International Journal of Science and Healthcare Research
Vol. 9; Issue: 4; October-December 2024
Website: ijshr.com
Original Research Article *ISSN: 2455-7587*

An Observational Study for Correlation of Trunk Extensor Muscle Endurance in Different Body Mass Index Among School Going Children of Surat City

Mehta Aishwariya Kintukumar[1], Joshi Jinal Hiteshkumar[2], Makwana Mirali A.[3]

[1,2,3]Vibrant Physiotherapy College, Veer Narmad South Gujarat University, Surat, India.

Corresponding Author: Mehta Aishwariya Kintukumar

DOI: https://doi.org/10.52403/ijshr.20240436

ABSTRACT

Background: Childhood obesity has important consequences for health and wellbeing both during and childhood and also in later adult life. The rising prevalence of childhood obesity poses a major public health challenge in both developed and developing countries by increasing the burden of chronic noncommunicable diseases. Muscular endurance improves performance of physical activities, improves muscle and bone health with aging, improves body composition, prevents musculoskeletal injuries, and also enhances self-esteem and quality of life. Back muscles are the main structural support for your trunk and strong back muscles provide essential support to the spine, reducing the likelihood of strains, sprains and other injuries that occur during lifting, bending, or twisting movements.

Objective: The objective of the study is to find out the correlation of trunk muscular endurance in different body mass index among school going children between 11 and 14 years of age by Biering- Sorenson test of back muscular endurance.

Methodology:100 school children between 11 and 14 years from the schools of Surat city were included in the study using purposeful convenient sampling method. Body mass index has been calculated for all the students. Biering Sorenson test of back muscular endurance was conducted on students to measure the trunk muscular endurance.

Result: The result was analyzed using SPSS 23 for windows. The statistical tool used was Pearson correlation. The Pearson correlation for BMI and endurance was-0.549, P value which shows that there is a significant correlation at 0.01 levels between BMI and endurance. Also the value shows that the correlation is negative.

Conclusion: This study concluded that there is a negative correlation between Body mass index and trunk extensor muscular endurance i.e. as the body mass index increases the trunk extensor muscular endurance decreases in children aged between 11 and 14 years old.

Keywords: Obesity, Muscular endurance, BMI, Childhood obesity, Biering- Sorenson test of back muscular endurance.

INTRODUCTION

- Obesity is defined as a condition of excess body fat that creates increased risk for morbidity and/or premature mortality, and the adult BMI thresholds of 25 and 30 kg/m2 for overweight and obesity, respectively, are based on prospective associations between BMI in middle- to late-aged adults and their subsequent mortality. In contrast, there is little consensus as to the best way to

operationalize this definition in children. [1]

- Physical fitness is generally considered to be "the ability to perform daily tasks without fatigue." Physical fitness includes several components: cardiorespiratory fitness, muscular endurance, muscular strength, flexibility, coordination, and speed. Most studies that have investigated differences in physical fitness according to body fatness have focused on only one aspect of fitness, namely cardiorespiratory fitness. Other components of physical fitness have not been thoroughly investigated in obese children and adolescents.[2]
- Body Mass Index (BMI) was calculated as weight (in kilograms) divided by height (in meter squared). High levels of Body mass index (BMI) among children are associated with adverse levels of various risk factors, and longitudinal studies indicate that high childhood. BMI is related to atherosclerosis, adult obesity and total mortality.[3]
- In1993, the WHO assembled an Expert Consultation Group with a charge of developing uniform categories of the BMI. Four categories were established: underweight, normal, overweight, and obese. An individual would be considered to be underweight if his/her BMI was in the range of 15 to 19.9, normal weight if the BMI was 20 to 24.9, overweight if the BMI was 25 to29.9, and obese if it was 30 to 35 or greater.[4]

Table 1: Classification of BMI

Underweight	15–19.9
Normal weight	20–24.9
Overweight	25–29.9
Preobesity	
Class I obesity	30–34.9
Class II obesity	35–39.9
Class III obesity	≥40

