injured and non-injured leg was taken for the evaluation.

Statistical analysis

Ordinary statistical methods including average and standard deviation were used. A Wilcoxon-test was employed to determine the statistical significance of differences between pre- and post-training values of sway variables registered in static and dynamic conditions, speed of step initiation and the soccer kick, $p < 0.05$ was considered significant.

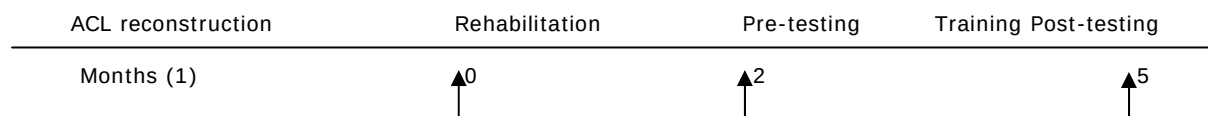
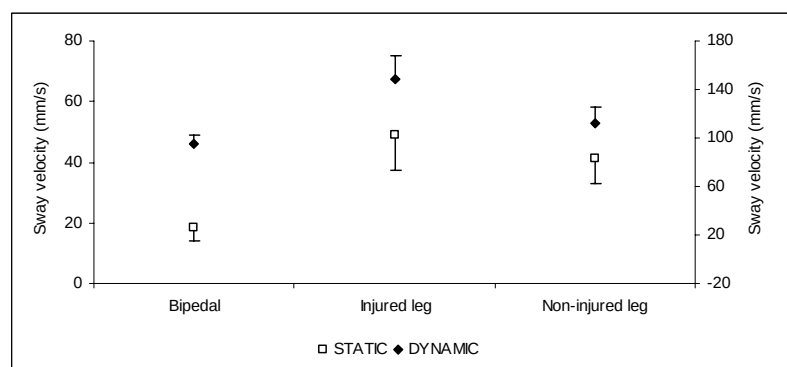


Figure 1 Schematic representation of the experimental protocol

Results



Pre-training measurements showed (Fig. 1) the non-injured-to-injured leg percent differences of 15.7% for static and 24.5% for dynamic balance. Figure 1 The COP velocity registered in static and dynamic conditions (wobble board) during bipedal and one-legged stance prior to training (after two months of conservative treatment). Following the training there were no changes in static balance on both legs (from 18.2 ± 3.3 mm/s to 15.8 ± 2.8 mm/s), on non-injured leg (from 41.3 ± 8.8

mm/s to 38.2 ± 7.8 mm/s), and on injured leg (from 49.0 ± 8.9 mm/s to 43.2 ± 7.7 mm/s) (Fig. 2). Likewise, the dynamic balance did not change while standing on both legs (from 95.2 ± 19.0 mm/s to 86.7 ± 17.8 mm/s) and on non-injured leg (from 112.3 ± 25.0 mm/s to 101.2 ± 21.8 mm/s), however a significant ($p \leq 0.01$) improvement on injured leg has been found (from 148.7 ± 22.8 mm/s to 118.0 ± 20.0 mm/s) (Fig. 3).

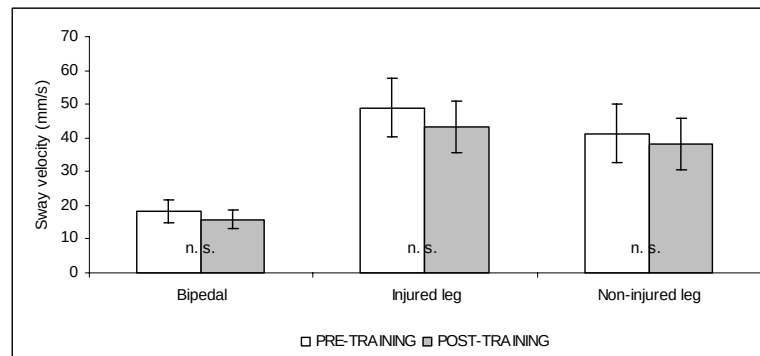


Figure 2 The COP velocity registered in static conditions during bipedal and one-legged stance prior to and after three months of instability resistance training

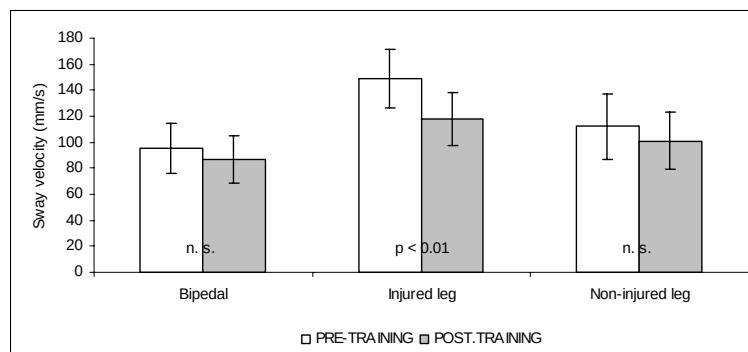


Figure 3 The COP velocity registered in dynamic conditions (wobble board) during bipedal and one-legged stance prior to and after three months of instability resistance training

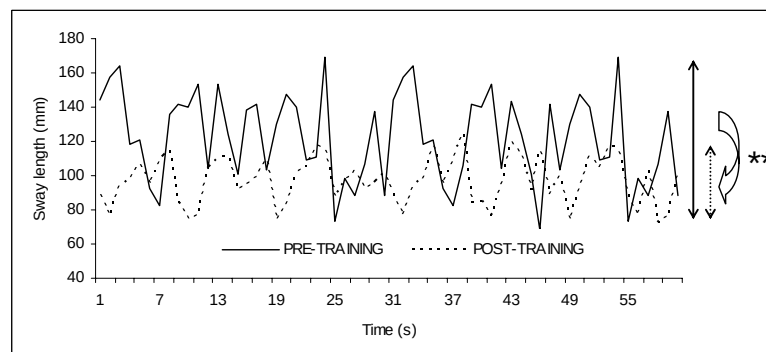


Figure 4 Kinetics of the COP velocity registered in dynamic conditions (wobble board) while standing on injured leg prior to and after three months of instability resistance training

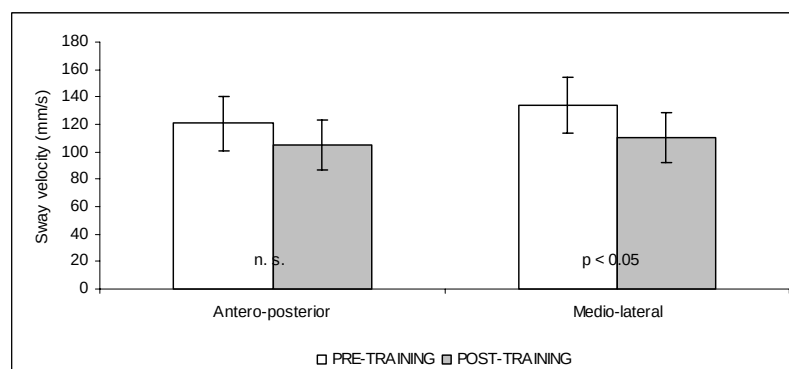


Figure 5 The COP velocity registered in dynamic conditions (antero-posterior / medio-lateral tilted platforms) during bipedal stance prior to and after three months of instability resistance training

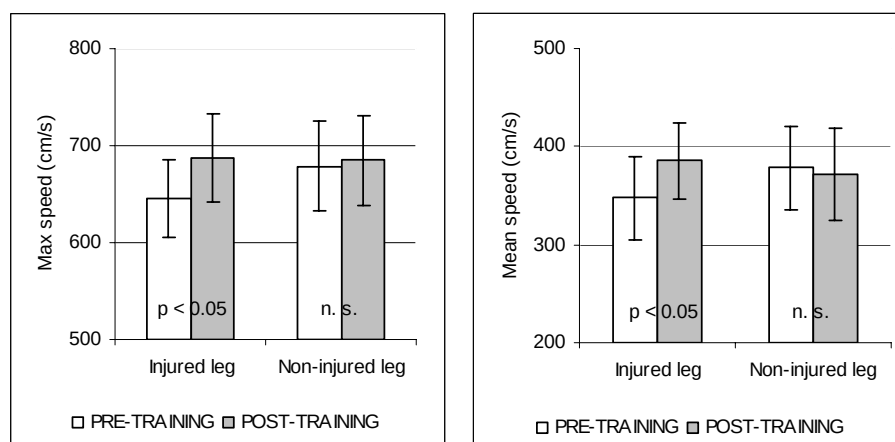


Figure 6 Max (a) and mean run-out speed (b) on injured and non-injured leg prior to and after three months of instability resistance training

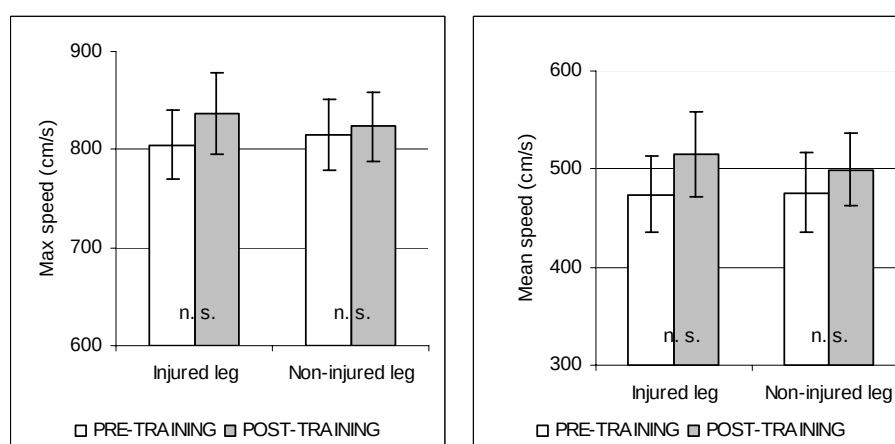


Figure 7 Max (a) and mean kick-off speed (b) on injured and non-injured leg prior to and after three months of instability resistance training

More specifically, the COP velocity not only decreased after training but also traversed on smaller amplitude (Fig.4). In addition, the COP velocity significantly ($p \leq 0.05$) decreased during bipedal stance on M-L tilted platform (from 134.2 ± 20.1 mm/s to 110.6 ± 18.2 mm/s) but not on those A-P tilted (from 120.6 ± 19.7 mm/s to 104.7 ± 18.0 mm/s) (Fig. 5). Furthermore, mean run-out speed significantly ($p \leq 0.05$) increased on injured leg (from 347.4 ± 42.3 cm/s to 385.3 ± 38.8 cm/s) but not on non-injured leg (from 378.1 ± 42.1 cm/s to 371.8 ± 47.1 cm/s) (Fig. 6). In contrast, no changes in mean kick-off speed on injured and non-injured leg have been found (from 474.0 ± 38.5 cm/s to 515.6 ± 43.3 cm/s and from 475.9 ± 40.7 cm/s to 499.5 ± 37.6 cm/s, respectively) (Fig. 7).

Discussion and conclusion

It has been found that even after 8-weeks of standard rehabilitation both static and dynamic balance was more profoundly impaired while standing on injured than on non-injured leg.

This finding is in agreement with those of Holder-Powell and Rutherford (2000) who showed the long-term effect on balance after unilateral lower limb musculoskeletal injury. According to them full recovery is frequently not achieved and perhaps recovery does not continue to improve once the formal rehabilitation period is over. For this reason individuals used to continue in exercise program under supervision of professional instructor, as has been done in our study too.

Following 12-weeks of the instability resistance training applied, there were no improvement in static balance. This may be due insufficient specificity of static-testing conditions to reflect changes in postural stability after exercises predominantly performed on wobble boards. More specifically, the exercise program was designed close to the idea of Latash (2008) that rehabilitation strategies should be directed at optimizing function rather than at bringing movement patterns as close to „normal“ as possible. In favour of this speak also our experience.

For instance, there is an overall agreement that higher COP velocity and area reflect impairment of postural stability, as has been seen in ACL-injured soccer players in our study. In such a case, the rehabilitation is focused on improvement of balance with goal to see subject's upright posture more stable.

However, this assumed improvement of balance does not take into account the fact that this ability in most situations is integrated with other task (e.g., kicking a ball). From this point of view is important to focus the rehabilitation process on improvement of adaptability of postural control to new situations. In other words „to teach the body“ to be flexible and adaptable to perturbations so that balance is maintained. In doing so, examined individuals performed a wide variety of soccer skills on unstable platforms with aim to practice in high-demanding conditions on motor control.

According to the concept of training specificity (Sale, 1988), no crossover effects of such a functionally directed balance training on static balance measures can be assumed. On the other hand, greater stability on injured leg evaluated under dynamic conditions has been observed. In addition, sway velocity decreased during bipedal stance on medio-lateral tilted platform, suggesting more efficient utilization of hip strategy in postural control. Contrary to viscoelastic forces inherent to the ankle muscles that correct small perturbations of posture, for larger sway displacements, active contractions are required. These contractions could originate from stretch and vestibular reflexes, or be voluntary responses triggered by multimodal sensory inputs (Allum, 1983). It has been postulated (Allum & Honegger, 1998) that a confluence of trunk and upper-leg proprioceptive input establishes the basic timing of automatic, triggered balance corrections. While instability resistance training applied should certainly tax a proprioceptive control of posture, it has not been established whether any positive adjustments would be mediated through anticipatory postural adjustments (central processing).

The underlying neural adaptations occur at different sites of the central nervous system and the plasticity of the spinal, corticospinal and cortical pathways proved (Taube et al., 2008) to be highly task specific. So far, little is known about the plasticity of cerebellar and subcortical areas with regard to balance training because the difficulty in accessing

these structures during postural tasks. Using transcranial magnetic stimulation Taube et al (2008) reported reduced cortical excitability following balance training, which was negatively correlated with changes in stance stability, i.e. subjects who reduced their cortical excitability to a greater extent showed greater improvements in stance stability. Conversely, when balance-trained subjects were measured in the voluntary task, enhanced cortical excitability was evident. These authors speculated that (synaptic) efficiency of direct corticospinal projections to the muscles encompassing the ankle joint increased by balance training and could be utilized in the voluntary contraction.

Since greater contribution of the motor cortex to voluntary movements like step initiation may be assumed, such adaptation might partly explain the increase in run-out speed on injured leg after training. However, combined Balance-strength exercises were insufficient stimuli to enhance speed of the kick-off. Similarly,

Aagaard et al (1996) found that even using different strength training regimes the kicking performance estimated by maximal ball flight velocity was unaffected. This may be ascribed to the fact that training program used could improve mainly feedback mechanisms. This assumption may be corroborated by findings of Kollmitzer et al (2000) who showed that motor-skill training including balance exercises increases the sensitivity of feedback pathways. However, during fast movements such as rapid kick a feedforward commands – in the absence of feedback – are used, and can even be used by central pattern generators to produce automatic behaviours. Therefore one may not expect substantial improvement of kicking performance without using specific soccer drills of appropriate intensity and duration.

Three months of instability resistance training including also soccer-specific drills improves balance under variety of dynamic conditions and speed of step initiation in athletes after ACL injury. However, such training is insufficient to enhance speed of the soccer kick. Therefore, more specific exercises should be implemented into training program in order to improve soccer-specific skills. Despite of this, resistance exercises performed on unstable surfaces represent an effective means for improvement of neuromuscular performance in athletes after lower limb injury.

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EFEKT NESTABILNOG ISTRAJNOG TRENINGA NA NEUROMUSKULARNO DJELOVANJE KOD SPORTAŠA NAKON POVREDE ANTERIOR CRUCIATE LIGAMENTA

Sažetak

Studija vrednuje efekte na statičku i dinamičku ravnotežu, brzinu početnog pokreta pri koraku i fudbalskog šuta nakon treniranja otpora nestabilnosti kod sportaša nakon ACL povrede. Grupa od 14 fudbalera (god. 21.8 ± 3.4 y, visina 182.2 ± 5.6 cm, i težina 76.7 ± 4.8 kg) je prošla kombinaciju vježbi za otpornost i ravnotežu dva mjeseca nakon oporavka (u trajanju od 30 min) u toku 12 sedmica (4-5 puta sedmično). Posturalna stabilnost je procijenjena i statičkim i dinamičkim uslovima (ljuljajuća ploča i antero-posteriorne/medio-lateralne nakošene platforme) za vrijeme stajanja na obje i na jednoj nozi. COP brzina je zabilježena na 100Hz pomoću posturografskog sistema FITRO Sway check koji je baziran na dinamometričkoj platformi. Brzina zakoračenja i fudbalskog šuta je mjerena pomoću Fitro Dyne Premiuma. Mjere prije trenažnog procesa su pokazale razlike od 15,7% za statičku i 24,5% za dinamičku ravnotežu kod povrijeđene i nepovrijeđene noge. Tokom treninga nije bilo promijena kod statičke ravnoteže na obje noge (od 18.2 ± 3.3 mm/s do 15.8 ± 2.8 mm/s), na zdravoj nozi (od 41.3 ± 8.8 mm/s do 38.2 ± 7.8 mm/s), a na povrijeđenoj nozi (od 49.0 ± 8.9 mm/s do 43.2 ± 7.7 mm/s). Također, dinamička ravnoteža se nije promijenila pri stajanju na obje noge (od 95.2 ± 19.0 mm/s do 86.7 ± 17.8 mm/s) i na zdravoj nozi (od 112.3 ± 25.0 mm/s do 101.2 ± 21.8 mm/s); ali značajan napredak ($p \leq 0.01$) je zabilježen na povrijeđenoj nozi (od 148.7 ± 22.8 mm/s do 118.0 ± 20.0 mm/s). COP brzina se znatno smanjila ($p \leq 0.05$) za vrijeme stajanja na obje noge na M-L kosoj platformi (od 134.2 ± 20.1 mm/s do 110.6 ± 18.2 mm/s) ali na na A-P kosoj platformi (od 120.6 ± 19.7 mm/s do 104.7 ± 18.0 mm/s). Brzina istrčavanja se značajno povećala na povrijeđenoj nozi, ali ne na zdravoj nozi. Pa ipak, nije bilo promjena u brzini ispucavanja na zdravoj i povrijeđenoj nozi. Možemo zaključiti da vježbe za otpornost izvođene na nestabilnoj površini predstavljaju efektno sredstvo za unaprijeđenje dinamičke ravnoteže pod različitim okolnostima i brzine zakoračenja kod sportaša nakon ACL povrede. Pa ipak, konkretnije vježbe bi se trebale koristiti pri treningu za poboljšanje specifičnih vještina, poput brzine ispucavanja.

Ključne riječi: sportaši, povreda ACL, nestabilni trening izdržljivosti

BASIC DISTINCTIONS IN FACTOR STRUCTURE OF THE SPECIFIC WORKABILITY OF 13-14 YEARS OLD SYRIAN WATER POLO PLAYERS UNDER THE CONDITIONS OF ONE AND TWO CYCLE PLANNING OF THE YEAR TRAINING SESSIONS

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Original scientific paper

Abstract

Its main objective is the organization and implementation of the sport preparation for one year period within the frame of two vs. mezzo-cycles of the growing up water polo players in Syria, where the level of the game is lower in comparison with the leading world countries. Thirty young water polo players from Syria, aged 13-14 are the subject of the study, divided into two groups: experimental one (15 boys) and a control one (15 boys). Both groups have undergone 9 tests the specific workability. Education and training program is developed for the complex preparation of the growing up water polo players (13-14 years old) from Syria. The results received were processed by the following mathematical-statistical methods: variation analysis and factor analysis. There are differences in the factor structure of the specific workability of the growing up Syrian water polo players while these are in direct dependence on the applied methodology of the year preparation.

Key words: water polo players, factor structure, specific workability, year training sessions

Introduction

One of the most important factors determining the effectiveness of the in-game activity of water polo players and the sport result, is the level of their swimming and special preparedness, the so-called complex preparedness, which covers both the various ways of moving into the water and the special swimming skills (with and without a ball) (Gamansky, 1981; Želyazkov, 1986; Dopsaj & Matković, 1994; Dopsaj & Matković, 1998; Smith, 1998; Matković & al., 1999; Falk & al., 2004; Aleksandrović & al., 2007; Lozovina & al., 2007; Dopsaj & al., 2007; Hraste & al., 2008). The issue of establishing the interaction between the swimming and special preparation is particularly topical for both the initial preparation and junior period (Šimenc & al., 1997; Dopsaj, 2004; Dopsaj & al., 2007) when the success is very often dependent on some of the additional requirements related to the individual and age particularities, defining the specific workability of the growing up athletes (Račev, 1999; Okičić, 1999; Želev, 2002; Bratuša, 2003; Dopsaj & al., 2003a; Dopsaj & al., 2003b; Dopsaj, 2004).

The year preparation of the growing up water polo players in Republic of Syria has not been an object of scientifically reasoned planning up to now on the reasons of various natures.

The distribution of training means has been made within the frame of one year cycle which has neither assisted the effectiveness of the training sessions, nor corresponded to the world practice. Proceeding from what has been said hereinabove, our expectations in relation to the present study can be formulated by the following working hypothesis: "Factor structure of the specific workability within the frames of the so-called bi-cycle year planning differs from the one for the one-cycle planning of the preparation and improves the effectiveness of the educational and training work with the growing up (13-14 years old) Syrian water polo players". The basic indications of the specific workability of the growing up water polo players are the topic of the study.

Methods

Sample

Thirty young water polo players from Syria are the subject of the study. For the purpose of the study, the competitors are divided into two groups: experimental one (nominated as A) and a control one (B). Fifteen boys (13-14 years old) from "Muhafaza" sport club (Damascus, Syria) are listed into the experimental group. The duration of their sports experience is 2 years $\pm$ 6 months.

The training sessions of the group took place in "Al Feiha" 50 m swimming pool in the same city. The control groups lists 15 boys at the same age and with the same duration of sport experience from "Maisalun" sport club (Damascus, Syria). The training sessions of that group took place at the same swimming pool. For solving the objective and tasks of the study, the participants in both the experimental and control groups have undergone tests (two times – in May and October 2006) according to 9 indications of the specific workability.

Sport-pedagogical testing

The water polo players observed were tested for the needs of the study according to 9 tests characterizing specific workability (Table 1.).

Table 1. List of the tests

Nº	Test
1.	50 m Crawl /sprint/
2.	3×25 m Crawl
3.	4×50 m Crawl
4.	200 m Crawl
5.	50 m Breaststroke
6.	25 m Dribbling
7.	5×5 m shuttle swimming
8.	Vertical jumps *
9.	Combined game test

* jumps with both arms up/10 times/; all units = seconds; accuracy = 0.1

Depending on the information provided, the tests have been differentiated into two groups. **Group I:** Tests from 1 to 5 are usually implemented in the sports practice for evaluating the swimming abilities (quickness, speed endurance and strength endurance) (Konstantinov, 1986; Platonov & Vaycehovskiy, 1988). **Group II:** Tests from 6 to 9 are used for evaluating the specific in-game skills (with and without a ball), (Želečev, 2002; Želyazkov, D., 1985; Dopsaj & al., 2007). The methodological requirements upon holding the tests refer to the following: **Test 1 – Swimming sprint 50 m crawl (s)** High-speed abilities of the competitors (under anaerobe-lactate regime of providing energy) are evaluated. Performed by a start. **Test 2 – Swimming 3x25 m crawl (s)** Quickness of swimming (under anaerobic-alactate regime of providing energy) is evaluated. Performed by a start from the water. The segments are swum by maximum speed and intermediate rest of 2 min. The best time is recorded from swimming all the three segments. **Test 3 – Swimming 4x50 m crawl (s)** Specific endurance (under anaerobic-glycolytic regime) is evaluated. Performed by a start from the water. The segments are swum by maximum speed in regime of 1 min. The results from the 4 segments are summed up.

Test 4 – Swimming 200 m crawl (s) Speed-strength endurance (under aerobe-anaerobe regime of providing energy) is evaluated. Held in standard environment in 50 m. swimming pool (by a start). **Test 5 – Swimming 50 m. breaststroke (s)** Swimming is held in standard environment in 50 m. swimming pool (by a start); used to evaluate the technique of the specific in-game ways of swimming ("eggbeater" at horizontal and vertical position, moving by breaststroke scissor, side swimming, etc.). **Test 6 – 25 m dribble with a ball (s)** Special technical skills related to moving with the ball are evaluated. Held in standard environment in 50 m. swimming pool (by a start from the water). **Test 7 – 5x5 m. shuttle swimming (s)** Technique of the special ways for in-game swimming (swimming with the head upright, stopping, turning, and changing the direction and a start) is evaluated. The test is held in a space of 5 m., limited by two corridors. Crawl swimming is applied (5 segment x 5 m) within the width between the corridors by touching the rope prior turning to the other direction. Time is counted from the start signal till the last touch of the corridor. **Test 8 – Vertical jumps with both arms up – 10 times (s)** Technique of the special ways for in-game swimming ("eggbeater", raising both arms up and jumping) is evaluated. The test is held from the goal line, facing the door. Ten vertical jumps are performed by touching the upper line of the door by both hands. Time is counted from the start signal till the last touch. **Test 9 – Combined game test (s)** The special ways of the technique for moving by water polo crawl, dribbling with the ball while moving, throwing, turning and changing the direction upon swimming crawl and back crawl are evaluated. The competitor starts with the ball at a distance of 14 m towards the door by water polo crawl (up to the line of the 6th meter), shoots into the door and goes back to the starting position. If the ball does not enter the frame of the door but is beat back by the goal keeper, time measured is increased by 5%. When the ball is out of the door, 10% are added to the time. All the tests are held in the standard environment of a 50 m swimming pool.

Pedagogical experiment

Education and training program is developed for the complex preparation of the growing up water polo players (13-14 years old) from Syria. Its main objective is the organization and implementation of the sport preparation for one year period within the frame of two mezzocycles (the so-called bi-cycle year planning). The distribution of the training sessions in each of the two macro-cycles (in periods and cycles) is presented in Table 2.

The participants in the experimental group were subjected to the effect of this training program within the frame of the period under study (March 2006 – March 2007). The education-training contents (in stages, periods and cycles) and the training schemes applied are coordinated with the age particularities and the level of the sport-technical preparedness of the young Syrian water polo players.

Statistical methods

The results received were processed by the following statistical methods: 1) Variation analysis – for disclosing the average values and variety of the indications observed of the specific workability. The following statistic parameters were calculated: X – an arithmetical mean value; S – average quadratic deviation; V – the least value measured; Max – the highest value measured.

2) Factor analysis – for disclosing the factor structure of the specific workability of 13-14 years old Syrian water polo players. The initial correlation matrixes have been processed by the method of the main components followed by Varimax orthogonal rotation. The following criteria and parameters have been considered for the identification and the arrangement of the factors: a) the percentage of the initial dispersion of the phenomenon (α) under study, explained by each factor, b) the degree of disclosure (manifestation) of the respective indication in the general factor structure, information about which is borne by the h^2 values; c) factor weight of each indication as of the respective factor and its direction (sign) which disclose the strength and character of the interrelation (positive or negative) between the indications of the separate factor.

Results

Table 2. Schedule for two-cycle year planning of the preparation

(GP = general preparation, SP = special preparation, CO = competitive, OV = overall, TP = transitional period)

Macro cycles	I 01. 03. – 08. 07. 06.			II 09. 07. – 15. 11. 06				
Periods	Preparative		CO	Preparative		CO	OV	TP
	GP	SP		GP	SP			
Mezocycles	01.03.-30.04.	01.05.-15.06.	16.06.-08.07.	09.07.-08.09.	09.09.-15.10.	16.10.-15.11.	01.03.-15.11.	16.11.-01.03.
Weeks	8	6	3	8	5	4	34	14
Training days	48	36	18	48	30	24	204	32
Days off	8	6	3	8	5	4	34	66
Competition days	-	-	6	-	-	6	12	-
Training hours	72	54	27	72	45	36	306	48
Swimming training (hrs.)	32	20	8	38	17	10	125	12
Physical preparation (hrs.)	30	8	2	16	4	2	62	24
In-game preparation (hrs.)	10	14	8	10	12	12	66	12
Tactical preparation (hrs.)	-	12	10	8	12	12	54	-

Table 3. Factor percent (TV) and cumulative (CV) for the experimental group first cycle A1

	TV	CV
1	31.0	31
2	25.9	57
3	21.7	79
4	9.7	88
5	7.5	96
6	2.1	98
7	1.4	99

Table 5. Factor percent (TV) and cumulative (CV) for the experimental group second cycle A2

	TV	CV
1	34.2	34
2	28.7	63
3	17.0	80
4	8.2	88
5	6.8	95
6	3.2	98

Table 4. Factor weights for the experimental group during the first cycle A1

Var	F1	F2	F3	F4	F5	F6	F7
1	-0.22	0.84	0.25	-0.08	-0.07	0.23	0.35
2	0.15	0.02	-0.77	-0.12	0.36	0.01	0.39
3	-0.85	0.17	-0.00	0.26	0.20	-0.14	0.32
4	-0.96	0.08	-0.02	0.07	0.16	-0.15	-0.00
5	-0.19	0.33	-0.21	0.04	-0.17	0.17	0.87
6	0.12	0.23	0.93	0.18	0.02	0.15	-0.01
7	-0.19	-0.05	0.19	0.96	-0.02	-0.05	0.02
8	0.29	0.07	0.11	0.02	-0.93	0.13	0.13
9	0.42	0.31	0.20	-0.09	-0.20	0.76	0.22

Table 6. Factor weights for the experimental group during the first cycle A2

Var	F1	F2	F3	F4	F5	F6
1	0.95	-0.18	0.02	0.07	0.15	0.20
2	-0.05	0.04	-0.97	-0.14	-0.17	0.04
3	0.18	-0.92	-0.11	-0.14	0.17	0.12
4	0.07	-0.96	0.12	-0.18	-0.04	-0.07
5	0.46	-0.28	-0.50	0.22	0.02	0.49
6	0.25	0.01	-0.07	0.28	0.21	0.90
7	0.16	-0.07	0.17	0.05	0.95	0.17
8	0.09	0.32	0.14	0.88	0.05	0.30
9	0.51	0.54	0.14	0.07	0.30	0.41

Table 7. Factor percent (TV) and cumulative (CV) for the control group during the general preparation period B1

	TV	CV
1	67.0	67
2	16.1	83
3	6.3	89
4	3.6	93
5	2.6	96
6	2.0	98

Table 8. Factor weights for the control group during the general preparation period B1

Var	F1	F2	F3	F4	F5	F6
1	0.59	-0.03	0.38	0.11	0.39	0.25
2	0.36	0.11	0.42	0.14	0.79	0.14
3	0.46	0.15	0.59	0.10	0.37	0.17
4	0.26	0.04	0.92	0.10	0.25	0.11
5	0.44	0.46	0.19	0.10	0.17	0.71
6	0.67	-0.05	0.38	0.44	0.33	0.27
7	0.44	0.59	0.26	0.48	0.35	0.11
8	-0.02	0.99	-0.01	-0.01	0.01	0.13
9	0.89	0.12	0.26	0.08	0.24	0.22

Table 9. Factor percent (TV) and cumulative (CV) for the control group during the special preparation period B2

	TV	CV
1	66.7	67
2	17.9	85
3	6.2	91
4	3.7	94

Table 10. Factor weights for the control group during the special preparation period B2

Var	F1	F2	F3	F4
1	0.64	-0.09	0.62	0.31
2	0.49	0.14	0.48	0.13
3	0.42	0.19	0.60	0.19
4	0.29	0.07	0.93	0.10
5	0.40	0.50	0.22	0.72
6	0.81	-0.04	0.38	0.26
7	0.54	0.69	0.20	0.10
8	-0.09	0.98	-0.01	0.14
9	0.88	0.14	0.31	0.17

Factor structure of the specific workability at the experimental group

More detailed analysis is provided of the correlation structure by the means of the factor analysis. The results from the factor analysis provide additional information about the basic methodological requirements related to planning and management of the training process of the growing up water polo players. Five-six factors are needed in all correlation matrixes in order to explain more than 95% of the dispersion. Other possible limitation for the choice of the factors is to make use only of such having their own values (Eigenvalues).

Usually, approximately equal or higher than 1 while their importance is determined on the base of Keiser's criteria. The results from the processing of the initial correlation matrixes for the experimental group in the first cycle are presented in Tables 3. and 4. Seven factors have been drawn, explains 99.32% of the initial dispersion.

That rather high percentage of the dispersion explained is also indicative of the complete factor coverage of researching the general and special swimming preparation with the growing up water polo players. **Factor 1** – explains 30.96% of the initial dispersion. Two of the selected indicators are entered in it (Test 3 – 4x50 m crawl and Test 4 – 200 m crawl), distinguished by the highest values of their factor weights. The analysis of the indicators entered in that factor allows the same to be defined as **specific endurance of the water polo players**; **Factor 2** – explains 25.90% of the initial dispersion. **Speed abilities** are disclosed. It is evident from the high factor weight of indicator No. 1 – Test 1 (swimming 50 m crawl); **Factor 3** – explains 21.72% of the initial dispersion. This factor is presented by the indicators: Test2 (3x25 m crawl) and Test 6 (25 m dribble with a ball), which are of high factor weights respectively: - 0.77 and 0.93. That factor can be defined as **technique of moving within the field of play with a ball, upon which the quickness of swimming effects negatively**. **Factor 4** – explains 9.74% of the initial dispersion. It discloses the **technique of the special means for the in-game swimming without a ball** (in-game crawl, start, turning around, change of the direction). This is evident from the high factor weight of the indicator – Test7 (shuttle swimming 5x5 m). **Factor 5** – explains 7.45% of the initial dispersion. It can be defined as strength of the lower limbs and "eggbeater" capabilities. This is evident from the high factor weight of the indicator No. 8 (10 dismounts with both arms). **Factor 6** – explains 2.12% of the initial dispersion. Presented by one indicator only – Test9 (combined in-game test) of factor weight 0.76. This factor can be defined as **in-game skills with and without a ball**. **Factor 7** – explains 1.43% of the initial dispersion. That factor is presented by indicator No. 5 (50 m breast) with high factor weight of 0.87. The factor can be defined as the **technique of the specific in-game ways of swimming**. The result we have received from the processing of the initial correlation matrixes for the experimental group during the second cycle are presented in Tables 5. and 6. The analysis of the tables shows that the factor structure of the general and special swimming preparation during the second cycle is a little bit different from the first one.

Under the second testing, the number of the factors is decreased to 6, explains the initial dispersion by 98.05%. Factors 1 and 2 are exchanged and are increased for their factor weights and the percentage of explanation from the initial dispersion following the application of two-cycle planning of the preparation of the experimental group. As to factor 3 – it is observed that following the experiment, the latter discloses the maximum speed only – Test 2 and factor weight (0.97). Factors 4 and 5 are exchanged and have similar factor weights of the same indicators. Factors 6 and 7 from the first cycle drop off in the second one and a new factor appears which discloses the **dribbling skills**. This is evident from the high factor weight (0.90) of the indicator - Test 6 (25 m dribble with a ball). From the factor analysis for the experimental group during the first and the second cycle we can limit the factors to three in number, which provide most clear interpretation of the dispersion. These factors are: **specific endurance, speed abilities, quickness of moving within the field of play with and without a ball**.

Factor structure of the specific workability for the control group

The results we have received from the initial correlation matrixes for the control group during the general preparation period are presented in Tables 7. and 8. Six factors have been drawn; explain 97.59% of the initial dispersion. The rather high percentage of the explained dispersion is as well indicative about the complete coverage of the factors on studying the general and special preparation of the growing up water polo players. **Factor 1** – explains 66.95% of the initial dispersion. It covers 1 of the selected indicators (Test9 – combined in-game test) which is distinguished by the highest value of its factor weight. The analysis of the indicator entered in that factor allows the same to be defined as **in-game skills of the competitors with and without a ball**. **Factor 2** – explains 16.06% of the initial dispersion. The **strength of the lower limbs and the “eggbeater” technique** is disclosed. This is evident from the high factor weight of the indicator - Test 8 (10 dismounts with both arms). **Factor 3** – explains 6.31% of the initial dispersion. This factor is presented by the indicator - Test 4 (200 m crawl) which is of high factor weight: 0.92. That factor can be defined as **strength endurance**. **Factor 4** – explains 3.62% of the initial dispersion. Discloses the **technique of the specific means for in-game swimming without a ball**. This is evident from the high factor weight of the indicator – Test 7 (shuttle swimming 5x5 m). **Factor 5** – explains 2.63% of the initial dispersion.

Can be defined as the **maximum speed of the competitors**. This is evident from the high factor weight of indicator – Test 2 (3x25 m crawl). **Factor 6** – explains 2.02% of the initial dispersion. Presented by one indicator only – Test5 (50 m breast) with factor weight 0.71. Can be defined as **technical abilities to implement the special means for in-game swimming**. The results we have received from the initial correlation matrixes for the control group during a special preparation period are presented in Tables 9. and 10.

Discussion and conclusion

The analysis of the tables shows that the factor structure of the general and special preparation during the second cycle is a little bit different from the first one. Under the second testing the number of the factors is decreased to 4, explains the initial dispersion by 94.41%. It is observed for factor 1 that throughout the special preparation period of the control group, the in-game skills with and without a ball, it disclosed the skill to swim with a ball; this is evident from the high factor weight of the indicator – Test 6 (25 m swimming with a ball). As to factors 2 and 3, no change is observed – neither about the percentage of explanation from the initial dispersion nor about their factor weights during the second testing. Factor 6 from the first test (general preparation period) has moved with the same value of its factor weight and percentage of explanation from the initial dispersion. From the factor analysis for the control group during the general preparation period and the special preparation one, the factors can be limited to three which provide for most clear interpretation of the dispersion. There factors are: **swimming skills with and without a ball and the strength of the lower limbs and the in-game “eggbeater” technique**. The analysis made provides the reason to state that there are differences in the factor structure of the specific workability of the growing up Syrian water polo players while these are in direct dependence on the applied methodology of the year preparation. Under one-cycle planning of the preparation of the Syrian water polo players, the basic factors of the training process are the swimming skills with and without a ball, the strength of the lower limbs and the specific in-game “eggbeater” technique. The basic factors of the training process under the two-cycle planning of the preparation are the specific endurance, speed abilities and quickness of moving within the field of play with and without a ball. We believe that our study shall contribute to the optimization and up-date of the training process in the states where the level of water polo is inferior compared to the leading world

schools; by defining and accentuating on the basic factors of the training process depending on the applied methodology of the year preparation a high efficiency could be achieved. The study is directed to the optimization and update of the water polo training process with

the growing up water polo players both in Republic of Syria and the other countries where the level of the game is lower in comparison with the leading world countries by introducing an adequate and scientifically reasoned methodology for an all year round preparation.

