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Hamstring flexibility and its correlation with body composition in children who were active indoor during pandemic: A pilot study

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Abstract
The present study's objective was to determine the relation between hamstring flexibility and body composition in children who were active indoors during the pandemic. The study included 25 children, ages 8 to 14, who were physically active indoors over the previous month but did not participate in outdoor activities. The body composition of the participants was evaluated using the BMI and body fat percentage, and the sit-and-reach test was used to assess hamstring flexibility. Karl Pearson's Correlation Coefficient was used to find a relationship between hamstring flexibility and body composition. According to the results, BMI and hamstring flexibility has a statistically significant weak negative correlation (r=-0.44, p=0.02), although body fat% and hamstring flexibility has a non-statistically significant weak negative correlation (r=-0.35, p=0.08). Thus, it can be concluded that BMI is negatively correlated with hamstring flexibility in children who were active indoors during the pandemic. However, a study correlating body fat percentage with hamstring flexibility in a larger population is required for further clarification.

Keywords: Body mass index (BMI), body fat percentage, hamstring flexibility, sit and reach test

1. Introduction
Flexibility refers to a joint's physiological range of motion, which is crucial for completing movements in daily activities. Flexibility is joint-specific and changes depending on the muscle engaged, hence total body flexibility cannot be determined by a single test [1]. In both children and adults, poor hamstring flexibility is linked to difficulties performing and maintaining daily motor activities, as well as chronic musculoskeletal injuries, postural deviations, and gait impairments [2]. Childhood and adolescence are indeed a critical period of life because dramatic physiological changes occur during this period [3].

Attempts to contain the spread of the COVID-19 pandemic changed activity habits and, as a consequence, weight status among people of all ages also got changed. As of March 26, 2020, >150 million children and adolescents in 165 countries were impacted by pandemic closures [4, 5]. According to a study by Shujuan Yang *et al*., the mean body mass index of all youths has increased significantly during the COVID-19 pandemic [5]. Following the lockdown, the total mean weight percentile was much greater (males > females) [6].

According to published data on overweight, obesity, and physical activity, 85 percent of girls and 78 percent of boys in school do not get the recommended levels of physical activity for their age group. The closure of organized sports and public sports facilities led in a complete shutdown of organized physical activity in the context of sports (outdoor), causing even more significant changes in young people's daily routines and opportunities to be active outside. During the pandemic, a study conducted by Stefen C. E *et al*. on boys and girls aged 4 to 17 found a decrease in sports activity and an increase in habitual activity (indoor activity) among boys and girls of all age groups [7].

Poor flexibility is a predictor of poor physical performance, which can be even more detrimental with decreased physical activity and a sedentary lifestyle, both of which are prevalent in children worldwide and has intensified during pandemics. Finding the relationship between flexibility and body composition during a period when the type of activity children participated in altered will allow us to understand how the restriction on outdoor activity will

modify that relationship. Thus goal of this study is to find an association between body composition and hamstring flexibility in children who were active indoors during the pandemic, with the hypothesis that there is a relationship between body composition and hamstring flexibility in children who were active indoors during the pandemic.

2. Materials and Methods

2.1 Research design and sample

Body composition and hamstring flexibility were correlated in children and adolescents from Mangalore and the surrounding areas using a cross-sectional research methodology. From September 2021 until December 2021, data was gathered. The study included children and adolescents aged 8 to 12 years who did not engage in outdoor activity and were physically active indoors last 1 month, willing to participate, able to understand and follow orders, and whose guardians were willing to participate. Orthopedic disorders, genu varus/valgus or spinal deformity, fractures or malunion, surgery of the lower limbs or spine, and a leg-length disparity of more than 2 cm were all excluded from the study.

2.2 Procedure

The Institutional Ethics Committee granted ethical approval. The participants and their guardians were given thorough information about the study, after which the participant's guardians signed an informed consent form and the child signed an accent form. Participants were recruited on the basis of the inclusion and exclusion criteria. The sit and reach test was used to assess hamstring flexibility, while the BMI and body fat percentage were used to assess body composition.