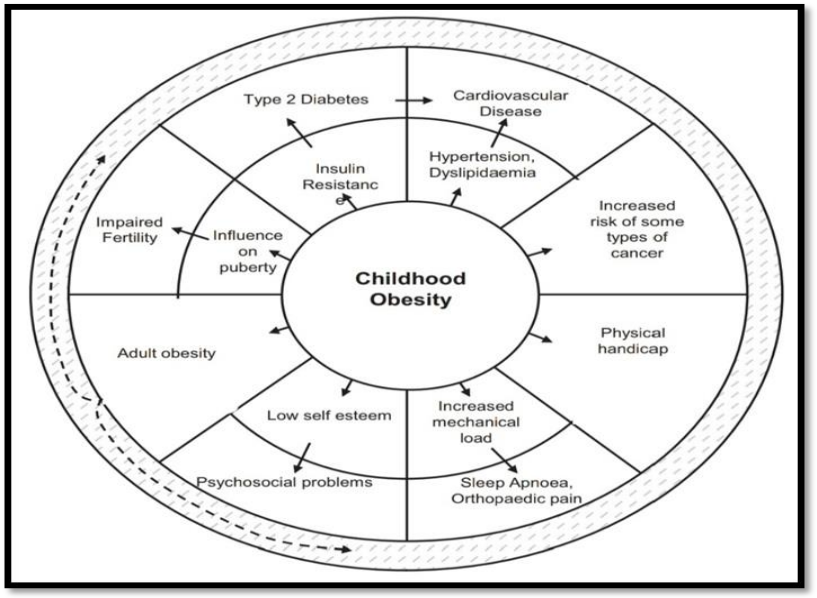
- According to Centers for Disease Control and Prevention (CDC) growth charts, children with BMI-for-age levels at or above the 95th percentile of the 1963-1994 reference population were originally considered overweight, and those between the 85th and 94th percentiles were considered at risk of overweight. Although the BMI-for-age cutoffs (85th and 95th percentiles of the CDC reference population) have not changed, the terms *overweight* (85th-94th percentile) and *obese* (_95th percentile) have recently been suggested to describe in these groups.[3]

Table 2: Child BMI percentiles range & categories

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy Weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obesity	Equal to or greater than the 95th percentile

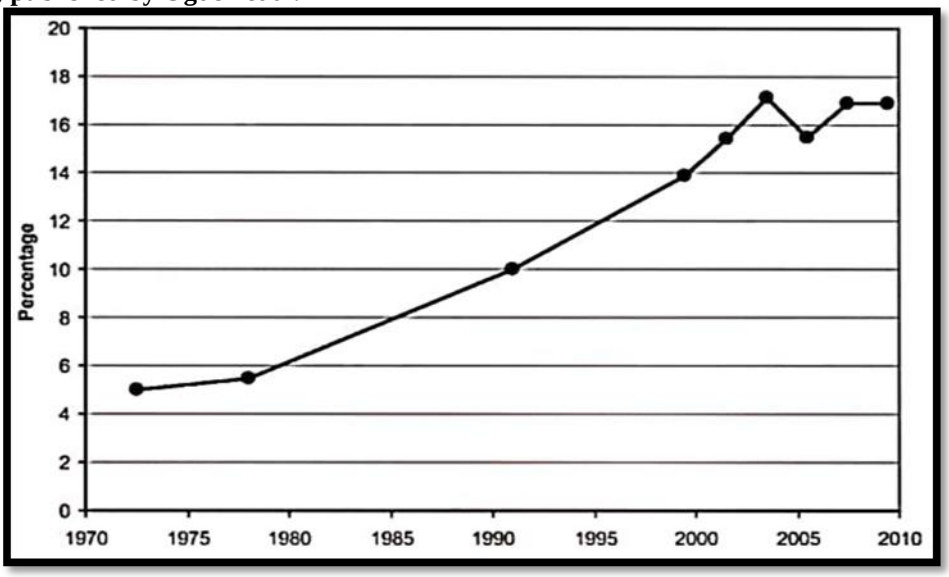
- **Childhood obesity** has come to epidemic extents and its prevalence is expanding over the world particularly in the Middle East and Eastern Europe. Body mass index (BMI)) is considered a reasonable measure that aids in the evaluation process of fatness in children and adolescents. Additionally it is a standard used to identify overweight and obesity. Moreover, BMI is related to the body size however it cannot differentiate between fat and muscle tissue. Factors like age and sex greatly affect levels of BMI among children and teens where they differ due to pattern of growth and presence of sex hormones. So it is essential to express the BMI of children relative to other children of the same sex and age. [5]
- **Childhood Comorbidities:** The need to tackle childhood obesity lies not only in the avoidance of poor adult health. Childhood obesity leads to many acute health problems and much suffering during childhood.[1]

Figure 1: shows Schematic summary of the complications of childhood obesity. Comorbidities of childhood obesity are depicted in the outer ring with their intermediate processes in the inner ring. Childhood obesity also increases the risk of adult obesity, which in turn increases the likelihood of those comorbidities.



