Deliberationes tudományos folyóirat
14. évfolyam 2. szám 2021/2, 27-38. oldal
Kézirat beérkezése: 2022.05.12.
Kézirat befogadása: 2022.06.03.
10.54230/Delib.2021.2.27

Deliberationes Scienfitic Journal
Vol.14; Ed.No. 2/2021, pages: 27–38
Paper submitted: 12th May 2022
Paper accepted: 3th June 2022
10.54230/Delib.2021.2.27

AZ 5-6 ÉVES LÁNYOK KOORDINÁCIÓS MINŐSÉGÉNEK KÜLÖNBSÉGE, FIGYELEMBE VÉVE A TÁPLÁLKOZÁSI ÁLLAPOTUKAT

Pap Róbert [1], Popović Boris [1], Halasi Szabolcs [2], Lepes Josip[2]
1. University of Novi Sad, Faculty of Sport and Physical Education,2. University of Novi Sad, Hungarian Language Teacher Training Faculty

Absztrakt

A legtöbb kutatás azt mutatja, hogy az elhízott gyermekek általában fizikailag inaktívak, és motoros készségeik fejletlenek. A kutatás célja az volt, hogy meghatározzuk az 5-6 éves lányok koordinációs minőségének különbségeit, figyelembe véve a BMI-t, illetve a táplálkozási állapotukat.

A vizsgálatot 132 óvodásból álló mintán végeztük el. A tápláltsági állapot felméréséhez antropometriai jellemzőket, testtömeget, magasságot és BMI-t (kg/m²) mértük. A koordináció minőségét a Körperkoordinationstest für Kinder (KTK) segítségével értékeltük.

Az eredmények statisztikailag szignifikáns különbséget mutattak, csak a gerendán hátrafelé járás változóban, 1-3 csoport között az 1. ($p = 0,01$) és 2-3 csoport között a 2. csoport javára ($p = 0,05$), míg a többi változókban, nem volt szignifikáns különbség a csoportok között.

A kapott eredmények alapján megállapítható, hogy a normál, túlsúlyos és elhízott lányok közötti koordináció minőségében tapasztalható különbségek nem drasztikusak, és a normál tápláltsági állapotú lányok összességében nem mutattak jobb motoros koordinációt, mint a túlsúlyos és elhízott lányok.

Kulcsszavak: motoros koordináció, óvodások, KTK teszt, BMI, különbségek.

Rövidítések:

BMI: Body Mass Index

KTK: Körperkoordinationstest für Kinder

QUALITY OF COORDINATION IN 5-6 YEARS-OLD GIRLS, IN RELATION TO NUTRITIONAL STATUS

Robert Pap[1], Boris Popović[1], Szabolcs Halasi[2], Josip Lepes[2]
1. University of Novi Sad, Faculty of Sport and Physical Education,2. University of Novi Sad, Hungarian Language Teacher Training Faculty

Abstract

Most research indicates that obese children are in general, physically inactive and their motor skills are underdeveloped. The aim of this study was to determine the differences in the quality of coordination in girls aged 5-6 years, taking into account their BMI, respectively their nutrition status.

The study was implemented on a sample of 132 pre-schoolers. To assess the nutritional status, anthropometric characteristics such as body mass, height and BMI (kg/m²) were measured. The Körperkoordinationstest für Kinder (KTK) was used to assess the quality of coordination.

The results showed a statistically significant difference, only in the variable walking backwards on the beam, between 1-3 group in favor of 1st ($p = 0.01$) and 2-3 group in favor of 2nd ($p = 0.05$), while in other variables of this study, there were no significant differences between the groups.

Based on the results obtained, we can conclude that the differences in the quality of coordination between normal, overweight and obese girls are not drastic, and that girls with normal nutrition status did not show overall higher quality of gross motor coordination than their overweight and obese peers.

Keywords: Gross Motor Coordination, Preschoolers, KTK test, BMI, differences.

Introduction

Over the last few decades, the number of overweight children has increased worldwide and has become a public health problem. One of the causes is, that children do not participate sufficiently in physical activity, which can lead to underdeveloped motor skills, which depend on each other.

