European Journal of Physical Education and Sport Science
ISSN: 2501 - 1235
ISSN-L: 2501 - 1235
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.838188 Volume 3 | Issue 8 | 2017

DIFFERENCES IN MOTOR ABILITIES MANIFESTATIONS DEPENDING ON QUANTITATIVE PARAMETERS OF BODY MASS INDEX OF STUDENTS

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Abstract:

Motor abilities as the anthropological status segment of a human participate in the implementation of various movement structures, and are an indispensable part of human latent and manifested space. Depending on the type of movement structures depends on their mode of manifestation. Most of them are more or less correlated with other segments of the anthropological area. The most common connection is related to the morphology and dimensions of the individual parameters of the morphological status, for example, Lorentz constitution index, body mass index (BMI), and so on. The current research was conducted on a sample of 40 male students, aged 16 ± 0.5 years from Busovača (BIH) in order to determine possible differences between individuals with different values of BMI. According to the objective of the research was selected the intentional sample of subjects: 20 normal weight students (BMI=20.79±1,79kg/m^2) and 20 students with excessive nutritional status (BMI=26.55±0,88kg/m^2). For the evaluation of motor abilities were defined tests for the assessment of the balance (flamingo-MFLA), flexibility (reaching in sitting-MFLE). To determine the difference between respondents was applied the module T-test for small independent samples. The results obtained confirm statistically significant differences between normal and over-fed students in the realization of defined motor abilities required a level of significance ($p < 0.001$).

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Key words: anthropological status, nutritional status, age, students, differences

1. Introduction

Today we live mainly in terms of the accelerated pace, poor quality and unhealthy diet, reduced or lack of movement, in one word - hypokinesian lifestyle. Hypokinesia consequences are many and most are related to diseases of the cardiovascular system, the respiratory system and the emergence of diabetes. In addition, it can be stated that uneven growth and development of the individual lead to a negative trend in the development of some anthropometric characteristics and even the physical status of the individual (Pavlović, Raković, & Pupiš, 2016).

It is known that correct and systemic activities of physical activities and sports have a positive impact on health, physical development and functional capabilities (Morris and Froelicher, 1991; Pate, Pratt, Blair, et al, 1995; Vadasova & Balogha, 2012), both in younger and in an older age (Trudeau, Laurencelle, Tremblay, et al, 1999). However, it also points to the possibility of health damage, as well as some diseases in which these activities will have the opposite effect, i.e. deterioration of health conditions (Koplan, Siscovick, & Goldbaum, 1985 Ghilarducci, Holly, & Amsterdam, 1989; Malina & Bouchard, 1991). It is therefore necessary to ensure that in these activities are included only healthy people, or those to whom these activities will be beneficial, and that we can continuously monitor their physical development through systematic and sports activities exercise (Telama, Leskinen & Yang, 1996, Stewart, Dennison, Kohl & Doyle, 2004).

One of the most important health problems of modern society is obesity, and worst of all, it seems to have a major negative impact on children. In today's modern world, children's obesity is on the rise and an epidemic. Very often at school age, caloric intake, which is on the rise is not accompanied by an increasing trend of physical activity, i.e. they are inversely related (Berkey, Rockett, Field, et al., 2000; Boreham, & Riddoch, 2001).

Hypokinesia and diseases of civilization influence '“our,, children to become like their peers in industrialized societies, where the increase in body fat in children is a commonplace (Szakály, 2008; Haug, Rasmussen, Samdal ... & Ahluwalia 2009; Gopinath, Hardy, Baur, Burlutsky, & Mitchell, 2012). It is alarming that the hypokinesia - the disease of modern society, as it is often called, is increasing among adolescents of both sexes and is more common in older than in younger age (Kohl & Hobbs, 1998). The consequences are numerous, in terms of damage to the health of an individual's health and often to the health the wider population. In order to fight the consequences, it is

necessary first to identify and define the causes of hypokinesia (Pavlović, Tosic, Idrizović, Raković, & Mihajlović, 2014). Younger children, unconsciously, mainly through the game, largely neutralize this problem, and with age, this problem increases. However, some studies have shown that this period is very sensitive to this issue. Even 13-14% of children in the United States are defined as obese, while in England the percentage is 10-17%. In 2001, the research on obesity, involving six countries (Brazil, United Kingdom, Hong Kong, Netherlands, Singapore and the United States) have confirmed that children aged 4-11 are overweight at a rate of 2-3%. Between 1984 and 1994 the number of obese children has risen to 50% (Jebb, Rennie, Cole, 2003), and the best way to prevent and stop the rapid growth of obesity is a combination of regular physical exercise and a balanced diet (Al Nakeeb, Duncan, Lyons, et al. , 2007).