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TEMELJNE DISTINKCIJE U FAKTORSKOJ STRUKTURI SPECIFIČNOG RADA KOD SIRIJSKIH VATERPOLISTA UZRASTA 13-14 GODINA U UVJETIMA JEDNOG I DVA PLANSKA CIKLUSA GODIŠNJE TRENAŽNE SEZONE

Sažetak

Glavni cilj je organizacija i provođenje sportskih priprema za jednogodišnji period u okviru dva protiv mezzo-ciklusa vaterpolo igrača u razvoju u Siriji, gdje je nivo igre niži nego u vodećim zemljama. Trideset mladih vaterpolista iz Sirije, starih 13 i 14 godina su predmet studije, podijeljeni u dvije grupe: eksperimentalna (15 dječaka), i kontrolna (15 dječaka). Obje grupe su prošle 9 testova radnih sposobnosti. Obrazovni i trenažni program je razvijen za složenu pripremu vaterpolista u razvoju iz Sirije. Dobijeni rezultati su obrađeni slijedećim matamatičko-statističkim metodama: varijacijska i faktorska analiza. Postoje razlike u faktorskoj strukturi specifičnih radnih sposobnosti koji su u direktnoj zavisnosti od upotrijebljene metodologije godišnje pripreme.

Ključne riječi: vaterpolisti, faktorska struktura, specifični rad, godišnja periodizacija

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FUNCTIONS OF OLYMPIC EDUCATION IN CONTEMPORARY SCHOOL

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Review paper

Abstract

Contemporary circumstances make specialists to connect the conception of Olympic education not only with the Olympic movement as an imposing social phenomenon but with school education on all levels as well. Nowadays two orientations are outlined: 1) Researches to Olympism, and 2) Teaching through Olympism. First direction of Olympic education is turned to the enrichment of the researches about Olympism in the different countries and spread the gathered new knowledge all around the earth. This direction concerns enrichment of the academic programmes. Second direction is connected with young generation (pupils, students and athletes) and youth programmes and projects, based on the Olympic principles. This paper is a study on the problem starting from the renewal of the contemporary Olympic Games in 1896 to nowadays and the Beijing Olympic Games in 2008. Olympic education concerns not only the content of the lessons of physical education but the other school subjects as well. This is a new world's tendency.

Key words: olympic education, school, lessons

Introduction

Social circumstances at the end of XIX century form the model of the Olympic movement, penetrated by the preserved traditions and the new image about the world. The world must be ruled by new moral norms. The main preconditions for the renewal of the Olympic Games and the Olympic Movement are (P. Бърдарева/R. Bardareva, 2008, p. 52): 1) New ideas about education and upbringing of young people: (a) They arise first in Germany and in the schools named *Filantropini*. Education in them is very close to the antique style. (b) Then is England - the inspirer there is *Charles Kingsley* (1819 – 1875). According to him the ideal person is the *young Christian-Athlete* – broadly educated and well developed physically. (c) Ingenuity in England is connected also with the name of *Thomas Arnold* (1795 – 1842) and the movement after his name *arnoldism*. Through the sport Thomas Arnold revives the national feelings of people and their Christian virtues. The ideal of the *Gentleman-Christian* is formed. Since that time is the idea of *fair-play*.

Thomas Arnold is connected with the sport rugby as well. (d) Ideas cross borders and go to France, Netherlands, Germany, Canada, India, Australia, etc. and so, all over the world. 2) Sports as a new spiritual onset with intrinsic structure and conditions for contacts – starting since 1881 International Sports Federations are founded. Sports are connected with the enthusiasm and ecstasies, entertainment, health, relaxation, achievements.

Creative activity of the International sports federations is projected in several directions: (a) It joins the athletes of the different sports into the universal rhythm of the international activity. (b) It secures exchange of ideas. (c) It popularizes the good practices and experience of the advanced sports world. (d) It serves as a moral barometer of society. 3) France in the role of a spiritual centre and with persons with systematic social experience – spiritual climate and cultural standards elevate France to centre of human civilization and development. Though the existence of two contradictory trends in the country, Pierre de Coubertin finds a new way and means for communication and in November 1892 he introduces a proposal for renewal of the Olympic Games. His proposal is realized in 1896. So, since the 90s of XIX century is spoken not only about Olympic Games and Olympic Movement but about Olympic education as well.

Development of the Content of the Olympic Education

A. *By the Renewal of the Olympic Games in 1896 and the Near Decades*

Beginning is connected with romantic attitude to Olympic movement and Olympic education. Olympic education was an idealized conception with prevalence of sport in it. Even in 1927 Pierre de Coubertin in a speech in front of young people still supported the opinion that "We have to accept **sport religion** in its antique sense and Olympism as the school of

broadminded intentions and moral tidiness, endurance and energy which stands against the threats of the degradation of today's sport". Pierre de Coubertin considered **sport as an effective educational tool**. He described Olympism as the double cult of physical effort and the endeavor towards performance which is expressed in the epigraph "*Citius - Altius - Fortius*" (A. Rychtecky, 2007). Furthermore, analyzing the "double cult" we have on one hand this epigraph. On the other hand is the harmony in the social structure of society, the personal experience and the influence of the natural environment. Coubertin strived to overcome the former performances but on the bases of discreetness and overlapping expressed as harmonization of performance and gift, as a balanced state of activation and aesthetic demonstration of performance (N. Muller, M. Messing, 2000). So, at the beginning, Olympic education has as its emphasis the identification with the Olympic Values and the active participation in sports to enhance the endmost effectiveness.

At the beginning the Olympic education is considered as a means that: a) *Focuses on the identification and dissemination of the values of Olympism*. These values are five as a number, so much as the Olympic circles are: Respect for self and others, Fair play, Excellence, Joy in effort, Balance of body, mind and will. b) *Supports the principles of humanization of education and self-realization*, c) *Creates motivation for active participation in sport*, d) *Plays an independent role in contemporary educational system by reach of the people of all ages all around the world in the form of the Olympic Games*. Olympic values are universal. They can be offered to pupils, students and older people in different context and not only in connection with the sport. Teachers in all school subjects not only in physical education have to seek and show to pupils examples of these universal values. This will lead to harmonization in society. And nobody must forget that still at the beginning of XX century Olympic values become a *cultural norm* that nowadays is still alive and starts to be more actual in contemporary society. Paragraph I of the Olympic Charter, Fundamental principles, says: "*Olympism is a philosophy of life, exalting and combining in a balanced whole the qualities of body, will and mind. Blending sport with culture and education, Olympism seeks to create a way of life based on the joy found in effort, the educational value of good example and respect for universal fundamental ethical principles*". Still at the beginning Pierre de Coubertin regarded himself as an educator. He saw sport to form a part of every young person's education, in the same way as this do science, literature and art.

Thereby his aim was to offer a *harmonious education* of body and mind. The Olympic Games are the means that enabled Pierre de Coubertin to give his educational concept international visibility and scope it needed. With the time this educational concept can become permanent and independent of the holding of the Games. Education through Olympism is universal and based on the fundamental human values, crystallized in the five Olympic values. Though, reality reviews unacceptable tendencies. A. Rychtecky (2007) brings out the associations of Czech young people (12 and 15 years old) arising in connection with the Olympic Games. Along with the positive principles such as peace, fair-play, etc. stay negative principles such as commercialization, increased role of money and mass-media. The conclusion of the author is that "young people in the Czech Republic very often reduce Olympism to the Olympic Games, sports and sports competition" (p. 39). Nowadays A. Rychtecky is one of the pioneers in the researches on the field of the Olympic education. Though by intuition, we can agree with him that the association of the young people in other countries will not differ too much with the mentioned one above. But here we have to pay attention on another view of A. Rychtecky and it is the broader sense that he gives to the content of Olympic education.

B. At the Beginning of XXI Century and on the Eve of the Beijing Olympic Games in 2008

Contemporary circumstances make specialists to connect the conception of Olympic education not only with the Olympic movement as an imposing social phenomenon but with school education on all levels as well. Bases of Olympic education still are the Olympic values and the connection with culture with all its diversity. Nowadays in Olympic education two orientations are outlined: 1) Researches to Olympism, 2) Teaching through Olympism. *First direction* of Olympic education is turned to the enrichment of the researches about Olympism in the different countries and the spread of the gathered new knowledge all around the earth. This direction concerns enrichment of the academic programmes. Researches on Olympism are politic of the IOC.

The IOC's Olympic Studies Centre (OSC) for 2009 has launched a programme aimed at young researchers "on Olympic Movement, its history and values, and the impact of Olympic Games on the various aspects of contemporary society and culture" (Internet information) (www.chinaview.cn). The objectives of this programme are as follow: (a) To encourage young people to undertake researches with a humanitarian or social science's perspective on the Olympic phenomenon.

The fields of research here can be: Olympic values and multiculturalism, how youth perceives Olympism, the relations of young people to it, various aspects of the legacy of the Olympic Games, role of Olympic Movement in society, etc. (b) To promote consultations of the IOC's written and audiovisual patrimony. (c) To encourage exchanges of information and networking. *Second direction* of Olympic education is connected with young generation (pupils, students and athletes) and youth programmes and projects, based on the Olympic principles. Objective here is education/teaching through Olympism. A real and very good example in this attitude did the Chinese people in connection with the Beijing Olympic Games in 2008. In China in the schools through out the country has been undertaken the world's largest-ever Olympic education programme. Purpose was the Beijing Games to ensure a lasting legacy for the country's young generation. In the centre was the first principle of the Olympic Charter (it is mentioned above). So, Olympic education reached 400 million children (www.chinadaily.com.cn/olympics). Beijing Organizing Committee for the Olympic Games (BOCOG) together with the China's Education Ministry and National Olympic Committee (NOC) managed to integrate Olympic education into the curriculum of over 400, 000 schools.

Manner of education at schools had changed

Teachers paid special attention to the Olympic values of excellence, friendship and respect. Textbooks highlighted the history of the Olympic Games, Olympic sports and the Olympic Movement and their contribution to international peace and friendship. Attention had been given also to the foreign languages. Foreign language speech contests had helped promotion of Olympism in schools. What was the result of this initiative? Still in December 2005 some 556 elementary and secondary schools in China have been given the honour to forge the international friendship. In Mid-December 2006 partnership with 205 NOC of the Olympic family was realized. Never before the influence of the Olympic Games on education had been more pronounced than at the Beijing Olympic Games in China with population more than 1, 3 billion people. Education of young people through sport was one of the primary goals of the Olympic movement in China. The initiative that emerged at that time was entitled "**Heart-to-heart**". Over 200 Beijing schools have "adopted" *sister schools* in countries represented by a NOC.

The purpose was to exchange ideas and to forge international friendship. *Several are the components of Olympic education at that time:* 1) Some schools integrated Olympic education *into the academic curriculum.* 2) During dedicated training sessions *teachers are educated on the Olympic values* and shown how to incorporate Olympism into the classroom setting. 3) *Series of textbooks* were created with the purpose to introduce pupils to the history of Olympic Games, to the various Olympic sports, the rules of play, Olympic symbols, the role of the Olympic movement for the international peace and friendship. 4) As further means for promotion of Olympic education are used the *photography, painting, poetry, calligraphy and the foreign languages.*

Third moment in Beijing Olympic Games was **the support the oversea athletes**. It was planned and realized the Heart-to-Heart school to greet their partner NOC delegation in the Team Welcome Ceremony at the Olympic Village and to support its athletes during the competitions. On the other hand, the NOC delegations had to make a visit to their Beijing partner school where Chinese and Greek folk and sport shows were equipped. These were the initiatives connected with the Beijing Olympic Games. They were a real good example of the motto "*Sports arena like a classroom*". We have to underline the words of Jacques Rogge to the pupils: "*The sports arena is like a classroom. There we learn to live together in society; there we learn solidarity and friendship; there we learn respect to others: whether one is a boy or girl, short or tall, young or old, from Asia, Africa, Europe, America or Oceania. Sport is all these things. And it is also health.*"

Conclusions and Recommendations

- 1) Undoubtedly nowadays Olympic education is philosophy of life to which pupils all around the world have to be taught.
- 2) Olympic education also is a good means for emotional education of children, something that lacks in some societies. Education is not only academic knowledge.
- 3) Chinese experience from the Beijing Olympic Games in 2008 is a good example and contribution in this attitude.
- 4) When at school or in society young generation has to be accustomed to respect to all people and neglect to nobody has to occur. Here sexual differences, race, social status, state of health, availability of some and more disabilities, etc. have to be minded.

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FUNKCIJA OLIMPIJSKE EDUKACIJE U MODERNOJ ŠKOLI

Sažetak

Trenutne okolnosti tjeraju stručnjake da povezuju koncept olimpijskog obrazovanja ne samo sa Olimpijskim pokretom kao dominantnim društvenim fenomenom, već i sa školskim obrazovanjem na svim nivoima. Dva smjera su naglašena: 1) Istraživanje Olimpizma, i 2) Podučavanje kroz Olimpizam. Prvi smjer olimpijskog obrazovanja je okrenut obogaćivanju istraživanja Olimpizma u različitim zemljama, i širenje novostečenog znanja. Ovaj smjer se bavi obogaćivanjem akademskih programa. Drugi smjer je vezan za mlade generacije (učenike, studente i sportiste) i omladinske programe i projekte, bazirane na olimpijskim principima. Ovaj rad je studija problema od obnavljanja modernih Olimpijskih igara 1896. do Olimpijade u Pekingu 2008. Olimpijsko obrazovanje obuhvata ne samo tjelesni odgoj, već i druge školske predmete. Ovo je nova globalna tendencija.

Ključne riječi: olimpijska edukacija, škola, nastava

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MANUAL REACTION SPEED AND MANUAL DEXTERITY IN ELDERLY PEOPLE: A COMPARATIVE STUDY BETWEEN ELDERLY PRACTITIONERS AND NON- PRACTITIONERS OF PHYSICAL ACTIVITY

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Original scientific paper

Abstract

The human being, as years go by, transforms and loses their normal movement abilities, like too quickly react and objects manipulate. Most of the epidemiological evidence argues that when a subject adopts an active lifestyle through physical activity (PA), this minimizes the effects of the aging process and improves their capabilities. To assess the influence of PA in manual reaction speed (MRS) and manual dexterity (MD) we applied The Nelson Hand Reaction Test and The Minnesota Manual Dexterity Test (the placing and turning tests), respectively. The sample consisted of 40 volunteers (between 67 and 85 years old) residents in two elderly institutions of the Porto city and they were divided into 2 groups, one by practitioners of PA and the other by non-practitioners (with 20 subjects respectively). This study had these conclusions: 1/Concerning to manual reaction speed (MRS): (i) there are statistically significant differences between practitioners and non-practitioners of PA, as well as between genders, and between males-practitioners and males non-practitioners of PA; (ii) between female practitioners and female non-practitioners of PA there weren't any significant differences; 2/ Concerning to the manual dexterity (MD) it was verified that: (i) either in placing or in turning tests, there are statistically significant differences between practitioners and non-practitioners of PA, and equally there are differences between practitioners and non-practitioners of PA in each gender; (ii) between genders, in the placing test, they observed differences with statistical significance, but in the turning test these differences were only verified in the third and fourth issues, and in the average of four issues.

Key words: elderly, reaction speed, manual dexterity, proprioceptive sensibility, physical activity

Introduction

Over the last years, the percentage of elderly people has significantly increased in the developed countries, being the number of subjects over 80 years old the highest growth segment of the elderly population (Puggaard, 1999). This increase, comparatively to total population, is due to the decline in birth rate and mortality and the improvement of life's expectancy at birth (Costa, 2007). Born, grow, mature and aging are characteristics of all living humans, being the aging an integral and natural part of life. How we age and experience this process depends not only of our genetic constitution, but also of what we do in the life (Heikkinen, 2003). According to the same author, aging is common to all members of a species; it is progressive and includes mechanisms that affect our ability to perform various functions. Knowing the existence of different concepts of aging, they all share the idea that is common to all living beings, where exist loss of functionality, an increase in susceptibility and incidence of diseases with the probability of death (Heikkinen, 2003; Mota, Figueiredo & Duarte, 2004). The successive growth of the elderly population in

contemporary societies, it became an urgent matter of research to aim the ways to maintain and improve the functional ability these people, helping them to maintain their independence in the community and acquire a quality of life with more accuracy (Heikkinen, 2003). This quality of life will be always related to the health, the ability to perform the normal tasks and the feelings of well-being and satisfaction (Spirduso, 1995). The evolution of the hand in humans reached a high development in the various functional and creative capabilities, particularly with the opposition of the thumb which was directly related to the development of Central Nervous System (CNS). This progress has improved the grasp and the hand control, leading the human species to expansion and becoming the most dominant of the world (Carmeli et al., 2003). According to Barreiros (1999, 2001), with age, the Nervous System (NS) works more slowly and the response of the muscle is late and ineffective. These facts are due to the combination of the effects of aging of muscular and nervous nature, justifying the slowing of elderly people. However, today the problem is to know the causes: what is due to natural biological causes, common to all members of the same

species, or what is due to the use reduction's activity with the inherent degenerative pathological processes, or the negative effects of sedentary life or the environment's effect of physical and chemical agents. The ability to detect small movements at the joints is narrowing, particularly with the decrease in the efficiency of proprioceptors. Note that the reaction time slows gradually, especially in subjects with low levels of activity (Barreiros, 1999, 2001; Francis & Spirduso, 2000; Godinho, 1999). Summarizing, the time needed to perform a movement increases in the elderly, which could be caused by inactivity and biological decline in sensory, perceptual, cognitive and motor functions. Many authors emphasize the importance of a constant involvement in the activities of day-to-day and to keep standards of living assets in order to prevent the harmful effects of aging (Barreiros, 1999, 2001; Godinho, 1999).

Methods

Subjects and variable

The sample of this study consisted of 40 volunteers elderly adults residents in two elderly institutions (Oporto city), with 67 to 85 years old. The sample was divided into 2 groups, formed by practitioners of physical activity the group one and non-practitioners the other group (each other with 20 subjects). Of the 40 subjects, 22 are female (10 practitioners and 12 non-practitioners) and 18 are male (10 practitioners and 8 non-practitioners). Instrumentarium: - The Nelson Hand Reaction Test (NHRT). For the assessment of the manual reaction speed was selected the NHRT. The aim of this test is to measure the reaction speed of the dominant hand of elderly people in response to a visual stimulus. - The Minnesota Manual Dexterity Test (MMDT). For the assessment of manual dexterity, we selected the MMDT. The MMDT includes two batteries: the Placing Test and the Turning Test. The MMDT is a standardized test, often administered for assessment: The ability to move small objects to various distances; The manual dexterity; From the simple but rapid eye coordination / hand; To diagnose problems of hand coordination.

Statistical Procedures

For statistical analysis of the variables we used the Statistical Package for the Social Sciences (SPSS) version 16.0. To analyse the results we use the Descriptive Statistics, which enabled us to calculate the mean, standard deviation, the percentage, the maximum and minimum values. Also, we use the Inferential Statistics to compare the 2 groups in both tests. To compare the data between each group (type of practice and gender) we use the Student t-test

for independent measures. For the analysis between subjects in each group we use the Mann-Whitney nonparametric test. The level of significance for the rejection of the null hypothesis in all statistical tests was set at $p \leq 0.05$.

Results

(Legend: PY = practitioners, PN = non-practitioners.
M = male, F = female, Att = attempt)

Manual Reaction Speed (MRS)

Table 1 - Comparison between practitioners and non-practitioners of PA in NHRT. Values in seconds (s). Maximum and minimum, mean, standard deviation (sd), t and p.

	PY	PN	t	p
	N=20	N=20		
Max.	0,30	0,33	-3,53	0,001
Min.	0,17	0,20		
Mean	0,22	0,25		
sd	0,03	0,03		

Table 2 - Comparison between genders in NHRT. Values in seconds (s). Maximum and minimum, mean, standard deviation (sd), t, p.

	M	F	t	p
	N=18	N=22		
Max.	0,32	0,33	2,46	0,019
Min.	0,17	0,18		
Mean	0,22	0,24		
sd	0,03	0,03		

Table 3 - Comparison between male practitioners and not practitioners of PA in NHRT. Values in seconds (s). Maximum and minimum, mean, standard deviation (sd), z, p.

	PY	PN	z	p
	N=10	N=8		
Max.	0,24	0,32	-3,42	0,001
Min.	0,17	0,20		
Mean	0,20	0,24		
sd	0,02	0,03		

Table 4 - Comparison between female practitioners and on-practitioners of PA in NHRT. Values in seconds (s). Maximum and minimum, mean, standard deviation (sd), z, p.

	PY	PN	z	p
	N=10	N=12		
Max.	0,30	0,33	-0,86	0,391
Min.	0,18	0,21		
Mean	0,23	0,25		
sd	0,04	0,03		

Table 5 - Comparison between practitioners and non-practitioners of PA in the Placing Test. Values in seconds. Mean, standard deviation (sd), t, p.

	PY (N=20)	PN (N=20)	t	p
1. att	103,68±10,93	120,51±10,06	-5,07	0,000
2. att	102,66±10,92	114,48±13,68	-3,02	0,005
3. att	101,16±12,06	114,52±12,82	-3,39	0,002
4. att	100,69±10,39	113,92±13,16	-3,53	0,001
Mean	102,05±10,39	115,86±12,43	-3,72	0,001

Table 6 - Comparison between genders in the Placing Test. Values in seconds (s). Mean, standard deviation (sd), t and p.

	M (N=18)	F (N=22)	t	p
1. att	122,35±09,39	103,71±9,97	-6,08	0,000
2. att	121,02±09,04	98,38±5,99	-9,49	0,000
3. att	120,02±09,95	97,87±7,36	-8,09	0,000
4. att	118,93±10,24	97,78±6,48	-7,94	0,000
Mean	120,58±09,54	99,44±7,44	-7,88	0,000

Table 7 - Comparison between male practitioners and not practitioners of PA in the Placing Test. Values in seconds (s), mean, standard deviation, z and p.

	PY (N=10)	PN (N=8)	z	p
1. att	114,27±1,54	132,46±1,08	-3,56	0,000
2. att	113,25±1,41	130,74±1,36	-3,56	0,000
3. att	112,25±5,78	129,74±1,75	-3,55	0,000
4. att	110,44±3,99	129,55±1,64	-3,55	0,000
Mean	112,55±2,99	130,62±1,44	-3,55	0,000

Table 8 - Comparison between female practitioners and non-practitioners of PA in the Placing Test. Values in seconds (s), mean, standard deviation (sd), z and p.

	PY (N=10)	PN (N=12)	z	p
1. att	93,10±1,00	112,55±1,10	-3,96	0,000
2. att	92,08±0,89	103,63±1,28	-3,96	0,000
3. att	90,07±0,84	104,37±1,25	-3,96	0,000
4. att	90,93±0,65	103,50±1,20	-3,96	0,000
Mean	91,55±0,83	106,02±1,17	-3,96	0,000

Table 9 - Comparison between practitioners and non-practitioners of PA in the Turning Test. Values in seconds (s). Mean, standard deviation (sd), t and p.

	PY (N=20)	PN (N=20)	t	p
1. att	108,69±6,94	133,62±3,24	-14,56	0,000
2. att	107,29±6,34	130,71±3,11	-14,84	0,000
3. att	107,23±7,16	128,70±4,23	-11,54	0,000
4. att	105,87±7,60	126,49±5,11	-10,08	0,000
Mean	107,27±3,99	129,88±3,89	-12,62	0,000

Manual dexterity (MD)

As we see in Table 1 the maximum and minimum values reached in MRS were far lower in practitioners. In general, the elderly practitioners of PA showed lower average results ($0,217 \pm 0,034$), compared to elderly non-practitioners of PA ($0,249 \pm 0,026$).

Table 10 - Comparison between genders in the Turning Test. Values in seconds (s), mean, standard deviation (sd), t and p.

	M (N=18)	F (N=22)	t	p
1. att	124,94±11,19	118,06±15,01	-1,61	0,115
2. att	122,51±10,67	116,12±13,96	-1,60	0,119
3. att	122,56±9,89	114,21±13,03	-2,24	0,031
4. att	121,58±9,84	111,76±12,43	-2,72	0,010
Mean	122,90±10,39	115,04±13,60	-2,02	0,051

Table 11 - Comparison between male practitioners and non-practitioners of PA in the Turning Test. Values in seconds (s), mean, standard deviation (sd), z and p.

	PY (N=10)	PN (N=8)	z	p
1. att	115,33±1,64	136,96±1,88	-3,56	0,000
2. att	113,34±1,54	133,98±1,79	-3,55	0,000
3. att	114,10±1,59	133,14±2,04	-3,55	0,000
4. att	113,16±1,52	132,10±2,08	-3,56	0,000
Mean	113,98±1,57	134,04±1,91	-3,55	0,000

Table 12 - Comparison between female practitioners and non-practitioners of PA in the Turning Test. Values in seconds (s), mean, standard deviation (sd), z and p.

	PY (N=10)	PN (N=12)	z	p
1. att	102,05±0,99	131,39±1,53	-3,96	0,000
2. att	101,23±0,97	128,53±1,32	-3,96	0,000
3. att	100,37±0,96	125,74±2,08	-3,96	0,000
4. att	98,57±1,12	122,75±2,05	-3,96	0,000
Mean	100,56±1,00	127,10±1,60	-3,96	0,000

We also found that the differences between averages of both groups are statistically significant ($p = 0,001$). So, we can say that older practitioners of PA have improved MRS. When comparing the genders (Table 2) we see that the maximum and minimum values of males were much lower in relation to females. Given the average results, the male subjects showed lower results ($0,220 \pm 0,030$), when compared with the female subjects ($0,243 \pm 0,034$), i.e., the elderly males are faster than the elderly females. The results indicate the existence of significant differences between genders ($p = 0,019$). By the analysis of Table 3, we can infer that the group of practitioners succeeded better average results ($0,201 \pm 0,018$), compared to the group of non-practitioners ($0,244 \pm 0,025$), i.e., the elderly practitioners of PA were faster than the elderly not-practitioners of PA. We can see that there are significant differences between male practitioners and not practitioners of PA ($p = 0,001$). As for the female subjects (Table 4) the older practitioners of PA showed better maximum and minimum results than the group of elderly non-practitioners of PA. As regards the average values, we see that the older practitioners of PA achieved better results ($0,233 \pm 0,039$), when compared with the

older non-practitioners of PA ($0,252 \pm 0,026$), i.e., the older practitioners of PA obtained better MRS results than the older non-practitioners of PA. Despite these results, there are no significant differences ($p = 0,391$). So, we can't say that female practitioners of PA have better MRS than non-practitioners of the same gender.

- Placing Test: Analyzing the results contained in Table 5, when comparing the practitioners of PA with non-practitioners, we found that the values of MD showed statistically significant differences ($p < 0.05$) in all attempts. Regarding to the sequence of issues, the values of MD of practitioners improves on average 1 second (s) between attempts; being the first to the last, the results indicate improvements in the order of 3s. In respect of non-practitioners it is noted that from the first to the second attempt, the value of MD improves about 6s, and between other issues the improvements are, respectively, 4 and 60 hundredths (hs) of second. According to the results, it is possible to observe the existence of a large difference in the performance between the two groups: in the first attempt less 16s and 83hs, in the second less 11s and 82hs, in the third less 13s and 36hs, in the fourth attempt less 13s and 23hs, and finally, in the average of all attempts less 13s and 81hs. Of all the attempts the last is where subjects have better results, i.e., their performance improves in each attempt. When comparing the two genders (Table 6), we can observe that the values of MD show significant differences in all attempts ($p < 0.05$). The elderly females have a uniformity of values of MD, i.e., they were faster in all attempts compared to the opposite gender. In the first trial we found that the female subjects showed a better performance ($103,71 \pm 9,97$) compared to males ($122,35 \pm 9,39$), therefore, less 18s and 64hs. In the second trial found that those females showed a better performance ($98,38 \pm 5,99$) compared to males ($121,02 \pm 9,04$), therefore less 22s and 64hs. In the third attempt we can see that the female subjects exhibited faster performance ($97,87 \pm 7,36$) compared to males ($120,02 \pm 9,95$), therefore, less 22s and 15hs. In the fourth attempt the female subjects showed faster performance ($97,78 \pm 6,48$) compared to males ($118,93 \pm 10,24$), therefore, less 21s and 15hs. Finally, in the average of four attempts we found that older females have faster performance ($99,44 \pm 7,44$) compared with older males ($120,58 \pm 9,54$), therefore, less 21s and 14hs.

- Through the analysis of Table 7, when compared male practitioners with male non-practitioners, we see that the values of MD show significant differences ($p = 0,000$) in all trials. We see uniformity in the results, having

male practitioners of PA obtained higher performance compared to non-practitioners of the same gender. We verify that male practitioners of PA showed faster performance than the non-practitioners. In the first attempt less 18s and 19hs, in the second and third attempts less 17s and 49hs, in the fourth attempt less 19s and 11hs and in the average of four attempts less 18s and 7hs. By the results displayed in Table 8, when comparing female practitioners and non-practitioners of PA, we see that the values of MD showed statistically significant differences ($p < 0.05$) in all trials. We see a congruence of values of MD, having the female practitioners of PA proved superior performance compared with non-practitioners of the same gender. In the first attempt less 19s and 45hs, in the second attempt less 11s and 55hs, in the third attempt less 14s and 30hs, in the fourth attempt less 12s and 57hs and in the average of four attempts less 14s and 47hs.

Turning Test

Through the analysis of Table 9, when comparing the practitioners and non-practitioners of PA, we can see that the values of MD differ with statistical significance ($p = 0,000$) in all attempts. You can also see a substantial difference in performance between the two groups: in the first attempt less 24s and 93hs, in the second attempt less 23s and 42hs, in the third attempt less 21s and 47hs, in the fourth attempt less 20s and 62hs and, finally, in the average of four attempts less 22s and 61hs. We can see that the fourth attempt for both groups is the best of all tests. Note that in the group of practitioners of PA, from the first to the last attempt, we see a decrease in execution time of 2, 82 s. In the group of non-practitioners of PA, the difference is 7, 13 s. For the analysis of Table 10, when comparing the two genders, we don't find statistically significant differences in the values of MD. Only in the third and fourth attempts, we can observe differences with statistical significance when compared the genders. We are also aware that females display better performances than the opposite gender. The females showed in the first attempt less 6s and 88hs, in the second attempt less 6s and 39hs, in the third attempt less 8s and 35hs, in the fourth attempt less 9s and 82hs and, finally, in the average of four attempts less 7s and 86hs. Overall the values of MD in males ranging from first to last attempt at about 2, 04s. Already, in females this variation is about 3, 02 s. For the analysis of Table 11, when comparing the two males groups (practitioners and non-practitioners), we can see that the values of MD showed significant statistically differences ($p = 0,000$), in all attempts. We found that male practitioners of PA exhibited higher

performance than non-practitioners of the same gender, in all attempts. So, in the first attempt we have less 21s and 63hs, in the second attempt less 20s and 64hs, in the third attempt less 19s and 4hs, in the fourth attempt less 18s and 94hs and, finally, in the average of four attempts less 20s and 6hs. In the results presented on Table 12, when comparing women practitioner and non-practitioner of PA, we found that the values of MD show statistically significant differences in all attempts. We found that female practitioners of PA showed better results than non-practitioners of the same gender. So, in the first attempt we have less 29s and 34hs, in the second attempt less 27s and 30hs, in the third attempt less 25s and 37hs, in the fourth attempt less 24s and 18hs and, finally, in the average of four attempts less 26s and 54hs.

Discussion and conclusion

This study presents a research on the manual reaction speed and manual dexterity in elderly people (practitioners and non-practitioners of physical activity). The results support, in almost its entirety, the hypothesis that physical activity improves the levels of manual reaction speed and manual dexterity in elderly subjects. Regarding to the manual reaction speed, only female practitioners of physical activity didn't showed significant improvements in its performance. Regarding to the manual dexterity, only when we compare the elderly subjects between genders in the placing test, we were unable to observe significant differences. However, overall the study, the results showed that physical activity improved the rates of manual reaction speed and manual dexterity in the elderly.

Manual Reaction Speed

Practice: Given the results, there were significant statistically differences ($p = 0,001$) among the elderly practitioners of PA and the elderly not-practitioners of PA at the MRS. These results are similar to various studies, such as Era, Jokela and Heikkinen (1986) that, using a sample of 75 elderly practitioners and non-practitioners of PA in three locations of northern Europe, concluded that reaction speed has more favourable value in physically active subjects. In this sense go the results obtained by Carneiro (2005), which conducted a study in order to investigate the simple reaction time and anticipation-coincidence time, in preferred and not preferred hands of elderly practitioners and non-practitioners of physical exercise.

The sample was made up of 86 elderly patients with mean age of 73.7 ± 7.4 years, of which 42 were males (72.1 ± 7.3 years) and 44 females ($75.1 \pm 7, 3$ years). For the evaluation of simple reaction time, the author applied the

Multi-Choice Reaction Time Apparatus, 63014th model. Of the results obtained, the author concluded that the practitioners of physical exercise show higher performance of simple reaction speed, with both hands, comparing to non-practitioners of physical exercise. On the other hand, we also found different results of our study. Azevedo (2005) conducted a study to compare the visuo-motor memory and MRS in the elderly population, practitioners and non-practitioners of PA in the past five years. The sample was made up of 46 elderly people of both genders, aged between 65 and 93 years, being divided in two groups: one group of PA practitioner in the past 5 years and the other group non-practitioner of PA in the past 5 years. To assess the MRS, the author used the NHRT. Regarding the type of practice, she concluded that the differences found between averages of both groups were not statistically significant. However, overall, the elderly practitioners of PA in the past five years showed below average performance (212 ± 41.1), compared to elderly non-practitioners of PA in the same period of time (219 ± 45.8). In turn, Binder, Brown, Craft, Schechtman and Birge (1994), after confronted a group of elderly subjects with a low/medium intensity program of PA, for eight weeks, verified that they were unable to find improvements in psychomotor speed. However, they added that these results didn't surprise them, because its protocol of PA not emphasizes the strengthening of the upper extremities and didn't provide a sufficient intensity and duration to allow changes in the performance of reaction speed. Gender: In relation to our study, there are significant differences between genders in MRS, regardless of the type of practice. When we assess practitioners and non-practitioners of PA for each gender, we find that only males show statistically significant differences ($p = 0,001$). However, in females, when compared the older practitioners and non-practitioners of PA, we observed that the differences are not significant ($p = 0,391$). In Carneiro's study (2005), to assess the simple reaction time in preferred hand and no preferred hand of elderly practitioners and non-practitioners of PA, the author concluded that the men obtained better results, i.e., less simple reaction time, either with the preferred hand or not preferred hand, when compared with females. However, the differences between genders were not statistically significant. Medell and Alexander (2000) also found that active older females have lower values of reaction speed than those more sedentary. On the other hand, in the study of Kauranen and Vanharanta (1996), the authors included in their research some aspects of motor performance, such as reaction time, movement speed, manual and pedal

coordination, using the Human Performance Measurement. Participated in the study 200 subjects (100 males and 100 females) aged between 21 and 70 years old. The authors observed the absence of statistically significant differences between genders.

Manual Dexterity

Practice: By the results obtained in this study, we can say that there are differences with statistical significance ($p < 0.05$) among the elderly practitioners and non-practitioners of PA. Our results converge on the same line of several previous studies. Mesquita (2002) conducted a study with 113 elderly over 65 years, 49 practitioners of PA and 64 non-practitioners of PA, which aim was the multidimensional assessment of elderly people (manual preference and proficiency). Millán (2002) in an elderly institution, conducted a program of regular PA with 42 subjects (35 women and 7 men), where the average age was 66 years. Okuma et al. (1994) compared 38 adult men, between 39 and 63 years, being practitioners of PA, undergoing 3 years of training to develop specific neuro-motor variables, including MD. In these three studies, it was possible to prove that practitioners of regular PA obtained better results in all functional areas, including the MD. Claiming to assess the effect of a training program in the manual function, Ranganathan et al. (2001) performed an experimental study in 28 elderly people, divided into experimental and control groups, 65 and 79 years old. The training program during a period of 8 weeks, with bi-daily sessions of 10 minutes, 6 days a week and included movements of digital dexterity. The experimental group and control group were evaluated through various tests. One was the Pegboard Test which measured the coordination of eye-hand movements required to perform manual tasks requiring speed and accuracy. The authors found that the elderly group, which was submitted to 8 weeks of training, improved their MD, compared to elderly people who were not subjected to regular training. A study conducted by Pinto (2003) aimed to meet some aspects of physical fitness, the MD and proprioceptive sensibility in elderly practitioners and non-practitioners of PA. For this, she used a sample of 57 elderly people, of whom 29 were practitioners of PA and 28 were non-practitioners of PA, and applied the MMDT to assess MD. As for the total sample, the author concluded that there are significant differences between the practitioners and non-practitioners of PA, both in Placing Test and Turning Test. So, changes in MD related to age may be delayed by entering in a training program, specific exercises to hand movements that increase the capacity and manual speed in the elderly, as

well as programs of manual strength and flexibility. These potential increases may be related to changes induced by training the peripheral and CNS, and probably for the elderly will benefit from a more independent life, since many of the daily activities call for MD (Carmeli et al., 2003; Ranganathan et al., 2001). Furthermore, a study of Ferreira and Gobbi (2003) check the influence of generalized and supervised physical activities, general agility (GA) and arms agility (AA) in elderly women, as well checking if there is a relationship between these two types of agility. Participated in the research 60 women (59.7 ± 5.9 years) divided into two groups: a) trained group (TG) - Participants of a generalized program of physical activity for at least one year, 3 weekly sessions of one hour; b) not trained group (NTG) - non-practitioners of generalized and supervised physical activities. For the assessment of the GA, they applied the EUROFIT tap test discs. They founded statistically significant differences between TG and NTG in the test of GA. However, this didn't happen for the AA test. The authors concluded that the regular practice of generalized and supervised physical activities improve the levels of GA, but not the AA. Gender: In our research, when comparing genders, we find statistically significant differences in all attempts, between males and females, in the Placing Test. However, the evaluation of MD in Turning Test we don't observe these differences. There only are significant differences in the last two attempts. As the values recorded for each gender, among the elderly practitioners and non-practitioners of PA, in both tests, it's possible to see statistically significant differences in MD. Our results are supported by several studies. Heuvelen, Kempen, Ormel and Rispen (1998) conducted a study with 624 individuals, of whom 274 were male and 350 female, between 57 and 91 years old. Among various parameters of a battery of tests to assess the physical fitness, they included the assessment of MD. In this research, the authors observed that the females showed significantly higher levels of manual performance in relation to males. In a study held in elderly people aged between 60 and 89 years on the manual functionality, Hackell, Wolfe, Bang and Canfield (1992) used a test consisting of seven sub-tests, representing seven different tasks of the day activities. In all sub-tests, except one, the women had a higher manual performance. Jebsen, Taylor, Trieschmann, Trotter and Howard (1969), in order to assess the manual function, implemented seven sub-tests representative of several manual activities (write a short text, turn three cards, take up small objects and place them in a container, stacking pieces of drafts, simulating the act of

eating, moving empty and filled boxes). The sample consisted of a group of 20 to 59 years and another from 60 to 94 years, being a total of 360 subjects. The females showed a superior performance in the oldest age group in both hands. In the same line of thought we note a survey conducted by Rudisill and Toole (1993), which held a study to access the differences in performances of several motor tasks in 73 individuals, men and women aged between 50 and 79 years. The differences between men and women in these motor tasks were significant. However, they also observed that men had greater motor performance (in the balanced long jump, sit and reach) and MD compared to women, which is contrary to the results that we obtained. On the other hand, some investigations have contrary results to those found in our study. In the research of Francis and Spirduso (2000), for the evaluation of manual preference and proficiency, they used 5 tests which assess the MD, precision, speed and manual coordination, in a group of 81 dexterous subjects (40 young people: 20 males and 20 females; 41 elderly people: 21 females and 2 males). This study revealed no differences in performance between genders. Pinto (2003) conducted a study with 57 elderly subjects of both genders, 65 and 99 years old, and assessed the MD using the MMDT. The author concluded that there was no statistically significant difference between genders, although the males present levels performance slightly higher than the females. These results contradict those obtained in our study, since there are significant differences between genders in both tests, with the exception of the first two attempts of the Turning Test. Moreover, in our study the elderly female had better values of MD than the elderly male. Another study by Desrosiers, Herbert, Bravo and Rochette (1999) intended to assess the changes that occur in the upper limbs in healthy elderly residents in a community, through a longitudinal study. They evaluated the following capabilities: manual function, power, sensitivity, MD and motor coordination. The sample was made up of 264 elderly subjects (128 females and 136 males) and the authors show that no significant difference was found between genders, in the evaluation of the different capacities. Identical conclusions resulted from the study conducted by Smith et al. (1999). The sample consisted of 56 adults (between 18 and 52 years) and 38 elderly subjects (between 61 and 94 years) and the authors used the Human Motor Activities Panel to assess the MD through 4 tasks with increasing degree of difficulty. The results showed no statistically significant differences in performance levels between genders. Mesquita (2002) in its study about multidimensional assessment of elderly people (manual

preference and proficiency) with a sample of 43 men and 70 women, 65 to 99 years old, in relation to manual proficiency and gender, the author found that the women presented more low values compared to the men, indicating, however, that the differences were not significant. The study of Cãmima, Arce, Real, Cancela and Romo (2001) with 804 elderly people of 65-85 years, aimed to quantify the physical abilities in the elderly. The battery of tests used beyond the assessment of strength, flexibility, endurance and balance, it also includes a test of MD. The authors reported a better manual performance in male in relation to the opposite gender. Fernandes (2004) held a study, which aimed was to investigate the relationship between the intensity of manual preference and manual proficiency of senior residents in an elderly institution, through the assessment of manual preference, manual proficiency, MD and eye-manual coordination. The sample was made up of 56 elderly (21 males and 35 females), aged 65 to 91 years. Regarding the assessment of MD, by gender and manual preference, the author concluded that there are no significant differences between genders, with preferred and non-preferred hands. However, the males had better performance, either the preferred hand (1.76 ± 0.48) or with non-preferred hand (1.86 ± 0.42) when compared with the opposite gender (1.86 ± 0.48 and 1.97 ± 0.61 , respectively).