Children have become less physically active in recent decades, moving significantly less than their peers 50 years ago and spend roughly 600kcal less and not meeting the average of 60 minutes of moderate activity per day (Boreham & Riddoch, 2001). This trend is accompanied by increased calorie intake with less physical activity, as well as an increased amount of time, that children spend in front of TVs and computers (Berkey et al., 2000).

The inactivity of a child brings with it a number of negative consequences both at present and later in adolescence and adulthood. Man evolved thanks to movement. High level of physical activity during childhood, is leading to decreased deposition of subcutaneous fat tissue during early adolescence (Moore, 2003; Rodrigues, Leitao & Lopes, 2013). The link between motor skills performance and physical activity is important for the health of the child, especially in the prevention of obesity (Hils, King & Armstrong, 2007; Wiliams et al., 2012).

Good motor coordination is essential for the overall well-being of children (Popović et al., 2010). Coordination is „the ability to perform complex motor tasks in a time and space-efficient and energy-efficient manner." The correlation between coordination and intelligence is very high. In contrast to other motor skills, intelligence is most closely associated with coordination. People who have excellent coordination are often intelligent (Luz, Rodriguez & Cordovil, 2014; Sekulić & Metikoš, 2007; Smits-Englesman & Hill, 2012).

The child has to start from the earliest period to develop coordination, because after puberty, little can be done about it (Đorđić & Bala, 2007).

In most studies, the results indicate that overweight and obese children have less developed motor coordination than children with normal body mass. (Graf et al., 2004; Hardman et al., 2017; Laukkanen et al., 2017), while in the cases where, there are no differences, are less frequent (Castenassi et al., 2007). In our research, we wanted to see, in which of these two cases are the children from kindergartens in Novi Sad.

Method

In relation to knowledge of the problem, this research is a confirmatory study, where, based on the known problem, the hypothesis is tested using appropriate methods and research plans. In terms of the nature of the research, this was a transversal research. In relation to the degree of control, this scientific research belongs to the category of field research, which was realized in natural living conditions (Bala, 2007).

This research is a part of a short-term project of particular interest for sustainable

development in AP Vojvodina in 2018, namely "Improving the evaluation of the level of development of motor abilities and skills of AP Vojvodina children, in relation to international tests and standards".

Sample

The quality of coordination was evaluated on a sample of 132 examinees (girls) aged 5-6 years.

-Sample of measuring instruments

Basic anthropometric characteristics:

1. Body height (cm)
2. Body mass (kg)
3. BMI (kg/ m^2)

KTK battery of tests were used to assess the quality of coordination (Kiphard & Schilling 1974):

1. Walking backwards (WB)
2. Hopping for height (HH)
3. Jumping sideways (JS)
4. Moving sideways (MS)
5. MQ- total

The sum of points in individually conducted trials, obtained for each KTK test, presents the raw results (values). Raw values say nothing about the height of a child's results. First, Raw results have to be be compared with the average values of a particular age group. For KTK test, there are norms (standards) based on sex and age, from 5 to 14 years. MQ - values (motor coefficient), are used as standards in this test. Raw resultas are compared to the values, writen in the table of norms for each task separetely, accordnig to age and gender. Finally, the MQ - values of all four KTK tasks are summed.The distribution of these cumulative values provides the basis for the total MQ – value, which is very reliable, undemanding and therefore suitable for individual diagnostics.

Based on the total MQ value, the level of coordination can be classified as: 1. very low (impaired motor coordination: MQ≤70; ≤2th percentile), 2. low (uncommon motor coordination: MQ = 71-85; 3-16. percentile), 3. normal (normal body coordination: MQ = 86-115; 17-84. percentile), 4. high (good motor coordination: MQ = 116-130; 85-98.percentile) or 5. very high (excellent motor coordination: MQ≥131; ≥99th percentile).