The fact is that a large number of children in the world grow up with a lot of IT stimulants, and lack of exercise (physical activity). Some data suggest that today adolescents spend up to 7.5 hours a day sitting down, and it has been proven that children who, for more than 4 hours a day, watch television have twice the opportunity to develop obesity (Dennison, Straus, Mellits, & Charney, 1988). American studies have confirmed the significant association between hours spent watching television and obesity (Dietz, & Gortmaker, 1985). In contrast to the children of the normal body weight, those with high body weight are less physically active or are less included in the extracurricular activities. Knowing the nutritional status is especially important in children because of the monitoring the growth and development and detection of individuals who deviate from the established criteria of nutrition.

The research of Togashi, Masuda, Rankinen, et al. (2002), Whitlock, Williams, Gold, Smith, & Shipman (2005) have confirmed that obesity in childhood usually results in obesity in adulthood. Negative attitudes adopted in childhood, can be transferred into adulthood and affect the willingness of people to engage in physical activities (Bailey, 2006; Barnett, Van Beurden, Morgan, Brooks, & Beard, 2009; Cliff, Okely, Smith & Mc Keen 2009, Haugen, Safvenbom, & Ommundsen, 2011). As a possible solution that may come up in such a very delicate situation are well organized and implemented physical education classes. Regular physical education as a complex and delicate social activity aimed at using the resources of physical exercise and specific forms of organization and methods and forms of work provide a positive transformation of anthropological dimensions and increases the level of motor skills of students (Branković, Milanović, & Pavlović, 2012). In the teaching process, it is necessary to apply the scientific methods for the determination of the structure of anthropological dimensions, relationships, and developmental characteristics, as well as effective

methods in the application of working methods, the organizational form, an adequate intensity and the extent of the resistance, and the choice of the motor exercises.

This approach can be implemented through optimally programmed and homogenized educational process, tailored to individual abilities and characteristics of children and youth. Physical Education Program provides a space for full engagement of students, the acquisition of theoretical knowledge and mastery of sports and technical skills, stimulating its own efforts to contribute to the development of personal skills and qualities and building personalities (Višnjić, 2008). Monitoring the implementation of a program of regular physical education teaching and assessment of the results achieved are important for the improvement of the educational practice of physical education classes and for encouraging teachers to have more responsible and creative approach to work. This process will provide reliable data to take any corrective intervention in the practical implementation of the working program. In this regard, it is well known that whilst in some motor activity, one type of body structure directly hinders the accomplishment of the kinetic program; the same type of body in another motor activity can be extremely favorable, as can be seen in some studies (Branković, Milanović, Pavlović, & Simonović, 2012).

One of the major goals of physical education should be encouraging physical development and improvement of motor abilities of students. Only appropriate level of motor skills enables successfully learning more complex motor tasks, acquisition of knowledge and the creation of habits (Višnjić, Jovanović, & Miletić, 2004). The motor tasks, tests, include indirect measurements, so it is necessary to have more indicators of a motor skill (Malacko, & Rađo, 2004). Many studies have shown that children who are overweight have limited motor skills compared to children with normal weight (Cairney, Hay, Faught, & Hawes, 2005; Cawley, & Spiess, 2008).