This study provides evidence of the influence of PA in the manual reaction speed and manual dexterity in elderly people, practitioner and non-practitioners of physical activity. On the manual reaction speed, our results allow us to conclude that PA improves the performance of the elderly practitioners of PA and the elderly males in detriment of the opposite gender. When comparing the two variables in the study, practice and gender, we find that only the elderly male practitioners of PA show improvements of this capacity when compared with sedentary elderly subjects of the same gender. The same can not be confirm in female, since the improvements found among the older practitioners and non-practitioners of PA were not significant. Regarding to manual dexterity we conclude that in both tests, placing and turning test, the practice of PA influences positively the performance of the elderly subjects. As for gender, only in the placing test we found significant improvement between genders, where the women have better performances comparing to males. For the turning test, only in the third and fourth attempts and the average of four attempts there were significant improvements in the manual dexterity.

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BRZINA REAKCIJE I POKRETLJIVOST RUKU KOD STARIJIH OSOBA: KOMPARATIVNA STUDIJA OSOBA KOJE SE BAVE I KOJE SE NE BAVE TJELESNIM VJEŽBANJEM

Sažetak

Ljudsko tijelo, kako vrijeme prolazi, se transformiše i gubi svoju pokretljivost, poput brzine reakcije ili manipulacije objekata. Većina epidemioloških dokaza pokazuje kada osoba prihvati aktivan stil života, to minimizira proces starenja i poboljšava mogućnosti. Da bi se ocijenili efekti fizičke aktivnosti (PA) kod brzine ruku (MRS) i pokretljivosti ruku (MD) upotrijebili smo Nelsonov test reakcije ruku i Minnesota test ručne pokretljivosti (test postavljanja i okretanja). Uzorak su činili 40 dobrovoljaca (između 67 i 85 godina starosti) stanovnici dva staračka doma u gradu Porto, i bili su podijeljeni u dvije grupe, jedna grupa se bavila fizičkim aktivnostima, druga ne. Ova studija je dovela do ovih zaključaka: 1/Što se tiče brzine reakcije ruke (MRS): (i) postoje statistički značajne razlike između aktivnih i neaktivnih subjekata, kao i među spolovima, i među aktivnim i neaktivnim (ii) među ženskim aktivnim i neaktivnim subjektima nije bilo značajne razlike 2/ Što se tiče ručne pokretljivosti (MD) potvrđeno je da: (i) ili u testovima smještanja ili okretanja postoje statistički značajne razlike između aktivnih i neaktivnih, i jednako ima razlika između fizički aktivnih i neaktivnih kod oba spola; (ii) među spolovima, u testu smještanja, primjećene su razlike od statističke važnosti, ali u testu okretanja ove razlike su potvrđene kod trećeg ili četvrtog pokušaja, u prosjeku kod četvrtog pokušaja.

Ključne riječi: stariji, brzina reakcije, manipulacija, proprioceptivna senzibilizacija, vježbanje

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PLAY RECONSIDERED, RESURRECTED AND REPOSITIONED IN CHILDREN: CASE STUDY RESULTS FROM SINGAPORE

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Review paper

Abstract

Hurried and highly scheduled lifestyles among children are common, especially among developed countries in East Asia such as in Singapore. Research data suggest that young people do not meet daily activity guidelines that promote physical health. There is a cogent need to reconsider, resurrect and reposition play in young people such that children can internalise the merits of play and caregivers can recognise that play confers social-emotional outcomes that are valued by those who invest in education. Data emanating from Singapore suggest very promising social-emotional learning outcomes following a 10-week intervention programme conducted during school curriculum hours.

Key words: *children, physical health, play, CASE study, Singapore*

Introduction

Physical inactivity prevalence among children and adolescents

Physical inactivity data among children and adolescents in Singapore are worrisome. For example Chia (2008) showed that on boys and girls of normal boys weight aged 10 and 15 years are largely still on activity monitored days over a 10-hour periods on a weekday (mean of Tuesday and Thursday) and on a weekend day (Saturday). This means that physiologically, they recorded mean heart-rate (HR) responses, over the 10 hours that were less than a mean of 120 beats per minute (bpm). Indeed, the children and adolescents spent 86-94% and 96-99% of the monitored time, respectively on the weekday and on the weekend at a HR<120 bpm. A HR response that is less than 120 bpm is normally described as sedentary. These data are also verified by survey data on the physical inactivity time of adolescents on a typical school day by the Health Promotion Board (2002) of Singapore, where boys and girls spent about 15 hours engaged in physically non-exerting activity like attending school, TV and computer, doing homework and transport time. In terms of daily pedometer steps, boys and girls accumulated an average of 9500 daily, evenly split between steps accumulated within-school-time and steps accumulated out-of-school time (Chia et al, 2005). Young people therefore do not meet recommendations for daily accumulated physical activity of at least up to 60-90 minutes of activity of at least a moderate intensity (HR>140 bpm) (Cavill et al, 2002; Andersen et al, 2006) or step counts of up to 13000 for girls and 16 000 for boys (Duncan et al 2006).

Reconsidering, resurrecting and repositioning play

Efforts at getting young children to be more physically active on a daily basis require a critical rethink. As the associations between physical activity and positive physical health outcomes among young people are low to moderate at best (Malina, 2001), there are compelling reasons to rethink and reconsider, resurrect and reposition play as the incentive for young people to get physically active and also to provide and strengthen the evidence that engaging in play can confer social-emotional outcomes that are important for the holistic development of young people. Play has the potential to improve all aspects of a child's wellness- social, emotional, mental, and also physical dimensions of health. Children are physically active in different ways than adolescents and adults. Preschoolers and primary school pupils at play engage in many varied activities and with frequent rest periods. Compared to exercising adults or adults playing sport, children are less preoccupied with winning or sustaining an exercise effort and there is greater spontaneity and creative and exuberant expression. These differences arise perhaps because the developing brain of the child requires a pattern of varied stimulation from the environment so that it can develop optimally (Rowland, 1998).

Threats to play

Children face many threats to play and lose the licence for play because of environmental, social and regulatory prohibitions in and outside of school.

Hurried and highly scheduled lifestyles among children mean little free time for play, even during the holidays. Parents feel compelled that children's lives must be full of gainful activities, mostly sedentary ones. While some may benefit from such highly structured and scheduled activities, the importance of downtime and free time for children to engage in self-directed spontaneous play cannot be ignored. In the push for academic excellence in Singapore, free play time and even physical education classes are oftentimes cancelled and used for academic work, enrichment classes in academics when examinations loom. Also, physical play is being substituted by play in cyberspace where the allure of cyber sports may be more attractive than the allure of physical sports among children and youths. For example, a cyber version of any sport is not dependable on the physical talent or skill of the player, there is also ease of access to playing the cyber sport, and you can play with anyone in the world and at any time of the day or night. A physical version of the sport is constrained by time, facility, skill and availability of team-mates and opponents. It is not difficult to understand why more young people are attracted to cyber-gamming than to the physical sport. It is a challenge therefore for promoters of the physical version of the sport in making the physical sport more fun and attractive and also accessible to the less-skilful so that more will play the physical version of the sport. Promoters of the physical version of the sport must not assume that the allure of the physical sport is for all-time, and remains unchallenged by a globalised environment that young people are exposed to, and find innovative ways to sustain and increase the popularity of the physical sport among young people.

Merits of play

Play promotes attention and cognition

Play can help to enhance or develop attention which is a highly valued aspect of cognitive function that involves impulse control and inhibition. This aspect of cognition in young children allows for group learning. Examples of impulse control in action is when young children listen attentively when a teacher speaks and allows for children to be engaged in a shared group activity where they many have to take turns to speak or to perform. Animal studies on rats and mice show that when they are exposed to enriched environments- cages with toys and tunnels to encourage exploration, more rodents, provided with an exercising wheel- they showed improved learning rates and better memory that was associated with brain neurogenesis (van Praagh et al 2000). When children engage in outdoor play, the

outdoors is the enriched environment, where opportunities for decision-making encourage problem-solving and creative thinking as outdoor spaces are more varied and less constraining than indoor spaces. There is also usually greater range of visual and gross motor exploration, when children engage in outdoor play that is unfettered and structured by adult-intervention. Free play outdoors induces curiosity and the use of imagination among children (Pica, 1997). Problem-solving that is associated with play may promote higher order cognitive skills such as planning, organising, sequencing and decision-making- sometimes referred to as executive functioning. These skills are not only useful for academic success in school but also important for children to cope with daily tasks like looking after their own personal belongings, travelling to new places and ultimately skills required for independence.

Play promotes affiliation and socialisation

Physical play allows for children to learn how to socialise and get along with others, and to be part of a group. A measure of a child's social health is marked by his or her ability to make friends, and to sustain friendships, to lead and to follow, to compromise and to negotiate when they do not agree with each other. Unstructured play with peers, significant others like brothers and sisters and parents or other adults allows children to make decisions such as what to play, who to play with, who can play, when to start, when to stop, and even what are the rules for play. There is experimentation and real learning about the rules of social engagement among peers and others. Hence time at play can, over time foster qualities in the child like flexibility, empathy, self-regulation, and self-awareness, qualities amalgamated as emotional intelligence or EQ. EQ is essential for successful social intercourse in adulthood and contributes to success in school and in the workplace.

Play promotes emotional well-being

Children play because they are happy when they play. Free play can improve many aspects of emotional well-being in children such as reducing anxiety, depression and aggression- these are however not yet subjected to much scientific research among normal children. Anecdotal evidence and focus group discussions with parents of preschoolers suggest that improved mood was the most immediate response of children after play (Harvey-Berino et al 2001). Research also suggests that when children play outdoors, sunlight may have a positive impact on improving mood (Wirz-Justice et al 1996). In the hurried and highly scheduled lives of young people, there is also much stress.

This 'allostatic load', which is experienced by the child's brain can impair health (McEwen, 1996). Contrarily, a smile on a child's face at play reflects many physiological processes in the body that can improve health. Gross motor play has the potential of alleviating these stresses in children. Moreover, when children learn that play helps them to manage their daily stresses, they learn an effective stress-alleviating strategy and they are likely to sustain physical activity in their lifetime. Despite these benefits of free play, research attention linking the time allocated for play and the associated socio-emotional-mental outcomes in children are lacking and represent a fertile area of research. Hence the purpose of the study was to evaluate the SEL outcomes in a large sample of male and female primary school pupils following a 10-week intervention programme called PRIDE for PLAY, which infuses daily pockets of play time in the school curriculum during the formal schooling hours.

Method

PRIDE for PLAY-a 10-week school based programme

PRIDE for PLAY is an acronym for Personal Responsibility in Daily Effort for Participation in Lifelong Activity for Youths (Chia, 2006). This programme is described in detail elsewhere (Chia, 2007) but has not been subjected to research attention. Two primary schools were approached for the implementation of the 10-week intervention programme that involved 490 pupils aged 8-9 years old. The programme, essentially involved an infusion daily physical play of between 20 to 45 minutes during school curriculum hours, either as stand-alone additional play sessions or as part of an extended recess, where pupils could have light refreshments and play. The arrangement involved working closely with the school leaders and all Primary Two Class teachers to forge a strong partnership for action and subsequent evaluation. Outcome deliverables like pre-and post school-based physical activity, assessed using pedometers, social-emotional learning (SEL) outcomes among pupils, assessed using modified questionnaires and indicators of academic achievement (semester examination results) were garnered. School-incident logs that detailed discipline cases and accidents were also monitor before, during and after the programme. SEL components measured included:- self-awareness (recognizing emotions, accurate self-perception, recognizing needs, strengths, values & self-efficacy); social awareness (empathy, respect for others, perspective taking & appreciating diversity); self-management (stress management, self-motivation, discipline, goal-setting, guiding;

relationship management (communication & social engagement, cooperation, negotiation, conflict management & seeking help) and responsible decision-making (problem-solving, personal, social & ethnic responsibility). The 70-item questionnaire was read out item-by-item by the principal investigator in a quiet classroom while pupils answered the questionnaire item. Each pre and post session took about 40 minutes to complete. Focus group interviews were also conducted on a sample of parents and teachers who were involved in the programme. Pre- and post-test data were collected and analysed using part-sample t- tests and the level of statistical significance was set as $p < 0.05$.

Results

Following the 10-week intervention programme, step count within-school-hours significantly increased by 24 % from 3742 to 4642 in one school that involved 270 Primary 2 pupils aged 8-9 years old. In the other school that involved 225 Primary 2 pupils, daily step count in school increased by 10 % from 4520 to 4984. The different margins of improvements in step count could be attributed to between school differences in terms of access to a school field and greater open spaces for play and perhaps to the different school ethos. Sample results of the 10-week intervention showed that indicators of (i) self awareness (e.g. I know what I am good at), (ii) impulse control and stress management (e.g. I can concentrate better after play), (iii) self-motivation and discipline (e.g. I can concentrate when doing homework), (iv) negotiation and conflict management (e.g. I will discuss with my friends further if they do not agree with me) and (v) personal and moral responsibility (e.g. It is wrong to cheat to win), all showed significant improvements after the 10 week programme among both normal weight and overweight pupils. There were no significant sex differences in the SEL outcomes. Results of focus group discussions before and after the programme with teachers and parents revealed that the pupils were most enthusiastic about the programme and would often remind the teachers that it was time for outdoor play. Parents revealed that their children were more cooperative at home and would even help out with household chores while teachers noticed that overall pupils were better behaved in class and that there were less disruptions and discipline issues with pupils as the PRIDE for PLAY programme progressed. In terms of academic achievement, the semester tests results of the pupils showed no discernable changes. There was also no discernable change in terms of the school incident and accident logs because of the programme.

Discussion and conclusion

This is apparently the first study in East Asia and in Singapore to examine the links between play and SEL outcomes in a sizeable cohort of primary school children. Collectively there were significant increases in step count from pre-test to post-test. These amounted to achieving 39-42% of the daily recommended step count for girls and 31-33% of the recommended step count step count for boys, during school-going hours, and makes a sizeable contribution to meeting the recommendations for accumulating 13000 steps for girls and 16 000 steps per day (Duncan et al 2006). Importantly, indicators of SEL- such as attention (concentration), affiliation (socialisation) and affect (emotion) showed marked improvements from pre-to-post test. These changes were verified and confirmed by the focus group discussions with parents and teachers. Concerns raised by teachers about increased incidences of accidents and discipline cases that could arise because of the play programme did not materialise. Teacher and parental feedback showed that the pupils were better behaved and displayed greater responsibility for their own well-being at school and at home. Social emotional learning outcomes of the pupils involved with the PRIDE for PLAY programme were also significantly improved with no compromise to academic standards in both schools. The principals of both schools raised the following points that are instructive for the success of PRIDE for PLAY- the programme had the support and buy-in from the key stakeholders- school management, teachers, parents and the pupils themselves; there was great enthusiasm among pupils for the programme as they were free to be themselves, and had the freedom to decide how they wanted to play and there was increased teacher-pupil understanding; reduced incidences of pupil indiscipline in class,

no increase in the number of physical accidents and no drop in academic achievement among the pupils. School leadership was instrumental in the initial success of PRIDE for PLAY and will play an even more important part in the continued success and sustainability of the play programme. According to Leithwood et al (2008), the success of health-promoting schools pivot on the following factors which were omnipresent in PRIDE for PLAY- shared vision, clear directions, beliefs and values, well-developed staff; well-organised school, structure and procedures and very good management of the teaching and learning programmes. Some other schools have translated, customised and adapted the PRDIE for PLAY programme into daily physical education. Further research directions associated with PRIDE for PLAY include garnering more secure evidence of the social-emotional learning outcomes as a result of programme implementation in a wider spectrum of schools in Singapore. As Singapore endeavours to build a Sporting Culture in the population, it is commonsensical to foster and inculcate a play culture among her youths first. After all, sport without play is playing sport devoid of fun and enjoyment.

The infusion of daily play sessions of between 20-45 minutes in the school curriculum can reap SEL outcomes that are difficult to materialise in a classroom setting. PRIDE for PLAY showed that with strong and positive school leadership and a strong buy-in from key stakeholders, pupils can benefit from daily play without any compromise in academic achievement. Pupils were enthusiastic about the programme and the daily play allows pupils to accumulate up to 40% of the recommended daily step count during the schooling hours. Further research is advised to verify if PRIDE for PLAY will benefit older pupils and also other schools with different ethos in Singapore.

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RAZMOTRITI, USPOSTAVITI I OBNOVITI IGRU DJECE: REZULTATI CASE STUDIJE U SINGAPURU

Sažetak

Užurban i detaljno isplaniran način života među djecom je česta pojava, posebno u razvijenim zemljama Istočne azije poput Singapura. Podaci kazuju da mladi ne ispunjavaju dnevne smjernice koje osiguravaju tjelesno zdravlje. Postoji potreba da se razmotri, obnovi i ponovo uspostavi igra kod djece. Djeca mogu iskoristiti blagodat igre, a odgajatelji mogu prepoznati društveno-emocionalne ishode koje vrednuju oni koji ulažu u obrazovanje. Podaci proizašli iz Singapura sugeriraju obećavajuću socijalno-emocionalnu naobrazbu nakon desetosedmičnog interventnog programa koji je proveden za vrijeme školskih sati.

Ključne riječi: djeca, tjelesno zdravlje, igra, CASE studija, Singapore

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SIMULATION OF THE SOME BIOMOTOR FEATURES FOR THE SELECTION OF THE VOLLEYBALL PLAYERS AGED 7

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Abstract

The purpose of this study was identification of talented volleyball players in the frame of morphological and motor parameters. Based on methodology, this study belongs to identification on the basis of the expertise and simulation. The methods applied are avantguard and introduced for the first time for the purpose of the description of selection in volleyball. Simulation protocol defined 12 initial conditions, or 'limitations', which are needed to ensure the selection of children with maximal exposition to selected conditions. The results have shown the strenghts of this protocol, and singled out children with highest chances for success in volleyball. The originality of this study is in simulation and applicability in various conditions. There are basically no limitations except in the domain of expertise on specific or a group of issues. The expansion of initial conditions is possible.

Key words: *biological dimensions, seven-year old pupils, simulation, volleyball*

Introduction

Volleyball with its structural features belongs to the group of polystructural acyclic sports. Dynamics of actions, especially in modern volleyball, is highly accentuated together with almost incredible individual movements which literally take a fraction of a second.

Features of this sport are multiple and multidimensional, where some features simply must be above average in order to achieve significant results (Janković and Marelić, 1995).

For the realization of volleyball demands in senior volleyball, there are three preconditions which must be fulfilled in order to achieve the professional level, which are articulated as sports' models (Bonacin, Bilić & Bonacin, Da., 2008): a) First precondition is understanding of the volleyball model, the characteristics of the game that are implemented, and the players' features needed for the realization of the goals; b) Second precondition is understanding the transformational process which brings the beginners aged 7 or 8 to the professional level; c) Third precondition is recognition of the specially talented children in accordance with their features (Bonacin & Smajlović, 2005).

Selection is one of the key terms, and it cannot be taken lightly, without some sort of insight to the future of the sport and of the given child who dedicates 10 or 15 years of life to achievement of the professional level.

Problem and aim

Assuming that introduction covered preconditions a) and b), there remains c) recognizing the potential in children. Such a procedure demands very clear differentiation and identification of necessary features in order not to exclude gifted children, and include children that are not gifted in long-term training processes. This is also a problem of this essay, objective realization of features needed in boundaries of defined parameters, morphological and motor in this case. The subject of this essay are children aged 7, basically the age in which children start to show interest for this sport, even though this does not imply that there is a systematic training, it implies above all games which develop the potential for the latter application in training. The goal of this essay is the exact identification of talented children based on initial values of their morphological and motor dimensions.

Methods

Data described with 26 variables from 249 boys aged 7 is analyzed for the purpose of this essay. 14 of those are morphological variables chosen to cover complete morphological area of longitude, volume and fat tissue: height, length of arms and legs, wrist diameter, knee diameter, shoulder width, pelvic width, weight, forearm girth, shin girth, chest girth, upper arm skin wrinkle, back skin wrinkle, torso skin wrinkle.

For the estimate of motor skills 11 variables are used, which are designed to cover primary motor dimensions like coordination, movement frequency, flexibility, balance, repetitive strength, agility, static strength and stamina. Exercises used are: side step, backwards training ground, hand tapping, foot tapping, standing on the balance bench, long jump from standing position, ball throwing, high start 20 metres running, sit ups.

Finally, one variable is used to assess functional capability of cardio-vascular system: three-minute running. The results are prepared and primarily processed using classical methods of univariant and multivariant analysis. After that data is transformed and processed in a way to enable the application of simulation protocols for the identification of the entities based on given criteria.

Results

Variable	Total sample parameters						SIM	Chosen entities			
	MIN	AVG	MAX	STD	Z-MN	Z-MX		E157	E221	AVG2	Z
height	113.97	128.43	146.83	5.44	-2.66	3.38	>132.00	132.23	138.97	135.60	1.32
arms length	60.00	71.44	82.10	3.70	-3.09	2.88	>74.00	74.23	82.10	78.17	1.82
leg length	42.93	53.00	65.70	2.98	-3.38	4.26		56.33	57.23	56.78	1.27
wrist diameter	3.57	4.19	5.00	0.26	-2.43	3.11		3.97	4.13	4.05	-0.56
knee diameter	6.50	7.74	9.50	0.47	-2.62	3.72	>8.00	8.03	8.07	8.05	0.65
shoulder width	20.30	27.24	30.40	1.54	-4.50	2.05		27.60	28.33	27.97	0.47
pelvic width	15.50	20.30	24.27	1.45	-3.32	2.74		21.10	22.50	21.80	1.04
weight	16.50	27.02	44.40	4.41	-2.39	3.85		27.33	30.00	28.67	0.37
forearm girth	13.90	17.79	23.07	1.54	-2.53	3.42	>26.00	17.30	17.60	17.45	-0.22
shin girth	19.20	25.76	34.03	2.19	-2.99	3.77		26.23	26.20	26.22	0.21
chest girth	49.90	60.68	79.60	4.12	-2.62	4.59		58.37	62.60	60.49	-0.05
upper arm skin wrinkle	5.83	11.44	25.90	3.63	-1.54	3.98	<10.00	6.17	9.60	7.89	-0.98
back skin wrinkle	3.47	7.01	24.97	3.13	-1.13	5.74	<6.00	3.97	5.67	4.82	-0.70
torso skin wrinkle	2.97	7.43	30.23	4.82	-0.93	4.73	<6.00	3.40	5.07	4.24	-0.66
side step	11.23	16.23	25.33	1.99	-2.52	4.58	<14.00	13.60	13.77	13.69	-1.28
polygon backwards	11.69	22.94	57.84	6.46	-1.74	5.40		13.87	21.77	17.82	-0.79
balance bench	0.17	1.73	5.00	0.70	-2.22	4.64	>2.00	2.03	3.03	2.53	1.14
torso flexibility	19.01	36.84	60.01	8.46	-2.11	2.74		29.86	47.34	38.60	0.21
hand tapping	12.00	19.27	30.67	2.86	-2.54	3.99	>21.00	24.00	21.00	22.50	1.13
foot tapping	8.99	15.71	22.68	1.96	-3.43	3.56	>15.00	17.99	15.32	16.66	0.48
long jump	56.65	112.89	163.35	17.28	-3.26	2.92	>125.00	128.00	125.01	126.51	0.79
ball throwing	3.17	10.45	22.00	3.04	-2.40	3.80		10.30	5.40	7.85	-0.86
20 metres run	4.07	4.93	6.30	0.43	-2.03	3.20		5.17	5.17	5.17	0.55
sit ups	0.00	21.55	39.00	6.67	-3.23	2.62		28.00	23.00	25.50	0.59
arms strength	0.00	10.91	50.50	8.66	-1.26	4.57		6.40	19.00	12.70	0.21
3-minute running	250.00	443.98	570.00	57.87	-3.35	2.18		485.00	459.00	472.00	0.48

(MIN=minimum, AVG=arithmetic middle, MAX=maximum, STD=standard deviation ,Z-MN, Z-MX=minimal and maximal z value, SIM=simulation values, E157, E221=chosen entities AVG2=average values of chosen entities, Z=z value of AVG2)

Results in sheet 1 show the applied protocol. Initial values were given for 12 variables, and those values had to be exceeded by applicants. Initial values were given to: height, leg length, knee diameter, forearm girth, standing on the balance bench, hand and foot tapping, long jump from standing position. Values that had to be smaller than those given were for fat tissue wrinkles, and side step. This is made under assumption that future volleyball players need accentuated height, and understandably long legs, also the ankle structure to withstand vertical jumps, and also accentuated sense of balance in tight spaces as occur in volleyball. This is also used to assess the speed of object handling(arms), and positioning in space (legs), and heightened leg agility. Logically, values of all variables differed in the function of random vectors, even though it is known that

all dimensions are structured together, but it is designed that neither has crucial or eliminatory influence on the simulation goal.

Discussion and conclusion

Simulation had been stabilized after tenth iteration and had chosen 2 entities which fulfilled all conditions based on given values (SIM). Those two entities, E157 and E221 are very much identical, and thus it is confirmed that this protocol is highly efficient. As shown, those are very tall children, which are over 1,2 of standard deviation in overall sample, on about -1 of standard deviation considering fat tissue, with great agility, speed, balance, and with all the other parameters that suggest that they can meet all the requirements of modern volleyball.

For the complete picture, further expansion of sets of variables is needed for those individuals chosen to continue with serious training (anticipation, reaction time, psychological variables), but this does not undermines achieved results. With the sample of 249 boys aged 7, described with 26 biomotoric variables, simulation protocol is applied for the purpose of identification of possible entities capable of great successes in volleyball.

On the basis of initial parameters (initial simulation conditions), algorithm singled out two boys that show a cluster of features needed to be a superb volleyball player. This shows that this protocol is indispensable in selection procedures, especially because it takes into account critical value of chosen parameters, but all the other parameters are constituted according to goals.

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SIMULACIJA NEKIH BIOMOTORIČKIH DIMENZIJA ZA SELEKCIJU ODOJKAŠA UZRASTA 7 GODINA

Sažetak

Svrha ovog istraživanja bila je identifikacija za odbojku nadarene djece u skupu morfološko-motoričkih parametara. Metodološki, istraživanje pripada identifikaciji temeljem ekspertnog znanja i simulacije. Primjenjene metode su avangardne i po prvi puta primjenjene u svrhu opisa selekcije u odbojci. Simulacijskim protokolom definiran je skup od 12 početnih uvjeta, odnosno "ograničenja" koji su u stanju osigurati odabir upravo one djece koja po izmjeranim parametrima imaju maksimalne mogućnosti ekspozicije u odabranim uvjetima (odbojci). Rezultati su pokazali svu snagu ovog protokola i izdvojili djecu s najviše izgleda za uspjeh u odbojci. Originalnost istraživanja je upravo u simulaciji i mogućnosti primjene modela u različitim situacijama. Ograničenja praktično ne postoje osim u prostoru ekspertnog znanja o pojedinom problemu ili skupu ciljeva. Naravno da je moguće proširenje startnih parametara, odnosno početnih uvjeta ili dodavanje novih varijabli.

Ključne riječi: biološke dimenzije, sedmogodišnjaci, simulacija, odbojka

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CHANGES IN BIOMOTOR DIMENSIONS OF SCHOOL BOYS AGED 11: EXPERIMENTAL PROGRAMME OF SPORTS GAMES VS STANDARD PE PROGRAMME

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Abstract

On a sample of 252 boys, aged 11 yrs±6 months, divided into the control (CG; N=127 subjects) and the experimental group (EG; N=125 subjects), a system of 33 measurement instruments was applied (12 morphological and 21 motor and functional variables). A goal was to determine changes in morphological characteristics as well as in motor and functional abilities of boys after the annual application of the experimental programme in the EG, composed of the fundamentals of sport games (basketball, volleyball, handball and football), and standard PE programme in CG, based on statistical significance of the differences in arithmetic means of the applied variables between the control and the experimental group in the initial and final measurement. Statistically significant differences between the control (Mc) and the experimental (Me) group in arithmetic means of the applied variables in the initial and the final measurement were determined by means of multivariate and univariate analyses of variance (MANOVA/ANOVA). The computed statistical values made it obvious that in the whole system (multivariate) of the applied variables (12 morphological and 21 motor and functional) statistically significant difference exists between the control and the experimental (Mc-Me) group in the initial and the final measurement at the level of $p=.00$. The results showed that the subjects of both groups scored better in the initial than in the final measurement in 6 different morphological variables each. In the final measurement, after the experimental programme treatment, the EG had better values in 8 variables (out of which only one at the level of $p=.03$), whereas the CG was better only in 4 variables. The finding indicated that only the whole system of the applied morphological variables evenly contributed to the differentiation of the groups, both in the initial and final measurements. In the space of motor and functional abilities the subjects in the CG were better in 5 variables in both the initial and the final measurement, whereas the subjects of the EG were better in 16 variables. In the initial measurement 8 individual variables (out of which 2 in favour of the CG and 6 in favour of the EG) contributed to the multivariate statistical significance of the differences in group arithmetic means at the level of $p=.00$, whereas in the final measurement 14 variables contributed to the statistical significance (out of which one in favour of the CG and 13 in favour of the EG). This indicated that the experimental programme, composed of sport games' movement structures, produced in the EG statistically significant changes in motor and functional abilities as measured in 7 variables assessing leg movement frequency, power (explosive strength) of arms and legs, flexibility of legs and arms, and arm-leg coordination.

Key words: morphological characteristics, motor abilities, functional abilities, age 11-12 years, boys, exercise effects, experimental programme, sports games

Introduction

Research in changes of certain anthropological characteristics of children under the influence of various programmes of physical exercise and/or sports training is one of the most important issues in physical education (PE) and sport (van Sluijjs, McMinn & Griffin, 2007). These research studies are based usually upon priory constructed, defined desirable final states (models), features of actual states of subjects (diagnostics, control, exercise effect control, genetic limitations) and longitudinal transformation of the states (planning and programming, operational) during the process of physical education (teaching) or sport training

(Milanović, 1999; Findak, 1999; Pejčić, 2002). It means it is impossible to design and apply any transformational procedure of physical exercise or sport training if the following is not known: which anthropological characteristics, abilities and motor knowledge and skills contribute to success in any educational or sporting activity; what is their significance and hierarchically defined influence on performance; which programme contents, methods and loads/intensities can optimally develop them within a certain time period; by which instruments can they be measured and how can they be controlled (Malacko, 2008).

The development of children's particular anthropological abilities and characteristics, efficiency of which depends primarily on the selection and application of adequate exercise or sport training contents (programmes) and respective optimal work loads, must not ever assume nature of aimless exercise, especially when the children selected for particular sport events are considered. It means that it is useless to develop individual anthropological abilities and characteristics separately from the actual need, that is, from the desired goal (Kretschmer, 2001; Pejčić, 2002). Additionally, we must always bear in mind that all human capacities and abilities are interwoven, especially in younger ages; they develop according to a certain genetically prescribed order and pace (Ortega, Ruiz, Castillo, & Sjostrom, 2008; Rogers, Fay, Whitfield, Tomlinson, & Grunau, 2005). Therefore, exercise or training programme contents, aimed at development of relevant anthropological abilities and characteristics, should be designed/selected and applied in accordance with the already acquired and automated movement structures. In this the well-known rule of economy reigns: regardless of what is the foundation of the selection, the more functional contents (of a higher complexity) should be preferred, that is, the contents by means of which several goals can be simultaneously accomplished (Mraković, 1992; Malacko & Popović, 2001). According to the above-mentioned, when research studies are conducted, much effort is put in the design of experimental programmes to make them efficient in two areas: (a) in training, mastering and acquiring (automatization) of certain movement structures, on the one hand, and (b) in causing optimal exercise/training effects on particular morphological characteristics and motor-functional abilities, on the other (Kurelić, Momirović, Stojanović, Šturm, Radojević & Viskić-Štalec, 1975; Gredelj, Hošek, Metikoš & Momirović, 1975). Both aspects are mutually related in a very specific way: to change any anthropological characteristic or ability, being responsible for performance in a particular educational or sporting activity, a particular movement structure (situational-technical element), by means of which the transformation is to be caused, has to be previously acquired up to the level of rational, economical and optimal performance. Training, mastering and acquisition of desirable and purposeful movement structures (elements of sport technique, motor information) should be based upon carefully selected or constructed specific movement structures which are by their form, character, structure and work load very close to the final movement patterns used in the activity in actual situations. The goal here is to quickly achieve as great exercise effects in acquisition of relevant movement structures with as few elements of the movement pattern as possible. These relevant movement structures are further used in training process to optimally condition (transform) anthropological characteristics and abilities, which are in the

function of optimal performance in any educational and/or sporting activity (Malacko & Radjo, 2004). Due to the fact that the effects of the movement structures applied depend also on the methods of exercising and/or training utilized, it is important to know in advance how much each exercise movement structure should be practiced for a particular purpose and how it should be applied. Practically, it means that one exercise structure due to its complexity might be adequate for a particular goal, but the goal is not going to be realized because of inadequate training (volume or intensity). Or, even negative effects may be produced (Mraković, 1994). Therefore, besides the information on the purpose which is to be realized and by which exercise contents, the information is indispensable on how much and in what way the very exercise contents should be applied, as well as what work load is to be implemented within the set time intervals. It is more than obvious that the exercise contents, methods and loads cannot be analysed and utilized separately. In the processes of design, programming and operationalization of any educational and/or sport training process they should be regarded as interdependent and correlated elements (Findak, Prskalo, & Pejčić, 2003). Practitioners of everyday school teaching, especially those who work with children aged 11-12 years, generally consider that the PE curriculum is overreaching and too ambitious, primarily due to the insufficient weekly time allocation. It leads to the one-sided predominance of the educational component over the developmental aspect of teaching PE. The type of PE teaching which is focused on learning, that is, mastering of large body of motor knowledge and skills, what is nowadays typical for the majority of elementary schools, cannot guarantee that these teaching contents will contribute to the desirable development of relevant anthropological characteristics and abilities of children, which should be the main purpose of school PE teaching. Namely, such an approach jeopardizes one of the principal developmental laws of growth and maturation: human characteristics and abilities are most successfully developed within the so called "critical periods", when such a development is objectively possible, meaning during childhood and youth (adolescence). In professional literature (Kuznjecova, 1975; Gužalovskij, 1984) the term "critical periods" is frequently understood as ontogenetic periods. Within their limits and on the basis of natural laws the greatest tempo of the development of certain personal characteristics and abilities is achieved, capacity of adaptation to the environmental factors is enhanced and the most favourable preconditions are created for certain skills and habits development and information acquisition (Harrison et al., 1999). The starting assumption is that, in these periods, the human organism is more than in other periods susceptible to external stimuli (transformations) if they are, by their direction, in accordance with the general tendencies of natural course of morphological,

motor and functional changes. Out of this stems the principal empirical rule: the development of individual physical abilities should start early. Practically, it means that "the greater the genetically determined portion of the variance of the particular anthropological dimension, the smaller the influence of conditioning process on it during life; and vice versa, the smaller the genetically determined portion of the variance, the greater the influence of the process of exercise" (Mraković, 1992). It corroborates the notion that the one-sided favourization of educational component of PE teaching may be, and is, erroneous. Namely, many motor information, skills and habits can be acquired later in life, whereas the environmental influences missed in critical developmental periods can hardly ever be compensated later.

