SPORT – Science & Practice, Vol. 8, №1, 2018, pp. 44-55

Original scientific paper

THE CONNECTION BETWEEN ANTROPOMORPHOLOGICAL CHARACTERISTICS AND BALANCE IN YOUNGER SCHOOL-AGE CHILDREN

Predrag Lazarević[1]
College of Sports and Health, Belgrade, Serbia

Srđan Milosavljević
College of Sports and Health, Belgrade, Serbia

Abstract: Motor abilities, such as balance, represent movement abilities that help solve motor tasks. Their development is reflected in the genetic program of organism's individual development and social-ecological adaptation. The goal of this research was to verify the connection between anthropomorphological characteristics and balance in younger school-age children. The sample included 150 examinees aged 9 and 10, 49.33% of which were males, and 50.67% females. The measurement results were analyzed by means of descriptive and correlative statistical method using the Pearson correlation coefficient. The research results show positive dependence of the Flamingo balance test on dominant and non-dominant leg with eyes closed on body mass and body mass index. A positive correlation with the same test was noted in the values of the measured volume of waist, chest and lower leg, but also the volume of lower arm with the Stork test on a dominant leg with eyes closed. The percentage of water is in negative correlation with the low beam test on the non-dominant leg with eyes closed (-0,197*), while the muscle mass percentage correlates with the same test on the non-dominant leg with eyes closed (0,209*). The results in this research are in accordance with other authors' results, but they also indicate that balance depends on the visual analyzer or vestibular apparatus. The possibility of greater engagement at physical education classes, training and improvement of basic motor actions in balancing positions without visual control could assist the development of balance in general.

Keywords: *younger school age, motor abilities, balance.*

[1] predrag.lazarevic@vss.edu.rs

INTRODUCTION

Motor abilities, which include balance, are nothing else but a person's movement abilities that participate in resolving motor tasks. These involve a person's physical, psychological, sociological, physiological and other characteristics. Motor abilities are used precisely for solving motor tasks and they are the most responsible for their successful resolution (Krsmanovic and Berkovic, 1999. p. 175).

When a motor ability that contains components of another ability is under development, the other ability is being developed, but not as intensively. However, other examples show that the development of one obstructs and inhibits the development of some other abilities. Namely, there is certain antagonism between aerobic and anaerobic processes, due to which the development of one obstructs the development of the other, and vice versa (Krsmanovic and Berkovic, 1999. p.182).

The development of motor abilities is manifested in two factors: a genetic program of individual development of an organism and its socio-ecological adaptation which precisely creates the conditions for a targeted effect on the functional characteristics of organs and systems of an organism, and in line with this, for a targeted control over the development of motor abilities (Krsmanovic and Berkovic, 1999. p. 176). There is a difference between the sensitive and critical period of the development of motor abilities. The sensitive phase represents a time period that is better for the effect of external stimuli than other developmental intervals. The critical period is a time frame within which stimulation must occur if developmental changes are to be made. It denotes the last moment or a deadline within which it is possible to achieve the best effect of training (Visnjic et al., 2004). Development represents qualitative changes during biological maturation which refer to the changes in the functions of cells, tissues and organs, as well as the reorganization of regulatory mechanisms, and every child undergoes developmental stages (Ugrakovic, 2004).

When it comes to the essence of the name of motor abilities, perhaps the most adequate interpretation is offered by Zacijorski, V.M. (1969), who believes motor abilities to be those aspects of motor activity that appear in movement structures, described by an equal parametric system, and which can be measured by an identical group of measures, but also in which analogue physiological, biochemical, cognitive and conative mechanisms occur. Thus defined motor abilities differ from motor habits and skills even though, of course, the manifestation of motor abilities is possible only through a concrete motor action (Visnjic, 2004). Motor abilities are a person's abilities that participate in the solving of motor tasks and they are a condition for successful movement, regardless of whether they are acquired by means of training or not. They are manifested through two areas: the manifest and latent ones (Malacko and Radjo, 2004). Children's motor behavior is greatly determined by the functional mechanisms of the central nervous system, which cannot be fully formed at younger school age, and this is one of the main reasons for the insufficiently clear differentiation of motor abilities at this age (Kurelic et al., 1975).

Balance as a motor ability is manifested in all motor actions in order to maintain a balanced position, i.e. to neutralize gravity which tends to disturb it. Balance is largely related to coordination. In addition, it is conditioned by deep sensitivity receptors and vestibular apparatus. When occupying a steady balanced position, the entire motor apparatus is engaged to a lesser extent, while vestibular apparatus plays a more significant role.