Analysis of the results of anthropometric measurements allows the development of a standard, using a standard method (a comparison of the results obtained by the anthropometric measurements of a given population of subjects with the previously established standards for a particular population, e.g. determining the optimum and the relative body weight per Demole, Brocov index, the optimal body weight per Brugsch, body weight by Willmoreu, the relative content of fat, body mass index Quetelet, Rorher index, Pignet, Lorentz constitution index , muscle index, ...), and methods of the index (the ratio of comparing the individual anthropometric parameters, i.e., by comparing the physical proportions). Evaluation of morphological characteristics of the body by index has a limited, relative value and gives the interviewer only a quick orientation to the physical development of the participants and is used primarily in adults. Body mass index is applicable to cases between the ages of 18 and 65, but it is

not suitable for children, pregnant women, athletes with high muscle mass and the elderly. Increased values of Body Mass Index increase the risk of cardiovascular diseases (hypertension, myocardial infarction, and pulmonary disorders (sleep apnea syndrome). Body Composition (BC) is an important indicator of physical fitness and general health of the athletes (Warner, Fornetti, Jallo, & Pivarnik 2004; van der Ploeg, Gunn, Withers, Modra, 2003) and is also frequently discussed topic in the scientific literature. According to the statements (Claessens, Hlatký, Lefevre, & Holdhaus, 1994) body shape and its morphology is, in addition to the physical capacity and psychological characteristics of the energetic capacity of the system, one of the main factors that determine the sporty performance and the realization of motor abilities.

Diagnosis of body weight is often the subject of research aimed to gain an insight into the current status of the defined population trends and potential negative growth and development in a given time period. Guided by all previously set forth with regard to obesity, all disadvantages when it comes to physical (motor) activity and all the negative consequences arising, the objective of the research is defined. The main objective is to determine the differences in the manifestations of motor skills in relation to the quantitative parameters of BMI at secondary school students. It is expected that the results provide insights on the basis of which we will be able to intervene in a timely manner so that in the future fewer children in adolescence, and later in adulthood, escape overweight.

2. Methods

The research was conducted on a sample of 40 male students, aged 16 ± 0.5 years, secondary school students from Busovača (BIH). This study is based on the target sample of subjects (20 normal weight students (BMI=20.79±1,79kg/m²) and 20 students with excessive nutritional status (BMI=26.55±0,88kg/m²). To estimate the nutritional state of students was applied the standard form for assessing the BMI=kg/m² (WHO, 2015).

For the definition and evaluation of the motor space was applied the battery of the five manifestation tests which covered the field of motor capacity - explosive strength, flexibility, coordination, balance and speed (Kostić, 1999):

1. Flamingo balance test (MFLA);
2. Sit and reach (MDOH);
3. Long jump (MSDM);
4. The polygon backwards (MPOLN);
5. Running 20m high start (M20V).

When selecting tests we took into account that they are known to students, that the difficulty of motor tests and their performance is adapted to their age and capabilities. The measurements were carried out in the course of teaching physical education in 2017 year, in optimal temperature of the air. All students voluntarily participated in measurements. For obtaining the necessary responses to the set objective of the research was applied module T-test for small independent samples and were calculated basic central and dispersion parameters with the statistical package Statistica 6.0 the sporty performance and the realization of motor abilities.

Table 1: Values of the of BMI (WHO, 2000)

BMI	**Status**
<18,5	Malnutrition
18,6-24,9	Normal malnutrition
25-29,9	Excessive malnutrition
30-34,9	Obesity I degree
35-39,9	Obesity II degree
>40	Obesity III degree

3. Results and Discussion

The main objective of the research is to determine the differences in manifestations of motor skills in relation to the quantitative parameters of BMI at secondary school students. It is known that excessive nutrition in children is a complex disorder. Its incidence is increasing significantly in recent years and many believe that it is a major health problem in the developed world, as evidenced by the research of some authors (Al Nakeeb, et al., 2007). Increased obesity is a result of the insufficient physical activity of a human. Development today runs in direction of the advancement of technology, however, the performance and the inclusion of both children and adults in the activities of physical character is reduced to a minimum. The assumption is that decreased physical activity has a major negative impact on school population and its psychomotor effects. The problem of reduced activity and reduced involvement of students in extracurricular activities is becoming increasingly apparent in recent years, which has resulted in a number of negative health effects on the body of the individual (Pavlović, Tošić, Idrizović, Raković, & Mihajlović, 2014). Investigations have shown that the incidence of obesity is increasing in all age groups and in both sexes. The more the index is beyond the scope of normal value, the higher the risk of developing various heart diseases, diabetes, and high blood pressure. BMI should be understood as a

framework method, since the actual state of health of the person should be assessed in the broader medical context.

