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Relationship between the Body Mass Index, Motor Skills, and Physical Activity of Early Elementary School Pupils

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Abstract

The aim of this research was to determine gender differences in the body mass index, motor skills, and physical activity among early elementary school pupils and their correlation. The TGMD-2 test was applied on a sample of 127 second-grade elementary school pupils (65 boys and 62 girls) to assess motor skills, while physical activity was examined using the Fels questionnaire. The body mass index was calculated based on body height and weight. Gender differences were calculated using the non-parametric Mann-Whitney U test, and the correlation was calculated using Spearman's correlation coefficient. The predictive value of the body mass index, locomotor, and manipulative skills based on total physical activity was calculated with the backward stepwise regression approach. According to normative values of the motor development index, the participants in this research showed an average result. The results indicate significant differences in favor of boys in manipulative skills, while no significant differences were obtained in locomotor skills, overall motor development, and the body mass index. Significant correlation of the body mass index was obtained only in girls, and it indicates a low negative correlation with the leisure time index (r = -0.29) and total physical activity (r = -0.29), and a moderately negative correlation with locomotor skills (r = -0.39) and the overall index of motor development (r = -0.35). The correlations between motor skills and physical activity were obtained only in boys and indicated a low positive correlation between manipulative skills and the leisure time index (r = 0.25) and total physical activity (r = 0.27). According to the regression analysis results, the variable's contributions to the overall explanation of the variance are significant but quite weak. Manipulative skills explain 7.2 % of the variance in the boys' total

physical activity, while the body mass index explains 6 % of the total physical activity's variance for the girls.
Keywords*: body mass index; motor skills; level of physical activity.*

Introduction

The increased prevalence of childhood obesity is a public health problem because the negative consequences of obesity are already evident in childhood. One of the problems that occur with reduced physical activity is obesity, i.e. overweight. Research results of the CroCOSI project 2018/2019 in Croatia show that 35 percent of eight to nine-year-old children are overweight and obese. At the national level, this percentage is higher in boys than in girls and amounts to 17.8 percent, compared to 11.9 percent in girls (Music Milanović et al., 2021). Compared to the results from 2015/2016, no significant increase in children's obesity is noticeable in the three year period. However, every third child in Croatia aged 8 to 9 years had an increased risk of being overweight or obese in adulthood, which consequently means a higher risk of leading chronic non-infectious diseases. In the same study, slightly more than two-thirds of the 8-year-olds, more boys than girls (72.9 % and 66.7 % respectively), engaged in regular physical activity through participation in sports activities: 91.0 % spent one hour or more during working days engaged in active play that involved running, jumping, and moving in outdoor or indoor sports games. It is indisputable that the acquired motor skills enable children to implement them in daily physical activities and improve their active leisure time, as well as in emergencies. Furthermore, it enables efficient transfer into specialized skills in sports and effective development of coordination, balance, strength, and precision, all of which are abilities that represent the foundation of motor functioning (Sekulić & Metikoš 2007). Parents, education institutions and children's living environment all play a crucial role in motor skills development. Compared to children of normal body weight, overweight children have significantly lower levels of motor skills (Paez et al., 2020; Spessato et al., 2013; Santos & Zubiau Gonzales, 2013; D'Hondt et al., 2009). Based on data acquired on a large sample of children (N = 4500) of different ages, Okely et al. (2004) conluded that the quality of biotic motor skills performance is directly and significantly related to the body mass index and abdominal circumference. They inferred that it is necessary for intervention strategies for the prevention of overweight in children and adolescents to implement biotic motor skills as one of the key components. In a review by Catuzzo et al. (2016), a negative correlation was found between the body mass index and motor development, wherein 27 of 33 studies showed that a higher body mass index was associated with poor motor development. Most transversal studies indicate a negative correlation; however, they do not offer its full explanation. In other words, it is unknown whether higher body weight contributes to a lower level of motor skills or vice versa. Cheng et al. (2016) explained the causal relationship in their longitudinal study. They proved that a higher body mass index at the age of five contributed to

a decline in motor skills between the ages of 5 and 10, while a lower level of motor skills at the age of five did not significantly affect weight gain in the tenth year of life. Obesity status after the age of five also contributes to a lower level of motor skills. Hence, the authors conclude that anti-obesity interventional measures are necessary from an early age to prevent decline in motor skills, which in turn could positively affect physical activity and overall fitness. Stodden et al. (2008) stated that the risk of overweight and obesity is based on the interrelationships between physical activity, motor competency, perception of motor competencies, and motor fitness. In other words, an overweight child will show lower motor competency and perceived motor competency, which could lead to further lower levels of physical activity in children. The same author describes a dynamic and reciprocal relationship between physical activity and motor skills, wherein those with higher levels of realized and perceived competency are more likely to participate in physical activities, which in turn could provide further opportunities for motor skills and competencies development. Also, higher levels of basic or biotic motor skills are associated with healthier body weight, reduced sedentary activities, and higher levels of cardiorespiratory and muscular fitness and physical activity (Lubans et al., 2010).

Research that dealt with determining the relationship between morphological measures and physical activity measured by accelerometers indicates negative correlations (Dencker et al., 2006; Jimenez-Pavon et al., 2010). The results proved that physical activity is important in the prevention of obesity. Also, a longitudinal study (Cairney & Veldhuizen, 2017) conducted on a sample of 9-10-year-old children showed a negative relationship between the body mass index and participation in sports during a three-year period. The authors stressed an unclarified two-way relationship: does a higher body mass index lead to a lower level of participation in sports or vice versa? However, a review study (Wilks et al., 2010) showed that physical activity is a weak predictor of excess fat increase. Research that dealt with this correlation suggests a high possibility of reverse causality, i.e. obesity leading to lower levels of physical activity, as opposed to physical inactivity leading to obesity (Metcalf et al., 2011). In a longitudinal study of determining causal relationships, the same author stated that being overweight led to inactivity in children, while inactivity did not cause obesity.

In a review study on the impact of motor skills on physical activity (Logan et al., 2014), on a sample of children aged 6 to 12 years, it was determined that it generally explains 5 % to 30 % of the variance of the criterion variable of physical activity. Furthermore, in a research implemented on a sample of preschool children (Xin et al., 2020), it was found that basic motor skills explain 16 % of the total physical activity variance, 21.3 % of locomotor, and 19.2 % of manipulative skills. Many health benefits of physical activity during childhood and adolescence make understanding the role of motor skills in promoting physical activity an important health priority.

The first goal of this research was to determine gender differences in the body mass index, motor skills, and levels of physical activity.

The second goal was to determine the interrelationships between the body mass index, motor skills, and levels of physical activity.

The third goal was to determine the impact of the body mass index and motor skills (locomotor and manipulative) on total physical activity.

Research methods

The sample consisted of 127 second-grade pupils of whom 65 were male and 62 female, with an average age of 8.5 years (± six months). The research was conducted in an elementary school in Čakovec. Based on the body height and weight, body mass index (BMI) was calculated as the ratio of body weight to squared height (kg/m2), while the nutritional status was calculated according to the recommendations of the Center for Disease Prevention and Control (CDC, 2000).