Bearing in mind that the development of coordination, and thereby balance, is closely connected with the development of the nervous system, it is no wonder that the development of the given abilities features its own sensitive periods. Certain authors claim that for balance this period lasts until the age of 14 (Kukolj, 1996). Bass (1939) was among the first to study balance as a motor ability. Using factor analysis, he underlined the dependence of balance on whether tests are conducted with eyes open or closed. He also explained balance by means of the function of semicircular canals in the inner ear, and he also checked the static and dynamic balance tests. The question of balance was also studied by: Fleisman and Hempel (1955); Ismail and Gruber (1967); Ismail, Kane and Kirkendall (1969) and others. The field of balance is divided into static and dynamic balance with Fleisman and Hempel (1955) call "equilibrium balance" and "achievement balance". Balance is considered to be one of the basic psychomotor abilities. A well-integrated nervous system with some afferent input, moveable joints and healthy muscles is a prerequisite for good balance functioning. In case any of the nervous factors are disturbed, the ability to maintain balance is also disturbed. Intensified or slower balance reactions appear when muscle hypertonia or hypotonia occur. Also, balance reaction can be changed in case of stiff joints or joints with limited movability (Obradovic, 2002).

According to Kurelic et al. (1975) the balance factor is defined as the ability to maintain body in equilibrium.

Namely, when it comes to motor ability, it characterizes timely reaction and correction of the position disturbed by gravity and other actions (Milanovic and Stamatovic 2004. p. 49). Kosinac (2009) explains the expression "balance reaction", indicating that this is the body's ability to establish a stable position quickly and efficiently at any point. Stable balance is found in training with machines, since all of them provide support above the body center. Every movement, or move, is based on the amount of muscle tension, duration, the speed of muscle contraction, the amplitude of movement and the coordination of muscle work, which enables and determines movement direction and path. Even when resting, muscles are still partially tense, and this basic degree of skeletal muscle contraction is called muscle tone. (Kocic et al. 2009. p. 131).

The significant role of the vestibular system in establishing the balance of the entire organism, motor control and motor planning, movement coordination and the development of normal muscle tone necessary for clear speech production, attracts more and more scientist to this field of research (Bucci et al. 2009; Hanes and McCollum, 2006).

Vestibular function disorders are sometimes clearly visible in spontaneous symptoms, however, they usually need to be provoked to perceive all the details, and precise devices and recording methods need to be used for direct symptoms. (Savic, 1994). Researching how vestibular system contributes to bodily experience and motor planning, Cheatum and Hammond (2000) stress that vestibular information orients our bodily "maps" in the surrounding space, and that they play a particularly significant role in the movement "navigation" of the entire body.

Planned training could achieve certain results, especially when the exerciser is brought into the situations in which they will demonstrate these movement abilities (moving on narrow surfaces, walking on a beam, log, bench, training with machines, etc.) (Milanovic and Stamatovic, 2004; Velebit, 2003).

Balance assessment in children has been acknowledged as an important link in the child development evaluation for a while now. Some disorders of the sense of balance that are detected at an adult age, originate from childhood. Due to significant variability, training mostly consists of maintaining balancing positions in specific conditions, characteristic of a certain activity (Kosinac, 2009). Balance provides basic conditions for maintaining the optimal position when training, so the students with a higher level of balance will be at an advantage when it comes to mastering and performing certain sports activities (Milanovic and Stamatovic, 2004. p.49).

The role of a coach will not affect the natural course of the development of an organism, but an adequate selection of training instruments and load dosage, applied through appropriate forms of work, will contribute to a correct and overall development of children. Bearing all this in mind, it is extremely important and useful that the persons who manage and participate in work with young children are those who are familiar with the overall developmental path of an athlete (Markic, 2012. str. 7-10).

The research subject was to examine whether there are statistically significant differences between the examinees in terms of motor abilities and balance, and to present their body status.

The goal is to determine the differences in motor abilities between girls and boys who practice and those who do not practice sports, but also to present their morphological characteristics and balance.

METHOD

Sample

The examinee sample consisted of young school-age children, precisely 150 third- and fourth-grade students. Out of the total number of examinees, 74 were boys (39 third-grade and 35 fourth-grade students) and 76 were girls (39 third-grade and 37 fourth-grade students). 94% of the examinees stated that they regularly attend physical education classes.

Note: when maintaining balance, examinees were allowed to control balance by moving arms in the air and bending their bodies (Bala, 1981).