Table 2: Descriptive parameters of Body Mass Index of pupils

Status of BMI	Mean	Min.	Max.	Rang	SD	CV%
Normal malnutrition	20,78	18,8	24,0	5,2	1,79	8,61
Excessive malnutrition	26,56	25,9	28,7	2,8	,88	3,31

Table 3: Statistical parameters of motor variables pupils the normal and excessive malnutrition

Sample	Variables	Mean	Min.	Max.	Rang	SD	CV%
Pupils of normal BMI (kg/m²)	MFLA	11,21	4,9	18,8	13,9	3,85	34,34
	MDOH	27,41	21,0	34,0	13	4,05	14,77
	MSDM	162,20	130,0	221,0	91	25,48	15,70
	MPOLN	20,79	12,2	27,5	15,3	4,47	21,50
	M20	4,12	3,6	4,6	1,00	,28	6,79
Pupils of increased BMI (kg/m²)	MFLA	14,00	8,2	20,0	11,8	2,88	20,57
	MDOH	25,97	21,0	30,5	9,5	2,28	8,77
	MSDM	148,85	122,0	174,0	52	14,72	9,88
	MPOLN	23,56	18,3	30,6	12,3	3,54	15,02
	M20	4,48	4,0	4,9	0,9	,25	5,58

Table 4: Differences between normal and excessive BMI students (T-test; $p < 0.001$)

Variables	Values of BMI pupils	Mean ±SD	t-test	Sig. (2-tailed)	95% Confidence Interval of the Difference	
					Lower	Upper
MFLA	BMI normal	11,21±3,85	21,71	0,000	12,650	15,350
	BMI excessive	14,00±2,88				
MDOH	BMI normal	27,41±4,05	50,83	0,000	24,905	27,045
	BMI excessive	25,97±2,28				
MSDM	BMI normal	162,20±25,48	45,20	0,000	141,958	155,742
	BMI excessive	148,85±14,72				
MPOLN	BMI normal	20,79±4,47	29,75	0,000	21,909	25,224
	BMI excessive	23,56±3,54				
M20V	BMI normal	4,12±0,28	77,48	0,000	4,359	4,601
	BMI excessive	4,48±0,25				

Table 2 presents the numerical quantitative indicators of BMI value of analyzed sample of students which provide the necessary information about the morphological status. What is noticeable is the difference in middle BMI values. However, it is to be expected because it is targeted subsamples from the main sample. By analyzing the range between the minimum and maximum values of the BMI of students, it is evident that

the numerical range is greater for students with normal BMI (5,2) than values of the students with increased BMI (2,8). This is confirmed by the value of SD, which is negligible in students with increased BMI (SD =0.88). Such a distribution of quantitative parameters indicates the heterogeneity of the entire sample, which was expected, because it is a targeted sample i.e. students with normal and increased values of BMI. However, analysis of the subsamples has also shown the oscillations in the homogeneity confirmed by the value of CV%. Substantially higher heterogeneity is present in normal weight students (CV = 8.61) in contrast to the over-nourished students (CV = 3.31). It appears that the students with increased BMI values were more homogeneous than students of normal BMI. The implication is a clear question, why such homogeneity? The response may be defined in the selection of the students. It can be concluded that the subsample of normal weight students had several individuals with lower BMI values, close to lower limit values of BMI units (18.5) contributing to the overall redistribution of the result as evidenced by the range of 5.2 index units, i.e. there were fewer of them with higher values of BMI (upper limit value-Table 1).

In Table 3 are defined quantitative numerical indicators of motor space of the analyzed sample of normal and over-fed students represented through manifestation motor variables (tests). By analyzing the mean values (mean) of motor tests, it is evident that the pupils of the normal BMI were more successful in the four tests (for the evaluation of flexibility, the explosive power, coordination, and speed). The balancing test (MFLA) was in favor of students with increased BMI, those students had better balance. This can be justified by fact that the body weight does not affect the balance, that is, does not affect those capabilities that are influenced by the central nervous system (the mechanism for the synergistic control and regulation of tonus) as opposed to the capabilities that are dominated by energy regulation (intensity mechanism and duration of excitation). It is a more physiological problem in which body weight has no significant influence. Also, measuring range in SD in motor space shows greater homogeneity of students with increased BMI values than at students with normal values. This is confirmed by the values of CV%. Here is the same case as with the morphological status, normal weight students have less homogeneity of the results of motor skills than over-nourished students. The trend of this phenomenon is present in all the motor variables of analyzed area. What could be the possible explanation? The answer which could clarify this situation and state lies in the nature of selected motor tests for assessment of motor abilities. In fact, it is a known fact that body weight has a negative impact on all manifestations of motor tests in the area of energy regulation of movement and that the impact of the tests under the domination of central regulation is negligible, practically does not exist. The amount of subcutaneous fat is the real

indicator of (de) balance between energy intake and consumption of energy materials and its increase is the direct consequence of the life of the hypokinesian regime.

