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Relationship of body mass index with some motor abilities of preschool children

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Abstract

Introduction and purpose: The body mass index (BMI) is a rough, but the most commonly used indicator for determining children's nutrition. It is an indicator of body composition, which can also affect motor abilities, which are to some extent innate but are also highly dependent on the environment in which the child lives. The study aimed to determine the relationship between body mass index and explosive leg power, balance, and coordination of children in the preschool period. *Methods:* The sample included seventy-five 5-6-year-old preschool children, for whom we measured some motor skills (long jump from the city, one-legged jumps on the left leg, one-legged jumps on the right leg, walking through hoops back, walking backwards on the shaft, rotating around its axis, standing on one leg with open eyes) with the help of motor tests and calculated BMI (body mass index). This represents the ratio between the value of body height and body weight. By the doctrine of the World Health Organization (BMI-for-age 5–19 years), BMI was classified into three categories: normal body weight (N = 54), overweight (N = 5), and obesity (N = 16). To analyze the relationship between BMI and the results of motor tests of explosive power, and between the motor balance tests and the results of motor coordination tests, we calculated the Pearson correlation coefficient. *Results:* In the category of normal body weight, in the calculations of motor tests, a negative insignificant correlation was detected between the variables BMI and the results of motor tests of explosive leg power (r = -0.059). Thus, as the value of one variable (BMI value) increases, the value of the other (the result of motor tests of the explosive leg power) decreases. A negative insignificant correlation (r = -0.013) is also observed in this category between BMI variables and the result of motor balance tests. A weak correlation (r = 0.264) can be observed between BMI variables and the result of motor coordination tests in the overweight category. There is also a slight correlation in this category between the variables BMI and the result of motor tests of explosive leg power (r = 0.012) and between BMI and the result of motor tests of balance (r = 0.045). In the obesity category, there is a negative weak correlation between BMI variables and the result of motor balance tests (r = -0.21). Thus, as the value of one variable (BMI) increases, the value of the other variable (the result of motor balance tests) decreases. A negative negligible correlation was detected between the BMI variables and the result of motor coordination tests in this category (r = -0.129). *Discussion and conclusions:* We found that the higher the BMI, the greater the standard deviation in the results of motor tests of both explosive leg power, balance, and coordination. Children with lower BMIs thus achieved better results in motor tests. Among the mentioned variables, the results are not statistically significant (p> 0.05). From the obtained correlations indicated that there could be some influence of BMI and motor abilities.

Keywords: BMI, motor abilities, preschool children

Introduction

Obesity has become a common and worrisome problem that can hinder the development of children‘s motor abilities. The body mass index (BMI) represents the ratio between the value of body height and body weight. Otherwise, it is rough, but the most common indicator for determine body composition. Among other things, it can also affect motor abilities, which are to a certain extent innate, but are also very dependent on the environment in which the child lives.

Previous studies (Marshall et al., 2004; Must and Tybor, 2005; McMurra et al., 2008; Volmut et al., 2010) indicate that children and adolescents who are overweight or obese compared to children with normal body weight are less active and spend less time in moderate and high-intensity physical activity, as a result, they do not have enough motor experience and have poorly developed motor abilities.Matarma et al. (2018) states that children in the category of overweight have significantly lower results in all measured motor abilities compared to children in the category of normal body weight. Logan et al. (2021) found that preschool children classified as overweight and obese have poorer motor abilities than their peers with normal body weight and underweight. Gentier et al. (2013) found that children in the categories of overweight and obesity have less developed hand skills, gross and fine motor skills than children in the category of normal body weight. Award (2022) found that the motor skills of 6-8-year-old children are negatively related to BMI, and that children with a normal body weight have better motor abilities than overweight children. Webster et al. (2021) state that BMI does not take into account the essential characteristics of an individual‘s body composition, so in their research they studied the relationship between the development of motor abilities, body composition and BMI. They found that in 6-8-year-old children, different components of body composition have different effects on the development of motor abilities. Thus, excess body fat may be a major morphological limitation in skillfully moving the body through space. In contrast, body composition did not significantly predict an individual's object manipulation performance. The researchers conclude that BMI has limited capabilities in assessing motor abilities.The purpose of our research was to determine the relationship between BMI and explosive power (leg), balance and coordination in preschool children. Rapid movement units are responsible for the expression of *explosive power*, but it is related to transverse dimensions of the body and muscle mass. Concentric muscle contractions occur in the manifestation of explosive power. Rarely, explosive power manifests itself in eccentric forms of muscle tension. Pistotnik (2011) states that explosive power appears as the maximum initial acceleration, which is achieved when moving the body in space or when acting on objects in the environment. So it is the ability to activate the maximum number of motor units in the shortest possible time. Innate explosive power is relatively high ($h^2 = 0.80$), so it can only be trained to a lesser extent. Videmšek & Pišot (2007) add that explosive power is the ability for a maximum initial acceleration of the body in space, such as starting, jumping and throwing. Pistotnik, Pinter & Dolenc (2002) believe that it is characterized by the rapid mobilization of a large amount of muscle power in a very short time. It manifests itself mainly in acyclic movement types of jumping, in throws and kicks, and in short sprints.