Variables

The tested variables belonged to anthropomorphological and motor areas.

Anthropometrically measured variables are:

- Measuring the longitudinal dimensionality of the skeleton, body height (BH);
- Measuring body mass, body mass (BM);
- Measuring volumes, body volumes (BV – upper arm, lower arm, chest, waist, lower leg and upper leg)

Morphological variables that were measured are:

- Measuring body fat percentage (BFP)
- Measuring body mass index (BMI)
- Measuring body water percentage (BW)

Tests used to evaluate the level of balance in motor area include:

a) Stork test (with open and closed eyes on the dominant and non-dominant leg)
   - Stork test (non-dominant leg) – SNL; Stork test (dominant leg) – SDL;
   - Stork test (non-dominant leg, closed eyes) – SNCE; Stork test (dominant leg with eyes closed) – SDCE;

b) Flamingo test (with open and closed eyes on the dominant and non-dominant leg)
   - Flamingo test (non-dominant leg) – FNL; Flamingo test (dominant leg) – FDL;
   - Flamingo test (non-dominant leg, closed eyes) – FNCE; Flamingo test (dominant leg, closed eyes) – FDCE;

c) Low beam test (with eyes open and closed eyes on the dominant and non-dominant leg)
   - Low beam test (non-dominant leg) – BNL; Low beam test (dominant leg) – BDL;
   - Low beam test (non-dominant leg, closed eyes) – BNCE; Low beam test (dominant leg with closed eyes) – BDCE;

Data processing method

The measurement results were analyzed by means of descriptive and correlative statistics. The SPSS Statistics 20 statistical program was used for data processing and it produced the results, and the correlation analysis was conducted using the *Pearson* correlation coefficient.

RESULTS

Table 1 shows the results of the potential effect of body height (BH), and body weight (BW) as well as the body mass index (BMI) to balance maintenance. The results show no statistically significant correlation between BH and the motor ability to maintain balance.

Table 1: *The correlation of body height (BH), body mass (BM) and body mass index (BMI) with younger school-age children's balance.*

BALANCE TESTS	BH	BM	BMI	
FNL (sec) n=150	-0,045	0,103	0,139	Correlation coefficient
FDL (sec) n=150	-0,067	0,102	0,148	
FNCE (sec) n=150	0,056	**0,199***	**0,205***	
FDCE (sec) n=150	0,085	**0,196***	**0,163***	
SNL (sec) n=150	-0,085	-0,034	0,001	
SDL (sec) n=150	-0,046	-0,028	0,013	
SNCE (sec) n=150	0,025	0,056	0,057	
SDCE (sec) n=150	-0,028	0,031	0,051	
BNL (sec) n=150	0,049	0,026	0,024	
BDL (sec) n=150	0,014	-0,022	-0,040	
BNCE (sec) n=150	0,017	0,117	0,159	
BDCE (sec) n=150	0,028	0,035	0,066	

* p<0,05; BH-body height; BM-body mass; BMI-body mass index; n-the number of examinees

Table 1 shows us that the impact of BW on the tested population's balance is statistically significant only in the FNCE and FDCE test results, which can be seen in the correlation values of these two parameters. BMI was also in positive correlation with the same balance tests with closed eyes (FNCE - 0,205*; and FDCE - 0,163*).

Table 2. *An overview of the correlation between circulatory anthropometric measurements (transversal dimensionality of the skeleton) and balance in younger school-age children*

BALANCE TESTS	UA	LA	CH	WST	LL	UL	
FNL (sec) n=150	0,043	0,113	0,076	0,083	0,118	-0,026	Correlation coefficient
FDL (sec) n=150	0,037	0,120	0,077	0,082	0,076	-0,039	
FNCE (sec) n=150	0,094	0,128	**0,171***	**0,167***	**0,204***	0,006	
FDCE (sec) n=150	0,076	0,150	**0,180***	**0,162***	**0,163***	-0,054	
SNL (sec) n=150	0,079	0,152	0,047	0,044	-0,029	-0,007	
SDL (sec) n=150	0,074	0,120	0,012	0,026	-0,025	0,002	
SNCE (sec) n=150	0,151	0,155	0,108	0,106	0,028	0,065	
SDCE (sec) n=150	0,117	**0,165***	0,081	0,069	0,033	0,055	
BNL (sec) n=150	0,016	0,034	0,049	0,042	-0,001	0,125	
BDL (sec) n=150	-0,016	0,007	0,004	-0,017	-0,037	0,081	
BNCE (sec) n=150	0,111	0,034	0,125	0,050	0,054	0,124	
BDCE (sec) n=150	0,037	-0,014	0,067	-0,031	-0,015	0,072	

* $p<0,05$; UA – upper arm; LA– lower arm; CH – chest; WST – waist; LL– lower leg; UL– upper leg; n - the number of examinees

The results indicate that certain tests for the assessment of balance in younger school-age children are in positive correlation with certain monitored anthropometric measurements, including: the Flamingo test on the non-dominant and dominant leg and closed eyes with the chest, waist and lower leg volume, but also the Stork test on the dominant leg and closed eyes with the lower arm volume.

