

DO THE OVERWEIGHT AND OBESITY EFFECT ON MOTOR ABILITY LEVEL AMONG GIRLS?

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Abstract

In the last two decades there has been an increase in the number of children who have increased body weight or become obese. This statement confirms the fact that the affected population of children are not only in developed countries, but also in those who have a lower economic standard. Therefore, strategies for prevention and treatment of obesity have become a top priority for public health. Aim of this study was to determine whether there is a difference in the level of motor skills with regard to the level of nutrition. Based on the obtained result, it could be confirmed hypothesis of this study that girls of normal body weight had a significantly better motor skills of the students who were overweight or obese. For students who have a problem with obesity must be developed intervention programs with a view to immediately engage in regular physical exercise to reduce body weight.

Key words: obesity, girls, nutrition, exercise

Introduction

In the last two decades there has been an increase in the number of children who have increased body weight or become obese. This statement confirms the fact that the affected population of children are not only in developed countries, but also in those who have a lower economic standard (Mamalakos et al., 2000., Bundred et al., 2001; Ebbeling et al., 2002; Ogden et al., 2002; Lobstein et al., 2004., Wang and Lobstein, 2006., Casajús et al., 2007., D'Hondt et al., 2008., Martins et al., 2010.). Obesity is recognized as one of the most serious public health challenges and the fact that obesity in childhood, especially in the last few years has increased (Castetbon & Andrey, 2012; Ogden, Carroll, Keith, & Flegal, 2012). Therefore, strategies for prevention and treatment of obesity have become a top priority for public health (Hill and Wyatt, 2005, Lopes et al., 2009). Obesity is a known risk factor for many chronic diseases, and is one of the causes of type 2 diabetes in children (Wang et al., 2006), and also increases the likelihood of coronary heart diseases, amounts of cholesterol and high blood pressure (Westcott 2006, Baker et al., 2007, Li L et al., 2007, Huerta et al., 2010). Biological development determines motor skills in all phases of human ontogenesis and the relationship between the sexes, maturation and body composition that are important for health and motor skills (Bronikowski, Mi and Bronikowski, Ma. 2008). Motor skills, that is their level, are essential for optimal growth and development of children, and thus to their health. It is certainly important fact that children have to do physical activity if they want to reach quality optimal level for motor abilities. In our school system, insufficient amount of physical activity of children in regular classes would be compensated through extracurricular (free time students) organized forms of physical exercise.

Thus distributed amount of physical activity would contribute to raising the level, primarily motor skills, as well as other skills and qualities to the highest level that are needed to preserve the health of the individual (Badrić, 2011). With the start of school age most nerve structures are developed and basic forms of movement are established and that age makes it ideal for practicing basic skills. The effects of exercise on the development of these skills were perceived earlier. During the middle and older school-age practice of basic skills growth into specific training and their combinations, according to the requirements of each sport / discipline (Misigoj-Durakovic, 2008). Studies showed that childhood obesity could have adverse effects on the overall motor development (Morano et al., 2011). In addition, obese and overweight children tend to have less developed motor skills compared to their peers with normal weight (D'Hondt, Deforche, De Bourdeaudhuij, and Lenoir, 2009; Logan et al., 2011; Morano et al., 2011; Poulsen et al., 2011). Hardy et al (2012) reported that children who had a low level of motor skills quite a bit involved in physical activity, and less often participate in sports and organized games. Motor skills are increasing during maturation. When girls achieve plateau motor skills plateau around 14 years old, and among boys a few years later. Biological mature boys are more vulnerable to the impact of the training, which is not the case among girls (Malina, 1994). Research have showed that the correlation of BMI levels and motor skills started declining with aging, while in girls this connection begins to decrease from 12 years of development (Lopes et al., 2012). Children in childhood who had a higher level of development of motor skills have a great prediction that in adolescents they will be more physically active (Raudsepp and Pall, 2006, Wrotniak et al., 2006, Barnnet et al., 2009).

The aim and hypothesis

Aim of this study was to determine whether there is a difference in the level of motor skills with regard to the level of nutrition. Hypothesis: H1: Students with normal body weight have significantly better motor skills from the students who are overweight or obese.

