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Correlation between abdominal muscle endurance with local muscular endurance test and body mass index among college students from Dakshina-Kannada: A cross-sectional study

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Abstract
Background: The study aimed to investigate the correlation between abdominal muscle endurance, local muscular endurance test, and body mass index (BMI) among college students.
Methods: The study used a correlation design, with 100 college students selected through convenience sampling. Height, weight, and BMI were calculated for all students, and abdominal muscle endurance was assessed using the partial curl-up test with a 40-beat per minute metronome.
Results: The mean value for BMI was 24.59 with a standard deviation of 5.12, and the mean value for repetitions was 25.67 with a standard deviation of 16.8. The p-value was 0.589. The study found that students with higher BMI had lower abdominal muscle endurance.
Conclusions: This cross-sectional study found a negative correlation between BMI and abdominal muscle endurance among college students with sedentary lifestyles. The study suggests that interventions to improve abdominal muscle endurance should be implemented to reduce the risk of mechanical low back pain. Additionally, the partial curl-up test was found to be a reliable and preferred measure of abdominal muscular endurance compared to the sit-up test. The study highlights the importance of maintaining a healthy BMI and developing endurance of inner core muscles to prevent low back pain.

Keywords: Body mass index, local muscular endurance test, abdominal muscles

1. Introduction
The background of the study highlights the importance of muscle endurance in daily activities and its relationship with back pain. The study aims to assess the muscular endurance of the abdominal muscles using the partial curl-up test and its correlation with age, gender, body weight, body mass index (BMI), and other indicators of obesity.
The research question of the study is whether the partial curl-up test can effectively measure the muscular endurance of the abdominal muscles and if there is a significant correlation between curl-up performance and age, gender, body weight, BMI, and other obesity indicators. The hypothesis of the study is that the partial curl-up test is a safe and reliable measure of abdominal muscular endurance and that there is a significant correlation between curl-up performance and the aforementioned variables.
Endurance is the ability to work for long hours and resist fatigue. Muscle endurance is defined as the ability to perform repeated contractions in isolated muscle groups for a specific period. Most of our daily activities require some degree of muscle endurance [1]. Back pain is caused by a combination of core muscle weakness and lumbar endurance that puts stress on passive tissues. Muscle endurance is lower in people with back pain than in people without back pain [2-3].
Local muscle endurance is the ability of a particular muscle or muscle group to perform repeated contractions against submaximal resistance [4]. Local muscle endurance testing should be performed continuously for seconds to minutes without rest and without external movement. Examples include pull-ups, parallel bar dips, push-up exercises, or resistance at a constant load (e.g., the athlete's 1RM or percentage of his body weight) performing the maximum number of repetitions in his training exercise [4].

Curl-up exercises to tone the abdominal muscles, especially the deepest muscle layer, the transverse Abdominis (TrA). Playing a less obvious mechanical role in fiber orientation, activation also increases with loading during straight trunk roll-up too, suggesting that this may not be the optimal strength training for this muscle [5].

The muscles of the trunk segment can be divided into two systems: rectus abdominis, external obliques, internal obliques, lateral part of the quadratus lumborum (QL), erector spinae and iliopsoas, etc. The external global system, including the superficial muscles of the deep local system including deeper muscles: Transversus abdominis (Tra), multifidus, deep QL, and deep rotator of the spine [9]. Among trunk muscles (local and global), tiger muscles are controlled independently of other trunk muscles [3].

The partial curl-up test measures the muscular endurance of the abdominal muscles. It is favoured over the sit-up test because it eliminates the use of the hip flexor muscles. The partial curl-up has been recommended as a better test of abdominal muscular endurance, replacing the one-minute speed sit-up with anchored feet. The curl-up begins from a supine position, with the knees bent at 140° and the feet unsupported [4].

The partial curl-up appears to be a safe protocol, with few people experiencing dizziness, headache, nausea, neck pain, or back discomfort. Males have higher average scores than females, and scores decline as people get older. Approximately 20% of men in their 60s and women in their 50s are unable to perform one curl-up. Correlations between curl-up performance and age, stature, body weight, BMI, girths, body fat, trunk flexibility, aerobic fitness, upper body strength, and muscular endurance were significant (p 0.0001) but accounted for less than 16% of the total variance. Fitter people (and/or those with less excess body fat), as well as younger people, can perform more curl-ups than less fit, fatter, or older people [8].

Obesity is defined as abnormal or excessive accumulation of fat that poses health risks. Obesity is a serious problem in modern society, especially in developed countries. Obesity is defined by an imbalance between energy intake and expenditure [6]. There are several indicators of obesity. For example, body mass index (BMI) is used as a common indicator to assess a person's overall weight status [3]. Traditionally, medical definitions of overweight and obesity are based on body mass index (BMI) results [7].

