International Quarterly of Sport Science 2009/3

DYNAMIC BALANCE IN WATER AND ITS INFLUENCE ON CHILDREN'S SWIMMING ABILITY

Lubomíra Benčuriková
Comenius University, Bratislava, Faculty of Physical Education and Sports
bencurikova@fsport.uniba.sk

Abstract

The aim of our research was to broaden the knowledge about the level of selected coordination skills in the water and determine its influence on the level of swimming skills of preschool-age children. The research group consisted of 189 children, randomly selected in eight kindergartens in Bratislava. The children took part in a 13-lesson swimming course in March, April and May 2008. The lessons focused on learning basic swimming skills. We evaluated dynamic balance in the water by using a non-standardized "The obstacle course in water" test, which we developed ourselves. We assessed the level of swimming skills at the beginning and at the end of the swimming course. For this we used the method of front float as well as measuring the distance which the children swam using a board and crawl leg movement. The improvement was noted in our research group after completing the swimming course. We recorded highly significant statistical relationship on the level $p<0.01$. We also noted statistical significance when assessing the influence of dynamic balance in water on the level of children's swimming skills.

Key words: *Swimming, swimming abilities, pro-school age, coordination abilities – dynamic balance*

Introduction

Swimming is one of the favourite movement activities which is very important for children's health and their harmonious development. Most children enjoy being in the water and it is this strong emotional feeling together with an active movement in the water that create a unique environment to improve children's emotional development. Active and regular movement in the water fosters children's psychomotor development and their fitness; supports movement coordination, gross and fine motor skills, and improves the body's immune system. From the health standpoint swimming is one the most effective movement activities.

The children all vary in how they adapt to a water environment. Those who fear water learn swimming skills at a slower pace than children who are not afraid of water. Each child is unique. A general and universal model for solving the issue of a child's adaptation to a water environment does not exist. In addition to external factors, the adaptation of a child to a water environment is influenced by developmental factors as well as the level of coordination skills.

To what degree, though, can the level of coordination skills influence a child's motor skills in the water? It was this unanswered question that led us to select the topic of our research in which we sought to extend the knowledge about the influence of dynamic balance of preschool-age children on the level of their swimming skills.

The matter of research measurement is dealt with in a grant assignment VEGA No. 1/06/0674/08/13 called "The study of human motor activity in water environment." Within this research task motor skill tests, adapted to children of preschool age, were developed.

At present, many domestic as well as foreign authors concentrate solely on evaluation of coordination on land. However, it is generally known that movement in the water and swimming itself are beneficial to the development of coordination.

Specialized literature gives little attention to the matter of finding the connection between the level of swimming skills of preschool-age children and their coordination skills in the water. Standardized motor skill tests to monitor coordination in a water environment are non-existent not only for preschool-age children but for older children as well. There are no other results, methods or research groups at our disposal with which we could compare our results. That was one of the reasons why we decided to pursue this topic.

Hirts et al (1985) define coordination skills as complex, relatively independent assumptions for the performance regulation of movement activities. They form and develop in movement activities and are based on hereditary mechanisms which can be improved by systematic training. According to the authors, the age between 7 and 11 years is a sensitive period of the progressive development of coordination skills.

According to Moravec and col. (2004), the development of coordination skills differs with age. In their opinion, the most sensitive and suitable is the age from about 7 to 13.

Coordination skills represent a mosaic of varied skills which are interconnected; they seldom exist separately. Many attempts have been made to arrange them hierarchically, or systematize them. Several specialists (Raczek-Mynarski, 1992; Halmová-Šimonek-Broďáni, 1998, Šimonek, et al., 2003; Kasa, 2004; Doležalová-Lednický, 2002; Moravec a kol., 2004; Lednický, 2005; Ružbarská-Turek, 2007) agree that a generally accepted taxonomy of coordinations skills does not exist. They share the opinion of Hirtz (1985), who defined five basic coordination skills: balance skill, spatial-orientation skill, rhythmic skill, reaction skill, and kinesthetic-differential skill.

The development of individual coordination skills is part of motor development. This development is irregular since the periods of various intensity of increasing alternate with periods of stagnation. This development is closely linked to the process of aging in the course of ontogenesis. Kinaesthetic-differential skill develops first, then reaction skill, followed by rhythmic, balance and orienting skills (Šimonek et al., 2003).