Motor skills were assessed with the standardized *Test of Gross Motor Development – Second Edition* (TGMD-2) (Ulrich, 2000), which assesses the quality, i.e. level of acquired motor skills in children aged 3 to 11 years. The test includes a total of 12 tests, among which six assess locomotor and six manipulative skills. Thus, for example, locomotor skills include running, galloping forward and sideways, standing long jump, jumping on one leg, and jumping over an obstacle, while manipulative skills include catching a ball, overhand throw, stationary bounce, kicking a ball, rolling a ball, and hitting with a baseball bat. Standard values of both groups of tests were calculated based on corrected values by age and gender. The sum of the standard values provided the overall test result, i.e. index of motor development. The above test was applied to provide the possibility of comparison with studies on children of the same age conducted in other countries.

Children's physical activity was examined with the use of *Fels Physical Activity Questionnaire for Children* (Treuth et al., 2005), which is used to assess the level of physical activity of children aged 7 to 19 years. The questionnaire consists of three groups of questions that provide information on the level of participants' physical activity assessed via three components: physical activity during leisure time, sports, and household chores. The sum of the mentioned components provides the overall level of physical activity, with the maximum value of 15 (5 for each category), or 5 after the value was displayed on the Likert scale. The metric characteristics of the questionnaire applied among Croatian pupils of younger school age showed very good validity and reliability (Kunješić, 2015).

The research was conducted in accordance with the Code of Ethics for Research with Children (Ajduković & Kolesarić, 2003). Children's parents approved their participation via written consent and filled in a physical activity self-assessment questionnaire with their children. The data were collected in January 2020.

The research results were processed in the IBM SPSS Statistics 23 program. Arithmetic mean (AS) and standard deviation (SD) were calculated using methods of descriptive statistics. Distribution's normality was tested with the use of Kolmogorov-Smirnov

test, while the non-parametric Mann-Whitney U test was applied for testing gender differences at the significance level of 95 % ($p < 0.05$). Spearman's correlation coefficient was used to calculate the interrelationship between body mass index, motor skills, and physical activity. A stepwise backward regression analysis was applied to explain the variance of the overall physical activity criterion variable. Previously, the variables that showed deviations from normal distribution were subjected to a normalization procedure (log 10) that allowed further processing via regression analysis.

Results

Table 1

Descriptive parameters and differences in the body mass index, motor skills, and the level of physical activity with respect to gender

	Overall (n=127)	Boys (n=65)		Girls (n=62)		Mann-Whitney U
Variables	AS± SD	AS± SD	KS-Z	AS± SD	KS-Z	p-value
Body mass index	16.91±2.68	17.00±2.44	0.03	16.82±2.93	0.02	0.59
Locomotor skills	42.90±4.10	42.61±4.56	0.06	43.21±3.58	0.06	0.70
Manipulative skills	39.05±5.59	40.96±5.17	0.03	37.03±5.34	0.20	**0.00**
Motor development index	99.29±12.27	98.29±12.73	0.05	100.33±11.80	0.01	0.42
Sports index	2.24±0.74	2.52±0.68	0.03	1.95±0.69	0.05	**0.00**
Leisure time index	3.11±1.16	3.37±1.17	0.02	2.84±1.10	0.03	**0.01**
House chores index	2.66±1.06	2.60±1.03	0.02	2.72±1.10	0.10	0.58
Total physical activity	7.86±2.17	8.40±2.23	0.03	7.29±1.96	0.04	**0.00**
Normal nutrition Overweight and obesity	N=93 (73 %) N=34 (27 %)	N=47(72 %) N=18(28 %)		N=46 (74 %) N=16 (26 %)		
Satisfies PA recommendations Does not satisfy recommendations (according to Treuth et al., 2005)	N=40 (32) N=87 (68 %)	N=30(46 %) N=35 (54 %)		N=10 (16 %) N=52 (84 %)		

Descriptive statistical parameters by gender and for the overall sample are presented in Table 1. Average values of the body mass index in both genders are very similar to the reference values of the Republic of Croatia (Juresa et al., 2011) and follow the curve of normal growth and development (CDC, 2000). Specifically, 73 % of pupils have a normal nutrition status, while 26.8 % are overweight and obese. According to Treuth et al. (2005), a higher percentage of boys fall within the recommended values of physical activity, compared to girls (46; 16), while this percentage is 32 for the overall sample. Average physical activity indices show that boys are physically active mostly in their leisure time (3.37), while their lowest average index is in sports (2.52). In girls, the highest average index is observable during leisure time (2.84), and the lowest in

sports (1.95). Boys are significantly more physically active in total physical activity (p = 0.00), as well as in sports (p = 0.00) and during leisure time (p = 0.01). According to normative values (Ulrich, 2000), the average value of the motor index (99.29) is positioned as the average test score.

Boys have significantly higher average values in manipulative skills (p = 0.00), while there are no significant differences in locomotor skills and the overall index of motor development.

Table 2
Overall motor development index according to the categories

Categories	Frequencies			Percentages		
	Overall (n=127)	Boys (n=65)	Girls (n=62)	Overall %	Boys %	Girls %
Very poor	0	0	0	0 %	0 %	0 %
Poor	14	8	6	11.0	12.3 %	9.7
Below average	15	10	5	11.8	15.4 %	8.1
Average	69	30	39	54.3	46.2 %	62.9
Above average	24	15	9	18.9	23.1 %	14.5
Excellent	5	2	3	3.9	3.1 %	4.8
Extremely good	0	0	0	0 %	0 %	0 %

According to the categories of the overall motor development index (Ulrich, 2000) shown in Table 2, the average result is achieved by 62.9 % of girls and 46.2 % of boys. Moreover, it is noticeable that none of the pupils achieved a very poor or an extremely good, i.e. the highest possible result in the overall motor development index.

Table 3
Spearman's correlation coefficients between the body mass index, motor skills, and the level of physical activity

	Body mass index	Locomotor skills	Manipulative skills	Motor development index
Boys				
Body mass index	1	-0.17	0.14	-0.01
Sports index	0.10	0.13	0.15	0.17
Leisure time index	-0.13	0.14	0.2**5***	0.22
House chores index	0.01	0.01	0.20	0.17
Overall physical activity	0.03	0.11	0.2**7***	0.22
Girls				
Body mass index	1	**-0.39****	-0.11	**-0.35****
Sports index	0.01	.070	-0.03	0.08
Leisure time index	**-0.29***	0.14	0.02	0.22
House chores index	-0.01	-0.12	0.06	0.04
Overall physical activity	**-0.29***	-0.04	-0.01	0.11

Table 3 shows the correlation coefficients of the body mass index, motor skills, and different areas of physical activity for boys and girls separately. Significant correlation of the body mass index in girls indicates a low negative correlation with the leisure time

index (r = -0.29) and overall physical activity (r = -0.29), and a moderately negative correlation with locomotor skills (r = -0.39) and the overall motor development index (r = -0.35).