Table 1: BMI categories for adults by obesity and metabolic surgery society of India

Weight category	BMI
Underweight	Under 18.5
Normal	18.5-24.9
Overweight	25-29.9
Obese	30.34.9
Severely Obese	35-39.9
Morbidly Obese	40 and over

The body mass index is calculated using the following formula;

BMI (kg/m) = weight (kg)/height (m^2)

The most used measure of obesity is body mass index, but it has limitations, particularly in men with large muscle mass and people of non-Caucasian ancestry [7]. A few other ways of measuring obesity are shown in the box.

Table 2: Demographic data of subjects

Mean SD	
Age (years)	18.23 ± 2.47
Height (cm)	167.4. ± 7.22
Weight (kg)	58.98 ± 13.42

SD =Standard deviation

2. Methods

2.1 Study design

This study was a cross-sectional study conducted at Alvas College of physiotherapy in Dakshina Kannada, India.

2.2 Participants

The study included 100 college students aged between 18 and 29 years, who were recruited through a convenient sampling method. Students with low back pain or recent lower limb fracture occurred less than 4 months were excluded from the study.

2.3 Intervention or exposure

The intervention used in this study was the partial curl-up test. Participants were asked to lie supine on a yoga mat with knees at 90°, and arms lying on the floor. Fingers touched the tape of 4 inches placed perpendicular to the fingers, at a distance appropriate for the athlete's age. Two tapes parallel to the first tape were also placed. The metronome was set to 40 beats per minute, and the subject performed a slow, controlled curl-up in time with the metronome, lifting the shoulder blades off the mat. The torso formed a 30° angle to the mat, and the upper back should touch the floor before each roll. Athletes performed as many curls as possible without rest, up to a maximum of 75.

2.4 Outcome measures

The primary outcome measure was the muscular endurance of the abdominal muscles, which was measured using the partial curl-up test.

2.5 Statistical analyses

Descriptive statistics were used to summarize the characteristics of the participants. The mean and standard deviation were calculated for continuous variables, while frequencies and percentages were calculated for categorical variables. The statistical significance of differences between groups was analysed using a t-test or chi-square test, as appropriate. A p-value less than 0.05 was considered statistically significant. All statistical analyses were performed using a statistical software program.

2.6 Material used

- Metronome.
- Yoga mat.
- Masking tape.
- Ruler.
- Weighing machine.
- Wall mounted stature meter.

Fig 1: Curl-up: a) Beginning position and b) End position.

Table 3: Percentiles by age groups and sex for partial curl-up

Percentile*	Age and sex									
	20-29		30-39		40-49		50-59		60-69	
	M	F	M	F	M	F	M	F	M	F
90	75	70	75	55	75	55	74	48	53	50
80	56	45	69	43	75	42	60	30	33	30
70	41	37	46	34	67	33	45	23	26	24
60	31	32	36	28	51	28	35	16	19	19
50	27	27	31	21	39	25	27	9	16	13
40	24	21	26	15	31	20	23	2	9	9
30	20	17	19	12	26	14	19	0	6	3
20	13	12	13	0	21	5	13	0	0	0
10	4	5	0	0	13	0	0	0	0	0

*Descriptors for percentile rankings: 90 = well above average; 70 = above average; 50 = average; 30 = below average; 10 = well below average.

3. Results

The study included 100 college students (mean age = 18.23 ± 2.47 years) with a mean height of 167.4 ± 7.22 cm and a mean weight of 58.98 ± 13.42 kg. The analysis of Pearson correlation revealed no significant correlation between REPS and BMI (r = 0.123, p = 0.589). The mean value of BMI was 24.59945 (SD = 5.123728) and the mean value of repetitions performed was 25.6700 (SD = 16.817532). Table 2 provides the descriptive statistics for age, height, weight, BMI, and repetitions.