Methods

The study included 413 girls of primary schools in Sisak County. Age of the girls ranged from 11-14 years. Girls were divided into two subgroups: 11-12 years (213 girls) and 13-14 years (200 girls). All students were completely healthy at the time of the research. The study was conducted in accordance with the Code of Ethics in Research with Children, prepared by the Council for Children as an advisory body of the Croatian Government. For each subject-girl parents gave their written consent to participate in research. The sample comprised students from elementary school "Dragutin Tadijanovic" and first elementary school "Petrinja", and girls in primary school "Brothers Ribar" and primary school "Ivan Kukuljevic Sakcinski" from Sisak. The sample of variables in this study consisted of 15 tests of motor skills and two measures of morphological characteristics. Body mass index (BMI) was obtained as a ratio of body weight and the square of body height. Based on the calculated body mass index, through the tables recommended by the International Obesity Task Force (Cole et al., 2000), subjects were classified into three groups according to the nutritional status: a normal body weight, overweight and obese.

In the area of morphological anthropometry each student was measured in body height and body weight. All measurements were performed by standard methods as described according to the instructions of the International Biological Program (IBP - Weiner and Lourie, 1968). Motor skills were measured by a set of 15 motor tests. To estimate the speed of simple gestures were used: 1) hand tapping (MBTR); 2) Taping foot (MBTNOG); 3) Taping feet against the wall (MBTANOZ). For the assessment of explosive strength were used: 1) Standing long jump (MESSD); 2) Throwing a medicine ball from lying on the back (MEBML); 3) Running from a standing start to 20m (METR20). To estimate the repetitive forces were used: 1) Raising the trunk (MRSPT); 2) Raising the trunk from the back (MRSPTL); 3) Squats (MRSC). For the assessment of coordination were used: 1) polygon backwards (MKPN); 2) The steps to the side (MKKUS); 3) Slalom run (MKSALT).

To estimate the flexibility were used: 1) V-sit and reach (MFLPR) ; 2) sit and reach (MFLPRK); 3) The thrust his hands behind his back up the mast (MFLPRJ) . The method of measurement for each test was repeated three times, except for the tests of dynamic forces. Tests for repetitive strength were measured only once.

A detailed description of the tests is available in the doctoral dissertation (Badrić, 2011). Data processing was performed with the program STATISTICA (data analysis software system), version 7.1. In processing the data for all the studied variables were calculated basic descriptive parameters: arithmetic mean (AS) and standard deviation (SD). The significance of differences percentages was determined by t-test for differences in percentage.

To determine the normality Kolmogorov-Smirnov test (KS test) was used. The significance of differences between formed subsamples was tested by multivariate analysis of variance (MANOVA). For variables where achieve was statistically significant F value in further analysis using the "Scheffe" post hoc test to determine differences between mean values of groups. Statistical significance was tested at a significance level of $p < 0.05$.

Results

Results of Kolmogorov - Smirnov test showed normality of distribution. In Table 1, the results showed the percentage of students divided into three levels of nutrition.

Table 1. Number of female students by level of nutrition

	Normal BW	Overweight BW	Obesity
11-12 years old	147	45	21
13 -14 years old	152	32	16
TOTAL	299	77	37

BW= body weight; *t-test $p=0,05$

Results showed that the percentage of students who were normal weight were greater for female students aged 13 to 14 years, while the younger girls were slightly higher number of overweight (21.13 %) compared to the older girls (16 , 00 %). Results of t-test determined the differences in percentages did not show statistical significance in subsamples schoolgirl defined by age according to the nutritional status. Looking at the total sample of female students aged 11-14 years, there were more than 27 % of all respondents who had a problem with obesity.

Table 2. Results of multivariate analysis of variance (MANOVA) in motor skills according to the nutritional status

	Wilks' Lambda	F	Effect df	Error df	p-level
11 i 12 years old	0,44	6,57	30	392	0,00

Results of multivariate analysis of variance (MANOVA) in table 2 showed that in multivariate space of the analyzed variables had statistically significant differences ($F = 6.57$; $p = 0.00$) in motor skills between the three groups of subjects divided according to their level of nutrition.