Correlations of motor skills and physical activity were obtained only in boys and indicated a low positive association of manipulative skills with the leisure time index (r = 0.25) and overall physical activity (r = 0.27).

Table 4

Regression analysis for the overall physical activity criterion variable

	Beta	t	p-value	Module summary
Boys				
Manipulative skills	0.29	2.43	0.018	R=0.29; Adjusted R^2 =0.072;F(1.63)=5.92;P=0.018
Girls				
Body mass index	-0.27	-2.22	0.030	R=0.27; Adjusted R^2 =0.060;F(1.60)=3.81;P=0.030

The results of backward stepwise regression for boys and girls are shown in Table 4. It is clearly visible that the contributions of the variables to the overall explanation of the criterion variable's variance are significant but quite small. In boys, 7.2 % of the overall physical activity's variance was explained only by object manipulation variable, and body mass index explained 6.0 % of the overall physical activity's variance in girls.

Discussion

The results obtained on this sample show a lower percentage of overweight and obese children (28 % of boys and 26 % of girls) than in a research amongst Croatian pupils aged 8 to 9 (boys 37 % and girls 32 %) (Musić Milanović et al., 2021). The average result in overall motor development is consistent with other studies that applied the same test (TGMD-2): for example, research on preschool children from Belgium (Bardid et al., 2016) and Australia (Cliff et al., 2009), and among school-aged girls from Ireland (Bolger et al., 2018). Below-average results were obtained in early school-aged children from Belgium (Bardid et al., 2016), Canada (Burrows et al., 2014), boys from Ireland (Bolger et al., 2018), and poor results were found among girls from Iran (Khodaverdi & Bahram, 2015). Furthermore, significant differences in favor of boys were obtained in manipulative skills, while no significant differences were obtained in locomotor skills, overall motor development, and body mass index. The results of this research are inconsistent with studies (O Brien et al., 2016; Castell & Valley, 2007; Paez et al., 2020) in which no significant gender differences were determined. Significant success of boys in manipulative skills is in accordance with other research on children of different ages (Bryant et al., 2013; Freitas et al., 2015; Slykerman et al., 2016; Spessato et al., 2013), and with research on a sample of Czech (Balaban 2018), Turkish (Kerkez & Tutal, 2020), and Irish pupils (Kelly et al., 2019). Another study has identified gender differences in individual tests of manipulative

skills on a sample of 12-year-olds and showed that throwing a ball significantly influenced the prevalence of gender differences in manipulative skills (O'Brien et al., 2016). Yet another study found significant differences in favor of 9 to 12-year-old boys in baseball kicking and throwing and kicking a ball (Hume et al., 2008). On the other hand, no significant differences in individual locomotor tests were determined. It is important to mention a longitudinal study by Barnet et al. (2010) in which no gender differences in locomotor skills from childhood to adolescence were obtained, while significant differences were observed in both periods in manipulative skills, namely kicking, throwing, and catching the ball. Okely and Booth (2004) state that differences in manipulative skills are environmentally conditioned and would be reduced if girls had equal opportunities in the learning and training process. It is assumed that boys' higher performance in manipulative skills is the product of their greater involvement in organized sports, higher levels of physical activity, or the involvement of fathers, who favour ball games. This view is supported by the results of this research showing the boys have significantly higher sports, leisure time, and overall physical activity indices, which is consistent with previous research (Pearce et al., 2012; Telford et al., 2016; Ekelund et al., 2012). A longitudinal study that addressed gender differences in physical activity (Telford et al., 2016) found that girls are less active because they have less support in Physical Education classes, less family support, and participate less in organized sports activities. As these impacts may change, future intervention strategies to increase physical activity should focus on each of these areas at the same time, and special attention should be paid to equal support and opportunities for both genders.

The second objective of this study was to determine the existence of correlations between the body mass index, motor skills, and physical activity. The obtained weak correlations are consistent with results of previous research on preschool and early school-age children which indicate a weak correlation; however, it increases with age, especially in adolescence (Lopes et al., 2011). The results in manipulative skills have not shown a significant correlation with the body mass index, for both genders, which is also in accord with previous research (Graf et al., 2004; Okely et al., 2004; Southall et al., 2004). The low negative correlation between body mass index and locomotor skills and the overall motor development in girls is consistent with the results of research by Duncan et al. (2017), carried out on a sample of pupils aged 6 to 11, which showed that girls with a higher body mass index have significantly lower level of motor skills. Also, in a research on Turkish pupils (Aktug & Iri, 2019), whose physical activity was assessed with a questionnaire, a significant negative correlation between the body mass index and locomotor skills and the overall motor development index was found only in girls. On the other hand, the mentioned negative correlation was determined only among boys in a research on Chilean pupils (Paez et al., 2020). It seems that in this sample, a higher body mass index interferes with the stabilization and movement of the body in space only among girls, which is particularly pronounced in locomotor skills and leads to less developed motor skills (Robinson et al., 2015).

Furthermore, the results show that girls with a higher body mass index spend less time in the area of leisure time and total physical activity, or vice versa. In the questionnaire, leisure time was assessed with the frequency of participation in sports during leisure time, then by walking or cycling to and from school, and watching television or reading a book. Comparing physical activity with the results of other studies was challenging due to different physical activity assessment methodologies. However, a study (Pantelić & Đošić, 2018) that used the same questionnaire shows that participants who are more physically active have lower values of body fat and body mass index, or higher values of muscle mass and lean body mass. Also, Cech and Ruzbarský (2020) have done a research on a sample of elementary school pupils and reported a low negative correlation between total physical activity and adipose parameters, although the results are not compared by gender. A negative correlation between the body mass index and physical activity on a sample of children of the same age was reported by Wrotniak et al. (2006).

No significant correlations were found between motor skills and levels of physical activity in girls, At the same time, a significantly low, positive correlation between manipulative skills and leisure time index ($r = 0.26$) and total physical activity ($r = 0.27$) indicates that boys who achieve better results in manipulative skills more often participate in physical activities in their leisure time. They also have higher levels of total physical activity. Furthermore, previous research (Cliff et al., 2009; Laukkanen, 2014; Temple et al., 2016; Balaban, 2018) indicates the existence of gender differences regarding the correlation between motor skills and physical activity, with boys having a higher, positive correlation ($r = 0.24–0.55$). The results of this research are consistent with the study by Cliff et al. (2009), who reported a positive correlation of manipulative skills with moderate to high-intensity physical activity in boys. In a study by Temple et al. (2016), no significant correlations were observed in girls, while a significant correlation of total physical activity was found with the locomotor, manipulative, and overall motor index in boys. Balaban (2018) recorded low correlations of high-intensity physical activity with locomotor and manipulative skills in boys, while no significant correlations were determined among girls. Likewise, Field and Temple (2017) reported a significant correlation among boys of manipulative skills and ball games not only in organized activities but also during leisure time with their peers, in which ball games usually dominate. Although in this research physical activity was assessed with a questionnaire, it is difficult to compare with other studies using direct assessment methods such as the accelerometer. However, we assumed that sports engagement during leisure time in boys involves moderate to high-intensity physical activity.