- It has been estimated that worldwide over 22 million children under the age of 5 are obese, and one in 10 children is overweight. The proportion of school-going children affected has almost doubled by 2010 compared with the most recently available surveys from the late 1990s up to 2003.[6]
- Limited evidences are available regarding burden of overweight and obesity among children in Indian scenario. A study conducted among 24,842 school children in south India showed that the proportion of overweight children increased from 4.94% of the total students in 2003 to 6.57% in 2005 demonstrating the time trend of this rapidly growing epidemic. Socio-economic trends in childhood obesity in India are also emerging. A study from northern India reported a childhood obesity prevalence of 5.59% in the higher socio-economic strata when compared to 0.42% in the lower socio-economic strata. Another school based study in 2011 reported the prevalence of overweight and obesity in 8- and 18-year-old children, respectively, was 14.4% and 2.8% by International Obesity Task Force (IOTF) cutoffs, 14.5% and 4.8% by Center for Disease Control (CDC) cutoffs, and 18.5% and 5.3% by World Health Organization (WHO) cutoffs. [6].

Graph 1: shows Prevalence of obesity (body mass index _95th percentile) among children and adolescents 2 to 19 years of age in the United States between 1971 to 1974 and 2009 to 2010 shows a recent plateau from 2003 to 2004. Based on data from the National Health and Nutrition Examination Survey (NHANES) published by Ogden et al.



- Endurance (a measure of fitness) is the ability to work for prolonged periods of time and ability to resist fatigue. It includes muscular endurance and cardio vascular endurance.[7]
- Muscular endurance is defined as the ability to perform repeated contractions over a period of time for an isolated group of muscle, whereas cardiovascular endurance is defined as the ability to perform dynamic exercises for larger muscle groups, such as walking, swimming, or biking for long periods of time. Low back pain occurs as a result of trunk muscle with the poor endurance in the lumbar spine which induce strain on the passive structures.[7]
- Endurance factors must be considered in light of other related variables, such as 1) cardiovascular fitness, 2) muscle

force capability, 3) motivation, 4) self-image, and 5) perceptual acuity. Endurance testing of trunk muscles examines the localized capability of the flexor and extensor muscles of the trunk to sustain activity.[8]

- The trunk muscles are physiologically suited to provide low levels of activity for long periods of time. These muscles are physiologically postural muscles, being rich in type I fibers, which, uncharacteristically, have larger diameters than the type II fibers. Although trunk flexor and extensor muscles are physiologically postural muscles, they are active throughout most activities, including quiet standing.[8]
- A number of isometric tests of trunk muscle endurance have been described for the trunk extensors, flexors and lateral musculature of the trunk. Typically these tests require minimal, inexpensive equipment, and are safe and simple to employ in clinical environments where performance is evaluated by recording the maximum time a person can maintain the test position. It is important that tests chosen to evaluate isometric trunk muscle endurance have good reliability to allow their use in studies comparing training protocols, predicting injury, or for calculation of the training change necessary to infer improvement. Except for the Biering–Sorensen test of trunk extensor endurance, reliability of other common isometric trunk muscle tests is not well established, with conflicting findings reported, as well as difficulties in implementing test protocols.[9]
- The Biering-Sorenson test of BME (back muscular endurance) has demonstrated moderate to high reliability correlation coefficients (0.66, 0.98) in both patients with LBP and the general population. The test appears to offer moderate construct validity, with fatigue the most common reason reported for test termination (62.5%).30 Despite potential confounding factors to test performance, electromyography and near infrared spectroscopy have confirmed fatigue at the muscular level of the erector spinae during the test, and, therefore, the Biering-Sorenson test remains the most widely used and accepted clinical BME assessment tool.[10]
- Of the isometric trunk endurance tests described in the literature, the Biering–Sorensen test of trunk extensor endurance has received the most attention.[9]
- Muscle is a potential source of low back pain. They argue that failure of muscles to protect passive structures from excessive loading may result in damage to these pain-sensitive structures and produce pain.4 Enhancing muscle endurance, therefore, may help to reduce low back pain. Poor endurance of the trunk muscles may induce strain on the passive structures of the lumbar spine, leading eventually to low back pain. Evidence suggests that muscle endurance is lower for people with low back pain than for individuals without low back pain.[11]
- The endurance of the trunk muscles may be related to low back pain. Fatigue can affect the ability of people with low back pain to respond to the demands of an unexpected load. Fatigue after repetitive loading also leads to a loss of control and precision, which may predispose an individual to developing low back pain. Therefore, trunk muscle endurance training has been recommended to elevate fatigue threshold and improve performance, thus reducing disability.[11] The muscles of the trunk are active whether one is sitting, standing, lifting, or rolling over in bed. Adequate endurance of trunk muscles is necessary to good health.[8]
- LBP has been shown to commence during childhood or early adolescence and some evidence suggests