2.3 Measurement

Body composition was assessed with body mass index and body fat percentage and hamstring flexibility was measured with sit and reach test. A correlation between hamstring flexibility and body composition was found.

2.3.1 Body mass index (BMI)

A measuring tape was used to measure height barefoot to the closest centimeter. Standard portable weighing equipment was used to measure weight barefoot and in light clothing to the nearest kilogram. The BMI of each participant will be computed using Quetelet's index (body weight divided by the square of body height, expressed in kg per m^2). [3, 8, 9]

2.3.2 Body fat percentage (BF %)

Slaughter's reliable equation was used to estimate body fat% from the skinfold. In many Indian studies, the slaughter equation has been used for children and adolescents. [10, 11, 12, 13, 14]

BF% for children with triceps and subscapular skinfolds <35 mm:

Boys = 1.21 (TSF +SSF) − 0.008 (TSF + SSF) 2− 1.7

Girls =1.33 (TSF + SSF) − 0.013 (TSF + SSF) 2 − 2.5

BF% for children with triceps and subscapular skinfolds >35 mm:

Boys=0.783 (TSF + SSF) – 1.7

Girls=0.546 (TSF + SSF) + 9.7

TSF= Triceps skinfold thickness; SSF= subscapular skinfold thickness

2.4 Skinfold thickness measurement

A skin caliper was used to measure triceps and subscapular skinfolds to the nearest 0.2 mm. With the dial-up and the instrument perpendicular to the skin surface, the skinfold was held between the index finger and thumb pads, and the caliper was used to hold the skinfold 1 cm below. At each location, two such readings were taken, and the average was used. The thickness of the triceps skinfold was measured at the posterior midline of the upper arm, midway between the tip of the shoulder and the tip of the elbow, with the elbow extended and relaxed. The Oblique fold was measured right below the inferior angle (or triangular part) of the left scapula for subscapular skinfold thickness. [13, 14]

2.5 Sit and reach test

The hamstring flexibility was assessed using a sit-and-reach test on a 33-centimeter-high box with a measuring scale on top. The participant was instructed to sit on the floor without shoes, with knees straight and feet flat against the front-end panel of a constructed box, and reach forward as far as possible while placing palms down along the measuring scale, keeping the position for approximately 2 seconds. The farthest point reached with the fingertips will be recorded (to the nearest centimeter). [15, 16]

2.6 Statistical Analysis

The demographic characteristics of the participants were tabulated using descriptive statistics. Karl Pearson's correlation coefficient was used to determine the correlation between body composition (BMI, Body fat percentage) and hamstring flexibility in children and adolescents. The statistical package SPSS ver.21.0 was used for analysis. All probability (p) values less than 0.05 was considered statistically significant.

3. Result

The study comprised a total of 25 children, with an average age of 10.40±1.09, including 14 boys (age: 10.64±1.01) and 11 girls (age: 10.09±1.38). Table 1 showing descriptive data indicates that boys were 140.36±10.47 cm tall and weighed 37.29±8.52 kg, while girls were 139.93 cm tall and weighed 37.29±8.52 kgs. Table 1 also shows differences in body composition and flexibility between genders, with boys having a non-statistically higher BMI (18.71±2.51 kg/m2, p=0.57), body fat percentage (28.49±8.52%, p=0.78), and less flexibility (0.28±4.05 cm, p=0.77) than girls, who had a BMI (18.04±3.41 kg/m2, p=0.77), body fat percentage (28.49±8.52%), and flexibility (0.73 ±3.65cm).