Previous observations, analyses, opinions and statements, as well as ever more serious warnings of professional and wider social community regarding the unacceptably low level of PE teaching efficiency, were a basic drive for commencing the presented research study and its goal orientation. The main issue here is: which programme can, if it can at all, induce greater changes - the standard, mandatory PE syllabus, implemented in standard, control group, or the specially designed programme, consisting of sport-specific movement structures (technical fundamentals), implemented in the experimental group during the same time period. The aim of the present research study was to determine the changes in the development of morphological characteristics as well as motor and functional/cardio-respiratory abilities of school boys in the fifth grade after the annual application of the experimental PE programme, composed of sport games' fundamentals (basketball, volleyball, handball and soccer). The changes will be determined on the basis of statistically significant differences in arithmetic means of the variables between the control and the experimental group in the initial and the final measurement.

Methods

Sample of subjects

A sample of subjects consisted of 252 boys, aged 11 years $\pm$ 6 months, who were divided into the control (CG; standard PE programme; 127 subjects) and the experimental (EG; 125 subjects) group.

Sample of variables

The sample of variables consisted of the 33-item test battery which included 12 morphological and 21 motor-functional variables. In the space of morphology the following latent and manifest variables (anthropological measures) were used: *dimensions of the skeleton* – body height (BOH), shoulder width (SHW), pelvic girdle width (PGW), *body mass and volume* – body mass (BOM), forearm circumference (FOC), upperarm circumference (UPC), thigh circumference (THC),

calf circumference (CAC), waist circumference (WAC), and *subcutaneous fatty tissue* – upper arm skinfold (UAS), subscapular skinfold (SUS) and abdominal skinfold (ABS). For the assessment of motor and functional abilities the following latent or manifest variables were used: *body coordination* – passing through and jumping over (PTJ), agility in the air (AGA), obstacle course backwards (OCB), *frequency of movement* – hand tapping (HTA), foot tapping (FTA), foot tapping against the wall (FTW), *power (explosive strength)* – standing long jump (SLJ), medicine ball throw from supine lying (MTL), 20m running from the standing start (20R), *strength endurance* – all-out declined sit-ups off the bench (ASB – A subject is sitting on the bench, 10-20 cm off the rim, with the knees bent 90° and the feet locked on the bench by the assistant. He puts his hands behind the neck and holds a stick with his elbows behind the neck. He has to lie down back until his head touches the padded mat on the floor. From that position he performs all-out sit-ups. The number of properly performed sit-ups is a result.), all-out hyperextension on the box (AHB – A subject, in prone position, extends upper body over the end of the box; the end of the box should be at his hips. A partner locks his legs. He bends down at waist with his hands and a stick behind his neck. He raises his torso straight up until parallel with the upper surface of the box. The number of properly performed back extensions is a result), undergrip chin-ups on the bar (UCB), *flexibility* – bent forward on the bench (BFB), straddle sit-and-reach (SSR), shoulder circumduction backwards with a stick (SBC), *leg-hand coordination* – slalom with three medicine balls (S3B – 10m long route with 5 stands 2 m apart; a subject should roll simultaneously three medicine balls with his legs and hands up and down the route.), slalom by kicking two balls (S2B), hand dribbling (HDR), and *aerobic capacity* – rest heart rate (RHR), vital capacity (VIC) and 1,000 m running (RTM).

Data processing

The multivariate and univariate analyses of variance (MANOVA/ANOVA) were used to determine the differences among arithmetic means of the variables measured in the initial and final measurement between the control (Mc) and the experimental (Me) groups of boys. The multivariate testing of the null hypothesis that the centroids of the groups equalled the common centroid (GENERAL MANOVA) was conducted by means of Λ -relations (Wilks' Lambda test) i Rao's coefficient (Rao's R), as well as their statistical significance (p-level). The univariate statistical significance of the differences (p-level) between the arithmetic means of the groups (Mc - Me) across the variables was computed by means of F-test.

Experimental programme

The experimental programme of sports games was approved as a pilot programme by the Croatian ministry of Education and Sport.

It was applied two times a week in the scheduled PE classes lasting 45 minutes. The classes were held in a school setting (either indoors, in the gymnasium, or outdoors). The total annual time allocation of 54 experimental PE classes was structured as follows: 37 classes were focused on sports-game-specific work – acquisition of motor (technical) elements (basketball 10, volleyball 9, handball 9 and football 9), whereas 17 classes were aimed at basic motor preparation/physical conditioning (elements of the drills with apparatuses - 7 classes, athletics - 6 classes, and dances - 4 classes). The programme of basic physical conditioning included callinetics (in place and on move), continuous (aerobic endurance) running, various modes of running with medicine balls, jumping over obstacles with balls, sprints up to 10m from various positions and stances, running with changes of direction and pace, carrying each other in pairs and triples, fartlek up to 300m (continuous running of variable paces), combination of a forward roll and a cartwheel, dive over an obstacle into forward roll, rope jumps and hops (one- and two-legged), various obstacle courses, pushing and pulling each other in pairs, movements performed according to certain rhythmical or aesthetic criteria, and others. In the area of specific motor preparation sport-game-specific technical elements were applied such as: moving without the ball; then holding, catching and passing the ball; straightforward and zig-zag dribblings, pivots, runner/extended lay-up shot (2-stride run-up for a lay-up, 3-stride run-up for a lay-up), set shooting and shooting from moving, punching the ball (spikes), feinting in place and while moving, basic steals, kicking the ball, receiving the ball (soccer), head shots, receiving low, intermediate and high passes (soccer), rebounding, block jumps, individual tactics, collective tactics and others. The general goal of the applied experimental programme was, on the one hand, to introduce the boys into the world of sport games, and on the other, to make them fond of any of the introduced sport games so that they would like to continue to train it in any of the sport clubs (extramural activities), according to their aptitudes, inclinations and interests. The partial goals of the applied experimental programme were:

- To adjust the programme to the needs and interests of the boys of the particular age who have decided to engage in programme activities of sport games,
- To implement in the process of teaching/training as simple and understandable sport-game-specific motor structures as possible to provide easy acquisition and application,
- To repeatedly apply the acquired and mastered technical elements of sport games in order to develop particular relevant morphological, motor and functional features,
- To teach particular technical elements with the purpose to introduce the boys to

the chosen sport game for the involvement in which they do have the genetical potential,

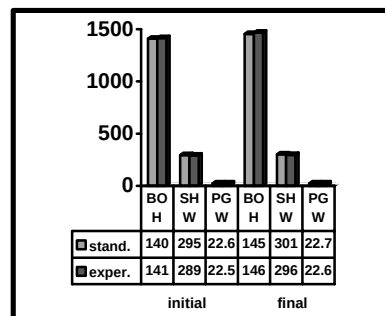
- To ensure the application of the acquired rules of sport behaviour and of the rules of the game in actual competition.

The control group attended regular physical education classes with the standard programme contents stipulated for the pupils of the elementary school fifth form.

Results

The obtained statistical values of arithmetic means, presented in Tables 1 i 2, revealed the statistically significant differences at the level of .00 ($p=.00$) between the control and the experimental group (Mc-Me) in the initial and the final measurement of the entire system (multivariate) of the applied variables (12 morphological - Table 1, and 21 motor and functional - Table 2). In the system of morphological variables (Table 1) it is obvious that in the initial measurement the subjects of the control and the experimental group had better values in 6 morphological variables (the variables are marked with *), whereas in the final measurement the experimental group, after the experimental programme implementation, had better values in 8 variables and the control group only in 4 morphological variables.

Graph 1. Dimensions of the skeleton



In the dimensions of body mass and volume (Graph 2) there were no significant changes in the final measurement. The values of *body weight* (BOM) and *upper arm circumference* (UPC) remained almost the same in both groups. Only the values of *forearm circumference* of the experimental group were better in the final measurement (FOC). There were also no statistically significant differences between arithmetic means of the variables *thigh circumference* (THC) and *calf circumference* (CAC) in the initial and final measurement (Graph 3). Only in the variable *waist circumference* (WAC) certain reduced values (logically, the better result) were obtained in favour of the experimental group, but it was not statistically significant. Also, no significant difference was found between two groups in the variables of subcutaneous fatty tissue, except for one variable.

Table 1. Multivariate and univariate (MANOVA/ANOVA) significance of the differences (*p*) between arithmetic means of the control (*Mc*; *N* = 127) and the experimental (*Me*; *N* = 125) group in morphological variables – the initial and the final measurement

Variables	Initial measurement				Final measurement			
	Mc	Me	F	p	Mc	Me	F	P
BOH	1408.70	1414.50*	.90	.34	1454.42	1465.63*	1.88	.17
SHW	294.63*	289.24	1.00	.31	301.04*	296.39	.82	.36
PGW	22.58*	22.46	.03	.84	22.74*	22.64	.08	.77
BOM	35.94	36.42*	.86	.35	39.83	40.75*	1.18	.27
FOC	205.44*	204.35	.01	.92	209.56	210.59*	.52	.46
UPC	213.29*	209.01	.32	.57	218.59*	214.45	.34	.55
THC	451.20*	443.66	.16	.68	465.68*	455.93	.53	.46
CAC	294.09	295.34*	.11	.73	299.27	300.84*	.20	.65
WAC	652.88*	656.91	.46	.49	668.86	662.51*	.00	.95
UAS	8.30	7.52*	.87	.35	7.96	6.59*	4.55	.03*
SUS	6.54	6.16*	.01	.91	6.15	5.58*	.59	.44
ABS	8.19	7.88*	.06	.79	8.65	7.94*	.16	.68

$\lambda = .88$ $R = 2.69$ $p = .00^*$

$\lambda = .77$ $R = 5.83$ $p = .00^*$

Legend: *Mc* - mean value of the control group, *Me* - mean value of the experimental group, λ - Wilks' Lambda, *F* - test, *R* - Rao's R, *p* - significance level **Morphological variables:** **BOH** - body height, **SHW** - shoulder width, **PGW** - pelvis girdle width, **BOM** - body mass, **FOC** - forearm circumference, **UPC** - upper arm circumference, **THC** - thigh circumference, **CAC** - calf circumference, **WAC** - waist circumference, **UAS** - upper arm skinfolds, **SUS** - subscapular skinfold, **ABS** - abdominal skinfold

Table 2. Multivariate and univariate (MANOVA/ANOVA) significance of the differences (*p*) between arithmetic means of the control (*Mc*; *N* = 127) and the experimental (*Me*; *N* = 125) group in motor variables – the initial and the final measurement

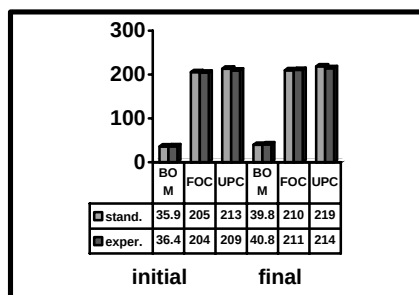
Variables	Initial measurement				Final measurement			
	Mc	Me	F	p	Mc	Me	F	p
PTJ	1650.04	1642.16*	.06	.80	1592.17*	1628.21	.41	.51
AGA	679.26	669.89*	1.83	.17	629.49	608.93*	2.70	.10
OCB	1907.95	1832.28*	2.45	.11	1814.08	1785.72*	.51	.47
HTA	23.42*	22.67	6.84	.00*	23.93*	23.53	2.33	.12
FTA	17.57	18.04*	2.00	.15	18.38	19.06*	6.48	.01*
FTW	16.97*	16.86	.15	.69	17.33	17.77*	3.26	.07
SLJ	140.19	142.27*	2.01	.15	147.68	152.47*	7.58	.00*
MTL	465.80*	463.04	.53	.46	557.68	586.39*	15.33	.00*
20R	403.79	394.31*	1.42	.23	382.98*	391.43	7.19	.00*
DSB	2.67	3.37*	15.35	.00*	3.60	4.09*	6.74	.01*
HLB	12.04	14.64*	17.70	.00*	13.14	15.14*	8.58	.00*
UCB	.67	.95*	13.23	.00*	.74	1.28*	39.33	.00*
BFB	27.25	28.10*	.55	.45	26.59	28.84*	8.49	.00*
SSR	351.82	363.08*	.29	.59	343.03	367.90*	4.00	.04*
SBC	52.79	51.05*	1.64	.20	54.42	50.34*	9.68	.00*
S3B	5521.83	5169.64*	19.46	.00*	5299.16	4982.50*	20.39	.00*
S2B	7529.13	7438.87*	.12	.72	7247.97	7034.25*	3.73	.05*
HDR	1267.06	1098.52*	4.39	.03*	1159.68	1012.69*	44.90	.00*
RHR	73.91*	74.95	6.98	.00*	73.76*	74.11	2.19	.14
VIC	316.24*	311.18	1.18	.27	329.17*	327.48	.23	.62
RTM	377.55	342.18*	21.58	.00*	359.99	34.23*	12.23	.00*

$\lambda = .67$ $R = 5.34$ $p = .00^*$

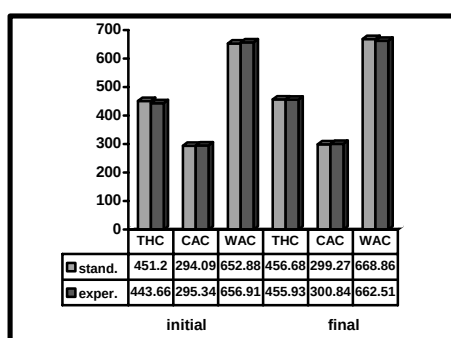
$\lambda = .49$ $R = 11.11$ $p = .00^*$

Legend: *Mc* - mean value of the control group, *Me* - mean value of the experimental group, λ - Wilks' Lambda, *F* - test, *R* - Rao's R, *p* - significance level **Motor variables:** **PTJ** - passing through and jumping over, **AGA** - agility in the air, **OCB** - obstacle course backwards, **HTA** - hand tapping, **FTA** - foot tapping, **FTW** - foot tapping against the wall, **SLJ** - standing long jump, **MTL** - medicine ball throw from supine lying, **20R** - 20m running from the standing start, **DSB** - declined sit-ups on the bench, **HLB** - hyperextension from prone lying on the box, **UCB** - undergrip chin-ups on the bar, **BFB** - bend forward on a bench, **SSR** - straddle sit-and-reach, **SBC** - shoulder circumduction backwards with a stick, **S3B** - slalom with three balls, **S2B** - slalom by kicking two balls, **HDR** - hand dribbling, **RHR** - rest heart rate, **VIC** - vital capacity, **RTM** - 1,000m run

Graph 2. Body mass and circumferences of the arm

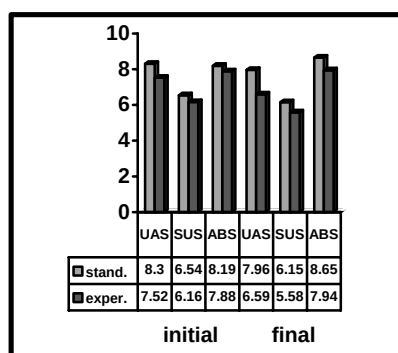


Graph 3. Circumferences of the leg and waist



Namely, in both groups the values were being equally reduced (logically, the better result) in *subscapular skinfold* (SUS) and *abdominal skinfold* (WAC). Only in the variable *upper arm skinfold* (UPC) the values were improved and the significant difference was obtained in favour of the experimental group ($p = .03$) (Graph 4).

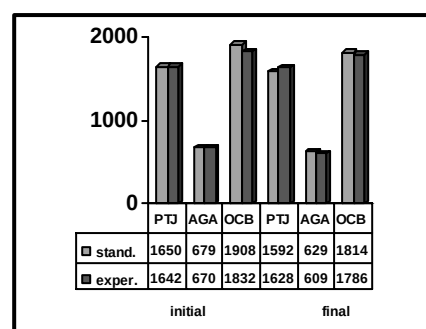
Graph 4. Subcutaneous fatty tissue



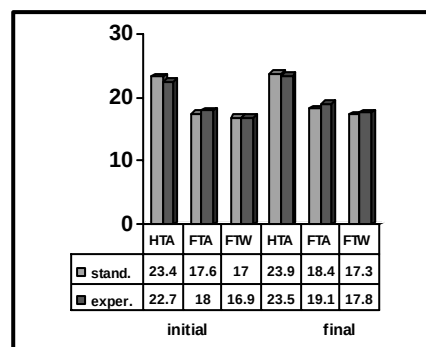
In the Table 2 the results in the system of motor and functional variables are presented. In both the initial and final measurement the control group had better results (the variables are marked with *) in 5 variables, whereas the subjects in the experimental group were better in 16 variables. The contribution of particular variables to multivariate statistical significance of the differences between the two groups at the level of $p=.00$ was as follows: in the initial measurement 8 variables contributed to the significance (out of which 2 in favour of the control group and 6 in favour of the experimental group), and in the final measurement 14 individual variables (out of which only 1 variable

in favour of the control group and 13 variables in favour of the experimental group). Graph 5 displays that in the variables aimed at assessing body coordination – *passing through and jumping over* (PTJ), *agility in the air* (AGA), *obstacle course backwards* (OCB), the results were slightly improved in the final measurement (reduced values mean the better results) in both groups, but with no expected statistical significance in favour of the experimental group. The control group even scored better in the final measurement in the variable *passing through and jumping over* (PTJ).

Graph 5. Body coordination

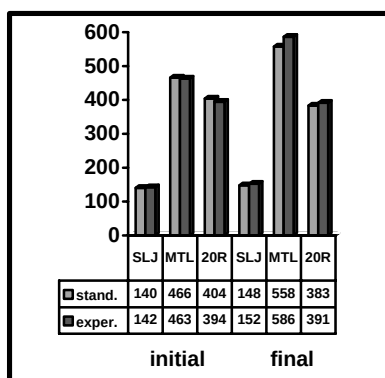


Graph 6. Frequency of movement



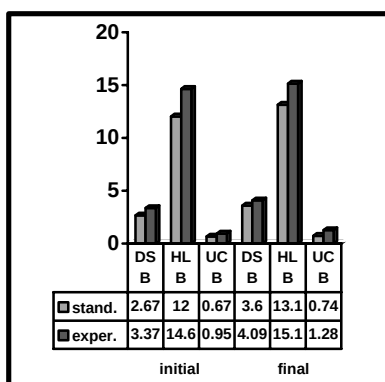
The similar situation is with the motor ability *alternate movement speed (frequency)* (Graph 6): the control group was better in the variable *hand tapping* (HTA) in both measurements, whereas it was better only in the initial measurement in the variable *foot tapping against the wall* (FTW). The experimental group was in the final measurement statistically significantly better ($p=.01$) in the variable *foot tapping* (FTA). In the test assessing power (explosive strength) (Graph 7) the statistically significant difference in the arithmetic means between the groups ($p=.00$) was determined in the variable *standing long jump* (SLJ), in favour of the experimental group. Similar is ($p=.00$) with the variable *medicine ball throw from supine lying* (MTL), but it should be mentioned here that in the initial measurement the control group scored better. In the variable *20m running from the standing start* (20R) the control group achieved better results (reversely scaled), which were significant ($p=.00$).

Graph 7. Explosive strength



It is obvious (Graph 8) that the values of all the applied variables assessing motor ability of strength endurance were evenly improved (all-out declined sit-ups off the bench - ASB, all-out hyperextension on the box - AHB, undergrip chin-ups on the bar - UCB and they were statistically significant ($p=.01$ and $=.00$) in the initial and the final measurement.

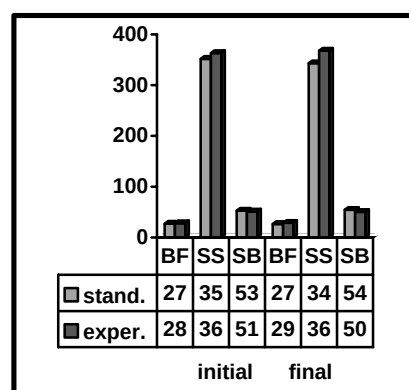
Graph 8. Repetitive strength



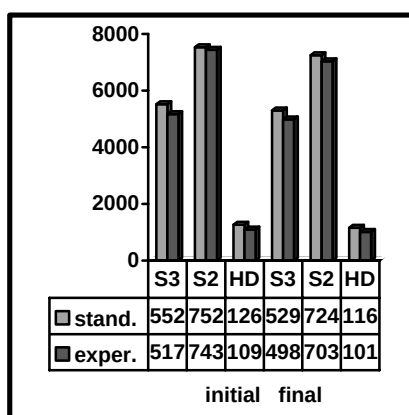
In the motor ability of flexibility (Graph 9) the results of the experimental group were better in both measurements (*bent forward on the bench* - BFB, *straddle sit-and-reach* - SSR, and *shoulder circumduction backwards with a stick* - SBC), they had the desirable statistical significance ($p=.04$ and $p=.00$) only in the final measurement and in favour of the experimental group.

In leg-hand coordination (Graph 10), that is, in the variables *slalom with three medicine balls* (S3B) and *hand dribbling* (HDR), the values were reduced (logically, the better result) in both groups in the final measurement. Significant changes occurred only in the variable *slalom by kicking two balls* (S2B). Namely, in the final measurement significant difference was obtained between two groups ($p=.05$) in favour of the experimental group. In the functional ability of aerobic capacity (Graph 11) no considerable change was obtained after the application of the experimental programme.

Graph 9. Flexibility

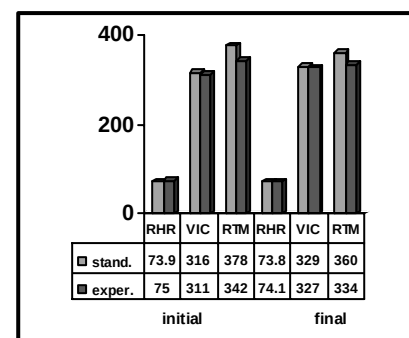


Graph 10. Leg - hand coordination



Only in the variable *heart rate at rest* (RHR) the statistically significant difference ($p=.00$) in favour of the control group, obtained in the initial measurement, was not maintained in the final measurement (it was transformed in the value at the level of $p=.14$), due to the reduced (logically positive) values in the experimental group. In the variable *vital lung capacity* (VIC) the values were evenly enhanced in both groups in both measurements, and no statistically significant difference was obtained between the arithmetic means. In the variable *1000 m running* (RTM) the experimental group maintained the the better and statistically significant values level of $p=.00$.

Graph 11. Aerobic capacity



Discussion and conclusions

It was expected to obtain statistically significant differences in the arithmetic means between the control and the standard group of the boys, elementary school fifth-formers, after the application of the experimental programme based upon sport-specific movement structures (basketball, volleyball, handball, and soccer), in favour of the experimental group both in the entire system of variables (multivariate difference) and in most of individual (univariate differences) morphological and motor and functional variables. The main objective of the research was to utilize multivariate and univariate analysis (MANOVA/ANOVA) in processing of the data collected in the initial and final measurement in order to determine statistically significant differences between the control and the experimental group in arithmetic means of individual variables. Further analysis of the experimental programme should reveal which programme contents induced the greatest changes (differences) in morphological characteristics, as well as in motor and functional abilities, simultaneously having in mind the genetical limitations typical for the children of that age. In the space of morphological characteristics the results indicated that only the entire system of the applied variables contributed equally to the differentiation between the groups in both the initial and the final measurement, due primarily to the fact that the most morphological variables were under the gene control. From the processed data it is obvious that the experimental programme induced somewhat higher values (although not statistically significant) in the morphological variable *forearm circumference* (FOC), probably under the influence of specific techniques of dribbling, spiking, catching and throwing the ball. The only statistically significant difference in arithmetic means between the two groups was obtained in the variable *upper arm skinfold* (UAS), in favour of the experimental group, at the level of $p = .03$. The values were reduced (it is logically better result) in relation to the somewhat reduced genetical component of subcutaneous fatty tissue, probably under the influence of the more efficient general exercise activity. In the space of motor abilities the experimental group achieved statistically significantly better results than the control group in the final measurement only in the variables *foot tapping* (FTA), *standing long jump* (SLJ), *medicine ball throws from supine lying* (MTL), *bent forward on the bench* (BFB), *straddle sit-and-reach* (SSR), *shoulder circumduction backwards with a stick* (SBC), *slalom by kicking two balls* (S2B). This means that the experimental programme, consisting primarily of the sport games' movement structures, produced positive changes in the following motor abilities: speed of alternate leg movements, power (explosive strength) of both the upper and lower extremities, flexibility and leg coordination. From the analysis of individual motor abilities it is obvious that the

experimental programme had the smallest influence on the transformation of body coordination. Namely, no significant differences were obtained between the two groups in arithmetic means of particular variables either in the initial or the final measurement, and, even more, no significant difference in favour of the experimental group, although expected in this research, was obtained in the final measurement, despite the fact that it is well known that body coordination is under strong genetic control. The finding is somewhat unexpected because most of the applied sport games' fundamental techniques are inherently composed of coordinated movements, on the one hand, and because, on the other hand, many coordination-type contents were used in the basic motor preparation (combination of a forward roll and a cartwheel, dive over an obstacle into forward roll, rope jumps and hops - one- and two-legged, various obstacle courses, movements performed according to certain rhythmical or aesthetic criteria). Yet, it seems that not enough effort and/or time was dedicated to improvement of this motor ability, very important in sport games. Much more repetitions under the specific and situation-related conditions is obviously necessary. Statistically significant difference ($p = .01$) in favour of the experimental group was obtained in the final measurement only in the variable *foot tapping* (FTA), assessing frequency of alternate movements. The improvement in the speed of leg movements was probably induced by the contents from football, such as kicking the ball, receiving the ball on move, head shot, catching low, intermediate and high passes and others. The biggest and statistically significant differences in the arithmetic means at the level of $p = .00$ in favour of the experimental group were achieved in the variables *standing long jump* (SLJ) and *medicine ball throw from supine lying* (MTL), used for assessing power (explosive strength) of legs and arms. The differences were probably induced by the following contents: holding, catching and passing the ball; pivots, runner/extended lay-up shot (2-stride run-up for a lay-up, 3-stride run-up for a lay-up), set shooting and kicking and shooting and kicking from moving, punching the ball (spikes), head shots, rebounding, block jumps and others. In the variables *all-out declined sit-ups off the bench* (ASB), *all-out hyperextension on the box* (AHB) and *undergrip chin-ups on the bar* (UCB), which were used to assess strength endurance, the experimental group scored statistically significantly better ($p = .01$ and $p = .00$) in both the initial and final measurement. That can probably be attributed to the fact that the mandatory PE contents were applied in both groups (callinetics in place and on move, carrying each other in pairs and triples, pushing and pulling each other in pairs). The greatest changes in the experimental group were achieved in the variables *bent forward on the bench* (BFB), *straddle sit-and-reach* (SSR) and *shoulder circumduction backwards with a stick* (SBC), which were applied to assess motor

ability of flexibility. In the final measurement the significant differences were obtained between the arithmetic means ($p=.04$, $p=.00$), due primarily to the application of stretching in the preparatory part of the classes/workouts (warming-up) of the experimental programme. Large changes in favour of the experimental group were achieved in the motor ability of leg-hand coordination, especially in the variable *slalom by kicking two balls* (S2B), because in the initial measurement there was no statistically significant difference between the groups in arithmetic means. The statistically significant differences in the final measurement ($p=.05$) in favour of the experimental group can probably be attributed to the technical drills consisting of straightforward and zig-zag dribbling and of feinting in place and on move. In the space of functional abilities no significant changes occurred because the statistical significance of the difference between the initial and the final measurement at the level of $p=.00$ occurred only in the variable *1,000 m*

running (RTM) in favour of the experimental group, probably due to longer (aerobic) running sessions in the introductory part of the classes/training sessions (the so called warming-up), when the subjects were preparing themselves for the main part of a class/training session, as well as due to fartlek up to 300m (continuous running of variable paces), which was a component of the experimental programme. Research results show that the whole system of applied morphological variables has equally contributed to differentiation between standard and experimental groups, due to the fact that most of the morphological variables are genetically controlled. As for the motor and functional abilities, the final measurements in experimental group indicate that experimental program has caused statistically significant changes in motor abilities with seven variables for evaluation of speed of leg movement frequency, leg-arm explosive strength, leg-arm flexibility and leg coordination.

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PROMJENE BIOMOTORIČKIH DIMENZIJA UČENIKA UZRASTA 11 GODINA: EKSPERIMENTALNI PROGRAM SPORTSKIH IGARA U ODNOSU NA STANDARDNU NASTAVU TJELESNOG ODGOJA

Sažetak

Na uzorku od 252 dječaka, starosti 11 godina ± 6 mjeseci, podijeljenih na kontrolnu (CG; $N=127$ subjekata) i eksperimentalnu grupu (EG; $N=125$ subjekata), sistem od 33 mjerna instrumenta je upotrijebljen (12 morfoloških i 21 motorička i funkcionalna varijabla). Cilj je bio odrediti promjene u morfološkim karakteristikama kao i u motoričkim i funkcionalnim mogućnostima kod dječaka nakon jednogodišnje upotrebe eksperimentalnog programa kod eksperimentalne grupe, sastavljene od osnovnih sportskih igara (košarka, odbojka, rukomet i fudbal), i standardnog TO programa, baziranog na statističkom značaju razlika aritmetičkih sredina upotrijebljenih varijabli između kontrolne i eksperimentalne grupe u početnim i krajnjim mjerenjima. Statistički značajne razlike između kontrolne i eksperimentalne grupe u aritmetičkoj sredini korištenih varijabli početnih i finalnih mjerjenja su određene pomoću multivarijantne i univarijantne analize varijance (MANOVA/ANOVA). Izračunate statističke vrijednosti su dale do znanja da u cijelom sistemu statistički bitne varijacije postoje između kontrolne i eksperimentalne grupe u početnim i krajnjim mjerenjima na nivou od $p=.00$. Rezultati su pokazali da su ispitanici u obje grupe bolje rezultate ostvarili na početnom nego na krajnjem mjerjenju u 6 različitih morfoloških varijabli. U krajnjem mjerjenju, nakon eksperimentalnog programa, EG je imala bolje vrijednosti u 8 varijabli (od kojih jedna na nivou $p=.03$), gdje je CG bila bolja u samo 4 varijable. Rezultat pokazuje da samo cijeli sistem primijenjenih morfoloških varijabli podjednako doprinosi diferencijaciji grupa, i u početnim i u krajnjim mjerenjima. U prostoru motoričkih i funkcionalnih sposobnosti ispitanici u CG su bili bolji u 5 varijabli u oba mjerjenja, gdje su ispitanici iz EG bili bolji u 16 varijabli. U početnim mjerenjima 8 individualnih varijabli (od kojih 2 u korist CG i 6 u korist EG), je doprinijelo multivarijantnom statističkom značaju razlika u grupnoj aritmetičkoj sredini na nivou od $p=.00$, a u krajnjem mjerjenju 14 varijabli je doprinijelo statistički bitnoj razlici (od kojih jedna u korist CG i 13 u korist EG). Ovo je pokazalo da eksperimentalni program, sastavljen od strukturalnih kretnji sportskih igara realizovanih u EG, dovodi do statistički značajnih promjena u motoričkim i funkcionalnim mogućnostima izmjerenim u 7 varijabli koje ocjenjuju brzinu rada nogu, eksplozivnu snagu ruku i nogu, fleksibilnost ruku i nogu, i koordinaciju udova.

Ključne riječi: morfološke karakteristike, motoričke sposobnosti, funkcionalne sposobnosti, 11-12 godina, dječaci, učinci vježbi, eksperimentalni program, sportske igre

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ROYAL JELLY AS A SUPPLEMENT FOR YOUNG FOOTBALL PLAYERS

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Abstract

In direct application of scientific discoveries to good quality training process, royal jelly as a supplement is applied as a criterion of positive change in the phase of adaptation and exhaustion of young football players' bodies. Research carried out with 25 FC "Red Star" Belgrade football players, 12 years old, separated in 2 groups. Experimental group (15) took the supplement daily for two months. The control group (10) did not use the supplement. All the examines during the two months had a regular regime of training (4 times per week) and they competed in the youngest Belgrade league. It were observed 13 morphological characteristics in initial and final measuring. On the basis of the research results it could be concluded that football players from experimental group who used royal jelly had statistically significant increase of body height and muscle component, and decrease of fat component in final measurement comparing to the initial. Also, the results show statistically significant increase in circumference above knee and circumference of lower leg in experimental group on the end of the experimental treatment. The examinees from experimental group had higher average values in body height, body mass, muscle and bone component, and lower average value in fat component.

Key words: royal jelly, nutrition supplement, muscle, fat and bone component.

Introduction

Physical activity is an integral part of a person's life and it is a constant battle of man and his environment which starts at his birth. The intensity of the battle grows as man matures and for every age there are specific characteristics. At a certain level of development and training a stressful reaction appears which is constant and has its development phases: alarm phase, adaptation phase and phase of exhaustion. The task of people employed in sports is to teach and prepare the body for creating stronger defense mechanisms for new stress agents. The question is raised how to involve a young body into a sports activity and not to disturb his biological development and, simultaneously, to achieve top results which sport requires. The body not involved in sports satisfies the requirements of normal mental and physical development by daily food intake. However, if the candidate performs increased physical activity, regular and daily food intake cannot be enough for both requirements - food supplements are needed, and those are vitamins, minerals, essential amino acids and an array of other biologically active substances whose task is to satisfy previously mentioned requirements.

Nowadays market offers thousands of remedies which are supposed to help young athletes. Their content and quality vary, from common water to hormonal remedies which can sometimes do greater damage to the body than good. One of those remedies is royal jelly which has positive effect on the body of an athlete and can be used for medical purposes and in medicine it is used from pediatrics to geriatrics. The structure of royal jelly can be used in many body states which we call non-physiological: improvement of heart function, strengthening of immune system, improvement of mental state and mood, strengthening and increase of body resistance, regulation of adrenal gland function under stress, depression relief, fatigue, neurosis, insomnia and the likes, stimulation of functioning of gland with internal secretion, regulation of functioning of all organs and tissues, improvement of convalescents recovery etc. Numerous scientific analysis (Ardry, 1956; Howe et al., 1985; Otani et al., 1985; Takenaka, 1984 and 1987; Schmitzova et al. 1998) show that royal jelly contains all of these substances for which we lobby and which should be taken in any form; they resorb rapidly and are taken to basic units – cells by transport mechanism.

At that level bioactive actions take place. Some research (Johansson & Johansson 1958; Bonomi 1983; Prosperi & Ragazzini 1956; Destrem 1956) followed the effects of use of royal jelly on a sample of adults over a certain period. The following was determined: improvement of heart function and blood vessels, better excitation of nervous system, faster relief of fatigue, shortening of recovery time and other parameters which are significant for achieving results in football. Johansson's research shows that royal jelly has positive effect on intestinal flora and this antimicrobial activity can be explained by PH value activity. The effect of some components on endocrinal glands or their intake and entering the enzyme system which affects the metabolism was investigated by Bonomi in 1983 emphasizing the positive effect. Prosperi and Ragazzini (1956) argue that royal jelly affects the basic state, increases body mass, erythrocytes, hemoglobin (80-100 mg daily). According to Destrem in 1956 royal jelly achieves good effects when 20 mg is injected every day or every other day. Takohashi et al. (1983) point out the appearance of allergic contact dermatitis caused by royal jelly in patients which are sensitive to it. Ardry (1956) thinks that royal jelly influences the body by stimulating the gland with internal secretion, especially the adrenal gland. The subject of research is royal jelly as the supplement in the preparation period with young football players, seventh and eighth grade primary school students and their morphological characteristics.

The basic concern of this research is how efficient the application of royal jelly is as a supplement in the preparation period for morphological characteristics development at the end of experimental period in the process of training work with experimental group. The general aim is to determine the efficiency of application of royal jelly as a supplement for the development of morphological characteristic in the experimental group. A specific goal is to determine the difference at the end of the experiment in morphological characteristics between experimental and control group. Based on the subject, the matter and the aim of the experiment the following tasks were set: a) to determine morphological characteristics on initial and final measurements in experimental and control group; b) to determine the differences in morphological characteristics between initial and final measurement in experimental and control group; c) to determine the differences in morphological characteristics between experimental and control group at the end of experimental treatment.

Methods

Sample of examines

Research was done on a sample of 25 young football players from „Red Star“ football club in Belgrade, 12-year-olds separated into two groups. Experimental group consisted of 15 examines who were taking royal jelly supplement five times a week for two months. Control group consisted of 10 young football players who were not taking royal jelly. All examines were during two months of experiment exposed to regular training (4 times a week) and competed within the Belgrade league.

Variables sample

Research was planned so as to register values of 13 characteristics in observation of all examines at the beginning of research and after two months in order to assess whether there is change in values of observed characteristics within all of the research groups as well as whether there is difference in values of observed characteristics between experimental and control group. The following characteristics of observation were monitored: body height (BH), body mass (BM), muscle component (MC), bone component (BC), fat component (FC), diameter of elbow (DE), diameter of wrist (DW), diameter of knee (DK), diameter of ankle (DA), circumference above elbow (CAE), circumference of forearm (CFA), circumference above knee (CAK), circumference of lower leg (CBK). Anthropometric measurements of morphological characteristics are taken from Kurelić et al 1975.

Determining bone component

Mateigka calculates bone component according to formula: Skeleton mass in grams = body height * K_1 * D^2 ; Body height in mm; K_1 (constant) = 1.2; D = (diameter of elbow + diameter of knee + diameter of wrist + diameter of foot joint) / 4. Relative bone component is calculated according to formula: Relative bone mass = skeleton mass in grams * 100 / body mass.

Determining muscle component

Mateigka calculates muscle component according to the following formula: Muscle component = r^2 * body height * K ; r = mean value of radii calculated from circumference of body segments, and it is calculated according to formula: $r = ((CAE + CFA + CAK + CBK) / 25.12) - ((SCAE + SCFA + SCAK + SCBK) / 8)$, where the abbreviations mean as follows: CAE – circumference above elbow, CFA – circumference of forearm, CAK – circumference above knee, CBK – circumference of lower leg, SCAE – skin crease above elbow, SCFA – skin

crease of forearm, SCAK – skin crease above knee, SCBK – skin crease of lower leg, K (constant) = 6,5. Relative muscle component is calculated according to formula: Relative muscle mass = muscle mass in grams * 100 / body mass

Determining fat component

Mateigka calculates mass component according to formula: Mass component = $d * TP * K_2$; d = mean value of measured skin creases (above elbow, forearm, above knee, lower leg, back and stomach) divided by 12. TP = surface of body in cm^2 , (nomogram for calculation of surface of body Barou and Rozmari 1975, 179, picture 8-6.); K_2 (constant) = 0.13. Relative fat component is calculated according to formula: Relative mass component = fat component in grams * 100 / body weight.

Method of data processing

Research of effects of royal jelly application as supplement in young football players preparatory period was carried out within 32

training sessions over a two-month period for the experimental group, which has used royal jelly as supplement five times a week.

The control group had 32 training sessions as well over a two-month period, simultaneously with the experimental group. The operational plan and program with both groups of examines were the same and they were drawn up in the football club. With both examine groups two measurements of morphological characteristics were performed at the beginning and at the end of the experiment. With the goal of getting statistical analysis of research results a database was formed using statistical program SPSS 11.5 for Windows.