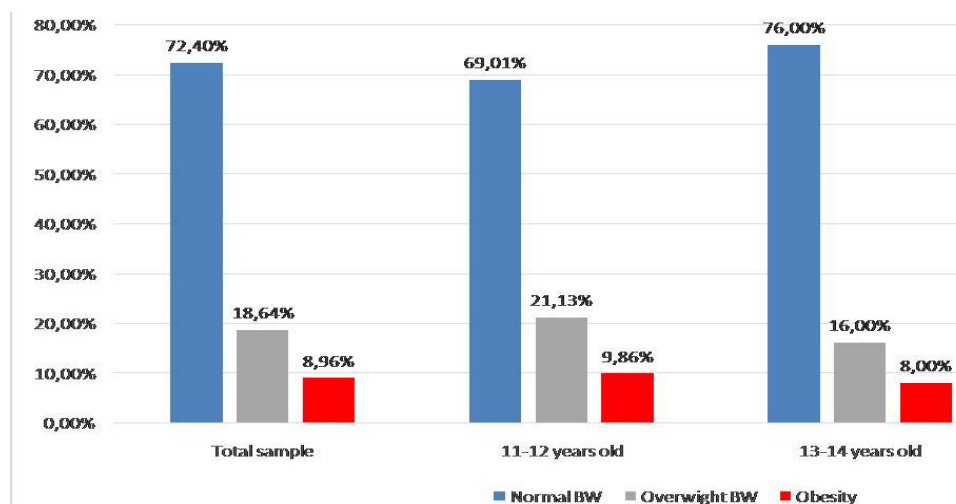


Figure 1. Results of percentages among female students by the level of nutrition

Table 3. Descriptive statistical parameters among girls 11 and 12 years old and the results of the univariate analysis of variance (ANOVA) and post hoc analysis

	Normal N=147		Overweight N=45		Obese N= 21		ANOVA	
	AS	SD	AS	SD	AS	SD	F	p
Polygon backwards	15,52±4,46* [#]		19,97±5,06		21,57±9,70		20,56	0,00
Steps to the side	11,78±1,33 [#]		11,94±1,23**		12,84±1,63		5,69	0,00
Slalom run	8,36±0,60* [#]		8,65±0,69		9,04±0,82		12,01	0,00
Sit and reach	26,70±6,71		24,93±7,41		28,43±7,92		1,99	0,14
V-sit and reach	60,80±12,05		59,07±9,57		64,95±15,07		1,75	0,18
Thrust the hands behind the back	26,86±7,77		26,33±7,80		23,43±7,72		1,79	0,17
Tapping hand	28,85±3,61		27,73±3,39		27,10±3,97		3,28	0,05
Tapping foot	21,71±2,33		21,02±2,07		20,90±2,39		2,3	0,10
Tapping feet against the wall	21,12±3,97		20,96±3,35		20,19±4,88		0,51	0,60
Standing long jump	159,99±21,04* [#]		146,80±19,22**		130,95±22,49		21,63	0,00
20m run	4,12±0,34* [#]		4,37±0,37		4,60±0,48		20,52	0,00
Throwing a medicine ball	583,54±101,93		614,87±106,58		655,33±141,07 [#]		4,89	0,01
Raising the hull	35,29±6,82 [#]		32,47±7,57		28,14±4,16		11,63	0
Squats	41,61±8,23* [#]		35,98±7,64**		28,76±9,96		26,26	0
Raising the trunk from the back	34,39±14,16 [#]		32,16±13,78**		21,38±13,85		7,91	0

* = difference between normal and overweight group; # = difference between normal and obese group; ** = difference between the overweight and obese groups, $p < 0.05$

Table 5. Descriptive statistical parameters girls 13 or 14 years and the results of univariate analysis of variance (ANOVA) and post hoc analysis