In order to reflect differences in events of motor abilities depending on the quantitative parameters of BMI of students, the analysis was performed using T-test, double test, at the level of significance of $p < 0.001^{**}$ (Table 4). Application of T-test showed the statistically significant differences in all five analyzed manifestation motor variables which define the motor abilities of balance, flexibility, explosive strength, coordination, and speed (Table 4). It can be concluded that between the two sub-samples of students with different BMI values were achieved statistically significant differences at the high level ($p < 0.001$). The differences in favor of students with a normal range of BMI are evident in the variables that are dominated by the mechanisms of regulation of energy (intensity and duration), while the students with a higher BMI values were much better in the realization of the test flamingo (the area of central regulation). It is important to note that this can and may not be the exception, but the fact to be aware of, and that is that increased weight is not a disturbing factor in maintaining balance. Also, flexibility is partly independent of BMI, it is more conditioned by the flexibility of muscles, ligaments, and joints.

The obtained results confirmed the differences between the students with normal and increased quantitative values of BMI. It is evident that students with smaller BMI were more successful in tests that require demonstration of muscle with CNS coordination. It is an indisputable fact. However, the thing we need to be aware of is the fact that although they are of the same sex and age group there are great differences in nutritional status that have a negative impact on the normal motor functioning of individual students. In this case, the trend of increased obesity is expressed at a relatively young age, only 16 years old and has a presumption of its growth over the years, moving to so-called red line. These results are consistent with the previous studies (Cairney, Hay, Faught, & Hawes, 2005; Cawley, & Spiess, 2008), which confirmed the fact that children with obesity have limited motor skills when compared to children with normal weight, particularly in the four critical areas (verbal skills, activities of daily living, motor skills, and social skills). Results of Ekblom, Ekblom, & Ekblom (2009) based on the six-year follow-up of 296 patients (aged 10 to 16 years in 2001 and 2007) have shown that a high BMI at age 10 years predicts obesity at the age of 16 years, which is also accompanied by reduced aerobic capacity. Many factors, endogenous and exogenous play a role in the development of obesity. Physical activity is an important part of human life. According to the data (WHO, 2015), the lack of physical activity is at the 5th position of causes of the total mortality in the world and there is scientifically proven and grounded connection between sedentary lifestyle and

the degree of overweight and obesity. The best way to prevent and stop the rapid rise in obesity is a combination of regular physical exercise and a balanced diet (Al Nakeeb, et al., 2007). Although genetic background can significantly influence the onset of obesity, environmental conditions are the main factors leading to it. In the past, obese children were considered healthy children. It is now known that obesity is a multisystem disorder, the cause of many diseases (Ebbeling, Pawlak, & Ludwig, 2002).

At the younger school age, the incidence of obesity is growing and is directly related to the level of physical activity or inactivity. The fact is that people have never spent less time in some physical activity, regardless of whether it is a programmed physical activity directed towards a specific target or activities intended solely for fun. According to data (Majurec, & Brlas, 2001), only 15% of high school students is engaged in sports in their leisure time. The alarming research results were given by Pavlović, Tošić, Idrizović, et al. 2014 who, in a sample of 209 students of both sexes, aged 15-18 years old, through a questionnaire, examined the involvement of students in extracurricular activities. The survey confirmed that only about 35% of students are physically active students and that there is an evident trend of physical activity declining. It is evident that children who lead a sedentary lifestyle and have unlimited access to the diet tend to have a much higher caloric intake than consumption, and therefore are at a greater risk of developing obesity (Ebbeling, & Ludwig, 2008). Continuous childhood obesity easily increases and causes many diseases in adulthood (Pišot, Završnik, & Kropej, 2005). The research (Trost, Kerr, Ward, & Pate, 2001) which have studied the causes of physical activity of obese and normal weight children, have shown that obese children are significantly less involved in the physical activity, or that certain body tasks are performed with a lower intensity. Some studies suggest that training can improve motor skills of children who are overweight (Matvienko, & Aharah-Fard, 2010; Cliff, Okely, Morgan, et al., 2011; Logan, Robinson, Wilson, & Lucas, 2012).