that back pain in youth has a high predictive value for back pain in adulthood. [12] There was a direct correlation found between the presence of LBP and back extensor weakness in the sample of school-aged children. A subsequent study found that individuals who had poor performance on the Biering-Sorenson muscular endurance test were three times more likely to have LBP than those who demonstrated greater performance.[12]

MATERIALS & METHODS

Source of data:

100 participants were selected from school of Surat city.

Shree Swaminarayan H.V. Vidhyalay, adajan, Surat.

Methods of collection of data:

Research design – Observational study.

Sampling design – Convenient sampling.

Sampling technique:

With purposeful convenient sampling technique, 100 participants from Shree Swaminarayan H.V. Vidhyalay were recruited.

Sample size:

Total sample – 100

(Participants including underweight, healthy weight, overweight, and obese.)

Inclusion criteria:

- Those whose Age is between 11 - 14 years
- Both girl and boy are included
- Willing to participate in the study.

Exclusion criteria:

- Those who have undergone any surgical operation.
- Those who have undergone any physiotherapy or rehabilitation treatment since last 3 months.
- Those who have having structural scoliosis, neurological (depression, anxiety, etc.) or systemic disease.
- Those who have having any musculoskeletal conditions, cardio vascular disease or any congenital disorder.

Materials needed for the study:

- Examination Table
- 2 - 3 Straps
- Stopwatch
- Chair
- Pencil and paper-sheet
- Weighing machine
- Stadiometer

PROCEDURE

- A purposive sample of 100 participants was taken from the school in Surat city. Participants who fulfill the inclusion and exclusion criteria were selected for the study. Guardian of all participants was asked to sign a Consent form prior to participation in this study. Base line assessments were taken of all participants. Measures of height and body mass were used to calculate each participant's BMI (weight/square of height).[10]
- BME was measured with a modification of the Biering-Sorenson method, which was found to be a good assessment tool for examination of the isometric endurance of the trunk extensor muscle.[10]
- For testing trunk extension endurance the subjects were made to lie in a prone position. The Participant's lower body was fixed to the table by applying a strap across the knee and stabilization was made by placing one hand on the Participant's lower back and one hand on the lower leg. The Participants upper body was off from the surface plinth, (from just above the level of anterior superior iliac crest). Initially, the

Participant's upper limbs were lifted off from the table and instructed to cross both their arms across the chest, placing their hands on their shoulders and instructed to maintain in a horizontal position as long as possible. The Participants maintained their position until they could able to hold and the time was measured using the stopwatch. The time being measured when the Participants made to lie in a above comfortable position until the subject visually deviated from the position.[7]

- Those who experience no difficulty in holding the position, the test is stopped after 240sec. (Maximum holding time)
- This test shows the reliable measure of trunk extensor muscle endurance.

Figure 2: Shows Biering-Sorenson test on Obese child.

Figure 3: Shows Biering-Sorenson test on Under Weight child.

Figure 4: Shows Biering- Sorenson test on Healthy Weight child.