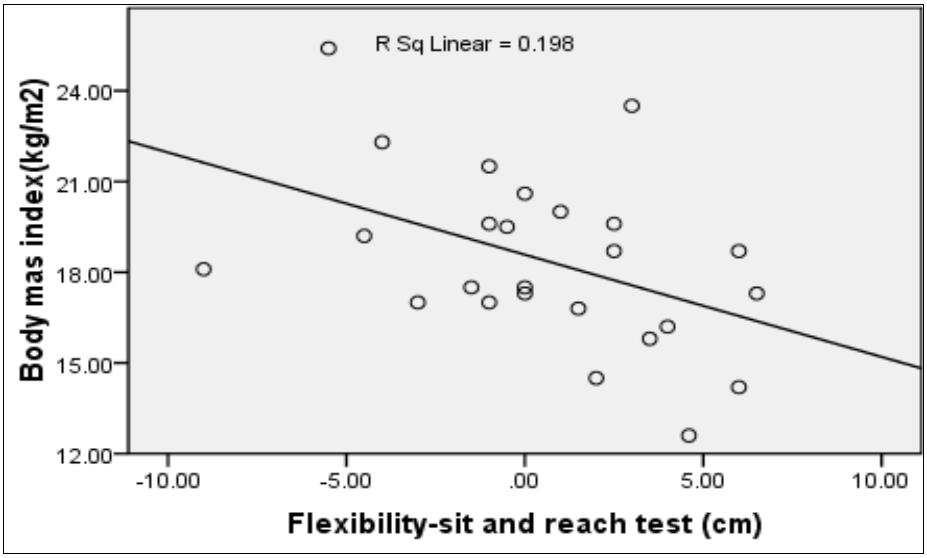
Table 1: Descriptive characteristic of body composition and flexibility of 25 children. Correlation is significant at the 0.05 level (2-tailed).

	Total (Mean+SD)	Girls (Mean+SD)	Boys (Mean+SD)	P value
Age	10.40±1.19	10.09±1.38	10.64±1.01	0.25
Height	139.76± 11.88	139±9.93	140.36±10.47	0.78
Weight	36.40±9.02	35.29±9.94	37.29±8.52	0.59
BMI	18.41± 2.89	18.04±3.41	18.71±2.51	0.57
Body fat%	28.81±6.57	29.22±2.99	28.49±8.52	0.78
Flexibility	0.48±3.81	0.73±3.65	0.28±4.05	0.77

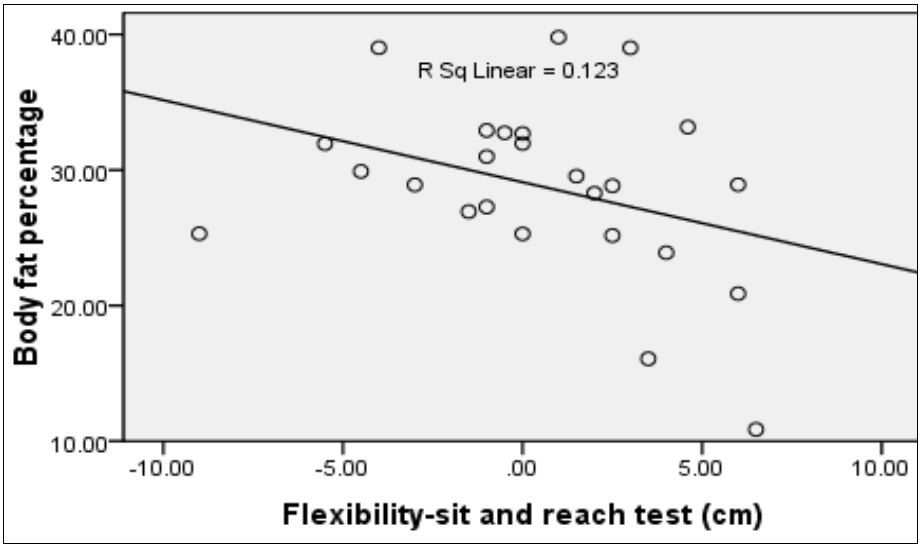
The correlation between body composition and flexibility shown in table indicates that BMI has a statistically significant negative weak correlation with the hamstring flexibility (r= -0.44, p=0.02) (table 2, graph 1), whereas body fat percentage has a non-statistically significant weak negative correlation with the hamstring flexibility (r= -0.35, p=0.08) (table 2, graph 2)

Table 2: Karl Pearson's correlation coefficient (r) to compare between body composition and flexibility. Correlation is significant at the 0.05 level (2-tailed).