An interesting study on physical abilities among 11,631 adolescents of secondary schools in the United States was implemented (Heath, Pate, & Pratt, 1993; Heath, Pratt, Warren, & Kann (1994) and it was concluded that in the specific motor skills the adolescents stagnate, while these skills in the younger population is increasing, especially if they are involved in some form of physical activity. From the total number, only 37% reported doing 20 minutes of physical activities three or more times a week, more male population. More than 70% of the pupils reported at least 1 hour of watching television every day after school, and more than 35% reported watching television three hours or more each day after school. Helping children and adolescents to adopt a physically active lifestyle is an integral part of health education and health promotion

whose services are provided by school nurses, family, and community. Some authors (Pender, 1998; Fox & Riddoch, 2000) propose the introduction of motivational models and variables that can be identified, and which are required for further testing in order to determine their significance in the promotion of physical activity during childhood and adolescence. Also, Merrick, & Kandel (2003) in their study in the USA and Israel came to the conclusion that young people and adolescents must have the necessary physical activity and healthy lifestyle habits even in adulthood.

According to Am. J. Pub. Health, the largest increase in the risk of premature death is with people who are obese in middle age. The study was conducted based on data collected since 1988, and it has been proven that obesity is associated with at least 20% greater risk of death from all ages. Recently published Danish study suggests that men who are obese in their early twenties have two times greater risk than their peers of average weight to die before the age of 55. Otherwise, the American Medical Association in June 2013 officially included obesity among the diseases (Press RS, 2014). From the available evidence (Al-Hazzaa, 2002), it seems that the majority of Saudi children and adolescents do not meet the minimum requirements of weekly physical activities necessary for the effective functioning of the cardiorespiratory system. Based on the available evidence, it is necessary to promote physical activity among Saudi children and adolescents and promote the national policy to encourage active living. Also, the research conducted by Milanović, 2012 on a sample of 375 obese children and adolescents aged 12-18 years, showed that 47.9% of men and 52.1% of women live sedentary lives

Results of this study represent a small contribution that is consistent with the results and conclusions of previous studies (Cairney, Hay, Faught, & Hawes, 2005; Cawley, & Spiess, 2008), which confirm that the increased value of body weight is very adversely influenced in the realization of motoric abilities and the overall health of the individual and also the cause of many diseases (Ebbeling, Pawlak & Ludwig, 2002). In any case, doing sports, especially doing the sport that is our personal choice, adapted to our shape, should be an integral part of our daily lives, and an important factor in maintaining health, work capacity and balance in today's modern society, which the high school students, unfortunately, increasingly avoid. The popularization of physical activity of society and the environment, as well as state policy, must be at a higher level and it is the main weapon in the fight against sedentary lifestyles, preserving a healthy nation and state.

4. Conclusion

The results of conducted research on the target sample of 40 persons with different BMI confirmed the differences between normal and over-nourished students in the realization of basic motor abilities. As the main factor that contributed to these differences is the increased value of BMI, or over-nutrition, which is the result of today's „modern"' way of lives of children and youth. The consequences are huge and already assume epidemic proportions worldwide. The research has shown that overweight students have certain limitations when performing the motor test, such as tests which are more influenced by the energy mechanisms. The development today runs in direction of the advancement of technology, however, the working performance and the inclusion of both children and adults in the activities of physical character is reduced to a minimum. A lot of researches are needed to understand the negative impact of obesity and to express the physical activity as a "cure" that builds a healthy environment and a population which is a necessary element for the future. This study is only a small contribution to the clarification of the problem of obesity. It would be good to implement another battery of tests and compare these results with the research. To prevent the potential negative consequences of reduced physical activity, it is necessary to have considerably greater involvement of students in sports activities, general physical activity, greater animation of students and knowing the negative consequences of the hypokinesian lifestyle

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