The third goal of this research was to determine the predictive value of the body mass index and motor skills regarding total physical activity. Manipulative skills of boys explain 7.2 %, while the girls' body mass index explains 6 % of the variance of total physical activity. Weak contributions in explaining the variance of total physical activity are also reported in the research carried out by Morisson et al. (2018) on a

sample of children aged 8 to 11 years. It showed that the perceived motor competency in boys (18 %), followed by the body mass index (0.7 %) and motor skills measured with the Bruininks-Oseretsky test (0.6 %), had the greatest predictive influence on overall physical activity, examined by self-assessment. In contrast, the perceived motor competency (17.5 %) and motor skills (0.8 %) in girls had the greatest predictive influence on overall physical activity. In a research on a sample of adolescents aged 16.5 years in average (Barnett et al., 2011), a weak predictive value was determined of locomotor skills (2 %) and a higher predictive value of manipulative skills (12 %) on physical activity of moderate to high intensity. Morgan et al. (2008) reported a greater contribution to total physical activity measured by accelerometers: manipulative skills in boys explained 25 % of the variance of total physical activity, while in girls neither locomotor nor manipulative skills had significant impact. Longitudinal research (Barnett et al., 2009) shows that manipulative skills in early school age is a strong predictor (12.7 %) of physical activity in adolescence, especially in moderate to high intensity activities. The same research stated that success in manipulating objects in childhood significantly affects the success in adolescence, which means that in the primary education period, exercise programs are necessary for the development and improvement of manipulative skills.

Different methodologies for assessing physical activity (questionnaires, pedometers, accelerometers), sample characteristics, differences in kinesiological education between individual countries, and different tests of motor skills assessment may have contributed to the contradictory results of these studies. The strongest correlations were obtained in research that objectively measured physical activity (Williams et al., 2008; Barnett et al., 2009). In the future, it would be useful to include other potential predictors of physical activity (e.g., perceived motor competency, socioeconomic status, motor fitness, etc.).

Conclusion

The results of this research suggest that boys with higher level of manipulative skills are more involved in the area of sports during leisure time and more engaged in overall physical activity.

In girls, a higher body mass index indicates a lower level of locomotor skills, less participation in physical activity during leisure time, and lesser total physical activity, and is a significant predictor of total physical activity. A small sample of participants and self-assessment of physical activity via a questionnaire prevents any broader conclusions and generalizations with regard to the population of pupils. Motor skills have little impact on overall physical activity, but it is undeniable that intervention strategies that should prevent overweight in children and adolescents should consider applying biotic motor skills as one of the key components in planning and programming activities in Physical Education. In addition to a number of factors that affect the level of acquired motor skills, it can be noted that organized physical activity in PE

classes and other sports activities at school represent a pivotal space for most pupils to acquire basic motor skills. Therefore, further intervention strategies should include daily organized exercise at school, which would contribute to better weight control and also increase children's daily physical activity.

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Povezanost indeksa tjelesne mase, motoričkih znanja i tjelesne aktivnosti učenika rane školske dobi

Sažetak

Cilj istraživanja bio je utvrditi spolne razlike u indeksu tjelesne mase, motoričkih znanja i razine tjelesne aktivnosti te utvrditi njihovu povezanost. Na uzorku od 127 učenika, polaznika drugog razreda osnovne škole (65 dječaka i 62 djevojčice) primijenjen je test TGMD-2 za procjenu motoričkih znanja, a tjelesna aktivnost ispitana Felsovim upitnikom. Na temelju tjelesne visine i mase izračunat je indeks tjelesne mase. Razlike između spola izračunate su neparametrijskim Mann Whitney U testom, a međusobna povezanost Spearmanovim koeficijentom korelacije. Stupnjevitom regresijskom analizom Backward postupkom izračunata je prediktivna vrijednost indeksa tjelesne mase, lokomotornih i manipulativnih znanja na ukupnu tjelesnu aktivnost. Prema normativnim vrijednostima indeksa motoričkoga razvoja ispitanici ovoga uzorka imaju prosječni rezultat. Rezultati su pokazali značajne razlike u korist dječaka u manipulativnim znanjima dok u lokomotornim znanjima, ukupnom motoričkom razvoju i indeksu mase tijela nisu dobivene značajne razlike. Značajna povezanost indeksa tjelesne mase dobivena je samo kod djevojčica te ukazuje na nisku negativnu povezanost s indeksom slobodnoga vremena (r = -0,29) i ukupnom tjelesnom aktivnosti (r = -0,29) te umjereno negativnu s lokomotornim znanjima (r= -0,39) i ukupnim indeksom motoričkoga razvoja (r= -0,35). Povezanosti motoričkih znanja i tjelesne aktivnosti dobivene su samo kod dječaka i ukazuju na nisku pozitivnu povezanost manipulativnih znanja s indeksom slobodnoga vremena (r = 0,25) i ukupnom tjelesnom aktivnosti (r = 0,27). Prema rezultatima regresijske analize doprinosi varijabli ukupnom objašnjenju varijance su značajni, ali vrlo slabi. Manipulativna znanja objašnjavaju 7,2 % varijance ukupne tjelesne aktivnosti dječaka, a indeks tjelesne mase 6 % ukupne varijance tjelesne aktivnosti djevojčica.

Ključne riječi: *indeks tjelesne mase; motorička znanja; razina tjelesne aktivnosti*