Balance skill is the ability to maintain and revert the body balance to the original position when there are quick and unexpected changes of conditions, or when moving on a narrow or unstable surface. Balance depends on the size of supporting surface, the position of the centre of gravity of the body, the state of vestibular apparatus and central nervous system.

Vision analyser is of great importance for balance, but vestibular analyser, which is called a balance organ, is even more significant. Its receptor part is located inside the labyrinth of the inner ear. Vestibular analyser contributes to our balance with the help of muscle and skin receptors which form part of reflex arches. They are also important for sensations of spatial orientation and have influence on muscle toning. Balance skill is important for all movement activities. It can be improved significantly by regular and systematic training.

Schnabel (1994) defines balance skill as a special coordination skill manifested in the fastest and most effective solution of motor tasks on a very small supporting surface by the influence of external forces jeopardizing this unstable balance. It is a special coordination assumption to perform movement tasks in challenging conditions as well as essential precise spatial orientation and control.

Dovadil (2005) interprets balance skills as assumptions of humans to precisely feel the influence of external forces on their body when performing movement as well as in various positions.

Using internal (muscular) forces, the body can react optimally and effectively with compensatory movement, relevant to accuracy of spatial, time and force parameters so that balance between internal and external forces is kept in biochemical system. Information received from vestibular, visual and kinaesthetic apparatuses is of great importance for retention of balance (Zemková, 2005). According to Měkota & Novosad (2005) balance ability is the ability to maintain the whole body in balance state, resp. to restore balance in strained balance conditions and changing external conditions.

We recognise:

- Static balance manifested by retention of a position while still or when doing a slow body movement. Kasa (2004) defines static balance as retention of a balanced position in designated positons while still. The retention of the body or its parts in one position cannot be perceived as total motionlessness but as incessant revertion to, or fluctuation around, an ideal course or point.

- Dynamic balance manifested by retention and revertion of balance when changing a body's position. It is the ability to resolve motor tasks in the fastest and most efficient way on a very small supporting surface by the influence of external forces jeopardizing this unstable balance (Halmová et al., 2007).
- Balancing an object

The relation between static and dynamic balance is confirmed by the well known Henry's hypothesis (1985). This hypothesis states that so-called automatic transfer between several skills does not exist as these are not specifically related to a particular task. It means that a person reaching a good level of static balance is not necessarily able to retain the stability of body stance in dynamic conditions (Zemková, 2008).

According to Šimonek et al. (2003) a period of preschool age, but especially of younger school age represents a sensitive period for development of balance skills. Balance skills increase from age of 10 up to 17 years and after this progressive stage a period of stagnation follows (Mlieczko, 1992; Moravec, 1996).

The assessment of dynamic skills is very often done by testing body stance in various challenging conditions. For this, balancing pads are used. A stabilographic platform is put on top of the pads, with eyes fixed on a designated point. A FITRO Sway Check stabilographic system can be used for the assessment. This system enables to monitor the centre of gravity in horizontal plane based on the analysis of distribution of vertical force which is monitored by using a dynamometric disk with three tensometric sensors of 100 Hz frequency (Zemková, 2008).

We can state that children aged 5-6 years do not reach a rapid increase in the level of their coordination skills. Neither is the period of preschool age considered to be a sensitive period for the development of coordination skills. The children achieve a higher level of coordination skills only when they reach a young school age. In the course of preschool age many aforementioned physiological changes occur (growth of limbs, intensity of physical development, skeleton strengthening, etc.) and due to the development of coordination between limbs and torso the children run, jump, swim, ride the bicycle, ride on a sledge, ski, etc. The children of this age group master basic social and hygienic habits and proper pronunciation. They are able to coordinate physical movement (Kasa, 2004).

Although coordination skills have been quite amply covered, only a few authors focus on preschool age (Šimonek, 1985; Doležalová & Lednický, 2002; Kasa, 2002; Junger, 2000; Halmová, 2005; Ružbarská & Turek, 2006; and others). According to Halmová et al. (1998) coordination skills standardized tests for preschool age children do not exist.

A uniform diagnostics of coordination skills of preschool-age children, leading to a standardized testing, is non-existent. Not all the tests recommended for young school age children are suitable for preschool-age children. We can just adapt them to a motor activity level of 5-6 year-old children based on our experience. Due to modification and non-uniform methodology and approach of researches partial results become incomparable (Macejková & Viczayová, 2007).