The development of *coordination* begins already in the fetal period, as the fetus gains its first movement experience in the mother's body. Pistotnik (2011) defines coordination as the ability to perform complex movement tasks and their effective design. Cemič (1997) describes coordination as the deliberate coordination of body movements in relation to space and time. The coefficient of innateness in coordination is relatively high ($h^2 = 0.80$), and its expressiveness depends on the good functioning of the central nervous system (Videmšek et al., 2003). Also Pistotnik et al. (2003) state the important role of sensory in the formation of movement programs and in their execution. Without adequate acceptance and discrimination of the spatial and temporal parameters of movements and without a good kinesthetic feeling, it is not possible to perform the coordination of the required movements. Videmšek & Pišot (2007) state that movement coordination is the ability responsible for the effective design and execution of complex movement tasks, and that this ability is the most characteristic of humans in the motor skills of all living beings.

Balance is the ability to quickly form compensatory or replacement movements, which are necessary to return the body to a balanced position when it is disturbed (Pistotnik, 2003), and at the same time, balance is the ability to maintain a stable position (Videmšek et al., 2003). In order to maintain balance, it is necessary to constantly and quickly create an appropriate movement program that contains corrective movements. However, in order to design appropriate programs, it is necessary to combine information from the environment, the senses of sight and hearing, and the balance organ in the middle ear (Videmšek et al., 2003). The ability to balance is also important in everyday life. As a person ages, the ability to balance decreases, but with suitable exercises, it can be maintained even into old age (Videmšek &Pišot, 2007). Škof et al. (2016) call the ability to perceive the position of posture and movement of individual body parts in space and time proprioception - a continuous flow of information from peripheral receptors to the central nervous system. Skin, muscle, tendon and joint receptors, the organ of vision and the organ of balance are also involved. Based on these, movement responses are formed to maintain or establish balance. Pistotnik (2011) defines two emergent forms of balance: The ability to establish a balance position (as quickly as possible to position in a balanced position after previous disorders of the receptors of the vestibular apparatus) and the ability to maintain a balance position (quick formation of compensatory movements that are proportional to deviations of the body from a stable position in balance position). Pistotnik et al. (2002) believe that the ability to maintain balance comes to the fore when we move on a reduced surface (skating, alpine skiing, walking in the mountains, etc.). Then, during the movement, there are rapid and large changes in the position of the body (change in the direction of movement or stopping or after the completion of rotational movements).

Methods

The sample consists of five to six-year-old children (N = 75). We calculated BMI based on their height and weight, and with the help of motor tests (Rančnik, 2021) we evaluated their motor abilities: *explosive power, balance* and *coordination*.

For the *explosive power*, we used the results of motor tests that supposedly explain the explosive power of the legs (Long jump from a standing position, One-legged jumps on the left leg and One-leg jumps on the right leg). For the *balance*, we used the results of motor tests that supposedly explain balance (Walking backward on a beam, Spinning around one‘s axis, Standing on one leg with eyes open, One-legged hops on the left leg and One-legged hops on the right leg). For the *coordination*, we used the results of motor tests that supposedly explain coordination (Walking on all fours through rings backward One-legged hops on the left leg and One-legged hops on the right leg).

In accordance with the doctrine of the World Health Organization (WHO: BMI for age 5–19 years), the BMI value was classified into three categories (BMI rank): normal body weight (N = 54), overweight (N = 5) and obesity (N = 16). To analyze the association between BMI and motor test results, we calculated the Pearson correlation coefficient.

Results

The results of the association between variables *BMI* and *motor test results* are shown in Table 1.