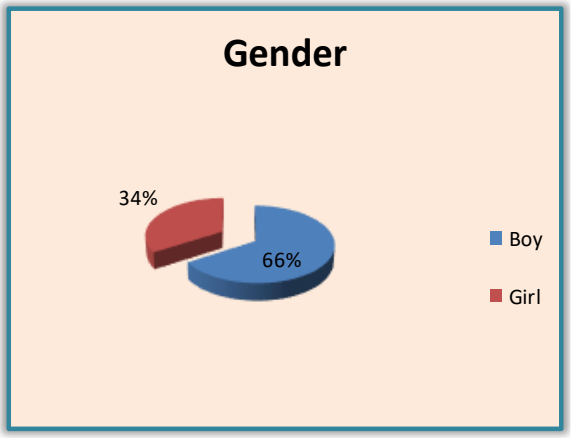
STATISTICAL ANALYSIS

All the statistical analysis was done using SPSS 21 for windows software. Data analysis was conducted to find out the correlation of trunk extensor muscle endurance in different body mass index.

Table 3: Gender distribution of participants

GENDER	PARTICIPANTS
Boys	66
Girls	34
Total	100

Graph 2: Gender distribution of Participants



About one-third of the sample has a value of 1, and the rest have a value of 0. Value 0 = boys and 1= girls.

Graph 3: Mean and median of age for participants

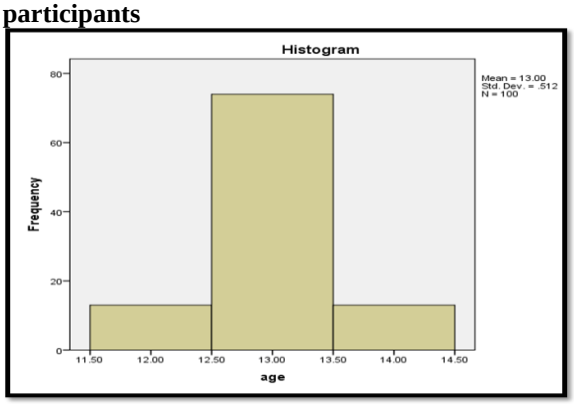


Table 4: Mean and median of age for participants

	Age(years)
Mean	13
Median	13
Minimum	12
Maximum	14

There are 100 valid cases in the sample. The mean age in the sample is 13years.
The median age is also 13 years.
The youngest participant in the sample is 12 years old (Minimum). The oldest participant in the sample is 14 years old (Maximum).

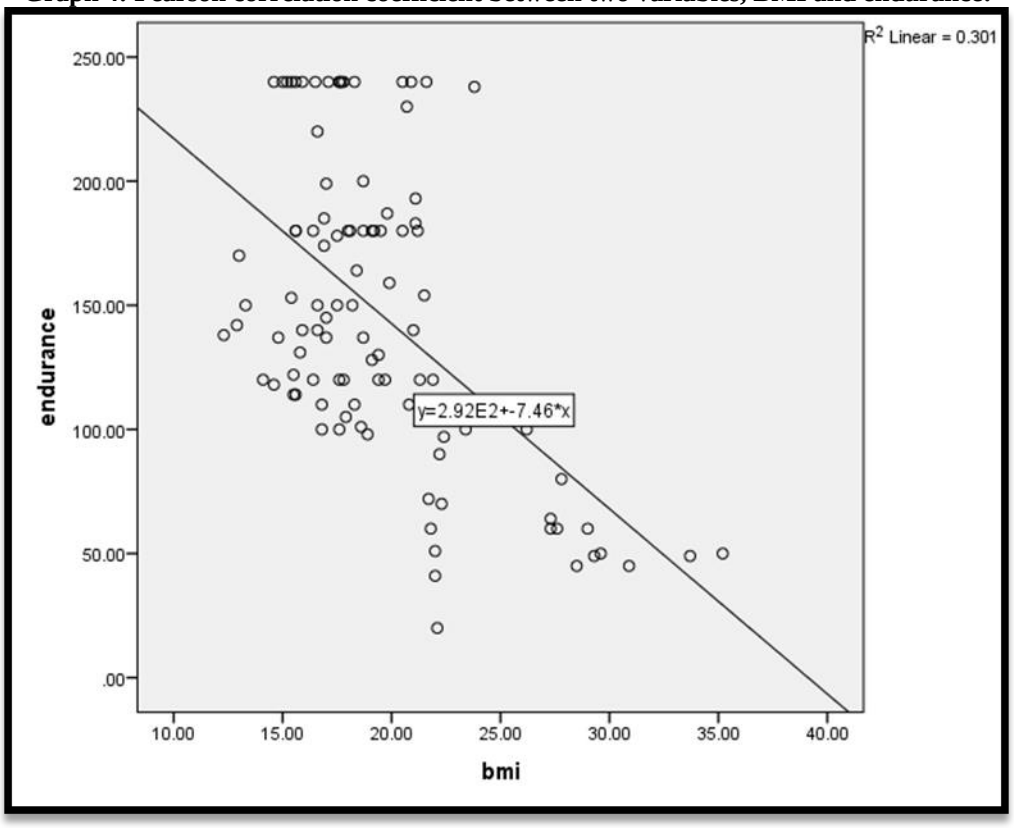
Table 5: Pearson correlation coefficient between two variables, BMI and endurance.