Central and dispersive parameters of attained anthropometrical measurement results for experimental and control group were calculated. Differences in anthropometrical measurements of experimental and control groups were determined by Student's T-test for dependant and independent samples.

Results

Table 1. Descriptive statistical indicators of experimental group examines in 1st and 2nd measurement and differences between 1st and 2nd measurement

Variables		AVG	N	SD	SE	AVG-D	t	df	p
BH	BH I	152,46	15	6,29	1,62	-1,66	6,74	14	0,000
	BH II	154,13	15	6,79	1,75				
BM	BM I	42,95	15	6,45	1,66	-0,35	1,21	14	0,246
	BM II	43,30	15	6,51	1,68				
MC	MC I	41,22	15	3,18	0,82	-2,13	2,67	14	0,018
	MC II	43,35	15	2,16	0,55				
BC	BC I	19,74	15	1,56	0,40	0,27	1,03	14	0,322
	BC II	19,47	15	1,28	0,33				
FC	FC I	16,87	15	4,90	1,26	2,76	5,84	14	0,000
	FC II	14,10	15	3,71	0,95				
DE	DE I	6,35	15	0,63	0,16	-0,029	0,16	14	0,878
	DE II	6,38	15	0,56	0,14				
DW	DW I	4,91	15	0,42	0,11	-0,053	0,93	14	0,370
	DW II	4,97	15	0,34	0,88				
DK	DK I	9,37	15	0,57	0,15	0,087	0,50	14	0,625
	DK II	9,28	15	0,60	0,15				
DA	DA I	6,40	15	0,81	0,21	-0,353	1,87	14	0,083
	DA II	6,76	15	0,26	0,68				
CAE	CAE I	21,79	15	1,72	0,44	-0,61	1,03	14	0,132
	CAE II	22,40	15	1,39	0,35				
CFA	CFA I	20,51	15	1,12	0,28	-0,15	1,00	14	0,335
	CFA II	20,67	15	1,00	0,25				
CAK	CAK I	44,61	15	4,50	1,16	-2,59	2,38	14	0,032
	CAK II	47,20	15	3,86	0,99				
CBK	CBK I	31,45	15	2,04	0,52	-1,20	3,24	14	0,006
	CBK II	32,65	15	2,07	0,53				

AVG = average, N = number of entities, SD = st. deviation, SE = st. error, AVG-D = difference average, t = t-test value, df degrees of freedom, p = probability

Table 2. Descriptive statistical indicators of control group examines in 1st and 2nd measurement and differences between 1st and 2nd measurement

Variables		AVG	N	SD	SE	AVG-D	t	df	p
BH	BH I	158,12	10	4,69	2,35	-0,50	2,45	9	0,092
	BH II	158,82	10	5,02	2,51				
BM	BM I	42,62	10	3,54	1,77	0,00	0,00	9	1,000
	BM II	42,62	10	3,42	1,71				
MC	MC I	43,52	10	3,09	1,54	1,01	0,90	9	0,437
	MC II	42,50	10	1,66	0,83				
BC	BC I	21,34	10	0,56	0,28	1,75	3,03	9	0,056
	BC II	19,59	10	1,19	0,60				
FC	FC I	12,19	10	4,46	2,23	-0,53	-0,70	9	0,535
	FC II	12,73	10	3,42	1,71				
DE	DE I	6,53	10	0,34	0,17	0,22	0,984	9	0,398
	DE II	6,30	10	0,33	0,16				
DW	DW I	4,85	10	0,10	0,05	0,02	0,52	9	0,638
	DW II	4,82	10	0,09	0,05				
DK	DK I	9,47	10	0,25	0,12	0,00	0,00	9	1,000
	DK II	9,47	10	0,46	0,22				
DA	DA I	6,87	10	0,36	0,17	-0,10	0,56	9	0,613
	DA II	6,97	10	0,21	0,10				
CAE	CAE I	20,52	10	1,25	0,62	-0,30	0,59	9	0,595
	CAE II	20,82	10	1,45	0,72				
CFA	CFA I	19,32	10	0,39	0,19	-0,43	1,35	9	0,118
	CFA II	19,75	10	0,59	0,29				
CAK	CAK I	43,02	10	1,98	0,99	-0,60	0,58	9	0,605
	CAK II	43,62	10	0,25	0,12				
CBK	CBK I	31,50	10	1,47	0,73	0,07	0,10	9	0,924
	CBK II	31,42	10	0,51	0,25				

AVG = average, N = number of entities, SD = st. deviation, SE = st. error,
 AVG-D = difference average, t= t-test value, df degrees of freedom, p = probability

Table. 3. Testing significance of difference between experimental and control group

Variables	t-test for independent samples			
	t	df	p	$\bar{X}_1 - \bar{X}_2$
BH	-1,664	23	0,114	-5,66
BM	0,095	23	0,926	0,32
MC	-1,290	23	0,214	-2,30
BC	-1,973	23	0,065	-1,59
FC	1,723	23	0,103	4,68
DE	-0,518	23	0,611	-0,17
DW	0,295	23	0,771	0,06
DK	-0,364	23	0,721	-0,11
DA	-1,108	23	0,283	-0,47
CAE	1,361	23	0,191	1,26
CFA	2,054	23	0,056	1,19
CAK	0,674	23	0,509	1,58
CBK	-0,048	23	0,962	-0,05

Discussion and conclusion

In Table 1 it is noticeable that the average values of body height, body mass and muscle component in the experimental group have increased, the average value of fat component has decreased while the average value of bone component has remained almost the same as at the beginning.

The values of Student T-test show the existence of high statistically significant increase of body height (=1,66cm) and

statistically significant decrease of fat component value (=2,76%) after the two-month consumption of the substance. Statistically significant increase of muscle component value was determined (=2,13%), whereas there is no statistical significance in value of body mass and bone component. Results also indicate that there are no bigger changes of values in circumference of elbow, arm wrist, knee and ankle in examines who have used royal jelly. In Table 2 it is evident that there are no bigger changes of values in body height, body mass, muscle and fat component at the final in comparison to initial measurement with control group. Also, there are no changes in diameter and circumference measures. Results of Student T-test indicate that there is no statistically significant difference of examined traits in the experimental group. Also, it can be seen that there has been a statistically significant increase of circumference above knee (=2,59cm) and circumference of lower leg (=1,20cm) in examines who have used the substance.

Table 3 shows the results of Student T-test for independent samples. By comparison of results at the end of research in the experimental and control group there are no statistically significant difference in measured variables.

However, the examines in the experimental group had, after the two-month substance consumption on average 1,58 cm greater circumference of lower leg than the examines of the control group. In modern football, in the conditions of high intensity game, longer intervals of endurance and shorter intervals of rest, high requirements of anthropological characteristics are set especially for motor and functional abilities and morphological characteristics. The development of listed anthropological characteristics has effectuated in the process of training work in line with individual abilities and football players' characteristics. A number of scientists (Jerković, 1986; Petrić, 1994; Hadžić, 2005; Joksimović, 2007.) point out that for anthropological characteristics development of football players proper methodical formation of training is crucial (planning, programming, control, methods for the development of abilities and other factors). There are almost no research studies which recommend substances to help young football players for the development of abilities and traits and proper biological development of body. In the last few years some researchers (Bonomi, 1983; Takahashi et al., 1983) point out that the royal jelly substance has positive effect on the body of a footballer and it ameliorates the growth and development of the body. In the last few years in the development of football game there have been changes in the

manner and the system of the game which caused the structure of the training process to be innovated by a new and more rational content of work. The modern game requires more dynamics and universal ability of the player in the phase of defense and offence (Joksimović, 2007). That kind of game requires a greater physical ability from the footballer which cannot be satisfied through regular and every day diet. Such cases require so called supplements and those are vitamins, essential amino acids and other biologically active substances, whose aim is to satisfy the requirements of diet in strenuous training process of young football players. With regard to length of experimental treatment (2 months), bigger differences in morphological characteristics couldn't happen.

On the basis of the research results it could be concluded that football players from experimental group who used royal jelly had statistically significant increase of body height and muscle component, and decrease of fat component in final measurement comparing to the initial. Also, the results show statistically significant increase in circumference above knee and circumference of lower leg in experimental group on the end of the experimental treatment. The examinees from experimental group had higher average values in body height, body mass, muscle component, and lower average value in fat component.

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MATIČNI MLIJEČ KAO SUPLEMENT KOD MLADIH NOGOMETAŠA

Sažetak

U neposrednoj aplikaciji naučnih saznanja u kvalitetnom trenažnom procesu matični mliječ kao suplement primjenjen je kao kriterijum pozitivne promjene u fazi adaptacije i iscrpljenosti organizma mladih fudbalera. Istraživanje sprovedeno sa 25 fudbalera FK "Crvena Zvezda" Beograd, starih 12 godina podjeljenih u dvije grupe. Eksperimentalna grupa(15) uzimala je preparat mliječa svakodnevno dva mjeseca. Kontrolna grupa(10) nije koristila preparat mliječa. Svi ispitanici u toku dva mjeseca imali su redovan režim treninga (4 puta nedjeljno) i takmičili su se u okviru pionirske Beogradske lige. U inicijalnom i finalnom mjeranju praćeno je 13 morfoloških obilježja. Na osnovu dobijenih rezultata može se zaključiti da fudbaleri eksperimentalne grupe koji su koristili matični mliječ u finalnom mjeranju u odnosu na inicijalno imaju statistički značajno povećanje tjelesne visine i mišićne komponente, a smanjenje masne komponente. Takođe, prisutno je i statistički značajno povećanje obima natkoljenice i potkoljenice kod eksperimentalne grupe na kraju eksperimentalnog perioda. Ispitanici eksperimentalne grupe su imali prosječno veće vrijednosti u tjelesnoj visini, tjelesnoj masi, mišićnoj komponenti i koštanoj komponenti, a manju prosječnu vrijednost masne komponente.

Ključne riječi: matični mliječ, suplement, mišići, mast i komponente kosti

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THE AUTOBIOGRAPHICAL APPROACH AS A TOOL OF SELF-ASSESSMENT FOR TEACHING SKILLS OF PRIMARY SCHOOL TEACHERS IN THE MOTOR FIELD: THE EXPERIENCE OF CAMPANIA

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Abstract

The results of the data analysis is coherent with the theoretical framework outlined above, which gives the motor laboratory an important role in the university training of primary school future teachers opening further and necessary research perspectives. Particularly, the results of the research require further and deeper inquiries aimed to confirm the methodological and educational effectiveness of the motor-evaluation training laboratory during a degree course, able to bring out the weaknesses and limitations of certain future teachers' motor skills that are essential for an effective didactic action focused on motor activities.

Key words: autobiographical, teaching, skills

Introduction

In Italy, until 1998, teaching in primary school was addressed only to teachers who held a four years course certificate taken at the Teacher-training High School Institutes. In the non-university training of teachers, motor evaluation studies were not included and will-be teachers were not required to conduct experiences on the field, even if they were didactic training and laboratory activities to acquire specific motor evaluation and self-motor evaluation competences. Nowadays, in the Italian schools, graduated teachers who have carried out University laboratory activities meet teachers with a high school certificate who have never done any laboratorial motor evaluation and self-motor evaluation training. They have different experiences in the motor-sports field which contribute to the effectiveness of teaching activities. In 1999/2000 the first four years degree courses were established to teach in primary schools and since 2003, teachers, who got a degree in The Science of Primary School Education, started to teach in primary schools. The degree in The Science of Primary School Education (Law 19 November 1990, n. 341) is the only course that qualifies for teaching in primary schools through a curriculum that includes 240 credits, of which 24 are assigned to laboratories, 36 to training activities and the remaining ones to specific subjects, to thesis and to other educational activities. This course scheduled specific subjects, laboratories and trainings in motor-sports field.

The function of the motor laboratory in the university training of will-be teachers is to realize a formative process bringing out the past motor and sport experiences, making the best of them in a teaching simulation experience (Sibilio, 2002,b), during which motor evaluation and self-motor evaluation competences have to be acquired. Each motor and sport experience of will-be teachers is included in their own portfolio of skills, representing an important support for teaching. The university motor laboratory allowed new graduates to make direct experience of teaching activities analysis, simulation and planning (Sibilio, 2002, a) able to examine and to revise the meaning of motor knowledge, skills and abilities. The laboratory, as a methodology for the training of primary school teachers "in the field" uses process of didactic simulation, analysis and planning in motor sports area. The four-years university training laboratory is aimed to give will-be teachers the tools useful to recognize and evaluate themselves on: Spatial organization, Temporal organization, Spatial orientation, Dexterity, Coordination, Balance.

Objective

The overall objective of this research is to compare the different motor self-evaluation judgments expressed by teachers (currently teaching at school) and by Science of Primary School final-year students about some motor competences required to carry out the motor activities teaching in the primary school.

The specific aim of this research is to analyze the possible relationship between the (university and non-university) training path performed by the primary school teachers in Campania and their motor self-evaluation skill with regard to: Spatial organization, Temporal organization, Spatial orientation, Dexterity, Coordination and Balance. In particular, the research is aimed to verify the methodological and educational effectiveness of the motor-evaluation laboratory for primary school future/will be teachers that is able to bring out the weaknesses and limitations of some future teachers motor skills. These skills are essential for an effective didactic action centered on motor activities.

Methods

The research has been carried out integrating three approaches: theoretical-argumentative, inquiring - Comparative. Specifically, the research programme was made of four phases: Phase 1. It was made a theoretical, historical-scientific reflection upon Italian teachers' training models with regard to knowledge, skills and personal resources required to teach motor and sports activities in the primary school. Particularly, we have focused on university and non-university teaching models defining the different competences in the motor-evaluation field to train teachers to teach children and pre-adolescents motor and sports activities according to the different ministerial programme guidelines for primary schools. Phase 2. It has been used a questionnaire as tool of survey to record the motor self-evaluation judgments related to spatial organization, temporal organization, spatial orientation, dexterity, coordination and balance necessary to teach motor activities in the primary school. Phase 3. It has been carried out a survey to make come out all the judgments related to the perceived adequacy

of teachers with regard to spatial organization, temporal organization, spatial orientation, dexterity, coordination and balance which are necessary to teach motor activities in the primary school. This survey was part of a national research project of initiatives aimed to strength physical motor and sports education, during school time, that involved the Science of Primary School Education Faculty of the University of Salerno and the General Direction of Campania of the Italian Ministry of Public Education, which is responsible for the provinces of Avellino, Benevento, Caserta, Naples and Salerno.

Participants were a sample of 83 primary school teachers, chosen as contact persons for the motor activities in the schools of the region Campania, and 100 final-year students of The Science of Primary School Education Faculty of the University of Salerno (Campania). Phase 4. In the fourth phase it has been carried out a comparative study aimed to relate the judgements expressed by primary school teachers, who were referents of the motor-sports activities and who got a High School certificate, primary school will-be teachers of the schools of Campania (Italy), and final-year students at The Science of Primary School Education Faculty of the University of Salerno, with regard to the self-evaluation of some motor competences required to teach motor activities in the primary school (Spatial organization, temporal organization, balance, spatial orientation, dexterity, coordination).

Instrument

The used tool of the survey was a questionnaire made of 6 multiple closed-answer questions. The questionnaire required teachers to evaluate the adequacy of their own motor skills in the following: spatial organization, temporal organization, spatial orientation, coordination and balance.

The question was the following:

1. The perception level of Spatial Organization is:	A	B	C	D
	Not evaluated	Not suitable	Suitable	Higher developed
2. The perception level of Temporal Organization is:	A	B	C	D
	Not evaluated	Not suitable	Suitable	Higher developed
3. The perception level of Orientation:	A	B	C	D
	Not evaluated	Not suitable	Suitable	Higher developed
4. The perception level of Dexterity:	A	B	C	D
	Not evaluated	Not suitable	Suitable	Higher developed
5. The perception level of Coordination:	A	B	C	D
	Not evaluated	Not suitable	Suitable	Higher developed
6. The perception level of Balance:	A	B	C	D
	Not evaluated	Not suitable	Suitable	Higher developed

Statistical Analysis

The data were statistically processed in order to verify significant differences between teachers of primary school who got a High School certificate and final-year students at The Science of Primary School Education Faculty of University of Salerno. The statistic test used is the two-way chi-square, which made it possible to probabilistically evaluate the hypothesis on a possible relationship between the type of training made by primary school teachers in Italy and their self-assessment ability.

Results

The results have shown that there is a relationship between the type of training done by primary school teachers in Italy and their motor self-evaluation related to the perception of adequacy with respect to the considered variables.

Particularly, with regard to the self-evaluation on dexterity, coordination, balance and spatial organization, the null hypothesis of no significant differences between the two groups has been rejected at 5%, so the alternative hypothesis, according to which the training path done by the participants involved in the research affected the self-evaluation of their motor skills, has been accepted.

(critical) Chi-square = 7,82 Alfa = 0.05, Gdl = 3		
Characteristic	Chi-square	0 Hypothesis
Coordination	7,88	Rejected
Dexterity	9,56	Rejected
Balance	12,24	Rejected
Spatial Organization	10,74	Rejected
Temporal Organization	4,82	Accepted
Spatial Orientation	6,58	Accepted

In the last two cases, the lack of significant differences could be attributed to poor teaching experiences done in the temporal organization

and spatial orientation, as stated by the participants in the introductory part of the questionnaire which investigated the previous motor experience lived at school.

Discussion and conclusion

There are statistically significant differences between primary school high school certificated teachers and students of The Science of Primary School Education Faculty of the University of Salerno concerning the self-evaluation of the level of their motor skills adequacy (spatial organization, temporal organization, spatial orientation, dexterity, coordination and balance) to their educational needs. Particularly, primary school teachers showed a predominantly positive view on their adequacy and the final-year students of The Science of Primary School Education Faculty of the University of Salerno mostly considered these skills inadequate. This difference could be attributed to the different training. As matter of fact, the students, unlike the teachers with the only high school certificate, attended, during their university courses, experience of analysis, planning and simulation (motor laboratories) that have provided them with the tools for a self-conscious and reliable attitude in the self-evaluation skill.

The results of the data analysis is coherent with the theoretical framework outlined above, which gives the motor laboratory an important role in the university training of primary school future teachers opening further and necessary research perspectives. Particularly, the results of the research require further and deeper inquiries aimed to confirm the methodological and educational effectiveness of the motor-evaluation training laboratory during a degree course, able to bring out the weaknesses and limitations of certain future teachers' motor skills that are essential for an effective didactic action focused on motor activities.

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AUTOBIOGRAFSKI PRISTUP KAO SREDSTVO SAMO-PROCJENE VJEŠTINA UČITELJA OSNOVNE ŠKOLE U PODRUČJU MOTORIKE: ISKUSTVO IZ CAMPANIE

Sažetak

Rezultati analize podataka se slažu sa teoretskim okvirom navedenim gore, koji daje motoričkoj laboratoriji važnu ulogu u fakultetskom obrazovanju budućih učitelja otvarajući dalje istraživačke vidokruge. Rezultati istraživanja zahtijevaju dalja i dublja istraživanja s ciljem potvrđivanja metodološke i obrazovne učinkovitosti motoričko-evaluacijske laboratorije za vrijeme trajanja kursa, s mogućnošću isticanja slabosti i ograničenja motoričkih osobina budućih učitelja, koje su ključne za efektanu didaktičnu akciju fokusiranu na motoričke aktivnosti.

Ključne riječi: autobiografski, podučavanje, vještine

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ATTITUDES TOWARD INCLUSION OF PERSONS WITH DISABILITIES IN SPORT ACTIVITIES

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Original scientific paper

Abstract

Research in many countries has shown that the most common barriers to the participation of persons with disabilities in sport, in addition to the lack of previous experience in the sport and the lack of knowledge of how to include a person with disabilities in sport, are social prejudices toward sport engagement of people with disabilities. Bearing in mind the importance of engagement in sport activities for the population of disabled, we aimed to examine social attitudes toward sport engagement of persons with disabilities. The sample included 178 respondents (93 men and 85 women). 45 of respondents are actively involved in sports, 45 are engaged in recreational sports, 43 are not engaged in sports and 45 are parents of children with disabilities. The obtained results show that among people without disabilities prevail indifference, lack of knowledge and negative attitudes toward participation in sport activities of persons with disabilities.

Key words: attitudes, sports, persons with disabilities

Introduction

Persons with disabilities, like other persons, have various needs, desires and goals, among which is a need to engage in sport. Psychophysical engagement through sports and physical exercise have positive influence on physical abilities and resistance of human body, preservation of health and better regeneration of motor functions. Participation in sport is one of the best ways to achieve personal affirmation within family and broader social surrounding. Shephard (1991) and Stewart (1981), have stated that participation in sport contributes to the reduction of anxiety and depression in persons with disabilities, increase their self-esteem and feelings of self-efficacy. In addition, people with disabilities who are involved in sport have more positive perception of their physical health and are at lower risk of chronic diseases, compared to persons with disabilities who do not engage in sport.

Also, according to these authors, sport experience provides an opportunity for the expansion of the network of friends. Research in many countries has shown that the most common barriers to the participation of persons with disabilities in sport are the following: - Lack of persons' with disabilities early experience in sport (this factor depends on whether the disability is congenital or acquired later in life); -Lack of knowledge of how to include persons with disabilities in sport activities; -Lack of financial resources; - Limited-access to information; - Social negative prejudices toward persons with disabilities.

The aim of the research

Given the fact that social attitudes represent one of the important factors that influence the degree of involvement of persons with disabilities in sport activities, we aimed to investigate attitudes of persons without disabilities toward sport participation of persons with disabilities. Attitudes are relatively permanent mental dispositions that are manifested as a tendency to think, feel and act in a certain way in relation to an object. Attitudes include cognitive, emotional and action component. Cognitive component consists of knowledge about the object of the attitude, emotional component consists of feelings toward that object, and action component is the need to act in accordance with the attitude.

Methods

Sample

The sample included 178 respondents (93 men and 85 women): 45 competitive athletes, 45 recreational athletes, 43 non-sporting persons, and 45 parents of children with disabilities. 25.8% of the respondents are under the age of 20, 46.1% of respondents are between 20 and 40 years, 28.1% of the respondents are more than 40 years old. The structure of the sample in terms of level of education is as follows: 20.8% completed primary school, 62.4% completed secondary school and 16.9% completed university or higher education. 37.6% of respondents live in an urban, and 62.4% in a rural community.

Their economic situation 28.7% of respondents estimated as satisfactory, 52.8% of respondents as average and 18.5% as poor.

Procedure

Respondents were asked to complete a questionnaire consisting of 29 close-ended questions.

Results

Familiarity with sport activities of persons with disabilities

Respondents answered questions about whether they had the opportunity to watch sport events in which participated persons with disabilities, to read about them in press and whether they are informed about the existence of sport clubs and sport associations of disabled persons in the country. Percentages of answers to these questions are presented in Tables 1-3.

Table 1: "Have you had the opportunity to watch sport events in which persons with disabilities have participated?"

	Several times	Once	Never
Recreational athletes	33.30%	31.10%	35.60%
Non-sporting	48.80%	23.30%	27.90%
Competitive athletes	44.40%	13.30%	42.20%
Parents	35.60%	31.10%	33.30%
Total	40.40%	24.70%	34.80%

Table 2: "Have you had the opportunity to read in press about sport events in which persons with disabilities have participated?"

	Yes	No
Recreational athletes	37.80%	62.20%
Non-sporting	48.80%	51.20%
Competitive athletes	37.80%	62.20%
Parents	48.90%	51.10%
Total	43.30%	56.70%

Table 3: "Are you informed about the existence of sport associations and sport clubs of disabled persons in the country?"

	Yes	No
Recreational athletes	53.30%	46.70%
Non-sporting	69.80%	30.20%
Competitive athletes	62.20%	37.80%
Parents	62.20%	37.80%
Total	Total	38.20%

Percentage of respondents' answers to the question whether, according to their opinion, sport events in which participate persons with disabilities receive sufficient attention in media are shown in Table 4.

Table 4: "Do you think that sport events in which participate persons with disabilities receive sufficient media attention?"

	Enough	Mostly enough	Not enough
Recreational athletes	42.20%	48.90%	8.90%
Non-sporting	37.20%	48.80%	14.00%
Competitive athletes	35.60%	53.30%	11.10%
Parents	31.10%	66.70%	2.20%
Total	Total	54.50%	9.00%

Opinion about the influence of sport engagement on psycho-physical functioning of people with disabilities. Respondents were asked about the general influence of sport engagement on persons with disabilities, and about its influence on their inclusion into society. Percentages of answers are presented in tables 5 and 6.

Table 5: "What influence does sport engagement have for persons with disabilities?"

	Positive influence	Negative influence	No influence
Recreational athletes	0.00%	6.70%	93.30%
Non-sporting	2.30%	7.00%	90.70%
Competitive athletes	0.00%	6.70%	93.30%
Parents	0.00%	2.20%	97.80%
Total	Total	5.60%	93.80%

Table 6: "Does sport engagement contributes to persons' with disabilities inclusion into society?"

	yes	no	I don't know
Recreational athletes	0.00%	13.30%	86.70%
Non-sporting	0.00%	25.60%	74.40%
Competitive athletes	2.20%	15.60%	82.20%
Parents	0.00%	6.70%	93.30%
Total	Total	15.20%	84.30%

Opinion of respondents on the impact of the participation of persons with disabilities in sport events on the quality of these events.

We asked respondents whether, according to their opinion, persons with disabilities should participate in active sport competitions and whether participation of persons with disabilities in sport events negatively affects the quality of these events. The questions were designed to obtain insight into the views of respondents on whether and how the participation of persons with disabilities in sports events affects the quality and attractiveness of these events. Answers to the questions are shown in the tables 7 and 8.

Table 7: "What do you think about the participation of persons with disabilities in active sports competitions?"

	I support it	I have nothing against it	I do not support it
Recreational athletes	2.20%	48.90%	48.90%
Non-sporting	0.00%	34.90%	65.10%
Competitive athletes	0.00%	26.70%	73.30%
Parents	4.40%	44.40%	51.10%
Total	Total	38.80%	59.60%

Table 8: "Does participation of persons with disabilities negatively affect the quality of a sport event?"

	yes	mostly yes	no
Recreational athletes	86.70%	8.90%	4.40%
Non-sporting	79.10%	14.00%	7.00%
Competitive athletes	75.60%	17.80%	6.70%
Parents	93.30%	6.70%	0.00%
Total	Total	11.80%	4.50%

Readiness for personal engagement in promotion of persons' with disabilities inclusion in sport activities

In order to explore the action component of attitudes towards the inclusion of persons with disabilities in sport, i.e. the willingness of respondents to be involved in promotion of sport activities for persons with disabilities, we asked them whether they would participate in sport activities together with persons with disabilities and whether they would take part in organizing sport events for persons with disabilities. Also, we asked them in which way would they be willing to contribute to the promotion of inclusion of persons with disabilities in sport activities. Percentages of answers to the questions are presented in Tables 9, 10, and 11.

Table 9: "Would you like to participate in a sport event in which are included persons with disabilities?"

	yes	No	yes	no
Recreational athletes	35.60%	64.40%	37,6%	62,4%
Non-sporting	53.50%	46.50%		
Competitive athletes	24.40%	75.60%		
Parents	0.00%	100.00%	0.00%	100%
Total	Total	71.90%	28,1%	71,9%

There is a statistically significant difference in the frequencies of responses of parents who have children with disabilities and other categories of respondents to the question on the willingness to take part in sport events with persons with disabilities, $\chi^2 = 23526$ ($p < .001$). None of the parents of children with disabilities from our sample would like to participate in such events, but 37,6% of other respondents would participate in them.

Table 10: "Would you like to take part in organizing sport events for people with disabilities?"

	yes	I haven't thought about it	no	Yes	I haven't thought about it	no
Recreational athletes	4.40%	71.10%	24.40%	3,8%	66,2%	30,1%
Non-sporting	4.70%	65.10%	30.20%			
Competitive athletes	2.20%	62.20%	35.60%			
Parents	0.00%	42.20%	57.80%	0.00%	42,2%	57,8%
Total	2.80%	60.10%	37.10%	2,8%	60,1%	37,1%

Table 11: "In which way would you contribute to the promotion of sport for persons with disabilities?"

	I would join a group of volunteers	I would financially help	I am not interested in it	I would join a group of volunteers	I would financially help	I am not interested in it
Recreational athletes	43.20%	29.50%	27.30%			
Non-sporting	20.90%	32.60%	46.50%			
Competitive athletes	46.70%	33.30%	20.00%			
Parents	82.20%	17.80%	0.00%	82,2%	17,8%	0.00%
Total	Total	28.20%	23.10%	48,6%	28,2%	23,1%

In table 10, parents of children with disabilities are statistically significantly less frequently willing to take part in the organization of sport events for persons with disabilities compared to other categories of respondents, $\chi^2 = 11,858$ ($p < .01$). Frequencies of answers of parents of children (table 12) with disabilities are statistically significantly different from answers of other respondents, concerning the ways in which they would contribute to the promotion of sport for persons with disabilities, $\chi^2 = 30,369$ ($p < .001$).

Willingness of parents to include children with disabilities in sport activities

We asked parents of children with disabilities how often they practice sport with their child in a free time, and whether they would allow their child to engage in sport activities under the supervision of professional trainers. Frequencies of answers are presented in Tables 12 and 13.

Table 13: "How often do you practice sport with your child during a free time?"

Often	Rarely	Never
40,0%	15,6%	44,4%

Table 13: "Would you allow your child to engage in sport activities under the supervision of a professional trainer?"

Yes	No
8,9%	91,1%

Discussion and conclusion

Previous research has shown that attitudes towards persons with disabilities are mostly negative and that they are manifested in the form of rejection, intolerance and distancing (Hanak and Dragojevic, 2002). Even when a willingness to interact with persons with disabilities is verbally expressed, feelings of

anxiety, confusion and fear prevail (Krahé and Altwasser, 2006; Matejić-Đuričić and Djuricic, 2007), as well as negative prejudices about the behavior, personality and achievements of persons with disabilities (Seifert and Bergman, 1983). Previous studies have examined the general attitude toward persons with disabilities. However, Rosenbaum and Katz (1980) indicate the need to examine attitudes in relation to the specific roles of persons with disabilities in different areas of life. According to our knowledge, this work is the first study that deals with social attitudes toward inclusion of persons with disabilities in sport activities.

Familiarity with sport events in which are included persons with disabilities and attitude towards these events

Although majority of respondents is informed that sport clubs and sport associations of persons with disability exist in the country, they have very seldom or never had an opportunity to watch a sport event for persons with disabilities or to read about it in media. Results show that among subjects from our sample prevail negative prejudices towards such events. A large percentage (95%) of respondents believes that participation of persons with disabilities reduces the value of sport events. Majority of respondents (60% of them) does not support the participation of persons with disabilities in sport events, about 40% declare that they are not against it, and less than 2% support it. In accordance with this, majority of respondents (over 90%) thinks that sport events for persons with disabilities should not get more attention in media.

Opinion about the influence of sport engagement on psycho-physical functioning of people with disabilities

A large percentage of respondents (93.8%) believe that engaging in sport does not have an influence on persons with disabilities, a small number (5,6%) believe that sport affects them negatively, and a very small number (less than one per cent) thinks that practicing sport has a

positive influence on persons with disabilities. Majority of respondents (84.3%) states that they do not know whether sport engagement contributes to the inclusion of persons with disabilities in society, 15% think that it does not contribute to their inclusion into the society, and less than one per cent state that sport engagement is beneficial for persons' with disabilities inclusion into society. These results indicate that among the respondents prevails insufficient awareness about the benefits which sport practicing brings to persons with disabilities.

Readiness for personal engagement in promotion of persons' with disabilities inclusion in sport activities

Majority of respondents state that they would not participate in a sports event together with persons with disabilities. A possible cause of this reluctance are unpleasant emotional states of fear, confusion, and sympathy which prevail in interaction with persons with disabilities (Krahé and Altwasser, 2006; Matejić-Đuričić and Djuricic, 2007, Seifert and Bergman, 1983). The majority of respondents (60.1%) have not thought about participating in the organization of a sport event for people with disabilities, more than one third (37.1%) declared that they would not participate, and a small percentage (2.8%) that they would participate in organization of such an event.. Among parents of children with disabilities, willingness to participate in these events and their organization is statistically significantly lower in comparison to other respondents. We assume that this can be explained by the fact that raising a child with disability requires much engagement that leaves little room for additional activities. Contrary to the findings that most respondents are not ready to participate in a sport event with persons with

disabilities and have not thought about the possibility to engage in organizing such events, the data indicate readiness of the majority of respondents to contribute to the development of sport for persons with disabilities. Approximately half of the respondents (48.6%) is willing to participate in voluntary work, and approximately one third (28.2%) to allocate funds to promote the development of sport for persons with disabilities.

Willingness of parents to include children with disabilities in sport activities

Sports activities with children with disabilities often practice 40% of the surveyed parents. Approximately the same percentage of parents (44.4%) declare that they never practice sport with their child, and 15% that they do so rarely. More than 90 percent of parents is not willing to include their child with disabilities in sport under the supervision of professional trainers. Further research should determine the reasons why parents reject the possibility that their child practices sport under sport coaches supervision.

Among people without disabilities prevail indifference and negative attitudes toward sport events in which participate persons with disabilities. Also, persons without disabilities are not sufficiently informed about positive effects of practicing sport on persons with disabilities.. However, the results reveal the readiness of the majority of respondents to contribute to the promotion of sport for persons with disabilities. Given the fact that social attitudes affect the degree of involvement of persons with disabilities in sport activities, the obtained results are important for planning future programs intended to increase the degree of involvement of persons with disabilities in sport.

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STAVOVI PREMA UKLJUČIVANJU OSOBA S ONEMOGUĆENJIMA U SPORTSKE AKTIVNOSTI

Sažetak

Istraživanja u brojnim zemljama nalaze da su najčešće prepreke za učešće osoba sa invaliditetom u sportu, pored nedostatka ranijih iskustava u sportu, nedostatka znanja i svijesti o tome kako uključiti osobu sa invaliditetom u sport, predrasude prema sportu osoba sa invaliditetom. Imajući u vidu značaj sporta za ovu populaciju željeli smo ispitati stavove osoba bez invaliditeta prema bavljenju sportom osoba sa invaliditetom. Uzorkom je obuhvaćeno 178 ispitanika (93 muškaraca i 85 žena), 45 osoba koje se aktivno bave sportom, 45 osoba koje se rekreativno bave sportom, 43 osobe koje se ne bave sportom i 45 roditelja koji imaju dijete sa invaliditetom. Rezultati dobiveni u istraživanju pokazuju da među osobama bez invaliditeta prevladavaju nezainteresiranost, nedovoljna obaviještenost i negativni stavovi prema sportskim događajima u kojima sudjeluju osobe sa invaliditetom.

Ključne riječi: stavovi, sport, osobe sa invaliditetom

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MODEL AND ALGORITHM FOR HIERARCHICAL ANALYSIS

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Abstract

The aim of this research was to define initial mode, i.e. paradigm for hierarchic identification in arbitrary set of data. Methodological design was organized based on identification of representative object in a total set. Results indicated that relations are in order naturally according to the hierarchic structure and can be recognized. The model limitations are not familiar because hierarchic data structuring, based on internal relations, occurred during many testing situations. Model originality is certain, since its appliance is literally unlimited, and the value of it lies in the building of new foundations towards relation determination based on internal consistency and relations.

Key words: *hierarchy, internal consistency, extremes*

Introduction and problem

The issue of determining objectively present hierarchic structure within any defined set of data has been known in science for a long time (Bonacin et al., 2003; Espinosa, 2007; Ané, 2008). According to standard consideration, hierarchy relation determination is directly connected with distance of the object in multivariate space, which is being solved with different methods that belong to different models. Some of them are taxonomization models – multidimensional scaling, clustering, polar (Bonacin, 2004b). However, as it is well known, conduction of taxonomization can not be objective for two, not so small, limitations. The first limitation relates to the need to define (exterior) criteria depending on the purposes for which this procedure is being conducted for, which certainly leads to acceptable solutions that are not universal or have such intentions. Second limitation is defined with inconvincible determination of existing taxons correct number in a larger initial data entrance, which definitely leads to different solutions regarding individual researchers' affinity, so in the same conditions we obtain a different configuration which often leads to confusion in concluding. For this two reasons, assurance and discovery strength of such procedures is largely contaminated with subjective settings, which means there is no convincing model that can be considered as stable in different conditions. Bonacin et al., (2009) suggested Uditax taxonomization based on type extremization the taxon is formed around and this procedure is currently the most convincing model for distinct taxon optimization, based on object affiliation to one and only one taxon (type).

Model of polar taxons is partly acceptable (e.g. Momirović et al., 1987), but since that is the procedure that allows non null object allocations on more than one taxon and basically it approaches to protocol of latent dimension determination in the space of variables, so it can not be completely considered as taxonomization. In any case, these two models can be accepted as the best procedures for group determination within some more or less compact sample. Existing and much applied procedures of multidimensional scaling, clustering based on criteria and other procedures (Veldman, 1967; Johnson et al., 1992; Tingquan et al., 1995; Bonacin, 2002; Kang et al., 2009) very often show very bad attributes. The most frequent is familiar "drawing" of objects on very small number of taxons, or even on only one derived taxon, which, inspection of initial data proves to be inconclusive and scientifically unsustainable (Gallizo et al., 2006; Jin et al., 2008). On the other side, there are almost no solid procedures intended for hierarchic modelling, especially if we exclude, for that purpose unacceptable factor procedures, which proves there is almost no recording on serious determination of objectively existing levels of hierarchic relations and imagined object/group allocations with arranged relations in scientific literature. For all mentioned reasons there is a need to establish logical paradigm that will define hierarchic analysis procedures, so we would equally support this important domain with solid system tools. Therefore, the aim of this research is paradigm definition, establishing foundations of hierarchic analysis and suggesting operational procedures for that purposes.

Model

The largest number of scientific discoveries in logically-philosophical basis related to hierarchy determination is generally bonded with settings, without some general consensus regarding purpose and existence of natural hierarchic relations issue. Many of these doubts are based on unsubstantiated philosophical thesis that can not endure serious criticism or serious analysis (Bonacin, 2008). Bonacin further (Bonacin, 2004a; Bonacin, 2005; Bonacin, 2006) proved it is possible to establish universal scale where objects can be projected and at the same time, that it is possible to determine Universal comprehension continuum which allocates objects according to perception in some domain (figure1).