Uvod

Povišenje prevalencije debljine u dječjoj dobi javnozdravstveni je problem jer se negativne posljedice debljine očituju već u djetinjstvu. Jedan od problema koji se javlja zbog smanjene tjelesne aktivnosti je debljina, odnosno prekomjerna tjelesna masa. Rezultati istraživanja u Hrvatskoj u okviru projekta CroCOSI 2018./2019. pokazuju da u Hrvatskoj 35 % djece dobi od 8 do 9 godina ima prekomjernu tjelesnu masu i debljinu, pri čemu je na nacionalnoj razini veći u dječaka nego u djevojčica te iznosi 17,8 % u odnosu na 11,9 % u djevojčica. (Musić Milanović i sur., 2021). U usporedbi s rezultatima iz 2015./2016. primjetno je kako u trogodišnjem razdoblju nije zabilježen značajan porast debljine u djece, međutim svako treće dijete u Hrvatskoj u dobi od 8 do 9 godina ima povećan rizik da u odrasloj dobi ima problem prekomjerne tjelesne mase i debljine što posljedično znači veći rizik od vodećih kroničnih nezaraznih bolesti. U okviru istoga istraživanja redovitom tjelesnom aktivnošću kroz sudjelovanje u sportskoj aktivnosti bavilo se nešto više od dvije trećine 8-godišnjaka, više dječaka nego djevojčica, njih 72,9 % naspram 66,7 %, a u aktivnoj igri koja uključuje trčanje, skakanje i kretanje na otvorenom ili sportske igre u zatvorenom, tijekom radnih dana jedan sat ili dulje provodilo je 91,0 % djece. Neosporno je da stečena motorička znanja omogućuju djeci primjenu u svakodnevnim tjelesnim aktivnostima čime se poboljšava aktivno provođenje slobodnoga vremena, zatim primjenu u urgentnim situacijama, efikasnoga transfera u specijalizirana znanja u sportu, a također i efikasnoga razvijanja koordinacije, ravnoteže, snage i preciznost, što su sposobnosti koje predstavljaju osnovu motoričkoga funkcioniranja (Sekulić i Metikoš 2007). U razvoju motoričkih znanja presudnu ulogu imaju roditelji, sve institucije koje ostvaruju odgojno-obrazovne programe i zajednica u kojoj djeca žive. Djeca s prekomjernom tjelesnom masom u odnosu na djecu normalne tjelesne mase imaju značajno nižu razinu motoričkih znanja (Paez i sur., 2020; Spessato i sur., 2013; Santos i Zubiau Gonzales, 2013; D'Hondt i sur,. 2009). Okely i sur. (2004) na velikom uzorku djece (N = 4500) različite dobi navode da je kvaliteta izvođenja biotičkih motoričkih znanja izravno značajno povezana s indeksom tjelesne mase i opsegom trbuha te zaključuju kako bi intervencijske strategije koje bi trebale spriječiti pojavu prekomjerne tjelesne težine kod djece i mladih, trebale nužno uzeti u razmatranje i primjenu biotičkih motoričkih znanja kao jedne od ključnih komponenti. Pregledno istraživanje Catuzzo i sur. (2016) pokazuje negativnu povezanost indeksa tjelesne mase i motoričkoga razvoja pri čemu su 27 od 33 istraživanja pokazala kako je veći indeks tjelesne mase povezan sa slabijim motoričkim razvojem. Većina transverzalnih istraživanja ukazuju na negativnu povezanost, međutim uzročni smjer nije do kraja razjašnjen. Odnosno, nije poznato doprinosi li veća tjelesna masa nižoj razini motoričkih znanja ili dovodi li niža razina motoričkih znanja do veće tjelesne mase. Uzročno-posljedičnu povezanost objašnjavaju Cheng i sur. (2016) u longitudinalnom istraživanju koje je pokazalo kako je veći indeks tjelesne mase u 5. godini doprinio padu motoričkih znanja u vremenu od 5. do 10. godine, dok niža razina motoričkih znanja u 5. godini nije značajno utjecala

na povećanje tjelesne težine u 10. godini. Status debljine nakon pet godina također je doprinio nižoj razini motoričkih znanja te autori zaključuju kako su intervencijske mjere prevencije pretilosti nužne već od najranije dobi kako bi se spriječio pad razine motoričkih znanja što bi pak moglo pozitivno utjecati na tjelesnu aktivnost i ukupnu razinu kondicije. Stodden i sur. (2008) navode da je rizik od prekomjerne tjelesne mase i pretilosti temeljen na međusobnim odnosima između tjelesne aktivnosti, motoričke kompetencije, percepcije motoričkih kompetencija i motoričkoga fitnesa, odnosno dijete prekomjerne tjelesne mase pokazivat će nižu motoričku kompetenciju i percipiranu motoričku kompetenciju koje bi u konačnici mogle dovesti do daljnje niže razine tjelesne aktivnosti djece. Isti autor opisuje dinamičan i recipročan odnos između tjelesne aktivnosti i motoričkih znanja, gdje oni s višim razinama ostvarene i percipirane kompetencije imaju veću vjerojatnost sudjelovanja u tjelesnim aktivnostima koje opet pružaju daljnje mogućnosti za razvoj motoričkih znanja i kompetencija. Također, viša razina temeljnih ili biotičkih motoričkih znanja povezana je sa zdravijom tjelesnom težinom, smanjenim sjedilačkim aktivnostima te višom razinom kardiorespiratornoga i mišićnoga fitnesa i tjelesne aktivnosti (Lubans i sur., 2010)

Istraživanja koja su se bavila utvrđivanjem odnosa između morfoloških mjera i tjelesne aktivnosti mjerene akcelerometrima ukazuju na negativne povezanosti (Dencker i sur., 2006; Jimenez-Pavon i sur., 2010). Rezultati navode da je tjelesna aktivnost važna u prevenciji pretilosti. Također longitudinalno istraživanje (Cairney i Veldhuizen, 2017) na uzorku djece dobi 9 do 10 godina pokazalo je negativnu povezanost indeksa tjelesne mase i sudjelovanja u sportu tijekom tri godine praćenja te autori ukazuju na dvosmjernu povezanost koja nije razjašnjena, odnosno dovodi li veći indeks tjelesne mase do manje razine sudjelovanja u sportu ili pak manje sudjelovanje u sportu dovodi do većega indeksa tjelesne mase. Međutim, pregledno istraživanje (Wilks i sur.,2010) pokazuje da je tjelesna aktivnost slab prediktor povećanja prekomjerne masnoće. Istraživanja koja su se bavila utvrđivanjem povezanosti značila su da postoji velika mogućnost obrnute uzročnosti, tj. pretilost koja dovodi do nižih razina tjelesne aktivnosti, za razliku od tjelesne neaktivnosti koja dovodi do pretilosti (Metcalf i sur., 2011). U longitudinalnom istraživanju otkrivanja uzročno-posljedičnih veza isti autor navodi da prekomjerna masa vodi do neaktivnosti kod djece, dok neaktivnost ne vodi do debljine.

U preglednom istraživanju koje se bavilo utjecajem motoričkih znanja na tjelesnu aktivnost (Logan i sur., 2014) na uzorku djece od 6 do 12 godina uglavnom objašnjavaju od 5 % do 30 % varijance kriterijske varijable tjelesne aktivnosti. Također na uzorku predškolske djece (Xin i sur., 2020) temeljna motorička znanja objasnila su 16 % varijance ukupne tjelesne aktivnosti, pri čemu lokomotorna 21,3 %, a manipulativna 19,2 %. S obzirom na brojne dobrobiti tjelesne aktivnosti u djetinjstvu i adolescenciji za sadašnje i buduće zdravlje, razumijevanje uloge motoričkih znanja u promicanju tjelesne aktivnosti važan je zdravstveni prioritet.

Prvi cilj istraživanja bio je utvrditi spolne razlike u indeksu tjelesne mase, motoričkih znanja i razine tjelesne aktivnosti.

Drugi cilj, utvrditi međusobne povezanosti indeksa tjelesne mase, motoričkih znanja i razine tjelesne aktivnosti.

Treći cilj, utvrditi utjecaj indeksa tjelesne mase i motoričkih znanja (lokomotornih i manipulativnih) na ukupnu tjelesnu aktivnost.

Metode rada

Uzorak ispitanika činilo je 127 učenika polaznika 2. razreda, od kojih je 65 muškoga i 62 ženskoga spola, prosječne dobi 8,5 godina (±6 mjeseci). Istraživanje je provedeno u gradskoj školi u Čakovcu. Na temelju tjelesne visine i težine izračunat je indeks tjelesne mase (ITM) kao omjer vrijednosti tjelesne mase i kvadrata tjelesne visine (kg/m^2), a stanje uhranjenosti prema preporukama Centra za prevenciju i kontrolu bolesti (CDC, 2000).