	Normal N=152		Overweight		Obese N= 16		ANOVA	
	AS	SD	AS	SD	AS	SD	F	p
Polygon backwards	13,93±3,22* [#]		16,43±5,58**		21,09±8,02		23,40	0,00
Steps to the side	11,54±1,44		11,69±1,32		12,47±1,67		3,05	0,06
Slalom run	8,31±0,77* [#]		8,69±0,74		9,24±0,96		12,31	0,00
Sit and reach	28,05±7,16		28,59±6,06		24,88±4,33		1,78	0,17
V-sit and reach	65,05±12,79		63,72±10,95		59,44±7,88		1,58	0,21
Thrust the hands behind the	30,89±7,55		29,50±4,98		29,31±6,94		0,76	0,47
Tapping hand	32,08±3,86		31,81±4,02		31,25±3,15		0,37	0,69
Tapping foot	22,99±2,12*		22,44±2,31		21,56±2,37		3,61	0,03
Tapping feet against the wall	22,69±3,89		22,81±4,22		21,94±5,58		0,27	0,76
Standing long jump	169,40±20,42* [#]		154,66±23,49		139,75±25,30		18,18	0,00
20m run	4,04±0,36 [#]		4,12±0,35**		4,52±0,50		12,67	0,00
Throwing a medicine ball	675,78±114,31		709,25±112,17		756,31±183,64 [#]		3,84	0,02
Raising the hull	34,72±7,56 [#]		33,63±8,62**		25,50±6,75		10,46	0,00
Squats	38,44±8,06 [#]		35,53±9,59**		25,81±7,46		17,42	0,00
Raising the trunk from the back	35,82±12,37 [#]		34,78±15,70**		18,25±13,14		13,23	0,00

* = difference between normal and overweight group; # = difference between normal and obese group; ** = difference between the overweight and obese groups, $p < 0.05$

Table 3 presents the main results of descriptive parameters with girls aged 11 and 12 years old. The results showed that students who had normal body weight had better results in almost all the motor skills of the students that were overweight or obese. Results of univariate analysis of variance (ANOVA) showed that a significant difference between groups divided into three subsamples defined according to the nutritional status of female students was reflected in variables that assess explosive power, coordination and repetitive strength. For variables that assessed the flexibility and speed of simple movements were no significant difference. For variables that determined the statistical significance were analyzed by Scheffe post hoc test analysis. The results showed that the variable "polygon backwards" among normal weight students (15.52 ± 4.46) scored better than the students who belong to the group of overweight body weight (19.97 ± 5.06) and obese (21.57 ± 9.70). Similar results were seen with variable "slalom run" where the girls of normal weight (8.36 ± 0.60) scored better than the students who belong to the group of overweight (8.65 ± 0.69) and obese (9.04 ± 0.82). For variables "steps to the side", girls of normal weight (11.78 ± 1.33) and overweight (11.94 ± 1.23) had significantly better results than obese (12.84 ± 1.63) student. In the "standing long jump" girls with normal body weight (159.99 ± 21.04) and overweight (146.80 ± 19.22) had significantly better results than obese (130.95 ± 22.49) student. Variable "20m run" showed significantly better results in girls with normal body weight (4.12 ± 0.34) than those with overweight (4.37 ± 0.37) and obese (4.60 ± 0.48). Results of post hoc analyzes showed that with variable "throwing a medicine" differences in favor of obese girls (655.33 ± 141.07) than girls of normal weight (583.54 ± 101.93). In the area of repetitive strength showed that the variable "lift trunk" girls of normal weight (35.29 ± 6.82) had better results than obese girls (28.14 ± 4.16). Also, the variable "squats" respondents normal body mass (41.61 ± 8.23) achieved better results than respondents overweight (35.98 ± 7.64) and obese (28.76 ± 9.96). For variable "raising trunk from the back position", students who belong to the group with normal body mass (34.39 ± 14.16) and overweight (32.16 ± 13.78) had significantly better results than obese female students (21.38 ± 13.85). Table 4 showed the results of multivariate analysis of variance (MANOVA). It is evidenced that in multivariate space of the analyzed variables had statistically significant differences ($F = 5.21$; $p = 0.00$) in motor skills between the three groups of subjects divided according to their level of nutrition. Results in table 5 showed the basic descriptive parameters among girls aged between 13 and 14 years old. The present results showed that students who had normal body weight had nominally better results in almost all the motor skills of the students that were overweight or obese. Results of univariate analysis of variance (ANOVA) showed that a statistically significant difference between groups