Table 1: Correlation of BMI with the results dor motor tests

BMI rang	*Statistic*	*Explosive Power*	*Balance*	*Coordination*
Normalweight (N=54)	r	0,06	-0,01	0,01
	p	0,67	0,92	0,92
Overweight (N=5)	r	0,01	0,05	0,26
	p	0,99	0,94	0,67
Obesity (N=16)	r	0,19	-0,21	-0,13
	p	0,48	0,43	0,63

r- Pearson Correlation; p- Significance (0.05)

In the category of *normal body weight*, an insignificant negative correlation (r = -.06) was detected between variables BMI and the result of motor tests of *explosive power*. So, as the BMI value increases, the value of the explosive power test result decreases. In this BMI category, an insignificant negative correlation (r = -.01) was detected also between variables BMI and the result of motor tests of *balance*. In the BMI category *overweight*, a weak positive correlation (r = .26) was detected between variables BMI and the result of motor tests of *coordination*. In the BMI category *overweight*, an insignificant positive correlation was detected between variables BMI and the result of motor tests of *explosive power* (r = .01) and between variables BMI and the result of motor tests of *balance* (r = .04). In the *obesity* category, a weak negative correlation was detected between variables BMI and the result of motor tests of *balance* (r = -.21). So, as the value of one variable (BMI value) increases, the value of another variable (the result of motor tests of balance) decreases. In the *obesity* category, a slight negative correlation was detected between variables BMI and the result of motor tests of *coordination* (r = -.13). The association between the mentioned variables is not statistically significant (p > .05) in any BMI category.

We found that the higher the BMI, the greater the dispersion of motor test results as shown in Figure 1.

In the BMI category of *normal body weight*, the dispersion of motor test results is the smallest (Figure 1). Most of the results are located around the arithmetic mean of this category.

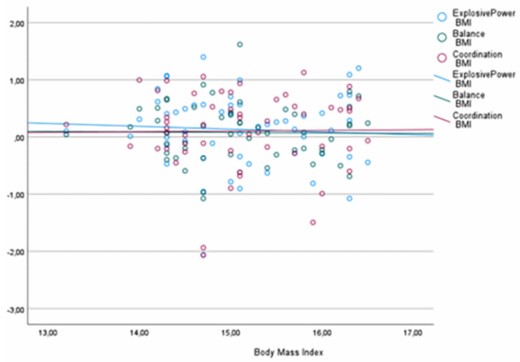

Figure 1: Dispersion of motor test results according to BMI (BMI rang Normal weight)

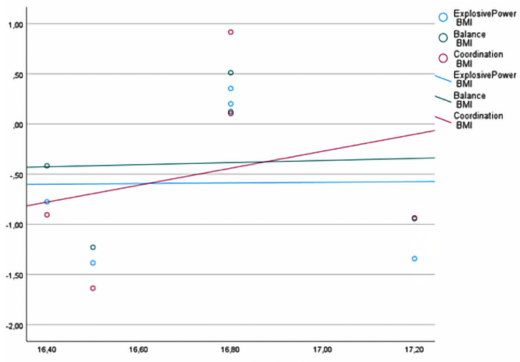

Figure 2: Dispersion of motor test results according to BMI (BMI rang Overweight)

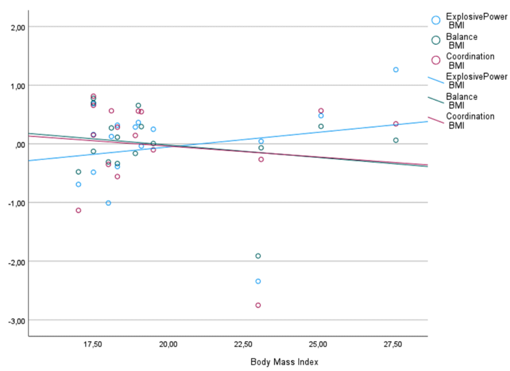

Figure 3: Dispersion of motor test results according to BMI (BMI rang Obesity)

There is a greater dispersion of motor test results in the BMI category *overweight, as show in* Figure 2. Most of the results are below the arithmetic mean of this category. Children with a lower BMI achieved worse results in motor tests of *coordination*. This finding is relative, as there were only 5 children in these categpry.

As shown in Figure 3 the greatest dispersion of motor test results is in the BMI category *obesity*. Most of the results are located around the arithmetic mean of this category. Children with a lower BMI achieved worse results in motor tests of *explosive power* and better results in motor tests of *balance* and motor tests of *coordination*.

Discussion

When studying BMI values, we were positively surprised by the number of children in the BMI category *normal weight* - as much as 72.0% of the entire sample. However, we were concerned by the fact that as many as 21.3% of children are in the BMI category *obesity*. We did not look for the reasons for these two data, but it is a clue for future research. Brettschneider & Bnemann (2005; based on Šimunič, Volmut & Pišot, 2010) state that we must find out the causes of obesity, look for ways to reduce the phenomenon in the part of the population where the phenomenon is already present, and prevent the possibility of new cases.

We found that the higher the BMI, the greater the standard deviation in the results of all motor tests: explosive power, balance and coordination. Children with a lower BMI thus achieved better results in motor tests than children with a higher BMI.