Motorička znanja procijenjena su standardiziranim testom *The Test of Gross Motor Development – Second Edition* (TGMD-2) (Ulrich, 2000) kojim se procjenjuju kvaliteta razine usvojenosti motoričkih znanja djece u dobi od 3 do 11 godina. Test sveukupno obuhvaća 12 testova, od čega 6 za procjenu lokomotornih i 6 manipulativnih znanja. Tako primjerice lokomotorna znanja čine trčanje, galop naprijed i strance, skok udalj iz mjesta, skokovi na jednoj nozi, skok preko prepreke, a manipulativna hvatanje lopte, bacanje loptice u dalj, vođenje lopte u mjestu, udaranje lopte nogom, rolanje lopte i udarac bejzbol palicom. Standardne vrijednosti obiju skupina testova izračunavaju se na temelju korigiranih vrijednosti prema dobi i spolu. Zbrojem standardnih vrijednosti dobiva se ukupni rezultat u testu ili indeks motoričkoga razvoja. Navedeni test primijenjen je kako bi se rezultati mogli uspoređivati s istraživanjima koja su provedena na djeci iste dobi iz drugih zemalja.

Tjelesna aktivnost djece ispitana je upitnikom *Fels physical activity questionnaire for children* (Treuth i sur., 2005) koji se koristi za procjenu razine tjelesne aktivnosti djece od 7 do 19 godina. Upitnik se sastoji od tri grupe pitanja koje daju informacije o razini tjelesne aktivnosti ispitanika koja se procjenjuje na temelju triju komponenata kao što su tjelesna aktivnost u slobodno vrijeme, sport i kućanski poslovi, a njihovim sumiranjem dobiva se ukupna razina tjelesne aktivnosti. Maksimalna vrijednost ukupne razine tjelesne aktivnosti je 15 (po svakoj kategoriji 5), odnosno 5 nakon što se vrijednost prikaže Likertovom skalom. Metrijske karakteristike upitnika pokazale su vrlo dobru valjanost i pouzdanost na hrvatskim učenicima mlađe školske dobi (Kunješić, 2015).

Istraživanje je provedeno u skladu s Etičkim kodeksom istraživanja s djecom (Ajduković i Kolesarić, 2003). Roditelji su pisanim pristankom odobrili sudjelovanje te zajedno s djecom popunjavali upitnik samoprocjene tjelesne aktivnosti. Podatci su prikupljeni u siječnju 2020. godine.

Rezultati istraživanja obrađeni su u programu *IBM SPSS Statistics 23*. Deskriptivnim statističkim metodama izračunati su aritmetička sredina (AS) i standardna devijacija

(SD). Normalnost distribucije testirana je Kolmogorov-Smirnovljevim testom, a za testiranje razlika između spolova na nivou značajnosti od 95 % ($p < 0,05$) neparametrijski Mann Whitney U test. Spearmanovim koeficijentom korelacije izračunata je međusobna povezanost indeksa tjelesne mase, motoričkih znanja i tjelesne aktivnosti. Za objašnjenje varijance kriterijske varijable ukupna tjelesna aktivnost, primijenjena je stupnjevita regresijska analiza *backward* postupkom. Prethodno su varijable koje su pokazale odstupanja od normalne distribucije podvrgnute normalizaciji distribucije postupkom (log 10) kojim je omogućena daljnja obrada regresijskom analizom.

Rezultati

Tablica 1.

Deskriptivni statistički parametri za ukupni uzorak i po spolu, prikazani su u Tablici 1. Prosječne vrijednosti indeksa tjelesne mase kod oba spola vrlo su slične referentnim vrijednostima Republike Hrvatske (Jureša i sur., 2011) te prate krivulju normalnoga rasta i razvoja (CDC, 2000). Točnije 73 % učenika u statusu je normalne uhranjenosti, a 26,8 % je prekomjerne tjelesne mase i debljine. Prema Treuth i sur. (2005) viši je postotak dječaka u odnosu na djevojčice koji spadaju u okvire preporučenih vrijednosti tjelesne aktivnosti (46;16), dok je na ukupnom uzorku postotak 32. Prosječni indeksi tjelesnih aktivnosti ukazuju kako su dječaci tjelesno najaktivniji u slobodnom vremenu (3,37) a najniži prosječni indeks kod dječaka je u sportu (2,52). Kod djevojčica najveći je prosječni indeks vidljiv tijekom slobodnoga vremena (2,84), a najmanji u sportu (1,95). Dječaci su značajno tjelesno aktivniji u ukupnoj tjelesnoj aktivnosti ($p = 0,00$), kao i u području sporta ($p = 0,00$) i slobodnoga vremena ($p = 0,01$). Prema normativnim vrijednostima (Ulrich, 2000), prosječna vrijednost motoričkoga indeksa (99,29) pozicionirana je kao prosječni rezultat u testu.

Dječaci imaju značajno više prosječne vrijednosti u manipulativnim znanjima ($p = 0,00$), dok u lokomotornim znanjima i ukupnom indeksu motoričkoga razvoja nema značajnih razlika.

Tablica 2.

Prema kategorijama indeksa ukupnoga motoričkog razvoja (Ulrich, 2000) prikazanih u Tablici 2 vidljivo je da prosječni rezultat postiže 62,9 % djevojčica i 46,2 % dječaka. Također, primjetno je da nijedan učenik nije postigao jako slabe i najveći mogući, veoma izvrsni rezultat u ukupnom indeksu motoričkoga razvoja.

Tablica 3.

U Tablici 3 prikazani su koeficijenti međusobnih korelacija indeksa tjelesne mase, motoričkih znanja i različitih područja tjelesne aktivnosti, zasebno za dječake i djevojčice. Značajna povezanost indeksa tjelesne mase kod djevojčica ukazuje na nisku negativnu povezanost s indeksom slobodnoga vremena ($r = -0,29$) i ukupnom

tjelesnom aktivnosti (r = -0,29) te umjereno negativnu s lokomotornim znanjima (r = -0,39) i ukupnim indeksom motoričkoga razvoja (r = -0,35).

Povezanosti motoričkih znanja i tjelesne aktivnosti dobivene su samo kod dječaka i ukazuju na nisku pozitivnu povezanost manipulativnih znanja s indeksom slobodnoga vremena (r = 0.25) i ukupnom tjelesnom aktivnosti (r = 0,27).

Tablica 4.

Rezultati Regresijske analize *backward* postupkom za dječake i djevojčice vidljivi su u Tablici 4. Može se jasno uočiti da su doprinosi varijabli ukupnom objašnjenju varijance kriterijske varijable značajni, ali vrlo mali. Kod dječaka 7,2 % varijance ukupne tjelesne aktivnosti objašnjeno je samo varijablom manipuliranje objektima, a indeks tjelesne mase objašnjava 6,0 % varijance ukupne tjelesne aktivnosti djevojčica.