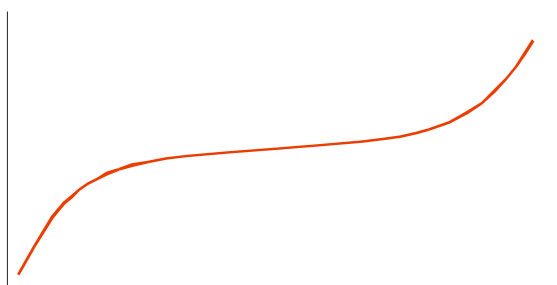


Figure 1. Continuum

Besides, Bonacin proved (2007a) that technical, biological and other processes are unique and universal and are submitted to the same rules, established Unique theory of entity existence and showed (Bonacin, 2008) that, so called, stochastic or "chaotic" models are not persistent. Finally, Bonacin et al., (2003) proved there is General expertise frame which describes discovery and possible hierarchic organizing of any entity according to constructive and destructive processes that actually exist (Bonacin, 2004a).

This is how all basic preconditions were achieved to consolidate necessary discoveries into set of information necessary for hierarchic analysis definition. The main issue that has to be solved is dualities that reflects in a discrete (dichotomy) advents in Universum (Bonacin, 2004b) but are globally generalized according to continuous type (Bonacin, 2004b) of registration. In simple terms, any generalized determination of some large sample attribute leads toward continuous model such is e.g. Comprehensive continuum (Bonacin, 2005) or simple data distribution (Bonacin, 2004b). Hierarchy however, assumes levels, in other words, discrete indicators. So there is unsolved problem of duality which disables logical establishment of serious discussion about hierarchic models.

To illustrate previous, in so called "macro" world there is almost no samples of clear continual advents except for the trace that rotation point leaves on the edge of a circle that rolls on some surface, and that advent is inquiring because of point definition as infinitesimal dimensions that the circle is composed of. We should evidently, search for the solution in some other domain different then mathematical or physical, and that is logical because it is the only one free of any undesired contamination.

Let's assume that somewhere, in any set of epiphany or advent, there must be more then one object. If they really exist, all this objects are different at least according to one parameter, which means it is necessary to determine presence of at least two objects for definition of difference. This follows that number two defines the **difference**. In the same context number 1 is **existence**, since it can not present anything else because in whole Universum there would be one and only one object, if it really exist and there is no other object or we don't know is there any, then we can not conclude anything else about it except that it really exists. In the same way, number 3 presents group i.e. **similarity**, since it is composed of three different objects and each has existence and differences. Further assorting through 4, 5, and further just presents higher degree of complex understanding of advents we are surrounded with, and contain special attributes that are not the subject of this discussion. So as long as there are two objects, there is some kind of difference.

This rule as any other (1, 2, 3 ...) remains even when the number of objects increases. Therefore, between the objects, whose existence we determined, are similarities and differences and everything else what was previously defined. It is obvious that similarities consider certain level of compatibility according to some parameters, and the differences certain level of incompatibility according to these or other parameters. When the number of individual objects in some set grows, if the level of similarity between some objects is greater regarding level of differences regarding other objects, it is clear this leads to formation of more or less homogeny sets gathered around typical – **representative**. However, further increase of the number of objects in some set will lead to assorting of all relations, not only to a set formation. Having in mind that sets "comprise" certain comprehensions (even though, immanently according to representative) it is clear that these comprehensions will vary from group to group.

So, if there are more individual objects as well as many groups, further relation assorting, just because of present differences, will lead to positioning of these groups on a different **levels** and then we face formation of hierarchy. This means "vertical" structuring is a natural flow, since it's certain that extreme difference with at least two groups means one group with a few and one group with many comprehensions. Regardless relations between groups, it is certain that the group with the most comprehensions in some domain (superior) will start domination in one way or another, while the other one will be inferior, which produces, at least, two levels.

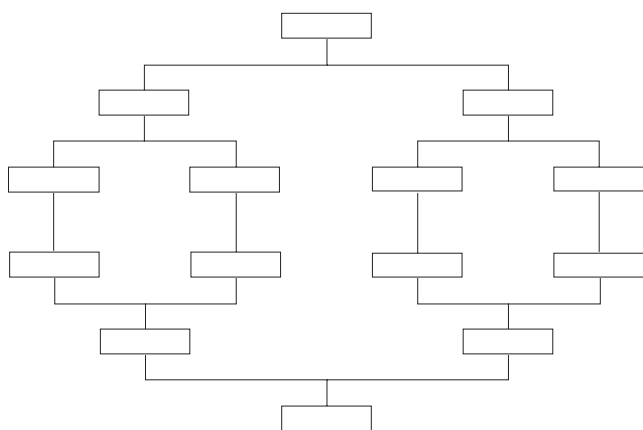


Figure 2. Logical model of hierarchy

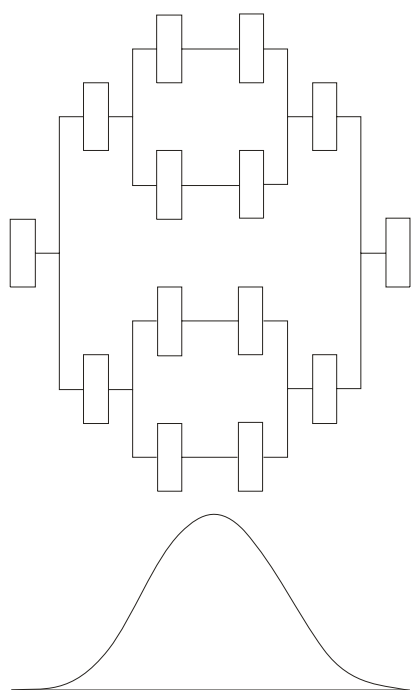


Figure 3. Normal distribution

Within each of these levels, objects are gathered on the same level and, according to the same logics, can be repositioned into inter-levels all the way to desired accuracy level.

This certainly defines hierarchy, which means that the problem of hierarchic analysis can be solved with identification of extreme representatives that gather such groups, which is mathematically relatively easily solved problem. It is also obvious there will be a small number of extremely superior object, which defines the top of the structure, but according to logical distribution it should be the same with extremely inferior (figure 2). As we can see from figure 2, maximum density of the object is in the middle and decreases towards the top and bottom. If we rotate figure 2 for 90 degrees it perfectly represents normal distribution (Bonacin, 2007b) which is almost always the rule when we talk about representative samples (figure 3).

If we assume that the objects are not static in development, but have **dynamics in development**, we will discover they can change their position within somehow defined "space". This enables us to, applying appropriate methods; determine their actual position, as well as previous and future states. This means that described protocol is applicable in any situation where we determine structure about some state and equally applicable if we determine changes in a structure influenced by any impact on objects in a certain time or under the influence of any comprehensions that eventually change their current position, which is undoubtedly extremely powerful tool in science and scientific methodology.

Algorithm

The procedure MOHA comprise of a few phases. In **the first phase** we find at least two objects mutually extremised in the set of objects described with a set of any variables that were previously assorted according to the rules of measuring theory (Bonacin, 2004b; Bonacin, 2009). In the **second phase** all other objects are joined with these representatives and we make (at least) two mutually extremised groups that represent basic levels (superior and inferior). In all previously described procedures and all analyzed situations, there were always identified superior and inferior objects and there is no doubt that the procedure is well founded, regardless of the way representative was determined by (which is possible to define in different ways).

In **the third phase**, each of these groups is dividing, according to the same principle, until the final set of levels is achieved. In **the fourth phase** we identify each object in accordance with its level and pertinence to the unique subgroup on the level of its belonging. This is how we defined hierarchy this article is describing.

Evidently, the algorithm is extremely simple and the procedure for uncovering extreme representatives is the same one used in Uditax model of distinct taxon analysis (Bonacin et al., 2009) with the only difference being the complete relaxation of maximal representative number in the sample described with many variables. Finally, we describe each identified subgroup in the frame of each level with the help of elementary statistic indicators and it is also possible to determine differences among such formed groups for more accurate determination of details depending on the problem that is being analyzed.

Example and methods

The sample of 249 first grade pupils from elementary school was described with 26 bio-motor variables in order to determine their basic bio-motor status. This set included 14 variables for morphological status description and 12 for motor- functional status description. The sample and variables were previously described in details (Bonacin, 2004a). Out of many derived results, in regards to this work, we presented only the ones that describe final elements of hierarchic analysis. All data was brought down to universal scale (Bonacin, 2006) in the range from 1 to 5 with no information loss on the correlation between objects and variables (Bonacin, 2004b).

Results, discussion and conclusion

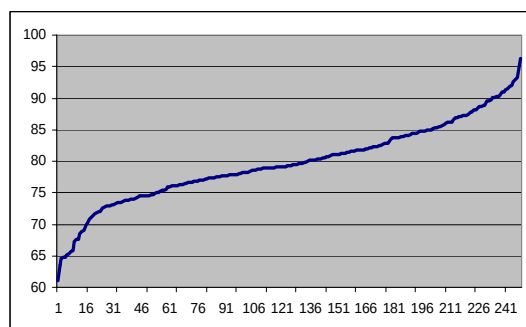


Figure 4. Sample continuum (on ordinate there is a sum according to universal scale)

After the procedure was conducted, extreme entities were identified (D095 as superior and E136 as inferior entity). Their values according to individual variables were presented in Table 1. With the procedure of joining other objects we obtained two sets of objects; the group of inferior includes 132 and the group of superior 117 objects. In the next step, 132 objects were "divided into layers" in the same way and we obtained 51 inferior and 81 superior object. The set of superior objects was also "divided into layers" and we obtained 67 inferior and 50 superior objects within this set.

The final result for 6 levels resulted in a structure where the representatives are the objects with global values as shown in table 2 in 10 groups.

Table 1. Values of extreme object per individual variable

	E136	E095
Var1	1.86	2.73
Var2	2.59	3.08
Var3	2.22	3.03
Var4	2.12	3.05
Var5	2.38	3.27
Var6	3.75	4.84
Var7	2.19	3.89
Var8	2.38	2.96
Var9	2.40	3.40
Var10	3.12	3.74
Var11	2.64	3.35
Var12	2.70	4.50
Var13	3.29	4.57
Var14	3.80	4.49
Var15	2.77	4.45
Var16	2.74	4.72
Var17	1.63	3.23
Var18	2.06	3.68
Var19	2.00	2.14
Var20	2.46	2.85
Var21	1.79	4.81
Var22	1.00	4.40
Var23	1.72	4.88
Var24	1.82	3.67
Var25	1.08	2.05
Var26	2.55	4.50

Table 2. Representatives, their values on global indicator and objects in the group:

Object	Global	Sample
E136	64.80	10
E009	69.27	9
E186	73.47	32
E194	76.49	37
E134	78.71	44
E249	80.99	35
E041	83.65	32
E059	86.61	27
E078	89.78	13
E095	92.48	10

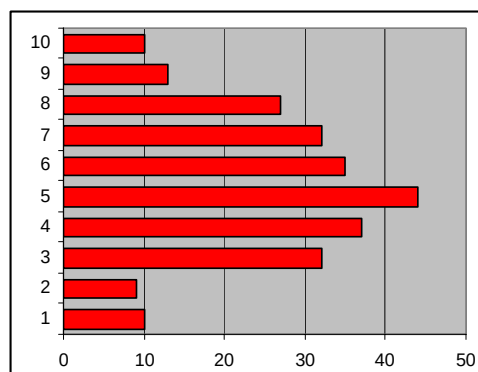


Figure 5. Sample distribution

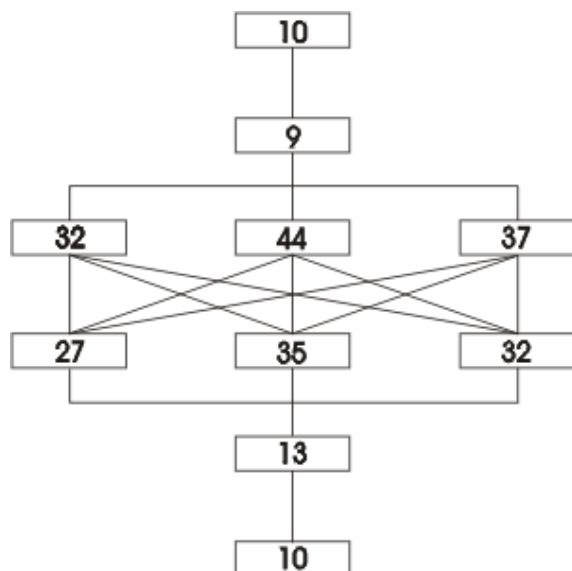


Figure 6. Final solution with number of group members

According to the results in Table 2 it is obvious there are differences in the sample. There are fewer objects on the outsides and more objects in the middle (figure 5).

It is also obvious that objects (as well as groups) are assorted according to an increasing range, resulting E136 as the most pronounced object in inferior, and E095 in superior. According to figure 6 it is evident that the preconditions and goals of this article are achieved. Also the hierarchic structure of the sample based on internal consistency of all data was identified. It is visible that the levels are clearly identified, as well as the number of object that belongs to a certain group. Certainly, the identification of each individual object or group is possible in the variable field, as well as analysis of difference and discrimination among the groups. Since this was not the intention of this article, these results are not significant, even though the inspection of individual and group indicators can be performed. Evidently the results on the complex sample with 249 objects explained with 26 variables indicated that hierarchy determination without an "outside" criteria parameter is possible. Of course, the real strength of this protocol will be confirmed through time and number of successfully solved models of hierarchic structuring in scientific research where this protocol is applied.

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MODEL I ALGORITAM ZA HIJERARHIJSKU ANALIZU

Sažetak

Svrha ovog rada bila je definiranje početnog modela, tj. paradigme za identifikaciju hijerarhije u proizvoljnom skupu podataka. Metodološki dizajn organiziran je na temelju identifikacije reprezentativnih objekata u totalnom skupu. Rezultati su pokazali da je hijerarhijska struktura prirodni redoslijed odnosa i da ju je moguće prepoznati. Ograničenja modela nisu poznata jer je u više testnih situacija uvijek dolazilo do jasnog i uvjerljivog hijerarhijskog strukturiranja podataka temeljem internih relacija. Originalnost modela je nedvojben, jer je njegova primjena doslovno neograničena, a vrijednost je naročito u postavljanju potpuno novih temelja utvrđivanju relacija temeljem interne konzistencije i relacija.

Ključne riječi: hijerarhija, interna konzistencija, ekstremi

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RELATIONS BETWEEN MOTOR ABILITIES AND JAVELIN THROW RESULTS OF ADOLESCENTS

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Original scientific paper

Abstract

The common aim of this research is directed to identifying significant relations between 12 standard composite motor tests as predictors (Kurelić et al., 1975) and situational-motor abilities of javelin throw, as criterion. Achieved values of central tendencies measures, variability and measuring results distribution shape, have suggested on the sample of male adolescents ($N=164$), age between 15 and 16, that majority of used motor variables statistics do not significantly differ from the Gauss' theoretical normal distribution of the frequency of results. Results of the multiple regression analysis have suggested: (a) statistically significant positive stochastic linear correlation of high intensity between predictor variables of criterion variable, where predictor has interpreted 37% of common variance criterion proportion; (b) statistically significant positive partial contribution in interpretation of total variability of criterion variable, giving relevant non-zero regression BETA coefficient of the following predictor variables: 20 meters sprint from a flying start ($\beta=.22$; $p<.02$), triple jump ($\beta=.31$; $p<.05$), long jump ($\beta=.19$; $p<.01$), split ($\beta=.27$; $p<.01$), one-leg standing on the balance bench, with the open eyes ($\beta=.21$; $p<.03$) and mixed chin-ups ($\beta=.17$; $p<.03$).

Key words: adolescents, motor abilities, multiple regression analysis

Introduction

Attaining the high-level sport results is increasingly caused by the implementation of science, especially in sport selection, defining the training operators, dosage and recovery of sportsmen, methods of training and programming sport shape, in the 21st century. Thus, the primary task of the researchers is to identify the dominant, hypothetical, motor abilities, which determine achievement of the best results in a sport discipline, using scientific, multidisciplinary procedures. Therefore, in sport it is especially significant to determine the equation of specification by the adequate mathematics and statistic methods, or in other words, hierarchy of success determinants, as a predictive value of the motor abilities for realisation of the results, being the highest-ranking. Its basis relies on multivariant linear regression pattern, which defines the criterion, i.e. the sport success in the individual sports. The javelin throw is popular athletics throwing discipline, structured from complex movements and motions. According to the Bonacin Da and Smajlović (2007) research, model of kinematics analysis of the final phases of composite javelin throw hypothetically integrates 5 factors (static stability, dynamic stability, object control, stability of center diameter and general dynamic stability of javelin thrower).

From the ballistic aspect, in order to achieve as higher reach of a oblique shot as it is possible (throwing an object), in the stages of delivery and flight, the javelin thrower has to activate muscle power as much as it is possible, in the shortest period of time, so as to produce the greatest initial speed in the optimal elevation angle, that is to say to replace energy from the body to the force of delivered instrument. In relation to the fact that sportsman represents the complex and dynamic system, which is integrated out of the particular subsystems of anthropological abilities, managing his training process and achievement of the high-level results primarily demands identification of the correlation-regression aspects of his motor and situational-motor abilities (Harasin et al., 2003; Bonacin Da. & Smajlović, 2007). It is assumed that the generators of motor factors are neuroendocrine, physiological, regulatory mechanisms, i.e. hierarchical devices of the central nervous system, which induces and retracts the secondary and tertiary level, regulating and controlling the cybernetics wanted, exiting state of the motion structures of the willing moves by its laws. Kurelić et al. (1975) define (on the theoretical level) functional-phenomenological hierarchical motor model, which is made of 4 fundamental motor dimensions: 1) **mechanism used for structuring of motion** – «in charge» with the shape and achievement of the whole body

motion coordination primary factor; 2) **mechanism for synergy and tonus regulation** – «in charged with» the course, volume and intensity of the activation and deactivation of antagonists and agonists primary balance factors motor units, pace of the alternative motions and flexibility; 3) **mechanism for regulation of excitation intensity** – «in charged» with the concurrent activation of the maximal number of motor units, along with the fulfilled or attempted motions of the explosive strength primary factor; 4) **mechanism for regulation of the excitation duration** - «in charged» with the most convenient exploitation of energy potentials during lasting labour of general, repetitive and static strength primary factors. The mentioned authors assume that the linear correlation of mechanism, for structuring the motion and mechanism for the synergy and tonus regulation, structures GENERAL FACTOR OF CENTRAL MOTION REGULATION, while the mutual dependence of mechanism for the intensity excitation regulation and mechanism for the duration excitation regulation structures GENERAL FACTOR OF ENERGY REGULATION. Initial research of the theoretical dominant background of motor abilities, using the multivariant analysis, was conducted by Strum, Horga & Momirović (1975), on the sample of 693 male examinees, at the age of 19-27. They analyzed relations between 75 motor measure instruments. Statistically significant and high linear correlation between factors of the structuring motion, and the excitation intensity regulation was achieved and explained by the influence of a hypothetical general functional mechanism. Hošek (1976) examined hypothetic factors of the motion coordination on the representative sample of male examinees (N=693), at the age of 19 to 27. In the level of the secondary importance, a general factor was extracted and interpreted as a functional mechanism responsible for integration and coordination of the devices used for forming, control, adaptation and realization of the kinetic programs, as well as 3 factors of the motion coordination (ability of the rhythmic structures realization, timing and coordination of the distal parts of the lower extremities). Naumovski (1984) deduced, according to the achieved coefficient of multiple .38 correlations, connection between the predictor systems of the motor and criterion variables (performing sport elements) on the level of .02 statistical significance, on the sample of 211 pupils, at the age of 15. The greatest partial contribution on the criterion variable variance have triple jump with no running start and agility on ground, as well as functional mechanism for the intensity excitation regulation and the functional mechanism for motion structuring.

Ivanovic (2001) extracted, on the sample of 154 pupils at the age of 12, using the multivariant analytical procedure, hypothetical five-dimensional model of fundamental factors, defined as: 1) speed alternative movements and static strength, 2) repetitive strength, 3) explosive strength, 4) flexibility. 5) movement coordination. Bošnjak (2005) deduced relations between motor abilities and the javelin throw results, on the sample of 150 male pupils, at the age of 15-16, according to the 28 applied measuring instruments. According to the Ivanović research (2008), on the adequate sample of (N=125) basketball player cadets, at the age of 16, using the system of 19 motor energetic regulation tests and the systems of 15 motor tests of the situational efficiency, general factor for the energy regulation (functional mechanism for the excitation duration regulation and functional mechanism for the excitation intensity regulation) was extracted. By the review of these relatively rare studies, dealing with the linear mathematical functions of the motor variables predictor systems and criterion variables, the relevant initial information about their cause and effect relations, as well as the positive and negative influences of the predictor motor variables systems on the variance, was achieved. Also, the lack of adequate methodological procedures and measuring instruments, as well as the theoretical unacceptance of mutual influences of the motor structural components and attempts of construction of the rational applicative model of motor tests, has been distinguished, in order to achieve the valorisation degree of development and the motor subspaces predictions of the examinees. Nevertheless, regardless of the mentioned methodological omissions and variations, the previous results of the motor domain have enabled significant contribution, which is related to the successful prediction of the motor abilities relations, as well as the achievement of the optimal result success of examinees. Considering that the correlation-regression relations of the basic motor abilities (as the predictors) of adolescents, as well as their partial influence on the situational-motor ability of the javelin throw (as the criterion), have not been researched enough, it is of great importance that this **basic problem** should be examined using the empiric and multidisciplinary researches.

Aims

According to the basic problem of this research, and the inspection of this referent literature, **the general aim**, being directed at the determination of relation between the basic motor abilities) and the javelin throw), was determined in this empirical research.

The concrete aim of this research represents determining relevant partial influence of the predictor variables on criterion variable. Taking into consideration that the general aim of this research, **the general hypothesis (H)**, has been determined, significant relations of the predictors (the group of applied motor variables) and the criteria (situational-motor abilities of the javelin throw) are expected.

According to the general aim and findings of the previous studies, two **partial hypotheses** have been determined and defined in the following manner: **h1** - *It is expected that the most of descriptive statistics applied to the variables do not significantly vary from the Gauss' law of the normal distribution frequency results.* **h2** - *The significant partial influence of some applied motor variables (as predictors) on the situational/motor abilities of the javelin throw (as criterion) has been expected.* Testing of the statistic hypotheses will be determined along with the critical conventional p-value ($p < .05$), i.e. along with the probability of error, being less than 5%.

Methods

Sample of examinees

Sample of the examinees has been derived from the population of 164 male examinees, at the age of 15 and 16. Selected pupils of the 1st grade of the Technical school in Valjevo, which is the center of Kolubara district in Serbia, have been trained in the javelin throw on their physical education classes, in the period of 10 school classes. In every composite test, before the official measuring, the examinees had an experimental attempt to perform the adequate motor task.

Research data have been collected during the March of 2009.

Variables

According to the most commonly applied hypothetical model of motor structure (Kurelić et al., 1975) those variables were applied: agility on the ground (KOKRETLU), leg tapping (TTNOGZID), arm tapping (TTAPRUKA), deep forward bend (GDUBPRET), split (GSPAGAT), one-leg standing on the balance bench (R1UZDOTV), 20 meters flying sprint (ESPRINT20), triple jump (ESTROSKO), long jump (ESKOODAL), sternal chin-ups (SVISZGIB), body lifting on the Swedish bench (SDIZTRŠK), mixed chin-ups (SMESZGIB). Criterion variable (BACK) has been determined by the help of the motor test for the evaluation of the javelin throw (600g) which belongs to the group of athletics throwing disciplines.

Data processing

The analysis of frequency results distribution has been performed according to the calculated standard parameters of the descriptive statistics (average, minimal result, maximal result, standard deviation, asymmetric or curve coefficient (SK) and flatness or roundness coefficient (KU). In order to deduce the relevant mutual relations between the predictor variables and criterion variables, the classic algorithm of the multiple regression analysis has been applied. Before the beginning of the multivariant analysis of data, the raw results have been transformed into z-results. Software „STATISTIC FOR WINDOWS“, version 5.0 was used for the statistic processing.

Results

Table 1. Testing of descriptive characteristics of the motor variables distribution

VAR.	X	σ	MIN	MAX	SK	KU
KOKRETLU	3.98	0.51	2.99	6.24	1.01	3.36
TTNOGZID	33.01	4.02	23.87	45.92	0.41	2.69
TTAPRUKA	37.96	5.95	23.97	53.89	-0.09	-2.30
GDUBPRET	21.00	7.99	1.98	43.88	-0.23	2.71
GŠPAGAT	175.94	13.02	145.22	200.78	-0.13	-2.64
R1UZDOTV	17.01	1.69	5.23	58.03	2.04	3.06
ESPRINT20	2.77	0.29	1.95	3.77	0.51	-2.84
ESTROSKO	226.69	28.06	3.95	69.84	0.49	-2.53
ESKOODAL	150.05	8.33	1.38	24.94	-0.16	-2.72
SVISZGIB	28.00	17.01	0.00	84.02	0.51	-2.69
SDIZTRŠK	13.91	7.49	0.00	34.00	0.51	-2.89
SMEŠZGIB	22.04	5.02	11.99	34.87	0.49	-2.78
BACK	22.40	5.11	11.93	34.87	0.48	-3.05

X- average, σ – standard deviation; Min. – minimal result; Max. – maximal result; Sk – coefficient of normal distribution asymmetry; Ku – stretch coefficient or peak of the roundness of the curved line distribution

Table 2. Regression analysis of motor (predictor) variables and javelin throw criterion variables

VARIABLES	Beta	p-level
KOKRETLU	-.49	.48
TTNOGZID	-.05	.76
TTAPRUKA	.28	.82
GDUBPRET	.48	.61
GŠPAGAT	.27	<.01
R1UZDOTV	.21	<.03
ESPRINT20	.22	<.02
ESTROSKO	.31	<.05
ESKOODAL	.19	<.01
SVISZGIB	-.03	.77
SDIZTRŠK	.19	.85
SMEŠZGIB	.17	<.03

R=.69 R²=.37 P=.03

In the table 1, the measures of the central tendency, variability and the measures of the distribution shapes of measuring results on the analyzed sample of examinees are given. In the majority of the applied variables, range between the minimal and maximal quantity of the value is bigger more than a five times from achieved values of the standard deviations. This indicator stresses the standard discriminative (sensitivity) characteristics of the motor measuring instrument and distinction between the examinees according to their measuring results, by the help of the manifest variables system. The values of the standard deviation, which are very low in the comparison with the values of the average values, have been observed by the overview of the matrix field. That indicates minimal differences, that is to say variability of original average results. Mutual relations between average measures and dispersion measures bring attention away from the ratio of the sum of the value of every single variable and total number of examinees, on the level representing clear balance of all applied variables, to the variability of the original results. Checking of the statistic hypothesis about correspondence between the empiric data and Gauss' theoretical curved line, has been realized with the help of the standard coefficient of asymmetry distribution (*Skewness*) and the homogeneous measures of distribution (*Kurtosis*). By observing the achieved asymmetry coefficient values – skewness – (the lateral deviation) derived from the normal distribution, it can be concluded that out of the 12 applied variables, in 11 of them the curved frequency has not suggested statistically significant variation from the theoretically normal distribution, since the values of these statistics do not exceed marginal (critical) value, larger than 1.00. This shape of distribution of the frequency results stochastically points out that applied standard composite motor tests are not complicated for the examined sample, so that they can discriminate in a right way most of adolescents (there is no curved line stretching – kurtosis). However, as far as variable *one-leg longitudinal standing on a balance bench with open eyes* ($Sk=2.04$) is concerned, the significant positive asymmetry of the frequency distribution is emphasized, i.e. results moving into the right side of the coordinate system horizontal axis. Statistical proof that achieved curved line has the normal (mesokurtic) results distribution frequency, concerning motor variables, also affirms calculated measure indicator of the distribution homogenous, kurtosis coefficient, which value is around 3.00. Achieved measures of the central tendency and variability **affirm the tested partial hypothesis (h1)** in this quantitative research, at the level of the significance ($p<.03$).

The multiple correlation coefficient that has been adduced in the table 2 is .69, indicating that the linear regression between all 12 motor predictors and criteria is of relatively high intensity and positive direction, at the level of the statistical significance ($p<.03$). Achieved stochastic linear function of the correlation of predictor and criterion variable brings attention to the higher precision of their mutual relations, since their results are less scattered around the regression straight line, while the value of **the multiple determination coefficient or the square of the multiple correlation coefficient** ($R^2=.37$), which represents the proportion of the predictor variability variable, being explained by each criterion variable, can explain 37% of the total variance criterion proportion (situational-motor abilities of the javelin throw). On the other hand, the coefficient of the non-determination hypothetically indicates that 63% of the total variability proportion cannot be interpreted, unless it has been determined by the predictor variables. Therefore, from the regression aspect, this unexplained residual sum of the square exceptions to the average cannot be attributed to the influence of the «independent» variables, but probably to the effect of a case, specific variations and influences of some unresearched variables to the «dependent» variable, not being included in this empirical research.

Discussion and conclusion

Summarizing achieved relevant values of regressions, the tested **general hypothesis (H)** has been **confirmed**. By referring to the positive values of standard **partial regression BETA coefficients**, and their statistically significant p-value in the matrix, it is discovered that 6 «independent» variables, topologically located into the caudal extremities which are under the influence of **functional mechanism for the regulation of intensity excitation**, have statistically significant positive partial influence on the variability of the «dependent» variable which are: 20 meters sprint in the flying start ($\beta=.22$; $p<.02$), triple jump without running start ($\beta=.31$; $p<.05$) and long jump without running start ($\beta=.19$; $p<.01$). The effect of this dominant predictor – primary factor of the explosive strength in the functioning of the central nervous system – during performing motor tasks, has been demonstrated by: Korogodskij (1981) and Hraski, Mejovšek and Antekolović (2003). This means that the explosive strength, or in other words the ability to exert maximal energy in one movement during the shortest time interval, is particularly important in the phase of the javelin delivery greatest acceleration.

At the position of «tense arch», when the kinetic chain of the muscle skeletal system arm-javelin is performed by the elbow up and forward under the throwing object, and then it is energy extended using the «whip» movement. Therefore, according to the achieved significant non-zero values and indicators of partial regression BETA coefficients in the regression motor level, it can be determined (at the hypothetical level) that the latent generator is **functional mechanism for the intensity excitation regulation**, being statistically the most significant, and in that way it can be successfully used in selection and training processes of the javelin throw. Achieved regression aspects about prediction of the hypothetical intensity excitation mechanism on the results in the javelin throw (BACK) in this research are also supported by the results of some researches. For example: Verhosanski (1979) has earlier indicated the development of hypothetical level of functional mechanism for excitation intensity. He states that «in training with the javelin throwers of the special importance is plyometric training method, by the use of which the explosive strength and reactive abilities of muscle-ligament system, i.e. elastic strength», is successfully increasing. Also, in the field of matrix, it is observed that linear function of two predictors – split variable ($\beta=.27$; $p<.01$) and one-leg longitudinal standing with the open eyes on the balance bench ($\beta=.21$; $p<.03$), which is under the influence of hypothetical **functional mechanism for synergy and tonus regulation** – give statistically significant partial share in the interpretation of total variability in the criterion variable.

In accordance with the expectations, determined dominant relativity of positive indicator of this primary motor factor of flexibility in predicting the results during the javelin throw corresponds with Bompá research (1985). He stresses the role of the latent elasticity dimension, i.e. engagement of the quadriceps muscles of the takeoff leg in phase of the longest accelerating crossover, while overtaking the javelin in the sagittal level and initiating some body parts amplitudes, in the phase of withdrawal and body movement while throwing the javelin aslant in comparison to the Earth surface. In the end, insight into the partial regression BETA coefficient of mixed chin-ups variable ($\beta=.17$; $p<.03$) into the data matrix, brings attention to the positive significant influence of hypothetical **functional mechanism for excitation duration regulation** on the successful prediction of the javelin throwing, in other words, the duration of dynamic muscle contractions.

According to the achieved positive direction and dominant values of partial regression non-zero BETA coefficient in regression motor level, it can be expected that the **examinees, who have higher degree of primary factors (explosive strength, elasticity and general strength), will achieve better results in criterion variable (BACK)**. On the other hand, achieved **zero partial regression coefficients** probably indicate to the fact that the causes for insufficient prediction of functional mechanism variables for structuring result changes in the javelin throwing (BACK), should be hypothetically found in minimal adoption of complex javelin motion structure.

This is probably also the factor, which causes that all examinees have insufficient engagements of the secondary level factors (movement coordination of the whole body and speed of alternative movements) for optimal functioning of all body parts. This statement is in correspondence with the Milanović research (1997). He assumes that the result of complex motor structures, that is to say results of the performance of examinees throwing crossover by which we can achieve the greatest overtaking acceleration of the system thrower-javelin, is mostly conditioned by maximal performing speed of the motion of the whole body in which movement coordination of the complete body size dominates. After the attained findings of the relevant partial regression BETA coefficients, it could be statistically concluded that **the tested partial hypothesis (h2) is acceptable**. According to the applied methodology and multiple analysis of relevant data in this empirical research, the following conclusions are derived: 1) Most of the applied standard composite motor variable parameters do not vary from statistically significant Gauss' theoretical distribution of frequency results; 2) The results of standard multiple regression model have suggested the significant and high stochastic linear correlation between the group of predictor variables (motor abilities) and criterion variables (situational-motor abilities in the javelin throwing), as well as relevant proportion of 37% of total interpreted variability of the criterion variable variance, according to the system of predictor variables in the population of examinees; and 3)

Structure of regression linear function suggested significant predictors: 20 meters sprint from a flying start (**explosive strength**), triple jump and long jump without running start (**explosive strength**), split and one-leg longitudinal standing on the balance bench, with open eyes (**flexibility and balance**), mixed chin-ups (**general strength**).

Those variables give statistically significant partial contribution to the prediction of the total «dependent» variable variability. All above mentioned variables are under the influence of 3 hypothetic functional mechanisms: a) **excitation intensity regulation, b) synergy and tonus regulation and c) excitation duration regulation.** Thus, it is necessary to affect these significant latent generators in order to improve predictive functioning of examinees to the criterion variable (BACK). This kinesiological research was conducted on the relatively small sample of examinees. However, regardless of the mentioned limit which reduces level of interpretation and generalization of the achieved data, translated relations confirm author's hypothesis about significant multidisciplinary calculation of this relevant problem.

For those reason in the future longitudinal researches we should check implication precision of the achieved measuring results on the larger primary statistical group of examinees, and larger composite measuring instrument number, as well as on the wider geographic area.

In that way, we will more precisely define mutual relations between predictor variables (motor abilities) and criterion variable (situational-motor abilities of the javelin throwing), which will, with the minimal error probability, enable more successful optimal selection prediction, physical education programming of the classes, evaluation and estimation of training processes and the best examinees results.

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RELACIJE MOTORIČKIH SPOSOBNOSTI I REZULTATA U BACANJU KOPLJA ADOLESCENATA

Sažetak

Opći cilj istraživanja usmjeren je na identifikaciju značajnih relacija između 12 standardnih kompozitnih motoričkih testova kao prediktora (Kurelić, i sur., 1975) i situaciono-motoričke sposobnosti bacanja koplja, kao kriterija. Dobivene vrijednosti mjera centralne tendencije, varijabilnosti i oblika distribucije rezultata mjerenja, na uzorku adolescenata muškog spola ($N=164$), uzrasta između 15 i 16 godina, utvrdili su da većina statistika primjenjenih motoričkih varijabli ne odstupa značajno od Gausove teorijske normalne raspodjele frekvencije rezultata. Nalazi višestruke regresione analize ustanovili su: (a) statistički značajnu pozitivnu stohastičku linearnu korelaciju visokog intenziteta između prediktorskih varijabli i kriterijske varijable, pri čemu prediktor interpretira 37% proporcije zajedničke varijanse kriterijuma; (b) statistički značajan pozitivni parcijalni doprinos u tumačenju ukupnog varijabiliteta kriterijske varijable daju relevantni nenulti regresioni BETA koeficijenti slijedećih prediktorskih varijabli: sprint na 20 m letećim startom ($\beta=.22$; $p<.02$), troskok s mjesta ($\beta=.31$; $p<.05$), skok udalj s mjesta ($\beta=.19$; $p<.01$), špaga ($\beta=.27$; $p<.01$), stajanje na jednoj nozi uzduž klupice za ravnotežu otvorenih očiju ($\beta=.21$; $p<.03$) i varijabla mješoviti zgibovi ($\beta=.17$; $p<.03$).

Ključne reči: adolescenti, motoričke sposobnosti, višestruka regresiona analiza

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THE INFLUENCE OF FLEXIBILITY ONTO THE SWIMMING RESULTS IN STUDENTS OF SPORT AND PHYSICAL EDUCATION

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Original scientific paper

Abstract

In this research we used the sample of 70 students of the third year at the Faculty of Sport and Physical Education in Niš applying 6 variables for evaluation of flexibility (predicative system) and 3 variables for evaluation of swimming results (criteria variables). The purpose of it is to define the influence of flexibility onto students' swimming results in 50 m swimming crawl, back and breast. The regression analysis was used to determine the influence of flexibility onto the swimming results. Based on the results obtained it can be concluded that there was no confirmed relevant influence onto the swimming results in the group of students in question. On the other hand, in competition swimmers there is a positive connection between the achieved results and flexibility. It is considered that the main cause of these results is students' poor knowledge of swimming techniques. It is recommendable to increase the number of practical swimming lessons in students of Faculty of Sport and Physical education, and to homogenize the groups according to the degree of implementation of the swimming techniques.

Key words: *students, flexibility, results, swimming, influence*

Introduction

Swimming is the ability to keep the body on the water surface and the ability to move through water with adequate movements of arms, legs and the body (Madić et al., 2007). Sport swimming appertains to the group of mono-structural sports of the cyclical type (Malacko & Rađo, 2004). Swimming techniques are the manners in which the swimmer is moving cyclically and they are determined by competition rules. There are four main techniques in sport swimming: crawl, back, breast and butterfly (Kapus et al., 2002). The efficacy in every sport discipline, in swimming as well, depends of 5 basic factors: 1) the correctness of movement performance (swimming technique) 2) energy capacities; muscles' contraction capability; 4) joint mobility and 5) technique (Milišić, 2003). Joint mobility refers to flexibility. It is defined as person's ability to do a movement with greatest possible amplitude (Malacko & Rađo, 2004). Optimum flexibility enables correct performance of swimming movements without spending extra energy to overpower the resistance of ligaments and tendons that form part of joints performing the movement. Many authors have done the researches of how the relation of flexibility and other motor skills influence the swimming results. Volčanšek (1979) in his research points out the relevance of flexibility when it comes to swimming results. The author thinks that the swimming success is guaranteed for those swimmers who

besides good coordination skills, fast movement frequency, and successfulness in resolving new motor tasks, also have greater degree of flexibility in the shoulder joint. Okičić (1996) concludes in his research that the swimmers of younger age categories have greater flexibility of shoulder area, knee and hock and they are obtaining better results, which can be used in selection of young swimmers. This was collaborated in the research of Madić et al. (2002). Also, the junior and senior swimmers of international level possess great level of flexibility that is in significant correlation with success in swimming (Colman et al., 1992; Rama et al., 2006). Pivač & Rađo (1996) and Vidović (2000, 2004) and others conducted a research on relations and influence of flexibility along with other motor skills onto the swimming results in population of students. The purpose of this research is to determine the influence of flexibility onto the 50 m swimming results crawl, breast and back.