DESCRIPTION OF THE MEASUREMENT PROCEDURE

The research was conducted on a sample of children from kindergartens in Novi

Sad, Serbia. Assessment of the quality of coordination was realized after the parental consent was obtained,given that they are underage children, which meant applying the provisions of the Declaration of Helsinki on the rights of children to participate in research. The girls who wanted to participate in research, their parents had to give us their signature for the child's participation in research (WHO, 2013).

An anthropometer and a digital scale were used to evaluate the anthropometric characteristics.

-Data processing methods

For the measurment of the basic statistical parameters, we calculated the basic descriptive statistics for all variables:Mean

- Standard deviation (SD)
- Minimal value (Min)
- Maximal value (Max)
- Skewness (SKW)
- Kurtosis (KUR)

A Shapiro-Wilk test was used to test the normality of the distribution.Non-parametric Kruskal-Wallis test (in the case where, there was a statistically significant deviation from the normal distribution) and the ANOVA parametric test was used to determine statistically significant differences between the groups (in the case where there was no significant deviation from the normal data distribution). The categorization of body mass index into 3 groups, was based on the standardization established by Cole et al. (2000), considering the intersection points by age and gender (Cole et al., 2000). Data processing was done by using an SPSS 20.0 statistical package.

Results

Table 1. Presents the basic descriptive statistics for all variables in children with normal, overweight and obese nutrition status and indicators of normality distribution.

Table 1. Descriptive statistics with normality of distribution for anthropometric characteristics and KTK test.

VARIABLE	NS	MEAN(SD)	MIN	MAX	SKW	KUR	SW
Body height (cm)	Normal	115,35(5)	102,90	131,60	0,371	0,56	0,45
	Overweight	119,62(4,9)	112,40	130,10	0,64	-0,26	0,52
	Obese	118,14(4,77)	109,80	124,60	-0,26	-0,61	0,68
Body Mass (kg)	Normal	20,30(2,4)	14,8	27,2	0,48	0,096	0,10
	Overweight	25,93(2,35)	23	31,9	1,24	1,91	0,06
	Obese	29,64(4,18)	24,5	39	0,95	1,51	0,39
BMI (kg/m2)	Normal	15,21(0,96)	13,3	17,2	0,14	-0,79	**0.05**
	Overweight	18,02(0,58)	17,4	19	2,23	-1,64	**0,04**
	Obese	21,15(1,81)	19,5	25,4	1,44	1,95	**0,04**
Walking Backwards (MQ)	Normal	92,02(11,31)	73	129	0,86	0,47	**0,00**
	Overweight	87,69(11,06)	75	122	2,17	5,97	**0,02**
	Obese	81,64(7,20)	74	99	1,56	2,58	**0,04**
Hopping for height(MQ)	Normal	95,37(16,32)	62	147	0,59	-0,21	**0,00**
	Overweight	93(17,38)	64	129	0,63	-0,06	0,39
	Obese	87,91(9,30)	78	106	1,17	0,64	**0,03**
Jumping Sideways (MQ)	Normal	105,21(13,97)	62	145	-0,2	0,49	0,77
	Overweight	99,19(12,04)	78	122	-0,13	-0,54	0,99
	Obese	101,36(8,48)	80	112	-1,67	3,84	0,52
Moving Sideways (MQ)	Normal	105,57(11,70)	77	142	0,34	0,40	0,21
	Overweight	103,56(8,71)	93	123	0,71	-0,19	0,20
	Obese	102,64(9,6)	89	123	0,76	0,66	0,59
Total result (MQ)	Normal	99,24(13,54)	72	142	0,29	-0,06	0,45
	Overweight	94,56(13,37)	73	126	0,74	0,65	0,70
	Obese	91,27(7,25)	78	103	-0,08	-0,12	0,97
Score- (MQ)	Normal	2,99(0,55)	2	5	0,33	1,70	**0,00**
	Overweight	2,81(0,54)	2	4	-0,19	0,55	**0,00**
	Obese	2,82(0,40)	2	3	-1,92	2,03	**0,00**

NS – Nutrition status; SD – Standard deviation; MIN – Minimal value; MAX – Maximal value; SKW – Skewness; KUR – Kurtosis; SW – Shapiro Wilk test.