Rasprava

Rezultati ovoga uzorka pokazuju manji postotak djece u statusu prekomjerne tjelesne mase i debljine (28 % dječaka i 26 % djevojčica) u odnosu na istraživanje hrvatskih vršnjaka dobi 8 do 9 godina (dječaci 37 %; djevojčice 32 %) (Musić Milanović i sur., 2021). Prosječni rezultat ukupnoga motoričkog razvoja spada u prosječni rezultat te je u skladu drugim istraživanjima koja su primjenjivale isti test (TGMD-2), primjerice na predškolskoj dobi djece iz Belgije (Bardid i sur., 2016), Australije (Cliff i sur., 2009), školske dobi djevojčica iz Irske (Bolger i sur., 2018). Ispodprosječni rezultati utvrđeni su u ranoj školskoj dobi djece iz Belgije (Bardid i sur., 2016), Kanade (Burrows, Keats, i Kolen, 2014), dječaka iz Irske (Bolger i sur., 2018), a slabi rezultati kod djevojaka iz Irana (Khodaverdi i Bahram, 2015). Nadalje, značajne razlike u korist dječaka dobivene su u manipulativnim znanjima dok u lokomotornim znanjima, ukupnom motoričkom razvoju i indeksu tjelesne mase nisu dobivene značajne razlike. Rezultati ovoga istraživanja nisu u skladu s istraživanjima (O Brien, Issartel, i Belton, 2016; Castell i Valley, 2007; Paez i sur., 2020) u kojima nisu dobivene značajne razlike između spolova. Značajna uspješnost dječaka u manipulativnim znanjima u skladu je s drugim istraživanjima djece različite dobi (Bryant, Duncan i Birch, 2013; Freitas i sur., 2015 Slykerman, Ridgers, Stevenson i Barnett, 2016; Spessato i sur., 2013), a također i na uzorku čeških (Balaban 2018), turskih (Kerkez i Tutal, 2020) i irskih vršnjaka (Kelly i sur, 2019). U nekim drugim istraživanjima koja su se bavila utvrđivanjem spolnih razlika u pojedinačnim testovima manipulativnih znanja na uzorku 12-godišnjaka pokazuju kako je bacanje loptice znatno utjecalo na dominaciju razlika unutar manipulativnih znanja (O' Brien, Belton i Issartel, 2016), a na uzorku djece 9 do 12 godina (Hume i sur., 2008) značajne razlike u korist dječaka u bejzbol udarcu, bacanju loptice i udarcu lopte nogom dok u pojedinačnim testovima lokomotornih znanja nije bilo značajnih razlika. Važno je spomenuti longitudinalno istraživanje Barnet i sur. (2010) u kojemu nisu dobivene razlike između spolova u lokomotornim znanjima od djetinjstva do adolescencije, dok su značajne razlike bile u oba razdoblja u manipulativnin znanjima i

to udaranju lopte nogom, bacanju loptice i hvatanju lopte. Okely i Booth (2004) navode da su razlike u manipulativnim znanjima okolinski uvjetovane, a smanjile bi se kada bi djevojčice imale jednake mogućnosti u procesu učenja i uvježbavanja. Pretpostavlja se da je veća uspješnost dječaka u manipulativnim znanjima produkt veće uključenosti dječaka u organizirani sport, zatim više razine tjelesne aktivnosti ili uključenosti očeva koji naglašavaju igre loptom. U prilog tomu pokazuju i rezultati ovoga istraživanja u kojemu dječaci imaju značajno veći indeks u području sporta, slobodnoga vremena i ukupnoj tjelesnoj aktivnosti što je u skladu s dosadašnjim istraživanjima (Pearce i sur., 2012; Telford i sur., 2016; Ekelund i sur., 2012). Longitudinalno istraživanje koje se bavilo razlikama u tjelesnoj aktivnosti između spolova (Telford i sur., 2016) pokazuje kako su djevojčice manje aktivne jer imaju slabiju podršku na nastavi Tjelesne i zdravstvene kulture, slabiju podršku obitelji te manje sudjeluju u organiziranim sportskim aktivnostima. Budući da se ti utjecaji mogu mijenjati, buduće strategije intervencija za povećanje tjelesne aktivnosti trebale bi se istovremeno usredotočiti na svako od ovih područja, a posebnu pozornost treba obratiti na jednaku potporu i mogućnosti za oba spola.

Drugi cilj ovoga istraživanja bio je utvrditi postoje li povezanosti indeksa tjelesne mase, motoričkih znanja i tjelesne aktivnosti. Dobivene su slabe povezanosti i u skladu su s dosadašnjim istraživanjima na djeci predškolske i rane školske dobi koje ukazuju na slabu korelaciju, međutim ona se povećava s dobi, a naročito u adolescenciji (Lopes i sur., 2011). Manipulativna znanja nisu pokazala značajnu povezanost s indeksom tjelesne mase kod oba spola što je skladu s dosadašnjim istraživanjima (Graf i sur., 2004; Okely i sur., 2004; Southall i sur., 2004). Niska negativna povezanost indeksa tjelesne mase i lokomotornih znanja i ukupnoga motoričkog razvoja kod djevojčica u skladu je s istraživanjem Duncan i sur. (2017) na uzorku učenika od 6 do 11 godina koje pokazuje kako djevojčice koje imaju veći indeks tjelesne mase imaju značajno nižu razinu motoričkih znanja. Također, na uzorku turskih vršnjaka (Aktug i Iri, 2019) kojima se tjelesna aktivnost procjenjivana upitnikom, samo je kod djevojčica dobivena značajna negativna povezanost indeksa tjelesne mase i lokomotornih znanja te ukupnoga indeksa motoričkoga razvoja, dok je na uzorku čileanskih vršnjaka (Paez i sur., 2020) navedena negativna povezanost primijećena samo kod dječaka. Na ovom uzorku čini se da samo kod djevojčica veći indeks tjelesne mase ometa stabilizaciju i kretanje tijela u prostoru, koje je naročito izraženo u lokomotornim znanjima te dovodi do slabije razvijenih motoričkih znanja (Robinson i sur., 2015).

Nadalje, rezultati pokazuju kako djevojčice koje imaju veći indeks tjelesne mase provode manje vremena u području slobodnoga vremena i ukupnoj tjelesnoj aktivnosti, ili obrnuto. U upitniku se slobodno vrijeme procjenjivalo učestalošću bavljenja sportom u slobodno vrijeme, zatim hodanja ili bicikliranje u i iz škole te gledanja televizije ili čitanja knjige te je usporedba tjelesne aktivnosti s rezultatima drugih istraživanja otežana zbog različite metodologije procjenjivanja tjelesne aktivnosti. Međutim, istraživanje (Pantelić i Đošić, 2018) koje je koristilo isti upitnik pokazuje

kako ispitanici koji su tjelesno aktivniji imaju niže vrijednosti tjelesnih masti i indeksa tjelesne mase, odnosno više vrijednosti mišićne mase i bezmasne tjelesne mase. Također, Čech i Ružbarský (2020) na uzorku učenika primarnoga obrazovanja navode nisku negativnu korelaciju između ukupne tjelesne aktivnosti i adipoznih parametara, iako rezultati nisu komparirani po spolu. Negativnu povezanost indeksa tjelesne mase i tjelesne aktivnosti na uzorku djece iste dobi navodi Wrotniak i sur. (2006).