Matarma et al. (2018) came to the conclusion in his research that attending an educational institution (kindergarten) has positive effects on the development of coordination, strength and flexiblity. A smaller part of the fat mass could be detected by girls, which is associated with greater strength and agility. The associations between moderate to high physical activity and time spent in sedentary activities showed no influence on the development of motor abilities. The researchers conclude that attending kindergarten is very beneficial for the early prevention of obesity and overweight in children. The positive links between attending kindergarten, motor skills and physical activity show the importance of early learning, as a place to raise awareness and encourage physical activity and motor development of children.

Conclusions

According to the findings of our research, as BMI increases, motor abilities deteriorate. We conclude that for the development of motor abilities in the preschool period, in addition to varied and sufficient physical activity, regardless of the child's environment, it is also important to prevent overweight and obesity.

References:

AWAD, A. S., & ANEIS, Y. M. (2022).*Correlation between body mass index and motor proficiency in Egyptian children: a cross-sectional study*. Bulletin of Faculty of Physical Therapy, 27(1), 1–9.

CEMIČ, A. (1997). Motorika predšolskega otroka. Ljubljana: Dr. Mapet.

GENTIER, I., D'HONDT, E., SHULTZ, S., DEFORCHE, B., AUGUSTIJN, M., HOORNE, S., ... & LENOIR, M. (2013). Fine and gross motor skills differ between healthy-weight and obese children. *Research in developmental disabilities*, 34(11), 4043–4051.

LOGAN, S. W., SCRABIS-FLETCHER, K., MODLESKY, C., & GETCHELL, 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.

MATARMA, T., LAGSTRÖM, H., HURME, S., TAMMELIN, T. H., KULMALA, J., BARNETT, L. M., & KOSKI, P. (2018). Motor skills in association with physical activity, sedentary time, body fat, and day care attendance in 5-6-year-old children—The STEPS Study. *Scandinavian journal of medicine & science in sports,* 28(12), 2668–2676.

PISTOTNIK, B. (2003). *Osnove gibanja: gibalne sposobnosti in osnovna sredstva za njihov razvoj v športni praksi: osnove gibalne izobrazbe*. Ljubljana: Fakulteta za šport, Inštitut z šport.

PISTOTNIK, B. (2011). *Osnove gibanja v športu: osnove gibalne izobrazbe*. Ljubljana: Fakulteta za šport.

PISTOTNIK, B., PINTER, S. IN DOLENC, M. (2002*). Gibalna abeceda*. Ljubljana: Fakulteta za šport.

RANČNIK, K. (2021). *Vloga nekaterih motoričnih sposobnosti pri skoku v višino v predšolskem obdobju*. Diplomsko delo. Maribor: Pedagoška fakulteta Univerze v Mariboru.

ŠIMUNIČ, B., VOLMUT, T. IN PIŠOT, R. (2010). *Otroci potrebujejo gibanje. Otrok med vplivi sodobnega življenjskega sloga – gibalne sposobnosti, telesne značilnosti in zdravstveni status slovenskih otrok*. Univerza na Primorskem, Znanstveno-raziskovalno središče Koper – Inštitut za kineziološke raziskave, Univerzitetna založba Annales.

ŠKOF, B. (2016). *Šport po meri otrok in mladostnikov: pedagoški, didaktični, psihosocialni, biološki in zdravstveni vidiki športne vadbe mladih*. 2. dopolnjena izdaja. Ljubljana: Fakulteta za šport, Inštitut za kineziologijo.

VIDEMŠEK, M. BERDAJS, P. IN KARPLJUK, D. (2003). *Mali športnik: gibalne dejavnosti otrok do tretjega leta starosti v okviru družine*. Ljubljana: Fakulteta za šport; Inštitut za šport.

VIDEMŠEK, M. IN PIŠOT, R. (2007*). Šport za najmlajše.* Ljubljana: Fakulteta za šport; Inštitut za šport.

VOLMUT, T., ČEKLIĆ, U., PIŠOT, R. IN ŠIMUNIČ, B. (2010). Razlike v gibalnošportni aktivnosti otrok glede na maščobno maso. V R. Pišot idr. (Ur.), *Sodobni pogledi na gibalni razvoj otrok* (str. 405–407).

WEBSTER, E. K., SUR, I., STEVENS, A., & ROBINSON, L. E. (2021). Associations between body composition and fundamental motor skill competency in children. *BMC pediatrics,* 21(1), 1–8.

WHO: BMI for age 5–19 years. Pridobljeno 1.8.2022 na https://www.who.int/toolkits/growth-reference-data-for-5to19-years/indicators/bmi-for-age