Table 2. Differences between the groups for the KTK battery of tests.

VARIABLE	NS	M/MR	SD	f	H²	p	P*	
	1	71,93	11,31				1-2	0,09
MQ(WB)	2	55,44	11,06		13,08	**0,00**	1-3	**0,01**
	3	30,77	7,20				2-3	**0,05**
	1	68,47	16,32				1-2	0.61
MQ(HH)	2	63,09	17,38		1,84	0,40	1-3	0,19
	3	52.68	9,30				2-3	0,57
	1	105,21	13,97				1-2	0,09
MQ(JS)	2	99,19	12,04	1,66		0,19	1-3	0,37
	3	101,36	8,48				2-3	0,68
	1	105,57	11,71				1-2	0,50
MQ(MS)	2	103,56	8,71	0,50		0,60	1-3	0,41
	3	102,64	9,60				2-3	0,83
	1	99,24	13,54				1-2	0,19
MQ- total	2	94,56	13,37	2,45		0,90	1-3	0,06
	3	91,27	7,25				2-3	0,52

MQ(WB) - Motor coefficient for walking backwards on the beam; MQ(HH) – Motor coefficient for single-legged jumping; MQ(JS) – Motor coefficient for jumping sideways; MQ(MS) - Motor coefficient for moving sideways; MQ – Total motor coefficient; NS – Nutrition Status; M/MR – Mean/ Middle rank; SD – Standard deviation; f – f-test for ANOVA; H² - Chi square value of Kruskal Wallis test; p- significance level for f / Chi square; P* - Level of statistical significance between groups.

The results (Table 2.) of the non-parametric Kruskal Wallis test showed a statistically significant difference in the variable walking backwards on the beam, between 1-3 group in favor of 1st (p = 0.01) and 2-3 group in favour of 2nd (p = 0.05), while between the 1-2 group (p = 0.09) there was no statistically significant difference. In the case of the single- legged jumping variable, there was no statistically significant difference between the groups (p = 0.40). For other variables, the parametric test, univariate analysis of variance, was used. The results showed no statistically significant differences between the groups, in the variable jumping sideways (p = 0.19). The same is the case with moving sideways variable, there were no statistically significant differences (p = 0.60). Regarding the results of the total motor coefficient of the KTK test, no statistically significant differences were found between the groups.

Table 3.Assessment of motor coordination quality in relation to nutritional status.

VARIABLE	Normal (n=105)	Overweight (n=16)	Obese (n=11)
Score-1	/	/	/
Score -2	16(15,2%)	4(25%)	2(18,2%)
Score -3	76(72,4%)	11(68,8%)	9(81,8%)
Score -4	12(11,4)	1(6,3%)	/
Score -5	1(1%)	/	/

With very poor coordination, or score-1, which indicates a disorder of coordination, there were no subjects, while with score-2, 15.2% of girls with normal nutritional status, 25% with overweight and 18.2% with obese nutritional status were found. with score-3 were found; 72.4%, 68.8% and 81.8% girls of normal, overweight and obese nutritional status (Table 3.). Score-4 was scored by 11.4% of girls with normal nutritional status, in overweight 6.3%, while obese girls failed to reach that score. The score-5 was scored by only one girl with normal nutritional status (Table 3).

Discussion

The study was conducted to determine the differences in the quality of coordination among girls aged 5-6 years in relation to nutritional status. A KTK battery of tests was used to evaluate the quality of coordination. The results of the study showed that there are statistically significant differences in the quality of coordination, in the case of a variable, walking backwards motor coefficient (WB). In this variable, obese children had the lowest scores, followed by overweight children, while children with normal nutritional status achieved the best results. Other variables found no statistically significant differences between the groups.In other variables, we found no statistically significant differences between the groups.