Kod djevojčica nisu dobivene značajne povezanosti motoričkih znanja i razine tjelesnih aktivnosti, dok značajno niska pozitivna povezanost manipulativnih znanja i indeksa slobodnoga vremena (r = 0,26) i ukupne tjelesne aktivnosti (r = 0,27) ukazuje kako dječaci koji su postigli bolje rezultate u manipulativnim znanjima češće sudjeluju u tjelesnim aktivnostima u slobodno vrijeme i ukupnoj tjelesnoj aktivnosti. Također, dosadašnja istraživanja (Cliff i sur., 2009; Laukkanen, 2014;Temple i sur., 2016; Balaban, 2018) ukazuju da postoje razlike između spola u odnosu na povezanost motoričkih znanja i tjelesne aktivnosti pri čemu je kod dječaka povezanost veća i pozitivnoa je smjera (r = 0,24–0,55). Rezultati ovoga istraživanja u skladu su s istraživanjem Cliff i sur. (2009) koji navode kod dječaka pozitivnu povezanost manipulativnih znanja s tjelesnim aktivnostima umjerenoga do visokoga intenziteta. U istraživanju Temple i sur. (2016) značajne povezanosti kod djevojčica nisu opažene, dok je značajna povezanost ukupne tjelesne aktivnosti uočena s lokomotornim, manipulativnim i ukupnim motoričkim indeksom kod dječaka. Niske povezanosti tjelesne aktivnosti visokoga intenziteta s lokomotornim i manipulativnim znanjima kod dječaka bilježe Balaban (2018) dok kod djevojčica nije bilo značajnih povezanosti. Isto tako, Field i Temple (2017) navode za dječake značajnu povezanost manipulativnih znanja i igara loptom u organiziranim aktivnostima, ali i u slobodno vrijeme s vršnjacima, u kojemu najčešće dominiraju igre loptom. Iako se tjelesna aktivnost u ovom istraživanju procjenjivala upitnikom, usporedba s drugim istraživanjima koja su primjenjivala direktne metode procjene poput akcelerometra je otežana, ali pretpostavljamo da bavljenje sportom u slobodno vrijeme kod dječaka uključuje tjelesne aktivnosti umjerenoga do visokoga intenziteta.

Treći cilj istraživanja bio je utvrditi prediktivnu vrijednost indeksa tjelesne mase, motoričkih znanja na ukupnu tjelesnu aktivnost. Manipulativna znanja dječaka objašnjavaju 7,2 %, a indeks tjelesne mase djevojčica 6 % varijance ukupne tjelesne aktivnosti. Slabe doprinose u objašnjenju varijance ukupne tjelesne aktivnosti navodi i istraživanje Morisson i sur. (2018) na uzorku djece od 8 do 11 godina koje pokazuje da je kod dječaka najveći prediktivni utjecaj na ukupnu tjelesnu aktivnost ispitivanu samoprocjenom, imala percipirana motorička kompetencija (18 %), zatim indeks tjelesne mase (0,7 %), motorička znanja mjerena *Bruininks-Oseretsky* testom (0,6 %), a kod djevojčica percipirana motorička kompetencija (17,5 %) i motorička znanja (0,8 %). Na uzorku adolescenata prosječne dobi 16,5 godina (Barnett i sur., 2011) dobivena je slaba prediktivna vrijednost lokomotornih (2 %), dok je veća manipulativnih (12 %) na tjelesne aktivnosti umjerenoga do visokoga intenziteta. Veći doprinos na ukupnu tjelesnu aktivnost mjerenu akcelerometrima navodi Morgan i sur. (2008) gdje

manipulativna znanja kod dječaka objašnjavaju 25 % varijance ukupne tjelesne aktivnosti, dok kod djevojčica ni lokomotorna, a ni manipulativna nisu imale značajan utjecaj. Longitudinalno istraživanje (Barnett i sur., 2009) pokazuje kako su manipulativna znanja u ranoj školskoj dobi snažan prediktor (12,7 %) tjelesne aktivnosti u adolescenciji, naročito u aktivnostima umjerenoga do visokoga intenziteta. Isto istraživanje navodi da uspješnost manipuliranja objektima u djetinjstvu značajno utječe na uspješnost u adolescenciji što znači da su u razdoblju primarnoga obrazovanja neophodni programi vježbanja za razvoj i usavršavanje manipulativnih znanja.

Oprečnim rezultatima navedenih istraživanja vjerojatno je doprinijela i različita metodologija procjene tjelesne aktivnosti (upitnici, pedometri, akcelerometri), zatim karakteristike uzorka, razlike u kineziološkoj edukaciji između pojedinih zemalja te različiti testovi procjene motoričkih znanja. Najjače povezanosti dobivene su u istraživanjima koje su objektivno mjerile tjelesnu aktivnost (Williams i sur., 2008; Barnett i sur., 2009). U budućim istraživanjima bilo bi korisno uključiti i druge potencijalne prediktore tjelesne aktivnosti (npr. percipirana motorička kompetencija, socioekonomski status, motorički fitnes).

Zaključak

Rezultati ovoga istraživanja sugeriraju kako dječaci koji imaju višu razinu manipulativnih znanja, više sudjeluju u području sporta, u slobodno vrijeme i ukupnoj tjelesnoj aktivnosti.

Kod djevojčica veći indeks tjelesne mase ukazuje na nižu razinu lokomotornih znanja, manje sudjeluju u tjelesnim aktivnostima u slobodno vrijeme i ukupnoj tjelesnoj aktivnosti te je značajni prediktor na ukupnu tjelesnu aktivnost. Mali uzorak ispitanika, samoprocjena tjelesna aktivnosti upitnikom onemogućuje bilo kakve zaključke i generaliziranje na širu populaciju učenika. Motorička znanja imaju mali utjecaj na ukupnu tjelesnu aktivnost, međutim neosporno je kako bi intervencijske strategije koje bi trebale spriječiti pojavu prekomjerne tjelesne težine kod djece i mladih, trebale razmatrati i primjenu biotičkih motoričkih znanja kao jedne od ključnih komponenti kod planiranja i programiranja rada u tjelesnoj i zdravstvenoj kulturi. Osim brojnih čimbenika koji utječu na razinu stečenih motoričkih znanja, može se reći da je organizirana tjelesna aktivnost na satima Tjelesne i zdravstvene kulture i drugih sportskih aktivnosti u školi većini učenika primarno mjesto za poučavanje temeljnih motoričkih znanja te bi daljnje intervencijske strategije trebale uključivati svakodnevno organizirano vježbanje u školi čime bi se doprinijelo boljoj kontroli tjelesne mase, a isto tako i povećala svakodnevna tjelesna aktivnost djece.