Table 3. *The impact of the percentage (%) of water and muscle mass in the total body weight on younger school-age children's balance.*

BALANCE TESTS	% OF WATER	% OF MUSCLE MASS	
FNL (sec) n=150	0,019	-0,015	Correlation coefficient
FDL (sec) n=150	-0,033	0,000	
FNCE (sec) n=150	-0,118	0,084	
FDCE (sec) n=150	-0,091	0,057	
SNL (sec) n=150	0,091	-0,123	
SDL (sec) n=150	0,063	-0,062	
SNCE (sec) n=150	0,019	-0,044	
SDCE (sec) n=150	0,036	-0,051	
BNL(sec) n=150	0,001	0,010	
BDL (sec) n=150	0,030	-0,022	
BNCE (sec) n=150	**-0,197***	**0,209***	
BDCE (sec) n=150	-0,094	0,114	

*$p<0,05$; n-the number of examinees

Table 3 shows that the percentage of water is in negative correlation with the balance test performed on a low beam on the non-dominant leg and closed eyes, while the body mass percentage positively correlated with the same test results.

DISCUSSION

When it comes to the impact body height (BH), as a variable for measuring longitudinal dimensionality of the skeleton, has on balance, the results of the research indicate that there is no statistically significant correlation between BH and balance as a motor ability. The obtained results are in accordance with the results of similar research studies (Ljubojević et al., 2012). Since the examinee sample consisted of younger school-age children, their process of growth still had not achieved the most intense stage (the body height measurements showed that the children were of average and uniform height), so it is logical that the balance level is not determined by body height. In the stage of intense longitudinal growth, a drop in coordination abilities which condition lower balance levels is justified, so it serves as a logical explanation for the obtained results. The research conducted on older school-age children (Delaš et al., 2008) indicates that there is a statistically significant correlation between the longitudinal dimensionality of the skeleton and balance, because body height and balance level are inversely proportional. An explanation for these results can be found in the fact that younger school age is not a period when children obtain greater body mass due to intense growth, so it is easier to control the entire body's balance. On the other hand, the constitutional characteristics of children at the given age enable properly distributed body mass, even in overweight children, which is a prerequisite for good balance. The research results in FNCE and FDCE confirm the existence of statistically significant correlation between balance and body mass. Greater body mass has a negative effect on the ability to maintain balance with closed eyes. Namely, when it comes to maintaining balance in a relatively difficult and atypical position, such as the Flamingo test, especially without visual control, there is a proprioceptive issue, where the awareness of the position of certain body segments (arms, legs, trunk) in space becomes weaker, which leads to loss of balance.

Takalić and Hosek (1973) implemented a battery of 11 balance tests, and determined the dimensions whose contents speak in favor of balance differentiation considering the involvement of visual analyzer, but also the size of the area. It should be noted that maintaining balance in a relatively steady condition is determined by the information obtained from the kinesthetic and tactile analyzer, and partially from the vestibular and optical analyzer. Returning to a balanced position, rotating the entire body, depends on the information obtained mostly from the vestibular analyzer (Mekic, 2007a. pp. 139-140). The research results from the Flamingo test on the non-dominant and dominant leg and closed eyes indicate the existence of statistically significant correlation with BMI. Since it is not possible to gain greater muscle mass at younger school age, the BMI values show the presence of obesity in children to a greater extent. Children with higher BMI values find it more difficult to control the position of their body, particularly without visual control, so the obtained results in the examined variables match the results of previous research studies (Delaš et al., 2008.), i.e. the characteristics of the morphological-functional development of younger school-age children (Ugarković, 2004.).