In some of the previous studies that indicated clumsiness, or less developed gross motor coordination D'Hondt et al., 2009; D'Hondt et al., 2014; Duncan, Bryant & Stodden, 2017; Lima et al., 2017; Logan et al., 2011; Marmeleira et al., 2017; Ortega et al., 2018; Silva-Santos et al., 2016; Spessato, Gabbard & Valentini, 2013), fine motor coordination (Gentier et al., 2013), manipulation of objects (Morano, Collela & Caroli, 2011), focus attention (Mond et al., 2007), etc. ... of overweight and obese children versus the children with normal nutrition status. In our study, specifically in the study of gross motor coordination, no drastic differences were found, that would indicate a superiority of children with normal nutritional status over the other two groups. Significant differences were observed only in the walking backwards variable.

The results of the study showed that girls with obese and overweight nutrition status, were present in 20% of girls, out of the total number of subjects we tested. This result is not ideal, but compared to a few years ago, the prevalence of obesity in Serbia was as high as 39% (Ostojić et al., 2011). While in studies which are unrelated to Serbia, were found over 30% prevalence of overweight and obese children (Brunet, Chaput & Tremblay 2007; Silva-Santos et al., 2016). Consequences of obesity are coprehensive, obesity adversely affects the health of the child and his health-related quality of life (Halasi et al., 2018; WHO, 2016).

Children with poor motor coordination (Lopes et al., 2011) and overweight nutrition status, reduce their physical activity levels earlier than children with normal nutrition status, especially girls, and feel that their physical activity levels are similar to children who are not overweight (Gillis, Kennedy & Bar-Or, 2006). The development of motor

skills is the primary mechanism that promotes physical activity (Stodden et al., 2008; Wrotniak et al., 2006).

More recent research by Ortega et al. (2018) is speaking about the paradox, where obese children who are in good cardiorespiratory and muscular form, are healthier than children with normal nutrition status, who are not in good cardiorespiratory and muscular form, which means that body mass itself does not appear to be the key factor for the health of the child and indicates that the health and development of the child is not solely related to the body mass or the child's nutrition status, but in this case it is rather placed on third place, immediately after cardiorespiratory and muscular form (Ortega et al., 2018).

Conclusion

Based on the results obtained, it can be generally concluded that children with normal nutrition status, were not much superior and did not show excessively higher quality of motor coordination than their overweight and obese peers.

Author Contribution

R.P. conceptualized the study and wrote the initial draft of the manuscript . B.P. prepared and analyzed the data. SZ.H. proposed the statistical analysis approach. J.L. critically reviewed the manuscript.

Compliance with Ethical Statements

Conflict of Interest: The authors declare that they have no conflict of interest.

Funding: The Republic of Serbia, Autonomous Province of Vojvodina, Provincial Secretariat for higher education and scientific research. Number: 142-451-2785/2017

Ethical approval: The study design was approved by the local IRB at the University of Novi Sad (ID 142-451-2785/2017/2019), with the study protocol systematized in accordance with the Declaration of Helsinki.

Kapcsolattartó szerző:
Pap Róbert
Újvidéki Egyetem
Sport és Testnevelési Kar
21000 Novi Sad, Szerbia
Lovćenska 16.
robert.the.king.94@gmail.com

Corresponding author:
Róbert Pap
Faculty of Sport and Physical Education
University of Novi Sad
Lovćenska 16.
21000 Novi Sad, Serbia
robert.the.king.94@gmail.com

References

Bala, G. (2007). *Dizajniranje istraživanja u kineziologiji*. Novi Sad: Fakultet sporta i fizičkog vaspitanja.

Berkey, C. S., Rockett, H. R., Field, A. E., Gillman, M. W., Frazier, A. L., Camargo, C. A., & Colditz, G. A. (2000). Activity, dietary intake, and weight changes in a longitudinal study of preadolescent and adolescent boys and girls. *Pediatrics*, 105(4), E56.

Boreham, C., & Riddoch, C. (2001). The physical activity, fitness and health of children. *Journal of Sports Sciences, 19*(12), 915-929.

Brunet, M., Chaput, P., & Tremblay, A. (2007). The association between low physical fitness and high body mass indes or waist circumference is increasing with age in children: the 'Quebec en Forme' Project. *International journal of obesity,* 31(4), 637-643.