Methods

The research sample consisted of 70 students of the third year at the Faculty of Sport and Physical education. The participants had two classes per week of their regular subject "Swimming". Testing was performed at the last practical class; at the end of second semester attending the "Swimming" class. The sample of variables consisted of six flexibility evaluation variables as a system of predictor variables and three swimming results evaluation variables as

criteria variables. Six measuring instruments were used for evaluation of flexibility: twist (FISK), a forward bend on the bench (FPRK) a forward bend in straddle (FPRR), plantar foot flexion (FPFS), dorsal foot flexion (FDFS) and arms retroflexion (FRFR). The first 3 tests were taken from the research of Metikoš & al. (1989), and the remaining three from Šoše & Rađo (1998). Three measuring instruments were used for evaluation of swimming results: the swimming result for 50 m crawl (PK50), swimming result for 50 m back (PL50) and swimming result for 50 m breast (PP50). The measuring was performed in the sports hall and the pool of the Sports Center "Čair" in Niš. All measuring was performed at the end of the third year of studies that consisted, among other things, of theoretical and practical classes of swimming. The practical classes consisted of one 90 minutes class per week. All the results obtained were processed in the program *Statistica 6.0*. The basic parameters of descriptive statistics were calculated for all variables AS-arithmetic mean, R- spread, MAX-maximum result, Min-minimum result; SD-standard deviation. Results distribution symmetry was evaluated based on the values of Skewness (Skew) and results distribution uniformity based on the values of kurtosis (Kurt). By using the Kolmogorov-Smirnov test it was determined whether the distribution of results in applied variables has a statistically relevant variation from the normal distribution (max D i K-S test). The correlation between applied variables was determined using linear correlation coefficients that are shown in the variables' correlations matrix. For determining the influence of the whole predictor system onto the criteria variables the regression analysis was used and following statistical parameters obtained: multiple correlation coefficient (R), determination coefficient, (R^2), F-test result (F), statistical relevance (p). For determining the influence of each individual variable in regression analysis we calculated: partial correlation coefficients (Part-R), Correlation coefficients (R), standardized coefficients of partial regression (Beta), t-test results (t) and statistical relevance (p). For statistical relevance we used the relevance level up to 0.05 ($p \leq 0.05$).

Results

Table 1. indicates the values of descriptive statistics basic parameters, the values of Skewness, Kurtosis and Kolmogorov-Smirnov test. The values of Kolmogorov-Smirnov test indicate that in all applied variables the distribution of results do not have a statistically relevant variation from normal distribution, since the greatest difference between the relative and the theoretical cumulative

frequency in each variable (max D) is lower than the constant (K-S test) 0.16. This enables using the obtained results for further analysis.

Table 1. The results of descriptive statistics

Var	AS	SD	Min	Max	Bnd	Sk	Ku	mxD
PK50	44,50	7,79	30,64	70,1	39,46	0,81	1,54	0,08
PL50	61,69	11,37	40,00	98,6	58,60	0,93	1,02	0,09
PP50	64,36	11,29	46,00	92,4	46,40	0,54	-0,36	0,09
FISK	80,90	14,52	42,00	110,0	68,00	-0,39	-0,34	0,15
FPRK	40,24	7,29	15,00	54,0	39,00	-0,58	1,02	0,08
FPRR	73,96	11,41	48,00	112,0	64,00	0,84	2,13	0,11
FPFS	46,23	6,82	25,00	60,0	35,00	-0,19	0,53	0,10
FDFS	20,41	4,72	10,00	29,0	19,00	-0,26	-0,29	0,09
FRFR	24,26	9,73	6,00	47,0	41,00	0,10	-0,59	0,07
K-S test = 0.16								

Table 2. shows the results of inter-correlation of applied variables matrix, where the statistically relevant correlations are indicated with an asterisk (*). There is statistically relevant and high correlation among all 3 variables for swimming results evaluation. There is also a statistically relevant correlation among certain variables for evaluation of flexibility. There is no statistically relevant correlation between the variables for evaluation of flexibility as a predictor system and the variables for evaluation of swimming results, except in variables FRFR and PL50 (-0.35). The negative sign in this case represents a positive correlation considering the fact that these two variables are inversely scaled.

Table 2. Applied variables correlation matrix

Var	PK50	PL50	PP50	FISK	FPRK	FPRR	FPFS	FDFS	FRFR
PK50	1.00	0.71	0.60	-0.04	0.09	0.04	0.05	0.04	-0.21
PL50		1.00	0.64	0.07	0.02	-0.04	-0.10	0.12	-0.35
PP50			1.00	0.07	0.07	0.08	0.07	0.15	-0.10
FISK				1.00	-0.33	-0.26	-0.36	-0.05	-0.14
FPRK					1.00	0.61	0.28	0.25	0.21
FPRR						1.00	0.31	0.13	0.33
FPFS							1.00	0.11	0.13
FDFS								1.00	-0.10
FRFR									1.00

Regression analysis results in Table 3. are indicating that there is no statistically relevant influence of the whole system of predictor variables for evaluation of flexibility onto the criterion variable *swimming result 50 m crawl* ($p = 0.59$). This is also confirmed by low values of multiple correlation coefficient ($R = 0.26$) and determination coefficient ($R^2 = 0.07$). Individually, out of each applied predictor variables, the statistically relevant influence onto the criterion variable has the predictor variable FRFR ($p = 0.05$). Since the whole system of predictor variables has no statistically relevant influence onto the criterion variable, then the influence of predictor variable FRFR is considered to be random. Regression analysis results in Table 4. indicate that there is no statistically relevant influence of predictor system of variables for evaluation of flexibility onto the 50 m results ($p = 0.11$).

Table 3. Regression analysis for 50 m crawl Swimming result (PK50) variable

Var	R	Part-R	Beta	t (63)	p
FISK	-0.04	-0.01	-0.01	-0.08	0.94
FPRK	0.09	0.08	0.10	0.62	0.54
FPRR	0.04	0.04	0.06	0.35	0.73
FPFS	0.05	0.04	0.04	0.30	0.77
FDFS	0.04	-0.02	-0.02	-0.18	0.86
FRFR	-0.21	-0.25	-0.26	-2.01	0.05

$$R = 0.26, R^2 = 0.07, F(6.63) = 0.78, p = 0.59$$

This is also confirmed by low values of multiple correlation coefficient ($R = 0.38$) and determination coefficient ($R^2 = 0.15$). Individually, out of each applied predictor variables, the statistically relevant influence onto the criterion variable has the predictor variable FRFR ($p = 0.00$). Since the whole system of predictor variables has no statistically relevant influence onto the criterion variable, then the influence of predictor variable FRFR is considered to be random.

Table 4. Regression analysis for 50 m back Swimming result (PL50) variable

Var	R	Part-R	Beta	t (63)	p
FISK	0.07	0.04	0.04	0.30	0.76
FPRK	0.02	0.06	0.08	0.49	0.63
FPRR	-0.04	0.05	0.07	0.43	0.67
FPFS	-0.10	-0.08	-0.08	-0.65	0.52
FDFS	0.12	0.07	0.07	0.57	0.57
FRFR	-0.35	-0.35	-0.37	-2.93	0.00

$$R = 0.38, R^2 = 0.15, F(6.63) = 1.82, p = 0.11$$

Regression analysis results in Table 5. are indicating that there is no statistically relevant influence of the whole system of predictor variables for evaluation of flexibility onto the criterion variable *swimming result 50 m breast* ($p = 0.75$). This is also confirmed by low values of multiple correlation coefficient ($R = 0.23$) and determination coefficient ($R^2 = 0.05$).

Table 5. Regression analysis for 50 m breast Swimming result (PP50) variable

Var	R	Part-R	Beta	t (63)	p
FISK	0.07	0.11	0.12	0.91	0.37
FPRK	0.07	0.03	0.04	0.22	0.83
FPRR	0.08	0.07	0.08	0.52	0.60
FPFS	0.07	0.08	0.08	0.60	0.55
FDFS	0.15	0.11	0.12	0.89	0.37
FRFR	-0.10	-0.11	-0.12	-0.88	0.38

$$R = 0.23, R^2 = 0.05, F(6.63) = 0.58, p = 0.75$$

Discussion and conclusion

The obtained results indicate that there is no relevant influence of predictor system of variables for evaluation of flexibility onto the predictor variables (swimming results for 50 m crawl, back and breast) in students that took part in this research. The results obtained in this way are similar to the ones obtained in the one researching relation of motor skills with styled forms of movements in swimming the techniques crawl, back and breast (Vidović, 2000; Vidović 2004). The author determined, inter alia, that the flexibility is not in relevant correlation with breast swimming technique, while the correlation of flexibility and swimming technique crawl is statistically relevant, but of low values. Pivač & Rađo (1996) determined that flexibility has a relevant influence on students' degree of successfulness in acquiring the swimming techniques. Unlike our own, the results of many other researches confirmed the influence of flexibility onto the swimming results, primary in population of swimmers, but in students as well. The reason we obtained this type of results in this research is inadequately acquired and mastered swimming technique, indicated by the swimming results themselves that are below the expected (Table 1). If the swimming technique hasn't been acquired properly the influence of flexibility and other motor skills onto the swimming efficacy is reduced and limited (Okičić et al., 2007).

It is obvious that one 90 minutes long swimming class per week is not enough for the students to acquire and master the swimming techniques properly. In general it can be concluded that in students of third year of Faculty of Sport and Physical Education in Niš hasn't been determined the existence of relevant influence of the flexibility onto the swimming results (techniques crawl, back and breast). We believe that the number of practical swimming classes where the swimming techniques would be practiced and mastered should be increased. There is also an issue of higher criteria when it comes to selection of future students of Faculty of Sport and Physical Education that should be introduced by tightening the swimming norms. Also we suggest redefining the teaching process of the swimming exercises towards homogenization of the groups.

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UTJECAJ GIBLJIVOSTI NA REZULTATE U PLIVANJU KOD STUDENATA SPORTA I TJELESNOG ODGOJA

Sažetak

Na uzorku od 70 studenata treće godine Fakulteta sporta i tjelesnog odgoja Univerziteta u Nišu, primjenjeno je 6 varijabli za procjenu gibljivosti (prediktorski sistem) i 3 varijable za procjenu rezultata u plivanju (kriterijske varijable). Cilj je bio da se utvrdi utjecaj gibljivosti na rezultate u plivanju na 50 metara tehnikama kraul, leđno i prsno kod studenata. Za utvrđivanje utjecaja gibljivosti na rezultate u plivanju korištena je regresiona analiza. Na osnovu dobivenih rezultata može se zaključiti da nije utvrđen značajan utjecaj gibljivosti na rezultate plivanja kod ispitanice grupe studenata. S druge strane, kod plivača takmičara postoji pozitivna veza između gibljivosti i ostvarenih rezultata. Smatra se da je glavni razlog ovako dobivenih rezultata nedovoljno pravilno i kvalitetno usvojena plivačka tehnika od strane studenata. Preporuka je da se u praksi poveća broj praktičnih časova plivanja kod studenata Fakulteta sporta i tjelesnog odgoja kao i da se izvrši homogenizacija grupa prema stepenu usvojenosti plivačkih tehnika.

Ključne riječi: studenti, gibljivost, rezultati, plivanje, utjecaj.

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UNCERTAINTY COEFFICIENT AS A METHOD FOR OPTIMIZATION OF THE COMPETITION SYSTEM IN VARIOUS SPORTS

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Review paper

Abstract

Larger equality of the matches in sport contests could hypothetically motivate the players and teams to play with greater pleasure, and to maintain that level of motivation for achievement that they can provide or maintain the progress achieved levels of achievement in a particular sport. What is the number of points scored (or other indicators of the success) at defeated teams, they are more uncertain. Coefficient of uncertainty of the competition, which proposes Bućo, is an attempt to define the uncertainty of the matches in certain competition. Based on the coefficient of uncertainty, could be proposed corrections competitive system, in terms of faster acceleration of the more successful teams in certain levels of competition. However, it should take account of the alert in making decisions on the basis of the coefficient of uncertainty, since it previously should be validated by the comparative studies, and longitudinal research of the accelerated and decelerated teams in league competitions must be performed.

Key words: system, competition, uncertainty coefficient

Introduction

There are two terms that usually occur in literature, important in sport economy, as same as in stimulating motivation for athletes in some sport contest and for sport attendants, too: "competitive balance" and "outcome of uncertainty". But the "competitive balance" and "outcome of uncertainty" are not the same phenomenon. Those terms are closely linked, but the "competitive balance" studies impact of alternative point systems on the competitive balance in professional sport leagues. The "outcome of uncertainty" means an effort that competition as a whole, doesn't have a predetermined winner at the outset of competition (Halicioglu, 2006). Despite of difference described, we shall present simultaneously previous researches in these necessary connected fields (uncertainty and competitive balance). One of the important differences between sports organizations and other industrial organizations is the issue of competitive balance. Whereas most industrial enterprises attempt to keep competition to a minimum, a lack of competition in the case of sport teams makes for boring games and ultimately fans lose interest (Depken & Wilson, 2006; El Hodiri & Quirk, 1971). This lack of interest would lead to a loss of revenue, as fewer fans would attend games or listen to or watch media presentations. While fans certainly prefer to see their teams win, they want them to at least have a chance of losing. Economists refer to this as the uncertainty of outcome

hypothesis (Leeds & Von Allmen, 2005). Fort & Maxcy (2003) summarize the literature on competitive balance. Different measurements are of different use, and all lines of research into competitive balance have, to date, proven quite instructive. To ignore this is to forget important insights into the behaviour of competitive balance. The North American model of resource allocation in professional sports leagues is adapted for English (association) football (Fort, 2000). Comparisons are drawn between the equilibrium allocations of playing talent under objective functions of profit maximization and win percent maximization subject to a financial constraint. An analysis of match results in the FA Cup suggests an increase in competitive imbalance between teams at different levels of the league's divisional hierarchy, as the theory suggests (Dobson & Goddard, 2004). In the models of Fort & Quirk (1995) and Vrooman (1995), competition becomes more unbalanced if the difference between populations sizes increases. Competition also becomes more unbalanced if the elasticity of revenue with respect to win ratio increases; here the equivalent condition is an increase in coefficient $\eta(L)$. If this elasticity increases, it is efficient for the big-city team to employ more talent and the small-town team less, because the former's revenue gain exceeds the latter's loss (Fort & Quirk, 2002). Szymanski (2001) interprets declining cup attendances (FA Cup) as signifying increasing inter-divisional competitive imbalance between league teams.

Competitive balance is measured directly using match results data, rather than indirectly via a hypothesized relationship with attendance. Halicioglu (2005) aims at predicting the most likely winners of international football tournaments. He employs a relatively simple statistical method, which is based on the seasonal coefficients of variation (CVs) of the end-of-season points from domestic football leagues to measure the degree of competitive balance and to use it as a comparative indicator between the contesting countries in international football tournaments. The results based on the short, mid and long-term seasonal CV values suggest that this forecasting approach provides significantly reliable results in the case of Euro 2000 but not in the case of Euro 2004. Halicioglu (2006) considered the fundamental importance of the competitive balance for the football demand. Amongst many point systems analyzed, the most competitive football league took place when the point system of three points for a win, two points for a draw and one point for a loss was in use. However, results showed that competitive balance in a league may not be approved just by switching between the point systems. Halicioglu (2005, 2006) suggested CV-point system that is better than classical point systems. Outcome of uncertainty in professional team sports is one of the fundamental concepts in the economics of professional sports, but it's very elusive to measure it. In analyzing competitive balance, the first approach is linked to the professional sports in USA, where there is no relegation or promotion between the separate divisions. European system is based on the seasonal promotion and relegation. Peel & Thomas (1988) analyze the determinants of match attendances in the English Football League using an improved measure of match outcome uncertainty based on the probability of home team success. Simmons, Forrest & Buraimo (2008) models both the choice of which games to show and the size of audience attracted by each game, exploiting data on audience sizes for games between 1993 and 2002. They propose a new measure of match outcome uncertainty and, from our results; both the broadcaster and the audience appear interested in competitive balance. Owen & Weatherston (2004) investigate the determinants of attendance at New Zealand matches in the First Division of the National Provincial Championship (NPC) in 2000 to 2003. A general-to-specific testing procedure is used to select a set of factors that have a statistically significant effect on attendance, including previous attendance, traditional rivalries, team success and Ranfurly Shield matches. Palomino & Rigotti (2000) analyze a dynamic model of strategic interaction between

a professional sport league that organizes a tournament, the teams competing to win it, and the broadcasters paying for the rights to broadcast it on television. Demand depends positively on symmetry among teams (competitive balance) and how aggressively teams try to win (incentives to win). In order to get some idea of competitive balance, the researchers needed to measure the dispersion of winning percentages around this average. To do this, they measured the standard deviation. This statistics measures the average distance the observations lie from the mean of the observations in the data set.

$$\sigma = \sqrt{\frac{\sum (Wpct - .500)^2}{N}}$$

σ - standard deviation, $Wpct$ - winning percentage,
 N = total number of regular season games played

The larger the standard deviation, the greater the dispersion of winning percentages around the mean, and thus the less the competitive balance. (If all teams had a winning percentage of .500, there would be a standard deviation of zero, and there would be perfect competitive balance). Berri et al., (2005) explore the level of competitive imbalance across a variety of professional team sports we require a measure of the dispersion of wins in a league that allows inter-sport comparisons. As noted, most studies have focused upon one sport. The exception to this trend lies in the work of Fort & Quirk (1995; 2002), who sought to compare the level of competitive imbalance in Major League Baseball, the National Football League, the National Basketball Association, and the National Hockey League. To make comparisons across sports, these authors turned to the earlier work of Roger Noll (1988, from Berri et al., 2005) and Gerald Scully (1989, from Berri et al., 2005). Both Noll and Scully argued that the dispersion of wins could be measured by comparing "the actual performance" of a league to the performance that would have occurred if the league had the maximum degree of competitive balance in the sense that all teams were equal in playing strengths. The less the deviation of actual league performance from that of the ideal league is; the greater is the degree of competitive balance. The above intuition suggests the measure of competitive balance (C_b) reported in equation:

$$C_b = \frac{\delta_{actual}}{\delta_{ideal}} \text{ where } \delta_{ideal} = \frac{\mu_{wp}}{\sqrt{N}}$$

C_b - competitive balance, μ - mean winning percentage in the league, δ_{actual} - standard deviation of winning percentage for one team, δ_{ideal} - standard deviation of winning % if each team in a league has an equal probability of winning, N = total number of regular season games played

Specifically, δ_{wp} is the standard deviation of winning percentages (or team points for leagues in which ties are possible) within league (i) in period (t). This is compared with the idealized standard deviation, which is defined by Fort & Quirk (1995; 2002) as the standard deviation of winning percentage if each team in a league has an equal probability of winning. The greater the actual standard deviation is relative to the ideal, the less balance exists within the professional sports league (Fort, 2000). The calculation of the idealized standard deviation employs both the mean winning percentage in the league (μ_{wp}) and the total number of regular season games played (N). Fort & Quirk (1995) argued that the above measure allows for inter-sport comparisons because it controls for the differing schedule lengths of professional sports leagues. Goossens (2006) introduce the National Measure of Seasonal Imbalance (NMSI): the standard deviation of the winning percentages divided by the standard deviation when there is complete certainty about all outcomes of the games. He found that European competitive balance differs among countries and that depending on the interpretation of the concept other groups exist. The concepts of competitive balance and uncertainty coefficient are interesting primarily from the aspect of sports economics. Namely, greater uncertainty of a sport game or sports competition as a whole means higher interest of viewers. A growing number of viewers mean greater financial profit.

The uncertainty coefficient

Among the various means of quality analysis of the team games with a "limited" results the uncertainty coefficient (Bućo, 2007) could be the simplest and useful. Bućo originally applied this measure in of table-tennis team games, but the uncertainty coefficient could be applied in any team or individual games where the final result is limited: like in tennis, table tennis, badminton, bowling, etc. These are games where the possible score could vary from 20:0 to 10:10 (par example, like in bowling, with 20 maximum points for both teams), or from 5:0 to 5:4 (par example, like in table tennis team games, where game is finished when one of the teams reach 5 individual wins). The "logics" of the uncertainty coefficient is based on a final score of the game. One of the means of measuring uncertainty coefficient in the league (or uncertainty coefficient in an individual team game) is to follow the score. For example, the larger the number of matches won by the defeated team, the higher the uncertainty coefficient. For the championship or the chosen league (team) an average number of matches of the defeated team in the chosen league or

team can be calculated (in case of a team it is irrelevant whether it won or lost the match). Besides calculating the average, more importance could be given to uncertainty of result and instead of the average result the average of some higher exponents from the defeated teams' matches can be calculated. The simplest "version" of uncertainty coefficient is the one that offers the same coefficients for matches with the same score (an example presented here is given in team games with 10 individual matches played in the one team game). Consequently, the matches with the score 10:0 or 0:10 were given the coefficient 0, those which scores 9:1 and 1:9 the coefficient 1, scores 8:2 and 2:8 the coefficient 2, scores 7:3 and 3:7 the coefficient 3, scores 6:4 and 4:6 the coefficient 4, and the score 5:5 the coefficient 5. The total coefficients for all championship matches divided by the number of matches gives an average coefficient (shown within the results given). However, besides calculating the average, more importance could be given to uncertainty of the result and instead of the average result the average of some higher exponents from the defeated teams' matches can be calculated. In case of squares (exponent 2), or cubes (exponent 3), up to the maximum exponent 12, the uncertain matches have larger influence on the uncertainty coefficient value. These exponents could be given arbitrary, according to the researchers. Generally speaking, the uncertainty coefficient equations (Bućo, 2007) are:

$$CU_{team} = \frac{\exp \sqrt[N_{rounds}]{loss^{exp.1.round} + loss^{exp.2.round} + \dots + loss^{exp.last.round}}}{N_{team.games}}$$

"loss" – symbol for the number of individual matches won by the defeated team, "exp" – exponent (arbitrary), CU_{team} – team uncertainty coefficient, CU_{league} – league uncertainty coefficient, N_{rounds} – number of rounds, $N_{team.games}$ – number of team games in league championship

While the exponent is growing the main idea is weakening – the group of results (5:5, 5:5, 9:1, 10:0, 2:8) is no more uncertain than (5:5, 6:4, 4:6, 4:6, 6:4). Therefore, it is desirable to limit the value of the exponent onto potential ranges of minimum 0.1 up to maximum 12. In this research we used the simplest "version" of uncertainty coefficient, with the exponent 1. So, in our research, formulae given could be transformed into:

$$CU_{team} = \frac{loss^{1.round} + loss^{2.round} + \dots + loss^{last.round}}{N_{rounds}}$$

$$CU_{league} = \frac{\sum loss}{N_{team.games}}$$

"loss" – symbol for the number of individual matches won by the defeated team, CU_{team} – team uncertainty coefficient, CU_{league} – league uncertainty coefficient, N_{rounds} – number of rounds, $N_{team.games}$ – number of team games in league championship

Discussion and conclusion

The meaning and the limitations of the uncertainty coefficient

The "logic" base of the uncertainty coefficient is very simple. It depends on very low and limited range of possible results in specific type of the team games competition (10:0, 9:1, 8:2, 7:3, 6:4 and 5:5). Thus, we can say that uncertainty coefficient is a limited measure, in general. It can be applied only in the competitions with a limited number of possible results of the team matches. Utilitarian value of the uncertainty coefficient could definitely be contained in the possibility, on the basis of principally varying "attractiveness" of the matches (which is practically manifested in a higher number of matches with more balanced results), and on behalf of the public and the players, to modify the competition system, i.e. uncertainty of the matches. Par example, the competition in some league can be quite certain during one season (with one or two "dominant" and one or two "weak" teams), while during the other season the competition becomes in the same league becomes uncertain (when "weak" teams were relegated and the dominant teams promoted). Teams that have replaced promoted and relegated teams can have same competitive quality as the average team league in which they are now. We can also compare uncertainty level of the whole leagues (not only the teams that play in the same league). It is possible that inter-league uncertainty is realistically higher than intra-league uncertainty, which could reflect in lower correlation values between the team uncertainty coefficients and ordinary number of the league in which a team is positioned. The number of teams in some leagues is equal, and their competition with each other is uncertain. That partial uncertainty could be the reason why we are able to try to make different acceleration and deceleration systems for teams in the "weaker" and "better" leagues. The possible situation in some sport competition is an option when in "weaker" leagues in certain sport has less uncertainty in general. Motivation of players that are playing in teams in the "weaker" leagues probably differs from the motivation of players in teams in the "better" leagues.

Some teams in the "weaker" leagues are probably much more ambitious (they want to be accelerated), while the other teams play without motivation to make a progress. In the "better" leagues, most of the teams could have the similar motivation, playing more competitively and with more ambition. However, it could be possible to think of other systems of "acceleration" and "deceleration" for the purpose of increasing the uncertainty coefficient in competition, and after that check the effects by application of uncertainty coefficient after the championship. But we have to be careful with application of the proposals for these "acceleration" and "deceleration" systems, based only on the uncertainty coefficient. This measure has to be compared with other formulae for calculating competitive balance. For example, we can compare the results obtained by using formulae made by Palomino & Rigotti (2000) or Fort & Quirk (1995). This comparative study could be some type of validation of this new measure. On the other hand, it is not sufficient to analyze the uncertainty coefficient within leagues, because it doesn't incorporate any information about uncertainty coefficient if two teams from different leagues compete against each other. It would be much better to analyze the results of the teams that accelerated to better leagues. For instance, it is common that the team that won (say) 4th league and progressed to 3rd league was superior in this league, and next season progressed to second league. Then, the analysis of the performance of this team in 3rd or second league should be performed. One could see the impact of the presence of this team in 4th or 3rd league on the uncertainty coefficients. In other words, a certain longitudinal study has to be performed, to validate the uncertainty coefficient measure. A crucial flaw of the uncertainty coefficients obtained directly from the competition system is the fact that the total result does not necessarily need to be the realistic "measure" of the player's success. In actual competitions there may be some "relaxing" of the players in situations of more important result advantages or "falling behind" the opponent, "prediction" of a safe win or loss, "teasing" the anticipated more inferior or "superior" opponent during the whole match. A similar situation may occur in team matches, where for example when the result is solved there may be some "relaxation" or a "fourth" player may be introduced into the match, of weaker playing quality. It would be useful to use the uncertainty coefficient in other research work (perhaps in some other sports as well) on a multiple number of respondents in various competition ranks. Following coefficients, we can propose different "acceleration" and "deceleration" systems in inter-league competition.

However, we should make caution at decision-making only on the basis of coefficient of uncertainty, since it previously should be validated in comparative studies. Specifically, the results obtained using uncertainty coefficient should be compared with other types of indicators of competitive balance, as

well as with the results in longitudinal research of "accelerated" and "decelerated" teams. Finally, we must not forget the fact that uncertainty coefficient is a limited measure. It can be applied only in the competitions with a limited number of possible results of team matches.

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KOEFICIJENT NEIZVJESNOSTI KAO METODA OPTIMIZACIJE SUSTAVA NATJECANJA RAZNIH SPORTOVA

Sažetak

Veća izjednačenost mečeva u sportskim natjecanjima hipotetski bi mogla motivirati igrače i momčadi da igraju s većim zadovoljstvom, a i da održavaju onu razinu motivacije za postignućem koja im može omogućiti napredovanje odnosno održavanje postignute razine postignuća u pojedinom sportu. Što je broj osvojenih poena (ili drugih pokazatelja uspješnosti) poražene momčadi veći, susret je neizvjesniji. Koeficijent neizvjesnosti natjecanja koji predlaže Bućo, pokušaj je da se definira neizvjesnost mečeva u određenom natjecanju. Na temelju koeficijenta neizvjesnosti, mogle bi se predložiti korekcije natjecateljskog sustava, u smislu brže akceleracije uspješnijih momčadi u pojedinim razinama natjecanja. Međutim, treba voditi računa o oprezu pri donošenju odluka samo na temelju koeficijenta neizvjesnosti, budući da ga prethodno treba validirati u komparativnim studijama, te u longitudinalnim istraživanjima akceleriranih i deceleriranih momčadi u ligaškim natjecanjima.

Ključne riječi: sustav, natjecanje, koeficijent neizvjesnosti

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CHANGES IN SOME MOTOR-FUNCTIONAL ABILITIES IN FOOTBALL PLAYERS OF YOUNGER AGE GROUPS AFTER A THREE-MONTH KINESIOLOGICAL TREATMENT

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Original scientific paper

Abstract

Statistically significant differences in several motor and functional abilities between initial and final measurements were determined on the specimen of 47 footballers aged 15 and 16. The measurement was carried out during three-month pre-season training. Transformational process contents included practice for pace expansion (sprint), agility, explosive strength and stamina. T-test results showed that the difference between two measurements was evident in all applied tests except explosive strength test (test for horizontal jump intensity) after only three months. Vertical jump intensity was rather emphasized than horizontal one. The main reason was that vertical jump intensity is more common and often in football and also during the training process. These results can serve as a guideline for youth coaches especially during training session correction. According to this they should increase and encourage practice for horizontal jump intensity. Globally, these kinds of data, referring to significant differences measured during pre-season training, were expected due to high training intensity based on basic motor and functional abilities development.

Key words: footballers, motor, transformational process, differences

Introduction

According to structural complexity in sports classification, football belongs to complex sport activities as well as to the group of team sport games such as basketball, handball, waterpolo... This involves various technical performances in terms of mutual cooperation of all team members within planned tactical framework. The regular duration of a match is 2*45 minutes with a fifteen-minute break in half-time which requires maximum physical strain. To be able to perform his football assignments, a football player must possess the required level of endurance (aerobic and anaerobic), power (maximum power, explosive power, speed power) and speed (reaction speed, start speed, maximum speed) (Weineck, 2000; according to Mihačić et al., 2003). According to the criterion of domination of energy processes, football belongs to the group of aerobic-anaerobic sports. Being as complex sport as it is, it is impossible to determine the exact proportion of anaerobic and aerobic energy share. This depends on several factors such as a player's position, technical-tactical training level and physical potentials of an individual. By analysing movement structures of players during a game, we came to a conclusion that all important game components develop in the zone of maximum and submaximum muscle and, at the same time, in the zone of energy intensity which is covered by anaerobic and mixed energy mechanisms (ATP, CP, anaerobic

glycolysis, anaerobic-aerobic glycolysis), while aerobic energy mechanisms dominate during periods of decreased performance intensity or during a break (anaerobic-aerobic glycolysis, aerobic glycolysis, aerobic disintegration of fat). These facts are very important in the implementation of this experimental procedure as well as in choosing variables which have been tested by different tests.

Aim

The aim of this article is to determine the differences in some motor-functional abilities in young football players after a three-month kinesiological treatment. The obtained results will help correct and update the syllabus as well as change the kinesiological treatment depending on the obtained results.

Methods

This research was conducted on 47 younger football players of FC *Hajduk*, Split, aged 15 and 16. The respondents underwent the testing voluntarily with the approval of their coach and the manager of the junior team. All the players were healthy on the day they were tested and had previously participated in the training syllabus of the football school on regular basis. Before testing they all underwent a medical examination where no morphological, pathological or other damages of locomotor system were discovered, so they were prepared for physical strains.

All the players were explained the procedure and the protocol of testing and they were given a possibility to freely leave if they did not wish to continue with it. To assess basic motor abilities we chose speed tests and explosive power tests in addition to one aerobic endurance test for the purpose of their relevance for success in this sport, proved by some previous researches (e.g. Hadžić, 2007). The sample of variables includes the following tests: standing start in 30 and 60-metre sprints and block starts in 30-metre sprints to assess explosive power of sprint, running on 10-metre distances with the change of movement course, 1500-metre runs to assess functional abilities, sargent test for explosive power of vertical jump ability and the long jump from a spot for explosive power of horizontal jump ability. The preparation period between two testing lasted for 10 weeks. The initial testing was done on 29 January, 2007, at the beginning of the second week of the preparation period, and final testing was done on 3 April, 2007, after two championship matches.

There were 52 training days during a 3-month cycle. The preparation of functional and motor abilities took 38 hours, while the technical-tactical preparations took 32 hours. There were six matches, two out of which had a competing character. Other forms of preparations (psychological, theoretical, motivational preparation) took additional 6 hours. The content of given syllabus within training units are available at the authors and they mostly involve operators with effect on the development of functional abilities and motor abilities such as sprint and vertical jump ability. The other part of the syllabus abounds in exercises characteristic for football and in tactical preparation of the players. The data obtained by initial and final testing of young football players were processed by basic elementary statistical procedures to determine central and dispersive variable parameters. To determine statistical significance of transformation changes in two time points, we applied t-test for dependent samples. The results were processed by *Statistica* ver. 7.1.

Table 1 – Periodization of the 3-month cycle and the training curriculum

TRAINING PERIOD											TOTAL
MONTHS											3
WEEKS											10
DURATION OF MIC	1	2	3	4	5	6	7	8	9	10	22/01/2007-01/04/2007
	22/01 – 28/01	29/01 – 04/02	05/02 – 11/02	12/02 – 18/02	19/02 – 25/02	26/02 – 04/03	05/03 – 11/03	12/03 – 18/03	19/03 – 25/03	26/03 – 01/04	
DYNAMICS MON	X	X	X X	XX	X	X					
OF TRAINING AND TUE	X	X	X	X	X	X	X	X	X	X	
COMPETITION WED		X	X X	XX	X	X	X	X	X	X	
IN MIC THU	X	X	X	X	X	X	X	X	X	X	
FRI	X	X	X X	XX	X	X	X	X	X	X	
SAT			X	X		X		X			
SUN									X	X	
NO. OF DAYS	14		28				28				70
TRAINING DAYS	9		23				19				52
MATCHES	0		3				3				6
TRAINING HOURS	12		32				26				70
WITHOUT TRAINING	5		5				9				19
TESTING DAYS	29/01/2007						03/04/2007				
HOURS OF FUN/MOT PREPARATION	8		18				12				38
HOURS OF TECH/TACT PREPARATION	4		14				14				32

Results

Table 2 displays results of descriptive parameters conducted on tests results for motor-functional abilities in young football players. Observing arithmetic means, it is evident almost every variable of values in final measuring is better than in the initial one, except for the SDM variable.

By further inspection of the table, we can see there are statistically significant differences between two points of measuring in most of the variables except in let30m and sdm variables. Let30m test is close to the borderline value, and observing the arithmetic mean, it can be noticed that values in the final measuring are somewhat higher than in the initial one.

Table 2 – Basic statistical parameters and t-test for dependent samples
(AM – arithmetic mean of the variable, SD – standard deviation, MIN, MAX – minimum and maximum value, a_3 – coefficient of asymmetry distribution of results, a_4 – coefficient of curve distribution of results, f – value of t-test, p – level of relevance)

VAR	AM	SD	MIN	MAX	a_3	a_4	t	p
30m_I	4,62	0,21	4,19	5,11	0,20	-0,31	2,64	0,011
30m_F	4,57	0,19	4,25	5,02	0,43	-0,46		
60m_I	8,48	0,45	7,61	9,55	0,28	-0,37	3,19	0,003
60m_F	8,34	0,40	7,63	9,33	0,31	-0,41		
1et30m_I	3,85	0,24	3,41	4,44	0,35	-0,40	1,85	0,071
1et30m_F	3,81	0,26	3,36	4,47	0,42	-0,39		
5x10m_I	11,47	0,39	10,80	12,34	0,23	-0,51	2,13	0,038
5x10m_F	11,38	0,39	10,77	12,30	0,22	-0,62		
1500m_I	5,21	0,20	4,58	6,02	0,91	7,15	2,97	0,005
1500m_F	5,11	0,23	4,52	5,44	-1,13	1,16		
sargent_I	44,45	5,15	30,00	58,00	-0,37	0,79	-3,59	0,001
sargent_F	46,43	5,10	34,00	60,00	0,16	0,82		
SDM_I	228,19	14,50	194,00	264,00	-0,20	-0,04	0,51	0,610
SDM_F	227,45	13,32	196,00	268,00	0,09	0,95		

Discussion and conclusion

The long jump from a spot test does not reveal any statistically significant difference, and further on, this difference in favour of final measuring cannot be observed even in central values, but is, on the contrary, in favour of initial measuring. The reason for this may be found in the syllabus which had too little operators influencing the development of explosive power of horizontal jump ability; therefore this ability was not significantly affected during preparation period. It should be stressed the treatment was based on the development of functional abilities, agility and explosiveness, but of sprint and vertical take-off. Football game abounds in vertical jumps relevant to score goals or to kick out the ball unlike long jumps which are more characteristic for games involving technical elements with this particular take-off, such as handball. In the end we can draw a conclusion that researches of this kind are very useful since they provide trainers with a more clear insight in the situation on the field.

The authors' opinion is that further testing of football players of all ages and qualities are necessary, not only in basic motor and functional abilities, but in other anthropological characteristics as well. In this way we obtain information which helps us not only make and correct the curriculum and syllabus of the training process, but also the possibility of choosing from the youngest age groups those football players whose anthropological characteristics can answer modern demands of game in top football.

In practice, this research can help the trainers of a certain group of respondents to correct the curriculum and syllabus in a way to focus on motor abilities of explosive power of horizontal jump ability, primarily due to previous researches which revealed this ability, among other, is rather essential in the entire anthropological framework of a quality football player.

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PROMJENE MOTORIČKO- FUNKCIONALNIH SPOSOBNOSTI NOGOMETAŠA MLAĐIH UZRASNIH SKUPINA NAKON TROMJESEČNOG KINEZIOLOŠKOG TRETMANA

Sažetak

Na uzorku od 47 nogometaša starosne dobi 15 i 16 godina utvrđene su statistički značajne razlike u nekim motoričko-funkcionalnim sposobnostima između inicijalnog i finalnog mjerenja. Mjerenje se vršilo u pripremnom razdoblju u razmaku od tri mjeseca, a sadržaji transformacijskog procesa obilovali su vježbama za razvoj brzine tipa sprinta, agilnosti, eksplozivne snage i izdržljivosti. Temeljem rezultata dobivenih t-testom utvrdilo se da je razlika između dva mjerenja vidljiva već nakon tri mjeseca i to u većini primjenjenih testova izuzev testa za eksplozivnu snagu tipa horizontalne skočnosti. Iako je skočnost bitna u nogometu ipak je naglasak stavljen na vertikalnu a ne horizontalnu skočnost, jer su takvi skokovi češći i uobičajeniji u nogometu pa se i u trenažnom procesu i na samim utakmicama ta sposobnost više razvija. Iz tog razloga ovi rezultati mogu biti smjernica trenerima mladih nogometaša pri korekciji trenažnog sadržaja u ovom razdoblju u smislu da povećaju vježbe i sadržaje koji potiču razvoj eksplozivne snage tipa horizontalne skočnosti. Globalno promatrajući ovakvi podaci o izraženim razlikama u dvije vremenske točke a izmjereni nakon pripremnog razdoblja su očekivani jer je intenzitet rada u tom periodu jako visok i baziran upravo na razvoju bazičnih motoričkih i funkcionalnih sposobnosti.