Testing the impact of the transversal dimensionality of the skeleton on younger school-age children's balance showed that certain anthropological parameters (the volume of chest, waist and lower leg) statistically significantly and moderately positively correlate with the Flamingo test with closed eyes (on the dominant and weaker leg). The lower arm volume statistically significantly and moderately positively correlates with the Stork test on the dominant leg with closed eyes (Table 2). The realized testing results show that there is no statistically significant correlation between the volume of upper arm/upper leg and balance. When it comes to the volume of lower arm, most of the tests showed no statistically significant correlation, with the exception of the Stork test on the dominant leg with closed eyes. Considering that it is a single variable in the area of transversal dimensionality of the skeleton in a single variant of the conducted testing, the impact of transversal skeletal dimensions on balance cannot be rationally claimed to exist. In a larger number of tests, the research results do not show a correlation between chest volume and balance, because there was no statistically significant correlation. The Flamingo test on the dominant and non-dominant leg with closed eyes showed statistically significant correlation between chest volume and balance. Considering that at younger school age chest volume represents and indirect measure of a child's obesity (Mišigoj-Duraković et al., 2007), a motor action that is more difficult coordination-wise is not easy to realize, especially without visual control, because the proprioceptive abilities of overweight children are not at a high level. The Flamingo test with closed eyes on the dominant leg showed the existence of statistically significant correlation between waist volume and balance. The constitutional characteristics of younger school-age children when it comes to the nutritional status or obesity of children are manifested through large volume of the waist (Mišigoj-Duraković et al., 2007), which is a condition for worse indicators of coordination abilities, balance and speed (Kocić et al., 2009). The Flamingo test with closed eyes on the dominant and weaker leg showed statistically significant correlation of lower leg volume and balance, which can be explained through previously described inverse proportionality between greater circulatory dimensions (lower leg volume) and balance. Research indicate that children with higher body mass and, thereby, greater circulatory dimensions, feature lower flexibility, which reflects on the difficulty of maintaining complex positions such as those in the Flamingo test.

The results concerning the correlation between balance tests and the percentage of muscles and water in the body point to moderately negative correlation of the percentage of water with BNCE, which is statistically significant at the 0.05 level, while the results of the same BNCE test showed statistically significant and moderately positive correlation with the muscle mass percentage. (Table 3).

Since the research into the correlation between the % of water/muscle mass and balance in younger school-age children showed dependence only in the low beam test on the non-dominant leg and closed eyes, it can be concluded that the % of water and muscle mass in the body do not affect balance in third- and fourth-grade children.

Concerning the correlation of the percentage of water in the body and the low beam balance test on the non-dominant leg and closed eyes, the results indicated the existence of statistically significant negative correlation. Higher percentage of water usually appears in children with a lot of adipose (fat) tissue, hence, slimmer children feature a lower percentage of water in their bodies. (Ugarković, 2004). For that reason, it can be claimed that those two measured parameters appear in negative correlation.

The balance testing results on a beam, standing on the non-dominant leg with closed eyes, point to statistically significant, positive correlation with the muscle mass percentage in the total body mass. Considering that those are younger school-age children, who have much lower muscle mass percentage due to physiological processes in their body (Ugarković, 2004), it can be concluded that higher muscle mass percentage is relative in relation to body mass.

Since modern training technology of young athletes implies multilateral impact on all motor abilities (Malacko and Rađo, 2004), it is assumed that the more difficult motor activities, such as standing on one leg without visual control, will be better performed by children with higher percentage of muscle mass, i.e. by those children who in addition to regular physical education classes, engaged in the training process of a certain sport.

CONCLUSION

The obtained results underline the need for physical education lessons for younger school-age children to dedicate more attention to training and mastering basic motor activities (walking, crawling, standing on one leg, etc.) in balancing positions and without visual control, in order to improve the general motor factor, coordination abilities and balance, as a basis for good posture which is crucial at that age and as an introduction to the intense growth stage. Considering that the formation of proper posture is one of the basic goals of physical education, it is clear that the classes must involve the given activities. Another rational explanation of the given results may be contained in the fact that the impact of children's extracurricular sports activities is still not very prominent at younger school age due to the shortness of engagement in the sport or inadequate training. The proprioceptive abilities of overweight children are not on a high level, so it can be concluded that the aspects that require particular attention are the degree of children's nutritional status and the variability of dynamic balance practice at the given age, with particular stress on dynamic balance practice without visual control.

The conducted research lacks subsamples and the assessment of correlation between the measured parameters and balance and by gender.