Castenassi, F., Marquess, I., Barbiero, B., Basso, L., Vaz Ronque, E., Mendes-Gerage, A. (2007). Relationship between body mass index and gross motor skill in four to six year-old children. *Revista Brasilera de Medicina do Esporte,* 13(4).

Cole, J., Belizzi, C., Flegal, M., & Dietz, H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ (Clinical research ed.),*320(7244), 1240-1243.

D'Hondt, E., Deforche, B., Bourdeaudhuji, I., & Lenoir, M. (2009). Relationship between motor skill and body mass index in 5 to 10 year-old children. *Adapted Physical Activity Quarterly,* 26, 21-37.

D'Hondt, E., Deforche, B., Gentier, I., Verstuyf, J., Vaeyens, R., De Bourdeaudhuji, I., Philippaerts, R., & Lenoir, M. (2014). A longitudinal study of gross motor coordination and weight status in children. *International Journal of obesity,* 22(6).

Duncan, M., Bryant, E., & Stodden, D. (2017). Low fundamental movement skill proficiency is associated with high BMI and body fatness in girls but not boys aged 6-11 years old. *Physical Acticity for Health,* 35(21), 2135-2141.

Đorđić, V., i Bala, G. (2006). Fizička aktivnost dece predškolskog uzrasta. U G. Bala (Ur.*), Fizička aktivnost devojčica i dečaka predškolskog uzrasta* (str. 57-74). Novi Sad: Fakultet fizičke kulture.

Gentier, I., D'Hondt, E., Shultz, S., Deforche, B., Augustijn, M., Hoorne, S., Verlaecke, K., Bourdeaudhuij, I., & Lenoir, M. (2013). Fine and gross motor skills differ between healthy-weight and obese children. *Research in Developmental Disabilities*, 34(11), 4043–4051.

Gillis, L. J., Kennedy, L. C., & Bar-Or, O. (2006). Overweight children reduce their activity levels earlier in life than healthy weight children. *Clinical journal of sport medicine,* 16(1), 51-55.

Graf, C., Koch, B., Kretschmann-Kandel, E., Falkowski, G., Christ, H., Coburger, S., ... Dordel, S. (2004). Correlation between BMI, leisure habits and motor abilities in

childhood (CHILT-project). *International Journal of Obesity and Related Metabolic Disorders*, 28(1), 2226.

Halasi, Sz., Lepeš, J., Đorđić, V., Stevanović, D., Ihasz, F., Jakšić, D., . . . & Marinković D. (2018). Relationship between obesity and health-related quality of life in children aged 7-8 years. *Health and Quality of Life Outcomes,* 16, 149.

Hardman, C., de Souza Wanderley Junior, R., Antunes de Oliveira, E., & Gomes de Barros, M. (2017). Relationship between physical activity and BMI with level of motor coordination performance in schoolchildren. *Revista Brasileira de Cineantropometria e Desempenho Humano,* 19(1), 50-61.

Hils, A., King, N., & Armstrong, T. (2007). The Contribution of Physical Activity and Sedentary Behaviours to the Growth and Development of Children and Adolescents. *Sports Medicine,* 37(6), 533-545.

Kiphard, E.J., & Schilling, F. (1974, 2007, 2017). Körperkoordinationstest für Kinder: KTK. Beltz-Test.

Laukkanen, A., Pesola, A., Finni, T., & Saakslahti, A.(2017). Body Mass Index in the Early Years in Relation to Motor Coordination at the Age of 5–7 Years. *Sports (Basel),* 5(3), 49. doi: 10.3390/sports5030049

Lima, R. A., Bugge, A., Pfeiffer, K. A., & Andersen, L. B. (2017). Tracking of Gross Motor Coordination From Childhood Into Adolescence. *Research Quarterly for Exercise and Sport,* 88(1), 52–59.

Logan, W., Scrabis-Fletcher, K., Modlesky, C., & Getchel, N. (2011). The relationship between motor skill proficiency and body mass index in preschool children. *Research quarterly for exercise and sport,* 82(3), 442-448.