A considerable number of motoric tests were undertaken experimentally. However, many of them cannot be applied, mostly due to the fact that they insufficiently respect the development of children's organisms. When assessing the level of development of individual organ systems influencing motor activity of preschool-age children, the central nervous system proves to be the most crucial. According to Ružbarská and Turek (2006) it generates the base for the development of a child's coordination abilities. The quality of movement is influenced by a high level of joint flexibility and the level of coordination abilities is closely connected with the level of speed abilities.

Objectives

The aim of our research was to extend the knowledge about dynamic balance in water and its influence on managing basic swimming skills.

Hypothesis

We suppose that a higher level of coordination skills will have a positive effect on managing swimming skills.

Hypothesis theory: We suppose that children who achieve better result in the obstacle course are braver and therefore able to manage the learning of swimming skills quicker than children whose time in the obstacle course was slower. This statement is based on objectives that these children have a greater respect to an unknown water environment.

Tasks

Following our aim and characteristics of observed children's group, we stated these tasks:

1. To find out the level of dynamic balance in water by means of an obstacle course designed for pre-school children.
2. To find out the level of swimming capability through swimming skills (floating, freestyle kicking) and to point out the changes after finishing the swimming course.
3. To find out relationships between dynamic balance and swimming capability of children at pre-school age.

Methods

We randomly chose 189 children (84 boys and 105 girls) from eight kindergartens, who participated in our research. Their average decimal age was 5,6 years. The swimming course involved 13 swimming lessons and took place from March to May 2008, with the frequency of one lesson a week. The content of the lessons was focused on learning basic swimming skills. During the swimming lessons we used various interesting forms of learning swimming skills and we tried to adapt the children slowly to the swimming environment. The particular lessons had their own target and were realized according to a plan of swimming preparation of children at pre-school age (Bencurikova, 2008).

We evaluated *coordination skills* in water on the first lesson of swimming course by means of a non-standardized test "obstacle course in water" (Šimonek et al., 1998) and „balancing on moving board – balansomer" (Zemkova & Hamar, 1998). The obstacle course in water was made of 5 swimming mats with the length of 3 m and size 75x55x5 cm (fig.1). The swimming mats were joined together by means of swimming noodles through the holes in the mats' corners. This way we built a moving surface and the children were asked to balance on it and run through it as fast as possible (fig. 2). The time measurement started with a bounce of pool's bottom and finished with a jump at the end of the obstacle course. Not running through all the length of the obstacle course or a fall into water was evaluated as a false attempt. After explanation and a trial attempt, the children had two attempts and the arithmetic mean of them was our result of testing.

We tried to find out the ability of maintaining dynamic balance in a playful and competitive way suitable for children at pre-school age. During the run through the obstacle course the children's balance abilities came out and affected the test's result.

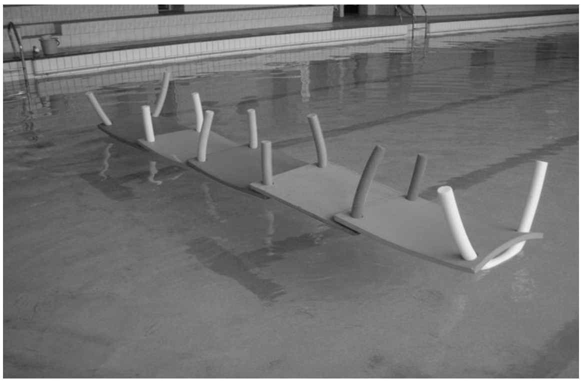

Figure 1. Obstacle course in water.

Figure 2. Run through the obstacle course in water.

We evaluated the swimming skill *floating* at the beginning and at the end of the swimming course. We observed the child's ability to lie on the water surface while holding breath and face under water for at least 5 seconds (passed, failed). *The crawl kicking* was evaluated only at the end of the swimming course because the children did not handle this skill at the beginning. The children swam kicking with a swimming board in water with depth to breast and we measured the distance in metres.

We used basic statistical characteristics for processing and evaluating of the results. The results of swimming skills were evaluated by means of subject, percentage and relation analysis. We used Chi-square method to consider the differences of the measurements at the beginning and at the end of the observation. The relation between the level of dynamic balance in water and the rate of learning swimming skills was evaluated by means of correlation relationship. Our interpretation of the results was based on graphic illustrations, methods of logical analysis and synthesis with using inductive and deductive approach.