divided into three subsamples defined according to the nutritional status of female students was reflected in variables that assess explosive power and repetitive strength, partly in variables for assessing coordination and speed of simple gestures. For variables that assessed flexibility, there were no significant difference. Based on statistically significant differences established in some variables, in the further analysis was used post hoc Scheffe test for determining the individual differences between groups of respondents. The results showed that the variable "polygon backwards" for girls of normal weight (13.93 ± 3.22) scored better than the students who belong to the group of overweight (16.43 ± 5.58) and obese ($21.09 \pm 8, 02$). Results in variable "slalom run" showed that girls with normal body weight (8.31 ± 0.77) had better results than students who belong to the group of overweight (8.69 ± 0.74) and obese (9.24 ± 0.96). For variable "taping foot" girls of normal weight (22.99 ± 2.1) had significantly better results than girls in overweight group (22.44 ± 2.31). In the "standing long jump" girls with normal body weight (169.40 ± 20.42) had significantly better results than girls in overweight group (154.66 ± 23.49) and obese (139.75 ± 25.30) girls. Variable "20m run" showed that those students who belong to the group of normal-weight (4.04 ± 0.36) and overweight (4.12 ± 0.35) had significantly better results than obese female ($4.52 \pm 0, 50$). Results of post hoc analyzes showed that variable "throwing a medicine" differences in favor of obese girls (756.31 ± 183.64) than girls of normal weight (675.78 ± 114.31). In the area of repetitive strength showed that the variable "lift trunk" for girls of normal weight (34.72 ± 7.56) had better results than obese girls (25.50 ± 6.75) and in those with overweight (33.63 ± 8.62) showing better results than the obese. When variables "squats" respondents normal weight students who belong to the group with normal body mass (38.44 ± 8.06) and overweight (35.53 ± 9.59) had significantly better results than obese female students (25.81 ± 7.46). "Raising the trunk from back position" for students who belong to the group with normal body mass (35.82 ± 12.37) and overweight (34.78 ± 15.70) had significantly better results than obese students (18.25 ± 13.14).

Table 4. Multivariate analysis of variance (MANOVA) in motor skills according to the nutritional status

	Wilks' Lambda	F	Effect df	Error df	p-level
13 i 14 years old	0,49	5,21	30	366	0,00

Discussion

Based on the obtained results, it was found that there were significant differences concerning the motor abilities of female students aged 11-14 years given the level of their nutritional status.

These differences were reflected in a group of female students aged 11-12 years, but also in the age 13-14 years. When you look at the total sample of respondents aged 11-14 years, it was evident that 9 % of all respondents were obese, and 19% of female students had overweight problem. These figures were quite worrying because 28% of girls had increased body weight as the further growth and development could bring negative consequences.

Looking at the results by age of respondents, it was observed that more young girls of a group of overweight or obese compared to older girls. Similar or slightly higher results were reported (Mamalakis et al., 2000; Casajús et al., 2007; Planinsec and Indiv, 2009; Ogden et al., 2010; Djokic and Mededovic, 2013). In studies (Antonic and Degac et al., 2004; Delas et al., 2008; Lazzeri et al., 2008; Koezuka et al., 2009; Huerta et al., 2010; Khasnutdinova and Grjibovski, 2010; Milanese et al., 2010, Martinez - Gomez et al., 2010; Bonvin et al., 2012; Jarani et al., 2014) obtained a smaller percentage of girls with overweight and obese.

Results of multivariate analysis of variance showed that in both subsamples students differ in the level of motor skills according to the level of nutrition and that students who were overweight or obese had a significantly lower results in motor skills. Thus the results confirmed by other studies conducted among children of this age (Khasnutdinova and Grjibovski, 2010; D'Hondt et al., 2013). The differences were not observed in the area of motor variables where gaining weight were not a prerequisite for the efficient execution of movements (tapping hand - the speed of simple movements and sit and reach - flexibility). Students in overweight group achieved almost the same or slightly better results in this assay which measures the ability of the motor and the reason probably laid in the fact that in this test, there was no movement of the lower extremities and trunk but was not required to run their mass body in space, only performed the task upper extremities.

Similar results were obtained in studies (Graf et al., 2004; Tokmakidis et al., 2006; Casajús et al., 2007). Looking at individual differences in motor skills , it was evident that in younger girls the difference was reflected particularly in the area of coordination, explosive power and repetitive strength. These results also supported other studies (Graf et al., 2004; Casajús et al., 2007; Lopes et al., 2012; Castetbon and Andrey, 2012; Drid et al., 2013). For older girls aged 13 or 14 years, it was evidential that overweight girls or those with overweight had a significantly lower results in repetitive and explosive strength and partly in co-ordination and speed of simple gestures. Significant differences did not occur in the space frequency of simple movement and flexibility. These findings confirmed earlier research (Deforche et al., 2003; Tokmakidis et al., 2006; Casajús et al., 2007; Djokic and Mededovic, 2013).