	Body mass index(BMI)		Body fat percentage	
Flexibility	r=-0.44	p=0.02	r=-0.35	p=0.08



Graph 1: Correlation between BMI and hamstring flexibility



Graph 2: Correlation between body fat percentage and hamstring flexibility

4. Discussion

This study analyzed the relationship between hamstring flexibility and body composition, such as BMI and body fat percentage, among 8 to 12 year old children who were active indoors during the pandemic. Body composition and hamstring flexibility were measured in a total of 25 children (14 boys and 11 girls). The results of this study demonstrate that there is a statistically significant negative correlation between BMI and hamstring flexibility (r = -0.44, p = 0.02) [Graph 1]. The correlation between body fat percent and hamstring flexibility was discovered to be non-statistically significant (r = -0.35, p = 0.08). [Graph 2].

This pilot study found a weak negative relationship between BMI and flexibility, which was tested by a sit-and-reach test, which revealed that as BMI increases, flexibility decreases. This reinforces the findings of Andreasi V *et al*. [17], who found an inverse relationship between flexibility and BMI in schoolchildren aged 7 to 15. In addition, Huijing He *et al*. [18] and Fogelholm *et al*. [19] also found that overweight and underweight children and adolescents perform worse in sit and reach than normal children and adolescents. In contrast to these findings, Esther Liyanage *et al*. [20] and Zahra A *et al*. [7] discovered that BMI and hamstring flexibility in 9–11-year-old children have no association.

An appropriate childhood obesity diagnosis is essential for an effective clinical and public health response to the obesity epidemic [21]. While BMI is sensitive to changes in adiposity, its poor specificity makes it a poor predictor of changes in total body fat (% fat). [22] As a result, more sophisticated techniques for measuring adiposity in children and adolescents are required, so in this study, body fat percentage was evaluated in addition to BMI. According to the findings, there was a weak negative correlation between body fat percentage and flexibility that was statistically non-significant, possibly due to the study's small sample size. This finding is consistent with Singh P *et al*.'s [23] study, which found a negative relationship between body fat percentage and flexibility in adults. As a result, more research with a large sample size is required to confirm the relationship between body fat percentage and hamstring flexibility.

Physical activity (PA) is one of the most important pillars in a child's optimal physical and psychological development. The closure of sports facilities and parks has made getting the prescribed amount of physical activity even more difficult. The WHO [24] supported this sentiment when Guan *et al*. [25] highlighted the importance of PA in preventing child sedentarism as a consequence of lockdown. In addition, *et al*. [26] Cachón-Zagalaz J *et al*., observed that children under the age of 12 engaged in a low amount of PA in sports during lockdowns, while activities at home increased.

As a result, decreased outdoor physical activity could be the cause of the lower flexibility in this study's link with body composition. This is in line with the findings of Liyanage E *et al*., who discovered a substantial positive weak to moderate correlation between hamstring flexibility and the amount of physical activity. [20] Thus, it can be said that physical activity is an important contributor to flexibility in children. Increased physical activity may result in a reduction in body composition and an improvement in flexibility.

The small sample size of the study was a limitation. The second limitation of this study was that body fat percentage was measured using the skinfold rather than a more reliable metric like bio impedance measurement.

5. Conclusion

BMI is inversely correlated with flexibility in children who were active indoors during the pandemic but non-significant correlation was found between body fat percentage and flexibility thus study with larger population is needed for further clarity.

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