Results

The level of dynamic balance in water of children in pre-school age

The evaluation of dynamic balance in water was realized by means of the obstacle course in water. The results are aimed at the level of dynamic balance in the observed age group. The average performance achieved by our group was 10.01 s (Tab.1). The worst achieved result was 26.3 s and the best one was achieved by a boy, who ran the course in 3.2 s. Testing the balance skills can be influenced by various internal parameters – focusing attention, health, fatigue and external parameters – time, testing conditions (Belej & Junger, 2006). In our research, one of the conditions was somatic parameter – weight – the obstacle course was suitable only for children under 36 kg. The importance of this test is also in developing balance skills, which are necessary for a swimmer in water environment.

Table 1. Basic statistical parameters (n = 189)

Basic statistical parameters	Obstacle course (s)	Crawl kicking with board (m)
AVERAGE	10.01	7.11
MIN	3.20	2.00
MAX	26.30	12.00
STDEV	4.2218	4.2212

The level of swimming capability of pre-school children and its changes after the swimming course

The test “floating“ was evaluated alternatively - passed or failed (Fig. 3). The test was used for testing a child’s ability to “familiarize“ with a water environment and to lie on his/her breast in the water while holding breath. At the beginning 77.8% of children were not able to lie on the water surface and 22.2% did not pass this test. After the swimming course the rate changed considerably. Almost two thirds of children (62.4%) were successful and only 37.6% failed. The changes in this test were in our research group (Chi=15.64**) statistically significant on level $p<0.01$.

The swimming test *crawl kicking* was evaluated at the end of the swimming course. After 13 lessons the children were able to swim 7.11m (Tab.1). The shortest distance was 2m and the longest was 12m. Boys and girls achieved almost the same results. The children in this age do not have any great differences in evolution and this biological factor was confirmed by our results.

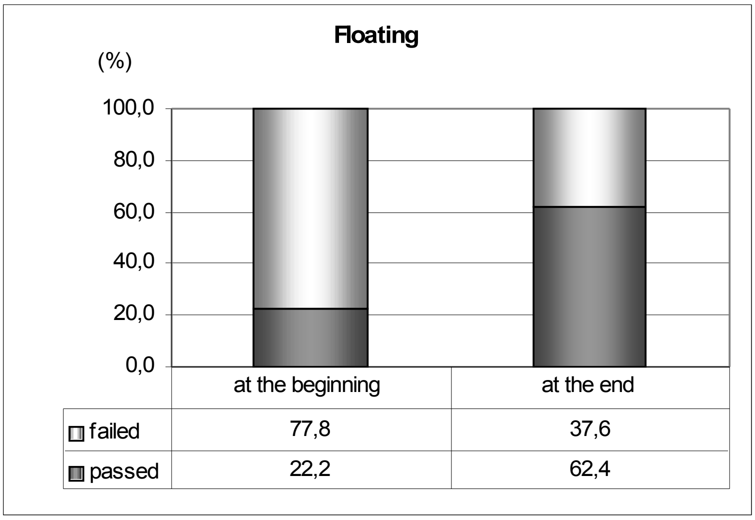

Figure 3. The test results of basic and swimming skill – floating measurement at the beginning and at the end of the course

The effect of dynamic balance in water on the level of swimming capability of children

We found statistical significance in the effect of dynamic balance in water on the level of developing swimming skills. In the group of successful (62%) and unsuccessful (37.6%) children we found statistically significant relationships on the level $p<0.01$ between swimming skills (floating and crawl kicking with board) and dynamic balance (obstacle course in water) (Tab.2).

Table 2. Correlation matrix

	Floating at the beginning	**Floating at the end**	**Crawl kicking with board**	**Obstacle course**
Floating at the beginning	1			
Floating at the end	0.384**	1		
Crawl kicking	-0.470**	-0.849**	1	
Obstacle course	0.322**	0.728**	0.733**	1

Consequently we tried to set a linear regression formula (Fig. 4, 5). The line formula presents statistically significant relationships between crawl kicking with a board and the obstacle course in water. The logical statement is that of 62.4% children who passed the test floating at the end of the course (Fig. 4), 60 children were able to swim 12 m with the board and only one child swam the minimal limit of 2 m. The group of successful children swam on average 9.8 m and needed the average time of 6.9 s for the obstacle course . In the group of unsuccessful children (37.6 %) (Fig. 5) only one child swam 10 m with crawl kicking and 58 children swam the minimal limit of 2 m. This group of children swam on average only 2.5 m and ran through the obstacle course by 7.1 s slower.