Lopes, V. P., Rodrigues, L. P., Maia, J. A. R., & Malina, R. M. (2011). Motor coordination as predictor of physical activity in childhood. *Scandinavian Journal of Medicine & Science in Sports,* 21(5), 663-669.

Luz, C., Rodrigues, L., & Cordovil, R. (2014). The relationship between motor coordination and executive functions in 4th grade children. *European Journal of Developmental Psychology*, 12(2), 129-141.

Marmeleira, J., Veiga, G., Cansado, H., & Raimundo, A. (2017). Relationship between motor proficiency and body composition in 6- to 10-year-old children. *Journal of Paediatrics and Child Health,* 53(4).

Mond, J., Stich, H., Hay, P., Kraemer, A., & Baune, B.(2007). Associations between obesity and developmental functioning in pre-school children: a population-based study. *International journal of obesity,* 31, 1068-1073.

Moore, L. L., Gao, D., Bradlee, M. L., Cupples, L. A., Sundarajan-Ramamurti, A., Proctor, M. H., . . . Ellison, R. C. (2003). Does early physical activity predict body fat change troughout childhood.? *Preventive Medicine,* 37(1), 10-17.

Morano, M., Colella, D., & Caroli, M. (2011). Gross motor skill performance in a sample of overweight and non-overweight preschool children. *International journal of pediatric obesity,* 2, 42-46.

Okely, A. D., Booth, M. L., & Chey, T. (2004). Relationships between body composition and fundamental movement skills among children and adolescents. *Research Quarterly for Exercise and Sport*, 75(3), 238–247.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., Sjostrom, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International journal of obesity,* 32(1), 1-11.

Ostojić, S., Stojanović, M., Stojanović, V., Marić, J., & Njaradi, N. (2011). Corelation between fitness and fatness in 6-14- year Old Serbian Schol Children. *Journal of Health, Population and Nutrition,* 29(1), 53-56.

Popović, B., Radanović, D., Stupar, D., & Jezdimirović, T. (2010). Efekti programiranog vežbanja na razvoj brzine i eksplozivne snage kod devojčica predškolskog uzrasta. *Conference: Kondicijska priprema sportaš,* at Zagreb.

Rodrigues, L. P., Leitao, R., & Lopes, V. P.(2013). Physical fitness predicts adiposity longitudinal changes over childhood and adolescence. *Journal of science and medicine in sport,* 16(2), 118-123.

Sekulić, D. i Metikoš, D. (2007). Osnove transformacijskih postupaka u kineziologiji. Split: Fakultet prirodoslovno-matematičkih znanosti i kineziologije Sveučilita.

Silva-Santos, S., Santos, A., Vale, S., & Mota, J. (2016). Motor fitness and preschooler children obesity status. *Journal of Sport Sciences,* 35(17), 1704-1708.

Smits- Engelsman, B., & Hill, E. (2012). The relationship between motor coordination and inteligence across the IQ range. *Pediatrics*, 130(4), e950-e956.

Spessato, B., Gabbard, C., & Valentini, N. (2013). The role of motor competence and body mass index in children's activity levels in physical education classes. *Journal of Teaching in Physical Education,* 32, 118-130.

Stodden, D., Goodway, J., Langendorfer, S., Roberton, M., Rudisill, M., Garcia, C., & Garcia, L. (2008). A developmental perspective on the role of motor skill competence in physical activity: an emergent relationship. *National Association for Kinesiology in Higher Education,* 60(2), 290-306.

WHO (World Health Organization). (2016) Report of the commission on ending childhood obesity. Geneva, Switzerland; WHO, http://apps.who.int/iris/bitstream/10665/204176/1/9789241510066_eng.pdf

Williams, G. H., Pfeiffer, A. K., O'Neil, R. J., Dowda, M., & McIver, L. K. (2012). Motor Skill Performance and Physical Activity in Preschool Children. *Obesity,* 16(6), 1421-1426.

World Medical Association. (2013). World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA,* 310(20), 2191-2194.

Wrotniak, B. H., Epstein, L. H., Dorn, J. M., Jones, K. E., & Kondilis, V. A. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics,* 118(6), e1758-1765.