Ključne riječi: nogometaši, motorika, transformacijski proces, razlike

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PITFALLS OF PHYSICAL INACTIVITY AND INNOVATIVE INTERVENTION PROGRAMMES TO REDUCE PHYSICAL INACTIVITY AND INCREASE PHYSICAL ACTIVITY AMONG SINGAPORE YOUTHS

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Review paper

Abstract

Concerns about childhood obesity are universal concerns around the world and resonate with many governments as health care costs that are associated with impairments caused by childhood and adult obesity escalate and threaten to spiral out of control. A key determinant of juvenile obesity is physical inactivity, which has multiple consequences for the health and development of young people. In Singapore, the consequences of physical inactivity include youth obesity rate of about 10%, one of the highest rates of childhood myopia and adult-onset type II diabetics in the world, afflictions of eating disorders, and some evidence of concentration and memory recall deficiencies among overweight students. Innovative and potentially successful programmes to reduce physical inactivity and increase physical activity in Singapore are elucidated.

Key words: *Inactive lifestyles, youth, consequences, innovative activity programmes*

Introduction

Physical activity is the natural inclination of all young people, regardless of race, language or religion in Singapore. Physical activity is the capstone for the growth and development of toddlers, children, adolescents and young adults. Among adolescent and young adults, physical activity through sports and games provide opportunities to build a sport-loving culture, for social inter-course, for stress-release and for the pursuit of a healthy lifestyle. However, there is a compelling attractiveness in embracing lives of convenience and sedentary forms of entertainment with the advancement of technology and innovation. In Singapore, young people are at a very young age 'socialised' into study, transport and leisure habits and activities that require minimal amounts of physical exertion and energy expenditure (Chia, 2007). This is exacerbated by the ease high-calorie convenience foods via food delivery services and lifestyle choices for study, work and leisure that are mostly sedentary. Indeed physical inactivity appears to be better tracked over time than physical activity from childhood to adolescence to adulthood (Kimm & Obarzanek, 2002). This means that it is easier for sedentary habits or the cycle of very little physical activity in daily life to be entrenched than it is for active physical activity habits to take root. Extended periods of physical inactivity once entrenched as a daily habit may result in adult ailments like cardiovascular disease and altered glucose metabolism, which are documented to begin in infancy and childhood (Williams et al., 2002).

Consequences of physical activity insufficiency and associated conditions

Other paediatric conditions arising from severe physical activity insufficiency include obesity, sometimes orthopaedic problems such as joint pains in the feet, knees and hip, which are exacerbated by excessive body weight, and disrupted sleep due to obstruction of the airflow because of too much fat around the neck (Williams et al., 2002). Obese and overweight children, including those in pre-schools (Chia, 2006) experience weight-teasing by peers and they are bothered by the teasing episodes. Weight-teasing in schools is associated with disordered eating behaviours that may place overweight children at risk for weight gain. In a survey of 4746 young people in the USA, 63% of the very overweight girls and 58% of the very overweight boys reported being teased by their peers, while weight teasing by family members was reported by 47% by these girls and 34% by these boys (Neumark-Sztainer et al., 2002). In an eight-year retrospective prevalence study on eating disorders (anorexia nervosa) in Singapore, Lee et al (2005) reported a six-fold increase in patient referrals, between 1994 and 2002, to the Child Guidance Eating Disorder Clinic at the Institute of Mental Health. The following results are instructive: the mean age of onset of the disorder was at 15.5 ± 3.9 years; 91% were female, 94% were Chinese and 74% of the patients were of school-going age with 47% coming from all-girl schools; the mean BMI at diagnosis was 15.56; 25.4% suffered from depression and the 26.9% identified the triggers as weight teasing.

And comments from others, with 11.1% having been members of the Trim and Fit (TAF) Scheme in schools. These results highlighted that perceived weight teasing was significantly associated with disordered eating behaviours among overweight and non-overweight boys and girls (Neumark-Sztainer et al., 2002), echoing in the Straits Times on eating disorders in all-girl-school in Singapore (Davie, 2006). Apart from health and physical ailments, other mental, social and emotional and disciplinary deficiencies are also likely to accrue, as the opportunities and outlets for stress-alleviation through exercise and physical play become limited. For example, unpublished data from the Physical Education and Sports Science laboratory showed that cognitive function, assessed by a recall of a series of simple words among normal weight and overweight youths from top elite schools in Singapore was significantly different, with normal weight students performing better in these cognitive function tests. However, whether these results can be extrapolated to more complex modes of cognitive function requires further research and validation among Singaporean youths. This is a fertile area for future research. In Singapore, paediatric growth charts had to be revised in the late 1990s to take into account the increased body mass of children aged 1 to 6 years, where there was an average increase of half a kilogram in body mass for all ages without any corresponding increase in stature. These changes were attributed to increased energy storage because of better nutrition but equally could be attributed to reduced energy expenditure at the paediatric ages. Research informs that at least in the USA, young people within the 95% percentile for BMI are likely to remain obese and overweight in adulthood and also suffer from obesity-related ailments (Williams et al., 2002). Therefore it seems prudent to monitor young people's BMI when they appear to be on an upward trend so as to ameliorate large groups of young people become overweight and obese in adulthood. Another indirect consequence of the lack of activity in childhood is also one of the highest incidence rates of adult-onset diabetes in the world among Singaporeans. Since the 1990s, heart disease and stroke continues to be the leading cause of premature death in adults (Singap. Heart Foundation, 2006). Yet, against this backdrop, regular physical activity in youth has a strong and effective preventative role in the onset of Type II diabetes (Chia, 2002). Singapore apparently also has one of the highest rates of childhood and juvenile myopia in the world and many youths suffer from myopia at a younger age than before. In 2001, 34% of Primary 1 students were myopic. This increased to 66% for Primary 6 students and 68% for Secondary 4 students (Teo, 2001).

There are cogent data that suggest that negative relationship between the rates of myopia and the amounts of physical activity, sports and outdoor activity. In a longitudinal study of 514 children from 1989 to 2001, the authors reported that the chances of children with parents without myopia becoming myopic were lowest in the children with the largest amounts of sports and outdoor activities (Jones et al., 2007). These health conditions among young Singaporeans are a wake-up call for action that much more needs to be done to motivate our young towards an active lifestyle of activity. Research data in the Singaporean context are urgently needed to verify if these observations are also valid in our youths.

Trim and Fit (TAF) and CHERISH programmes

The TAF scheme was launched in 1992 and was successful in reducing national school rates of overweight from about 15% in 1991 to about 10% in 1998 and has largely stayed about 10% since year 2000 (Chia via personal communication with MOE, PE Unit 2007). Chia (1998) in his published discourse on rethinking TAF programme strategies raised concerns about some of the deleterious effects that the programme may have on some vulnerable school students. Sceptics and cynics argue that the programme stigmatizes overweight children and that the programmes spelt 'FAT' in mirror image. Chia also provided suggestions about engaging overweight youths with forms of physical activity and exercise that are more suited and personalised to the conditions of overweight youths. In 2003, Chia & Wang published survey results among primary school children that showed that a sizeable proportion of children of normal body weight voiced the intention to lose body weight, rather than to gain body weight. In the study that involved 518 pupils in a primary school in Singapore, where the relationships between weight-for-height classifications, body weight satisfaction, perceived physical self-worth and physical fitness among 275 boys and 243 girls aged 9 - 13 years were examined, results revealed that across the three weight-for-height classifications, more pupils intended to want to lose body weight than to gain body weight. Underweight pupils were the most satisfied with their body weight, were the most physically fit and had the highest rating for perceived physical self-worth than the healthy weight and overweight groupings. It is noteworthy that girls and boys had similar ratings for perceived physical self-worth but younger pupils had higher perceived physical self-worth than older pupils. These data suggest that physical activity; sport or exercise programme leaders must practise sensitivity

and care by not perpetuating negative stereotypes about body weight. Concomitantly, education and awareness of the dangers of body image disorders among school youths particularly in all-girl schools and in young secondary school students should be stepped up. The MOE reviewed the TAF scheme and with the MOH launched a nationwide holistic health framework for schools in 2000, (CHERISH; Championing Efforts Resulting in Improved School Health) which targets the holistic development of students, which included a healthy maintenance of body weight for all students, not just those who are under-weight weight or over-weight. Importantly CHERISH echoes the WHO's Health Promoting Schools concept, adopted by many countries. Innovative school-based interventions to increase physical activity and reduce physical inactivity among Singaporean youths

HealthTrek Information Tracking System - a tool for building a health-enabling environment in schools

NIE researchers juxtaposed the use of information and computer programming technology to come up with a world's first HealthTrek Information Tracking System (HITS) housed in a Personal Digital Device (PDA) (Quek, 2002). HITS, allows an individual to appraise his current body weight, food intake, physical activity patterns and mood status over time. Importantly, the system is able to prescribe suggestions for remediation based upon recommendations enunciated by the Health Promotion Board of Singapore. Highlights of the HITS' features include an age and a sex-specific weight gain/weight loss calculator, for safe weight gain or weight loss, a food planner that gives a breakdown of key nutrients in foods that are selected and a physical activity planner that gives the rates of energy expenditure for different activities that are selected. The food database houses over 2000 local and non-local food items, while the physical activity database has more than 800 specific activity types. The mood gauge allows a person to track negative or positive feelings over time. The attractiveness of HITS is that it offered real-time data of participants, overcoming the need for recall, which can be used on its own or pooled as group data in providing individualised evidence based data so that specific lifestyle changes can be made. The effectiveness of HITS for monitoring individualised physical activity and food consumption and mood states was evaluated in 37 primary school pupils, aged 9-10 years (Wang et al 2005). Participants kept track of their daily food intake, physical activity consumption and mood state for seven days, by keying in the relevant data required as soon

as they consumed food or engaged in physical activity while data on mood was keyed in immediately before and after food and/or physical activity consumption. Results affirmed the researchers' assertions that in IT-savvy primary school pupils, the use of HITS housed in a PDA, provided an excellent means for the transmission of individualised and real time data that effected positive intentions and increased awareness for a healthy lifestyle- 92% of pupils felt that HITS made them more discerning of their food choices and 95% of the pupils reported that HITS made them more conscious of their daily energy expenditure and for a healthy lifestyle. Nearly 100% of the pupils surveyed reported that they wished to continue using HITS and also continue to raise their levels of daily physical activity. At the present time, HITS is no longer available for use due to cost factors but its utility and effectiveness (real-time localised and holistic data- food, physical activity consumption and mood) as a health-enabling device can be further explored, when the cost of its implementation becomes more affordable.

PRIDE for PLAY- personal responsibility in daily effort for participation in lifetime activity for youths

PRIDE for PLAY is an acronym for Personal Responsibility in Daily Effort for Participation in Lifelong Activity for Youths (Chia, 2006). MOE advocates that schools should emphasize holistic development of pupils- this means paying sufficient and appropriate attention to the mental, physical, emotional, social and environmental development of all pupils and students. Weekly compulsory physical education classes of 70 minutes in schools and the associated sports activities after classes are inadequate to meet emergent physical activity guidelines of a daily accumulation of at least 90 minutes of physical activity of at least moderate intensity (Andersen et al., 2006). Daily play sessions that are exclusive of an active daily recess, physical education classes taught by trained specialists and after-school sport sessions, can provide many developmental and holistic health benefits that may carry over into adulthood. A school environment that is play-encouraging, play-enabling and play-inviting can help a useful, innovative and natural way of inculcating a love for movement and help redress a serious trend of physical activity insufficiency while youngsters engage electronic gaming activities. Pilot initiatives in two primary schools for the PRIDE for PLAY programme were conducted (Chia, 2007). This involved working closely with the school leaders and all teachers involved to forge a strong partnership for action and subsequent evaluation.

The pilot study involved an infusion daily physical play of between 20 to 45 minutes during curriculum hours, either as stand-alone additional play and physical activity sessions or as part of an extended recess. Outcome deliverables like pre-and post school-based physical activity, assessed using pedometers, social-emotional outcomes among pupils, assessed using age-modified questionnaires and indicators of academic achievement were garnered.

For one pilot school that involved 270 Primary 2 pupils, daily step count in school was significantly increased by 24% from 3742 to 4642. In the other pilot school that involved 225 Primary 2 pupils, daily step count in school increased by 10% from 4520 to 4984. These amounted to achieving 39-42% of the daily recommended step count for girls and 31-33% of the recommended step count step count for boys (Tudor-Locke et al 2004). Social emotional learning outcomes of the pupils involved with the PRIDE for PLAY programme were also significantly improved with no compromise to academic standards. The principals of both schools raised the following points that are instructive for the success of PRIDE for PLAY- the programme had the support and buy-in from the key stakeholders- school management, teachers, parents and the pupils themselves. Other schools have translated, customised and adapted the PRDIE for PLAY programme into daily physical education. Further research directions associated with PRIDE for PLAY include establishing holistic or social-emotional learning outcomes as a result of programme implementation in a wider spectrum of schools in Singapore.

Every step counts- how an active recess can help to buttress physical activity achieved during PE lessons

Chia & Wangye (2008), embarked on a study to evaluate the step rate of 125 boys and girls from Primary 2 and Primary 6, using the Omron HJ-005 pedometers during four 30-minute PE lessons, taught by specialist PE teachers with games-based activities, rope skipping, throwing, jogging and shuttle-run based activities and during an 30-minute unstructured recess where pupils were free to play with games equipment. Results revealed that the average number of steps achieved in a typical 30-minute PE lesson was 1660 ± 535 steps with a step rate of 55.4 ± 17.8 steps/min. Steps accumulated during daily recess averaged 1208 ± 526 steps or a step rate of 40.3 ± 17.5 steps/min. There was no significant sex difference ($p > 0.05$) in steps accumulated

or step rate among the four structured PE lessons. However, the boys were significantly more physically active than girls ($p < 0.05$) during unstructured daily recess. The difference in steps accumulated between Primary 2 and Primary 6 pupils was not significant during daily recess ($P > 0.05$). Aggregated step count or step rate during PE and recess among Primary school pupils in Singapore are within the range of findings documented elsewhere (e.g. Scruggs et al 2005; Tudor-Locke et al 2006). When the steps were aggregated for PE and recess, girls achieved 24% and boys achieved 19% of the daily recommended steps (Tudor-Locke et al 2004). Primary school girls were just as physically active as the boys during school structured PE, but boys were significantly more active during the unstructured daily recess.

Primary 6 pupils were just as physically active as Primary 2 pupils during the daily recess periods and the results of the present study did not support the view that physical activity declines with age, (e.g. Trost et al., 2002) at least not during the daily recess periods, a finding that finds agreement with Ridgers et al. 2005. Schools should capitalise on young pupils' natural inclination for play and the availability of qualified PE teachers and games equipment during recess to chalk-up as many steps as possible so that more youths are able to meet the daily recommended step count of 12 000 for girls and 15 000 steps for boys (Tudor-Locke et al., 2004).

Conclusion

The consequences of physical activity insufficiency among young people are multifaceted and have a negative impact on the holistic development of the young person. Intervention programmes that target the holistic development of young people can be successful and sustainable when there is whole school acceptance of the programme, a strong trust between the school management, stakeholders (parents, and MOE) and the researchers, when the interventions are multifaceted- before, during and after school programmes, active recess, an extended recess, tuck-shop or canteen nutritional programme, the availability of safe equipment and facilities, parental involvement, school events and school partnerships with the community.

The use of electronic gadgets such as PDAs, mobile phones and new technology monitors, coupled with youth-friendly software programs can help increase awareness of the need for a healthy lifestyle among youths in Singapore.

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Ključne riječi: *nogometaši, motorika, transformacijski proces, razlike*

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THE LATENT STRUCTURE OF MORPHOLOGICAL CHARACTERISTICS OF TOP HANDBALL, BASKETBALL AND FOOTBALL PLAYERS

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Original scientific paper

Abstract

The aim of the research is to apply the system of 25 variables of morphological characteristics and determine its factor structure due to forming as rational procedures as possible during the implementation of continuous selection of sportsmen in those sports and determine the transformational training process; the research has been carried out on the sample of 158 top sportsmen of male gender (51 handball players, 51 basketball players and 56 footballers). By applying factor analysis (direct oblimin) and Kaiser-criterion ($\lambda \geq 1.00$) for obtaining common characteristic roots and explained parts of common variant, in case of handball player five latent variables (mass and volume of the body and panniculus adipose of the torso, longitudinal dimension of the skeleton, transversal dimension of the lower limbs and chest, transversal dimension of the shoulder and elbow have been isolated; in case of basketball players there are also five latent variables (longitudinal dimension of the skeleton, mass and volume of the body and panniculus adipose of the torso, transversal dimension of the lower limbs and wrist, transversal dimension of hands and pelvis, panniculus adipose of the upper and lower limbs); and for footballers there are six latent variables (longitudinal dimension of the skeleton, panniculus adipose of the upper and lower limbs, mass and volume of the body, transversal dimension of the legs, shoulders and pelvis, panniculus adipose of the chest and transversal dimension of the arms). On the basis of identified factor structures of the latent variables and their common relations, it can be concluded that there are various morphological structures of sportsmen according to sports, among which there are internal and statistically important correlations.

Key words: handball, basketball, football, morphological characteristics, factor analysis

Introduction

As far as morphology is concerned, there are numerous works dealing with manifesting and latent characteristics of people. The measurement is based on measuring human body as a whole or its specific parts, so the methods of International Biological Program (IBP) are carried out in the world, using 39 anthropometric measures and including complete morphological status of the man (Stojanović, Momirović, Vukosavljević & Solarić, 1975; Malacko & Rađo, 2004).

The way of implementing specific morphological measures (anthropometric measures) and the way in which the influence of gene and/or ecological factors is interpreted are described and presented in the majority of recent research (Maver, Muftić, Rudan & Taboršak, 1975; Buzina, Grgić, Kovačević, Maver, Momirović, Rudan, Schmutzer & Štampaj-Plasaj, 1975). The majority of research dealing with transformation of morphological characteristics points out to the great complexity since they are mainly under the

influence of gene factors (endogenic influence), and it is important to state that the influence of gene factors is not the same for all latent morphological dimensions (Malacko & Doder, 2008).

Regarding this, it should be noted that such studies examine the effects of doing exercises on the changes within the morphological build, but also they examine other motor, cardiovascular and other parameters (Bompa, 2000). In earlier research the identification of the latent variables in the morphological sense is carried out by factor analysis, and there were more methods of taxonomy (cluster) algorithms with the aim of determining morphological structure of human organism, and then the relations of these characteristics with other anthropological characteristics, abilities and properties and how much they contribute to the success in sports achievements (Szirovicza, Momirović, Hošek & Gredelj, 1980; Malacko & Popović, 2001; Stanković, 2000; Stanković & Popović, 2001).

Aim

The aim of the research is to determine the structure of latent variables of morphological characteristics of top handball players, basketball players and footballers due to forming as rational procedures as possible for optimal modelling, planning, programming and controlling of training process and efficient monitoring of their development during continuous selection of sportsmen and implementing the transformational training process.

Methods

The system of 25 variables of morphological characteristics was applied on the sample of 158 sportsmen of the top level of Serbia (51 handball players, 51 basketball players, and 56 footballers) of the male gender, aged between 18 and 30 years, who actively participate in the training process and competitions. For the purposes of estimating morphological characteristics the following variables have been applied: *longitudinal dimension of the skeleton*: 1. HEIGBO – the height of the body, 2. SPAARM – span of the arms, 3. LENLEG – the length of the leg, 4. LENLFO – the length of the foot 5. LENARM – the length of the arms, 6. LENHAN – the length of the hand, *transversal dimension of the skeleton*: 7. PLPAHA – planimetric parameter of the hand 8. BIABRE – biacromial breadth, 9. BICBRE – bicrystal breadth, 10. DIAELB – diameter of the elbow, 11. DIAWRI – diameter of the wrist, 12. DIAKNE – diameter of the knee, 13. DIAANK – diameter of the ankle, *circular dimension and mass of the body*: 14. MASBOD – mass of the body, 15. PECHES – perimeter of the chest, PEUPAR – perimeter of the upper arm, 16. PEUNAR – perimeter of the underarm, 17. PEUPLE – perimeter of the upper leg, 18. PESHAN – perimeter of the shank, 19. panniculus adipose: 20. SKCRUA – skin creases of the upper arm, 21. SKCRBA – skin creases of the back, 22. SKCRBE – skin creases of the belly 23. SKCRAR – skin creases of the armpit, 24. SKCRUL – skin creases of the upper leg, 25. SKCRSH – skin creases of the shank. All above-mentioned variables are measured according to the methods of International Biological Program (IBP).

Determining the structure of latent morphological variables is carried out by factor analysis by using oblique rotation (direct oblimin); in case of extracting the number of characteristic roots the criterion $\lambda \geq 1.00$ (Kaiser) is applied. The communalities (h^2) are calculated specifically for all applied variables in order to get their informatics values.

The structure of the latent variables is calculated by matrix of the main components, the loading matrix which contains parallel projections (coordinates) of the variables on the factors, the matrix of structure, that is to say the correlations between manifesting and latent variables and matrices of inter-correlation factors. The data is processed by statistical package SPSS Statistics 17.

Results

The interpretation of the isolated morphological latent variables, due to the limited space, is carried out by oblique rotation (loading matrix) which contains parallel projections, that is the length of coordinates of the vectors in the coordination system.

Table 1: The structure of morphological latent variables of the handball players (matrix of the oblique oblimin rotation)

Variables	Lv-1	Lv-2	Lv-3	Lv-4	Lv-5	h^2
HEIGBO	.00	.82*	.09	-.15	.17	.86
SPAARM	-.02	.90*	.04	-.05	.08	.87
LENLEG	-.17	.81*	.16	.13	.42	.86
LENLEFO	-.06	.57*	.00	-.43	-.23	.62
LENARM	.00	.98*	.06	.11	-.09	.87
LENHAN	.13	.58*	-.27	-.16	.08	.60
PLPAHA	.20	.75*	-.15	-.03	-.16	.69
BIABRE	-.07	.28	-.03	-.32	.48*	.54
BICBRE	.58*	.06	.05	-.19	-.03	.47
DIAELB	.12	.00	.02	.07	.83*	.72
DIAWRI	.63*	.37	-.34	.17	.10	.64
DIAKNE	.40	-.06	-.10	-.54*	.27	.65
DIAANK	-.03	.04	.04	-.75*	-.00	.58
MASBOD	.74*	.19	.10	-.21	.08	.88
PECHES	.75*	.12	.00	-.21	.00	.78
PEUPAR	.78*	-.07	.07	-.19	.19	.82
PEUNAR	.80*	.02	-.05	.09	.28	.73
PEUPLE	.66*	-.14	.19	-.21	.14	.69
PESHAN	.42	.11	.10	-.54*	-.12	.69
SKCRUA	.31	.16	.74*	.02	-.10	.82
SKCRBA	.86*	-.13	.17	.03	-.21	.84
SKCRBE	.78*	-.00	.29	.11	-.13	.80
SKCRAR	.81*	.01	.21	.16	-.07	.78
SKCRUL	.30	.07	.70*	-.01	.05	.72
SKCRSH	-.00	-.04	.90*	-.04	.06	.81
	Lv-1	Lv-2	Lv-3	Lv-4	Lv-5	
Lv-1	1.00					
Lv-2	.22	1.00				
Lv-3	.32*	-.11	1.00			
Lv-4	-.25	-.28*	-.05	1.00		
Lv-5	.13	.22	-.07	-.09	1.00	

Lv-1 - first latent variable, Lv-2 - second latent variable, Lv-3 - third latent variable, Lv-4 - fourth latent variable, Lv-5 - fifth latent variable, h^2 - communalities

The first latent variable (Lv-1) in case of handball players (Table 1) may be defined as mass and volume of the body and panniculus adipose of the torso whose structure consists of variables of the mass of the body, perimeter of the upper arm, perimeter of the underarm, perimeter of the upper leg, perimeter of the shank, skin creases of the back, skin creases of armpit, skin creases and skin creases of the belly, and planimetric parameter of the hand,

and diameter of the wrist; the second variable (Lv-2) as a longitudinal dimension of the skeleton (height of the body, span of the arms, length of the arms, length of the hand, length of the leg, length of the feet and biacromial breadth); the third variables as panniculus adipose of the upper and lower limbs (skin creases of the upper arm, skin creases of the upper leg and skin creases of the shank); the fourth (Lv-4) as transversal dimension of the lower limbs and chest (diameter of the knee, diameter of the ankle and perimeter of the chest); and the fifth variable (Lv-5) as transversal dimension of the shoulders and elbow (bicrystal breadth and diameter of the elbow). The communalities (h^2) show that during measurement the biggest mistakes are made in case of variables of the bicrystal breadth ($h^2=.54$) and planimetric parameter of the hand ($h^2=.47$). There is a statistically important correlation in case of handball players between the first (the mass and volume of the body and panniculus adipose of the torso) and the third (.32) latent variable (panniculus adipose of the upper and lower limbs) as well as between the second (longitudinal dimension of the skeleton) and the fourth (-.28) latent variable (transversal dimension of the lower limbs and chest).

Table 2: The structure of morphological latent variables of the basketball players (the matrix of oblique oblimin rotation)

Variables	Lv-1	Lv-2	Lv-3	Lv-4	Lv-5	h^2
HEIGBO	.90*	.04	-.01	-.03	-.08	.89
SPAARM	.90*	.09	-.00	-.10	-.02	.92
LENLEG	.85*	-.02	.00	.09	-.05	.74
LENLEFO	.66*	-.00	.14	-.40	.01	.79
LENARM	.95*	.04	-.03	.03	.03	.88
LENHAN	.84*	.03	-.00	.07	-.13	.79
PLPAHA	.81*	-.07	-.01	-.09	.04	.63
BIABRE	.22	.02	.16	-.74*	-.05	.76
BICBRE	.44	.36	-.00	-.44*	-.05	.73
DIAELB	.59	-.05	.15	.59*	-.05	.69
DIARWI	.43	-.14	.64*	-.02	.29	.80
DIARKE	-.01	.26	.79*	.26	-.09	.75
DIARAK	-.09	-.12	.85*	-.29	.12	.79
MASBOD	.52	.58*	.10	-.09	.02	.88
PECHES	.36	.63*	.04	-.21	-.10	.80
PEUPAR	.14	.79*	.27	-.10	-.08	.83
PEUNAR	.11	.58*	.43	-.08	-.08	.72
PEUPLE	-.01	.85*	.11	-.01	.02	.77
PESHAN	.11	.58*	.27	-.09	-.11	.55
SKCRUA	.03	.39	.05	-.06	.71*	.80
SKCRBA	-.02	.90*	-.20	-.03	.14	.88
SKCRBE	-.18	.73*	-.05	-.08	.26	.71
SKCRAR	-.06	.80*	-.28	.13	.23	.78
SKCRUL	-.02	.16	-.01	-.01	.85*	.83
SKCRSH	-.03	-.13	.09	.08	.92*	.83
	Lv-1	Lv-2	Lv-3	Lv-4	Lv-5	
Lv-1	1.00					
Lv-2	.25	1.00				
Lv-3	.42*	.15	1.00			
Lv-4	-.15	-.16	-.12	1.00		
Lv-5	-.26	.21	-.02	-.06	1.00	

Lv-1 - first latent variable, Lv-2 - second latent variable, Lv-3 - third latent variable, Lv-4 - fourth latent variable, Lv-5 - fifth latent variable, h^2 - communalities

The first latent variable (Lv-1) in case of basketball players (Table 2) may be defined as longitudinal dimension of the skeleton whose structure consists of variables of the height of the body, span of the arms, the length of the arms, the length of the hands, the length of the leg, the length of the feet and biacromial breadth; the second variable (Lv-2) as the mass and volume of the body and panniculus adipose of the torso (the mass of the body, perimeter of the upper arm, perimeter of the underarm, perimeter of the upper leg, perimeter of the shank, perimeter of the chest, skin creases of the back, skin creases of the armpit and skin creases of the belly); the third (Lv-3) as transversal dimension of the lower limbs and wrist (diameter of the knee, diameter of the ankle and diameter of the wrist); the fourth (Lv-4) as transversal dimension of the arms and pelvis (bicrystal breadth, planimetric parameter of the hand and diameter of the elbow); and the fifth variable (Lv-5) as panniculus adipose of the upper and lower limbs (skin creases of the upper arm, skin creases of the upper leg and skin creases of the shank). All the values of the communalities of the specific variables (h^2) have satisfactory values and it means that the explained parts of the vectors of variables are satisfactory, that is to say that manifesting variables are statistically balanced and that they are measured without any bigger mistakes. There is a statistically important correlation in case of basketball players between the first (longitudinal dimension of the skeleton) and the third (.42) latent variable (transversal dimension of the lower limbs and wrist). The first latent variable (Lv-1) in case of footballers (Table 3) may be defined as longitudinal dimension of the skeleton whose structure consists of variables of the height of the body, span of the arms, the length of the arms, the length of the hand, the length of the leg, the length of the feet and planimetric parameter of the hand; the second (Lv-2) as panniculus adipose of the upper and lower limbs (skin creases of the upper arm, skin creases of the upper leg and skin creases of the shank); the third (Lv-3) as the mass and volume of the body (the mass of the body, perimeter of the upper arm, perimeter of the underarm, perimeter of the upper leg, the perimeter of the shank, perimeter of the chest); the fourth (Lv-4) as transversal dimension of the legs, shoulders and pelvis (biacromial and bicrystal breadth, diameter of the knee and elbow); the fifth (Lv-5) as panniculus adipose of the torso (skin creases of the back, skin creases of the armpit and skin creases of the back); and the sixth variable as transversal dimension of the arms (diameter of the elbow and diameter of the wrist).

Table 3: The structure of morphological latent variables of footballers (matrix of the oblique oblimin rotation)

Variables	Lv-1	Lv-2	Lv-3	Lv-4	Lv-5	Lv-6	h ²
HEIGBO	.84*	-.12	-.03	.23	-.05	.06	.81
SPAARM	.91*	.10	.16	-.09	.02	.10	.88
LENLEG	.90*	-.03	-.01	.14	-.00	.03	.85
LENLEFO	.59*	-.11	-.26	.11	.04	.24	.76
LENARM	.79*	-.04	.24	.00	-.00	.18	.72
LENHAN	.79*	-.13	-.19	-.21	-.01	-.10	.77
PLPAHA	.18	.12	-.08	-.48*	.10	.40	.55
BIABRE	.22	.23	-.16	-.33*	.32	.20	.46
BICBRE	.52*	.09	-.40	-.20	-.00	-.07	.57
DIAELB	-.02	-.09	-.06	.01	-.04	.82*	.70
DIAWRI	.14	-.10	.12	.23	-.01	.81*	.82
DIKNE	-.04	.20	-.22	.74*	.10	.15	.69
DIAANK	.25	.20	.02	.74*	-.02	.15	.73
MASBOD	.44	-.00	-.71*	.18	-.13	.06	.93
PECHES	.38	.28	-.45*	-.14	-.04	.12	.65
PEUPAR	-.19	-.12	-.88*	-.11	-.12	.03	.77
PEUNAR	.08	-.23	-.62*	-.06	.02	.30	.71
PEUPLE	.01	.03	-.83*	.02	-.04	-.06	.68
PESHAN	.01	.00	-.75*	.32	.28	.03	.74
SKCRUA	-.08	.82*	.06	.08	-.16	.07	.81
SKCRBA	-.23	.29	-.17	-.05	-.68*	.24	.74
SKCRBE	.06	.01	.13	.07	-.88*	-.00	.82
SKCRAR	.21	.11	-.16	-.11	-.84*	-.05	.83
SKCRUL	-.08	.89*	.08	.01	-.07	-.09	.87
SKCRSH	-.04	.78*	.06	.23	-.09	-.28	.86
	Lv-1	Lv-2	Lv-3	Lv-4	Lv-5	Lv-6	
Lv-1	1.00						
Lv-2	-.00	1.00					
Lv-3	-.27*	-.03	1.00				
Lv-4	-.06	.08	.07	1.00			
Lv-5	.08	-.27*	-.02	-.03	1.00		
Lv-6	.43*	-.02	-.27*	.03	.08	1.00	

Lv-1 - first latent variable, Lv-2 - second latent variable, Lv-3 - third latent variable, Lv-4 - fourth latent variable, Lv-5 - fifth latent variable, Lv-6 - sixth latent variable, h² - communalities

The communalities (h²) show that during measuring the biggest mistakes were made in cases of the variables biacromial breadth (h²=.55), bicrystal breadth (h²=.46) and planimetric parameter of the hand (h²=.57). There are statistically important correlations in case of footballers among the first (longitudinal dimension of the skeleton), the third (-.27) latent variable (the mass and volume of the body) and the sixth (.43) latent variable (transversal dimension of the arms). The second latent variable (panniculus adipose of the upper and lower limbs) is in the correlation (-.27) with the fifth (panniculus adipose of the torso), and the third (the mass and volume of the body) with the sixth (-.27) latent variable (transversal dimension of the arms).

Discussion and conclusion

The earlier research of the morphological space in the field of determining factor structure of the morphologically latent variables showed that the four basic isolated latent variables (dimensions) which determine the morphological structure of a human being as follows – longitudinal dimension of the skeleton, transversal dimension of the skeleton, the volume and mass of the body and panniculus adipose.

These latent variables are sometimes connected which depends on the age, gender, type of sport, the duration of the sports career, conditions and the level of achievement as well as other relevant characteristics so they often form larger number, or only one or two latent variables. When they are joined into two latent variables, that is on the one hand skeleton complex (longitudinal and transversal dimension of the skeleton) and voluminous complex (the mass and volume of the body and panniculus adipose). This research is directed towards determining factor structure of the morphological latent variables (constitutional types) of the top handball players, basketball players and footballers, that is to say, within three different sports. The obtained results showed that in case of handball players five latent variables have been isolated (the mass and volume of the body and panniculus adipose of the torso, longitudinal dimension of the skeleton, panniculus adipose of the upper and lower limbs, transversal dimension of lower limbs and chest, transversal dimension of shoulders and elbow); in case of basketball players there are also five latent variables (longitudinal dimension of the skeleton, the mass and volume of the body and panniculus adipose of the chest, transversal dimension of the lower limbs and wrist, transversal dimension of the arms and pelvis, panniculus adipose of the upper and lower limbs); and in case of footballers there are six latent variables (longitudinal dimension of the skeleton, panniculus adipose of the upper and lower limbs, the mass and volume of the body, transversal dimension of the legs, shoulders and pelvis, panniculus adipose of the torso and transversal dimension of the arms). On the basis of identified factor structures of latent variables and their common relations, it can be concluded that there are various morphological structures of the sportsmen according to sports and between them there are internal and various statistically important correlations.

The first latent variable in case of handball players which has the biggest informatics value has integrated the volume (perimeter) of the arms and legs, transversal dimension (width) of the hand and wrist and panniculus adipose of the torso into its specific structure; therefore, constituent type of handball player has been defined. The results showed that in case of handball player there is the dominance of the mass of the body, volume of the body, panniculus adipose of the torso and width of the hand and wrist, and there are longitudinal dimension of the skeleton, skin creases of the arm and legs as well as transversal dimension of the upper and lower limbs. In case of basketball players the distribution of latent variables is a bit different.

The first latent variable has integrated the longitudinal dimension of the skeleton into its specific structure, and through the second (the mass of the body, volume of the arms and legs and panniculus adipose of the torso), the third and the fourth (transversal dimension of the arms and legs) the latent variables the other latent variables. It means that constituent type of the basketball players dominantly determines the longitudinal dimension of the skeleton, and then in the second place there are mass of the body, volume of the arms and legs, panniculus adipose of the torso as well as transversal dimension of the arms and legs. The first latent variable in case of the footballers, similarly to the basketball players,

has integrated longitudinal dimension of the skeleton in its specific structure, whereas the variables of panniculus adipose of the upper and lower limbs have been integrated into the second latent variable. In contrast to handball and basketball players, in case of footballers the variables of the mass and volume of the body have been integrated into the third latent variable, and in the fourth there are the variables of transversal dimension of lower limbs and variables of shoulder and pelvic girdle. The variables of panniculus adipose of the torso have been integrated into the fifth, and the variables of transversal dimension of elbow joint and wrist have gone into the sixth latent variable.

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LATENTNA STRUKTURA MORFOLOŠKIH ZNAČAJKI VRHUNSKIH RUKOMETAŠA, KOŠARKAŠA I ODBOJKAŠA

Sažetak

Cilj istraživanja je da se na uzorku 158 vrhunskih sportista muškog spola (51 rukometaš, 51 košarkaš i 56 fudbalera), uzrasta od 18 do 30 godina, primjeni sistem od 25 varijabli morfoloških karakteristika i utvrdi njihova faktorska struktura radi formiranja što racionalnijih procedura tokom provođenja kontinuirane selekcije sportaša u tim sportovima i transformacioni trenažni proces. Primjenom faktorske analize (direktni oblmin) i Kaiser-kriterija ($\lambda \geq 1.00$) radi dobijanja zajedničkih karakterističnih korjenova i objašnjenih dijelova zajedničke varijance, kod rukometaša je izolirano pet latentnih dimenzija (masa i voluminoznost tijela i potkožno masno tkivo trupa, longitudinalna dimenzionalnost skeleta, potkožno masno tkivo gornjih i donjih ekstremiteta, transversalna dimenzionalnost donjih ekstremiteta i grudnog koša, transversalna dimenzionalnost ramena i lakta), kod košarkaša takođe pet latentnih dimenzija (longitudinalna dimenzionalnost skeleta, masa i voluminoznost tijela i potkožno masno tkivo trupa, transversalna dimenzionalnost donjih ekstremiteta i ručnog zgloba, transversalna dimenzionalnost ruku i karlice, potkožno masno tkivo gornjih i donjih ekstremiteta), a kod fudbalera šest latentnih dimenzija (longitudinalna dimenzionalnost skeleta, potkožno masno tkivo gornjih i donjih ekstremiteta, masa i voluminoznost tijela, transversalna dimenzionalnost nogu, ramena i karlice, potkožno masno tkivo trupa i transversalna dimenzionalnost ruku). Na osnovu identificiranih faktorskih struktura i njihovih međusobnih relacija, može se zaključiti da se radi o različitim morfološkim strukturama sportista po sportovima, između kojih postoje interne i statistički značajne korelacije.

Ključne riječi: rukometaši, košarkaši, fudbaleri, morfološke značajke, faktorska analiza

GUIDELINES FOR AUTHORS

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