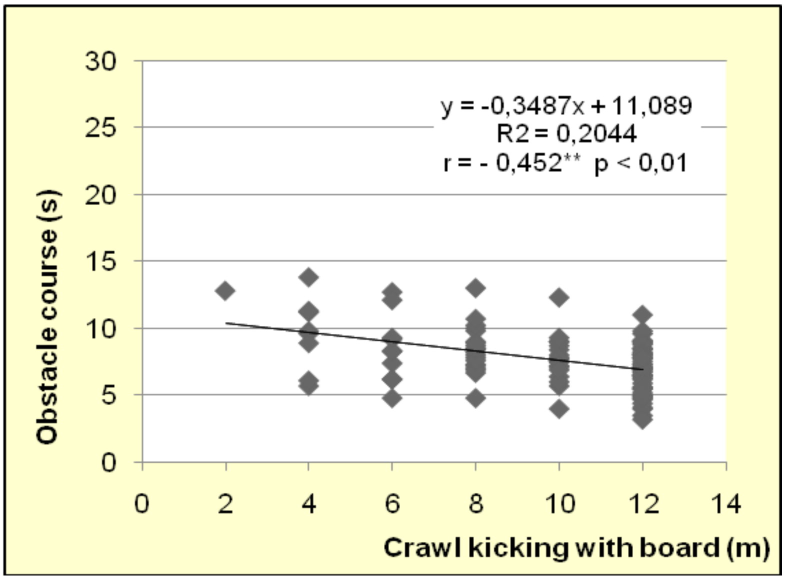

Figure 4. The effect of dynamic balance in water on the level of swimming capability in the group of successful children (n=119)

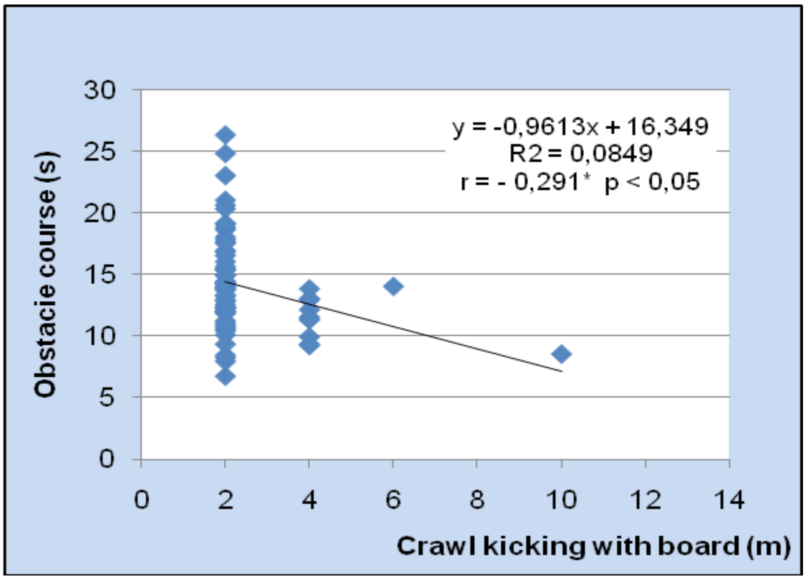

Figure 5. The effect of dynamic balance in water on the level of swimming capability in the group of unsuccessful children (n=70)

We consider statistically significant relationships for a logical result because there is relevance in the balance skills needed for motor learning between swimming skills and coordination.

Conclusions

The aim of our research was to try to find the relationship between dynamic balance in water and swimming skills.

1. By means of the obstacle course in water we tried to find out the level of dynamic balance of the observed children. We point out that the non-standardized test of balance coordination skills in water "obstacle course in water" was used for the very first time in our research. Our group achieved the average performance 10.01 s. Following our experience we can recommend this test for testing dynamic balance of children at pre-school, school age less than 36 kg. We can apply it also in larger group of probands. The advantage is a quick set up of the obstacle course, material availability and the possibility of use in other swimming pools with suitable water depth for children (70-90 cm). We have decided to build "obstacle course in water" because only few authors deal with the diagnostics of children's coordination skills which a swimmer uses in water environment.
2. On the basis of our results we can state that the children improved significantly on the level $p<0.01$ after the swimming course.
3. When we evaluated the effect of dynamic balance in water on the rate of developing swimming skills of children at pre-school age, we also found statistically significant relationships on the level $p<0.01$ between basic swimming skills – floating and crawl kicking and dynamic balance. A statistically significant relationship is a logical result because of certain connection between swimming skills and coordination due to motor learning.