Girls who had a higher body mass had problem in mastering tests that required fast moving bodies or raising their own body weight. The reason certainly laid in the fact that in these tests did not require the use of additional power and these tests were performed in a sitting position or in place without having to move the entire body. In both age groups, students who were obese or overweight have had better results in the test throwing a medicine ball which measures the explosive force of arms. The students who had more body mass achieved better results in an assay that measures this motor ability. The probable reason was the fact that in this test, there was no movement of the lower extremities and trunk and therefore it was not necessary to trigger the mass of the body in space, but the task performed by only the upper extremities. Daily physical exercise had for prediction of increasing levels of motor skills, which was positively correlated with body mass index (Biddle et al., 2005; Koezuka et al., 2006; Wrotniak et al., 2006; D' Hondt et al., 2009) . Also, daily physical activity is very important to maintain normal body weight but also in weight reduction. Creating a habit of exercising every day is very important in maintaining the health of man and this habit can and must only create children in childhood. Additional physical activity in the form of school intervention has contributed to raising the level of motor skills (Graf et al., 2008; D'Hondt et al., 2013; Morano et al ., 2013; Galot et al., 2014). Prevention and education of preschool and school-age children is great importance. The most sensitive period for children in developing overweight and obesity coincides with the period of puberty and rapid growth and development, and this is the period in which it is possible to make preventive action (Tudor - Locke et al., 2011). Effect of physical exercise on the maintenance of normal body weight girls in correlation with quality food has a great prediction for the preservation of health from an early age.

The fact that the imposed refers to the practice of daily and continuous physical activity without no possibility of progress in the development of motor skills. Programming in teaching kinesiology education would have positive benefits on the health of students who have a lower level of motor skills. Motor skills optimally develop at a younger age and their maximum development reaches in adolescence. Due to this fact it is extremely important that at a young age the habit of exercising is applied every day. Also confirms that regular participation in kinesiology activities associated with health benefits, and motor development of children with overweight. The limitations of this study relate to the sample of respondents as limited to one geographical area. Also, the number of respondents is relatively limited in the case of the formation of subsamples defined by age, and the probability of error of results is becoming more likely. Future research of this problem should need a larger sample size and greater number of tests to check the motor skills.

Conclusion

Based on the obtained result, it could be concluded that girls of normal body weight had a significantly better motor skills of the students who were overweight or obese. Overweight significantly reduces the level of motor abilities in girls in the younger and older age. Girls who are overweight have a significantly poorer performance in motor skills that require mobility

or strength of their own body. It is very important that experts in the field of kinesiology made preventive programs aimed at creating a habit of exercising every day and thus the development of motor skills. For students who have a problem with obesity must be developed intervention programs with a view to immediately engage in regular physical exercise to reduce body weight.

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UTJEČE LI PREKOMJERNA TEŽINA I GOJAZNOST NA RAZINU MOTORIČKIH SPOSOBNOSTI KOD DJEVOJAKA?

Sažetak

U posljednja dva desetljeća došlo je do povećanja broja djece koja su prekomjerne tjelesne težine i postaju pretila. Ovu tvrdnju potvrđuje činjenica da je zahvaćena populacija djece, ne samo u razvijenim zemljama, ali i u onima koje imaju niži ekonomski standard. Dakle, strategija za prevenciju i liječenje pretilosti postaje prioritet za javno zdravstvo. Cilj ovog istraživanja bio je utvrditi postoji li razlika u razini motoričkih sposobnosti s obzirom na način prehrane. Na temelju dobivenih rezultata, može se potvrditi hipoteza ovog istraživanja da djevojke normalne tjelesne težine imaju značajno bolje motoričke sposobnosti od učenica koji su bile prekomjerne težine ili pretile. Za učenike koji imaju problema s pretilošću moraju biti razvijeni interventni programi s ciljem da se odmah uključe u redovite tjelesne vježbe za smanjenje tjelesne težine.

Ključne riječi: pretilost, djevojke, nutricionizam, vježbanje

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