		BMI	Endurance
BMI	Pearson correlation	1	-5.49
	Sig. (2-tailed)		.000
	N	100	100
Endurance	Pearson correlation	-5.49	1
	Sig.(2-tailed)	.000	
	N	100	100
Correlation is significant at the 0.01 level (2 tailed).			

The correlation coefficient between BMI and endurance is -0.549.
This indicates a moderate negative correlation between these two variables. The significance level (Sig.) is 0.000 for both correlations, which means the correlation coefficients are significant.

A negative correlation coefficient means that as one variable (BMI) increases, the other variable (endurance) tends to decrease. In this case, it suggests that higher BMI is associated with lower endurance levels.

Graph 4: Pearson correlation coefficient between two variables, BMI and endurance.



In summary, the provided data suggests a significant moderate negative correlation between BMI and endurance in the sample population.

DISCUSSION

The study aimed to find out the correlation of trunk muscle endurance in different body mass index among school going children. The findings of this study indicate that obesity has a significant negative impact on trunk extensor muscular endurance in school going children regardless of which measure of obesity is assessed.

Noha Abdel Kader Hasan has concluded that according to the body mass index, muscle strength of the quadriceps, triceps, and abdominal muscles are more in obese children when compare to the underweight and the normal weight individuals. But in case of the muscle endurance was relatively very low in the obese children when compare to the other weight group children. Similarly in this study, trunk extensor muscle endurance for obese is less than normal, when compared with their body mass index. Hence, the study is negative.

K. Bharathi, S. Sathyapriya conducted a study on Correlation of Trunk muscle endurance in different body mass index among college student. He concluded that there is no significance of spinal flexor and spinal extensor endurance among college students in different body weight. But in our study, there is significant negative correlation which means as the body mass index increases the trunk extensor muscular endurance decreases and vice versa in children aged between 11 and 14 years old.

Anne F. Mannion conducted a study on the Relationship Between Psychological factors and Performance on the Biering back muscle endurance test. The study concluded that it is important that the underlying nature (psychological or physiological) of performance deficits be identified during such tests because this may influence the interpretation of prospective studies reporting risk factors for LBP and dictate the particular treatment or interventional approach required to remedy the situation in

individuals with LBP. Similarly in this study, other factors may be the reason for less holding time in some participants.

Limitations of this study:
Due to less time duration, correlation was not able to conduct on individual gender.

Suggestions for further study:
Further studies are recommended to do the endurance test for other group of muscles, upper and lower limbs.

CONCLUSION

This study concluded that there is a negative correlation between Body mass index and trunk extensor muscular endurance i.e. as the body mass index increases the trunk extensor muscular endurance decreases and vice versa in children aged between 11 and 14 years old.

Declaration by Authors

Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Mehta Aishwariya Kintukumar, Joshi Jinal Hiteshkumar, Makwana Mirali A. an observational study for correlation of trunk extensor muscle endurance in different body mass index among school going children of Surat City. *International Journal of Science & Healthcare Research.* 2024; 9(4): 295-305. DOI: *https://doi.org/10.52403/ijshr.20240436*

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