   The results confirmed our hypothesis, where we supposed that a higher level of coordination skills will positively influence the rate of developing swimming skills. The fact is that children who achieved a better time in the obstacle course were really more skilful, braver and able to learn swimming skills faster in comparison with children who achieved worse results in the obstacle course.

References

1. Belej, M. & Junger, J. et al. (2006). *Motorické testy koordinačných schopností*. Prešov: Prešovská univerzita v Prešove.
2. Benčuriková, Ľ. (2008). *Plavecká príprava detí predškolského veku*. Bratislava: ICM Agency.
3. Doležajová, L. & Lednický, A. (2002). *Rozvoj koordinačných schopností*. Bratislava: Slovenská vedecká spoločnosť pre telesnú výchovu a šport.
4. Dovalil, J. et al. (2002; 2005). *Výkon a tréning ve sportu*. Praha: Olympia.
5. Halmova, N. (2005). *Koordinačné schopnosti a možnosti ich rozvoja v predškolskom veku.* Bratislava: Peter Mačura & PEEM.
6. Halmová, N., Šimonek, J. & Broďani, J. (1998). *Zisťovanie úrovne koordinačných schopností 5 – 6 ročných detí v materských školách v Nitre a ich závislosť od somatických ukazovateľov a materiálnych podmienok.* In: Zborník z celoštátnej vedeckej konferencie doktorantov, Bratislava: FTVŠ UK a VSTVŠ, 105-110.
7. Halmová, N., Šimonek, J. & Viesová, M. (2007). *Pohyb hrou*. Bratislava: AT Publishing.

8. Hirtz, P. et al. (2005). *Koordinative fähigkeiten im schulsport*. In: Moravec et al. (eds) Teória a didaktika športu. Bratislava: ICM AGENCY, 135-142.

9. Junger, J. (2000). *Telesný a pohybový rozvoj detí predškolského veku*. Prešov: SVSTVŠ, FHPV, PU.

10. Kasa, J. (2004). *Športová antropomotorika*. Bratislava : Slovenská vedecká spoločnosť pre telesnú výchovu a šport, FTVŠ UK, 3. doplnené vydanie.

11. Macejková, Y. & Viczayová, I. (2007). *Koordinačné schopnosti a vodné prostredie*. *Curricular transformation of education in physical education & sport in Slovakia*, Nitra: Univerzita Konštantína Filozofa.

12. Měkota, K. & Novosad, J. (2005). *Motorické schopnosti*. Olomouc: Uni. Palackého, Fakulta TK.

13. Mlieczko, E. (1992). Przeglad pogladów na temat motorycznošci czlowieka. In: *Antropomotoryka*, 8, 109-140.

14. Moravec, R. et al. (2004): *Teória a didaktika športu*, In: Moravec, R. (ed.) *Koordinačné schopnosti a ich rozvoj*. Bratislava: SVSTVŠ, 135-142.

15. Moravec, R. et al. (1996). *Eurofit: Telesný rozvoj a pohybová výkonnosť školskej populácie na Slovensku.* Bratislava : SVSTVŠ.

16. Platonov, V. N. (2002). *Struktura podgotovlenosti sportsmenov*. In: Doležajová, L. & Lednický, A. (eds) *Rozvoj koordinačných schopností*. Bratislava: ICM AGENCY, 5-8.

17. Raczek, J. & Mynarski, W. (1992). *Koordinacijne zdolnošci motoryczne dzieci i mlodziežy*. Katowice: AWF.

18. Ružbarská, I. & Turek, M. (2007). *Kondičné a koordinačné schopnosti v motorike detí predškolského a mladšieho školského veku*. Prešov: PU v Prešove FŠ.

19. Schnabel, G. (1994). *Trainingswissenchaft*. Berlin: Sportverlag.

20. Šimonek, J. (1985). *Koordinačné schopnosti*. Bratislava: Slovšport Bratislava.

21. Šimonek, J. et al. (2007). *Rozvoj koordinačných schopností v telesnej výchove a športe*. Prešov : Pre Sokol na Slovensku. Expres Print.

22. Šimonek, J. et al. (2003). *Základy kondičnej prípravy v športe*. Bratislava: UK.

23. Zemkova, E. & Hamar, D. (2005). Spoľahlivosť stabilografických parametrov na dynamometrickej platni. In: Lednicky, A. (ed.) *Koordinačné schopnosti*. Bratislava: ICM, 5-11.

24. Zemkova, E. (2008). *Diagnostika koordinačných schopností*. Bratislava, 1.vydanie.