REFERENCES

1. Bala, G. (1981). *Struktura i razvoj morfoloških i motoričkih dimenzija dece SAP Vojvodine*. Fakultet fizičke kulture, Institut fizičke kulture.
2. Bass, R.I. (1939). An analysis of the components of tests of semicircular canal function and of static and dynamic balance. *Research Quarterly. American Association for Health, Physical Education and Recreation*, *10*(2), 33-52.
3. Bucci, M.P., Lê, T.T., Wiener-Vacher, S., Brémond-Gignac, D., Bouet, A., & Kapoula, Z. (2009). Poor postural stability in children with vertigo and vergence abnormalities. *Investigative ophthalmology & visual science*, *50*(10), 4678-4684.
4. Cheatum, B.A., & Hammond, A.A. (2000). *Physical activities for improving children's learning and behavior: A guide to sensory motor development*. Human Kinetics.
5. Delas N., Tudor A., Ružic L. i Sestan B. (2008). *Povezanost stupnja uhranjenosti dece 5-8. razreda osnovne skole i nekih motorickih sposobnosti*. Rijeka: Medicinski fakultet.
6. Fleishman, E.A., & Hempel Jr, W.E. (1955). The relation between abilities and improvement with practice in a visual discrimination reaction task. *Journal of experimental Psychology*, *49*(5), 301.
7. Hanes, D.A., & McCollum, G. (2006). Cognitive-vestibular interactions: a review of patient difficulties and possible mechanisms. *Journal of Vestibular Research*, *16*(3), 75-91.
8. Ismail, A.H., & Gruber, J.J. (1967). *Integrated development; motor aptitude and intellectual performance*. CE Merrill Books.
9. Ismail, A.H., Kane, J., & Kirkendall, D.R. (1969). Relationships among intellectual and nonintellectual variables. *Research Quarterly. American Association for Health, Physical Education and Recreation*, *40*(1), 83-92.
10. Kocic, J., Aleksic, D., Tosic, S. (2009). *Osnove kineziologije i sportova estetsko-koordinacionog karaktera*, Jagodina: Pedagoski fakultet.
11. Kosinac, Z. (2009). *Igra u funkciji poticaja uspravnog stave i ravnoteze u djece razvojne dobi, Split*: Zivot i skola.
12. Krsmanovic, B. i Berkovic, L. (1999).*Teorija i metodika fizickog vaspitanja*, Novi Sad: Fakultet fizicke kulture.
13. Kukolj, M. (1996). *Opšta antropomotorika*, Beograd: Fakultet fizicke kulture.
14. Kurelić, N., Momirović, K., Stojanović, M., Šturm, J., Radojević, Đ. i Viskić-Štalec, N. (1975). *Struktura i razvoj morfoloških i motoričkih dimenzija omladine.* Beograd: Institut za naučna istraživanja fakulteta za fizičko vaspitanje.

15. Malacko, J., Radjo, I. (2004*). Tehnologija sporta i sportskog treninga,* Sarajevo:Fakultet sporta i telesnog odgoja.
16. Markic, N. (2012). *Trenazna sredstva motorickih sposobnosti fudbalera uzrasta od 10 do 12 godina*. Beograd: Fakultet sporta i fizickog vaspitanja,Diplomsi rad.
17. Mekic, B. (2007a). *Osnovi opste antropomotorike,* Leposavic: Fakultet za sport i fizicko vaspitanje.
18. Milanovic, Lj., Stamatovic, M. (2004*). Metodika nastave fizickog vaspitanja*,Uzice: Uciteljski fakultet.
19. Mišigoj-Durakovic, M., Matkovic B.R. (2007). *Bioloske i funkcionalne osobitosti djecije i adolescentne dobi i sportski trening*, Zagreb: Peta godisnja medjunarodna konferencija, kondicijska priprema sportasa.
20. Obradovic, M. (2002). *Opsta kinezoterapija sa osnovama kinezoterapije,* Podgorica.
21. Savic, D.(1994). *Funkcionalno ispitivanje sluha i vestibularnog aparata.* Beograd: Medicinski fakultet.
22. Ugrakovic, D. (2004). *Biomedicinske osnove sportske medicine,* Novi Sad: CIP.
23. Velebit, R. (2003). *Savremeni fudbalski trening*, Beograd: Spotrska akademija.
24. Visnjic, D. (2004*). Teorija i metodika fizickog vaspitanja*. Beograd: Fakultet sporta i fizickog vaspitanja.
25. Visnjic,D., Jovanovic, A. i Milekic, K. (2004).*Teorija i metodika fizickog vaspitanja*. Beograd:Fakultet sporta i fizickog vaspitanja.
26. Zaciorski, V. M. (1969). *Fizička svojstva sportiste*. Beograd: JZFK i FFK.