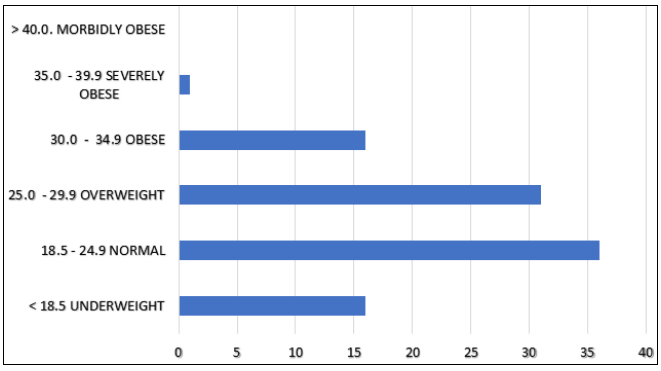

Fig 2: BMI of 100 students

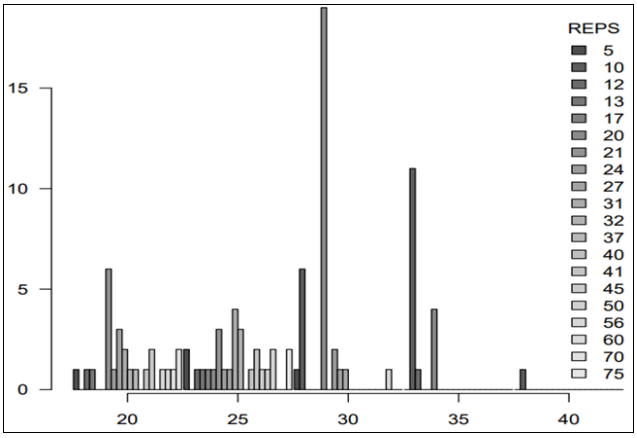

Fig 3: Comparison of BMI and REPS in percentage

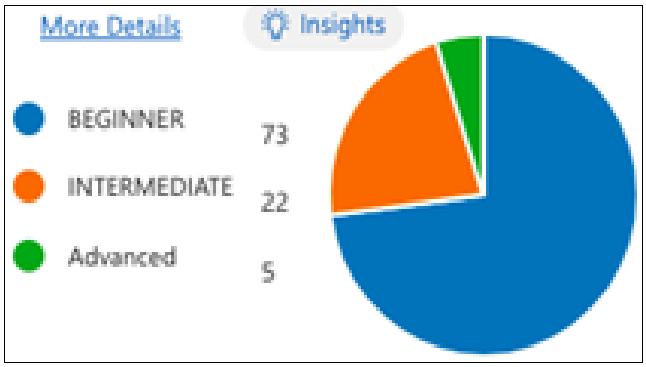

Fig 4: Physical activity status (0 point)

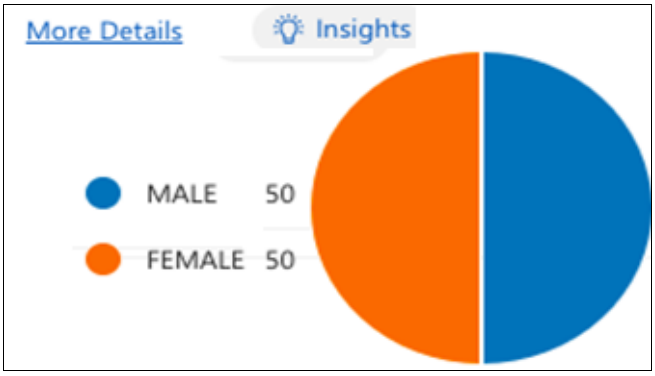

Fig 5: Gender (0 Point)

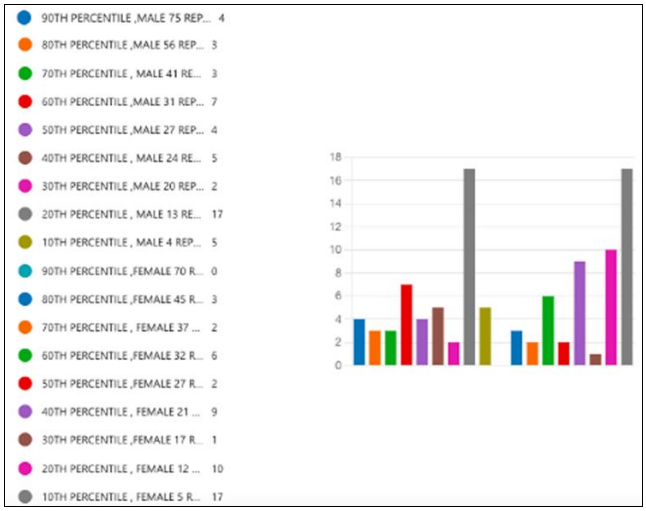

Fig 6: 10th to 90th percentile, male and show graph

Table 4: Percentiles of males and female samples

Male		Female	
Reps	**Number of person**	**Reps**	**Number of person**
90 Percentile	4	90 percentile	0
80 Percentile	3	80 percentile	3
70 Percentile	3	70 percentile	2
60 Percentile	7	60 percentile	6
50 Percentile	4	50 percentile	2
40 Percentile	5	40 percentile	9
30 Percentile	2	30 percentile	1
20 Percentile	17	20 percentile	10
10 Percentile	5	10 percentile	17
Total	50	Total	50

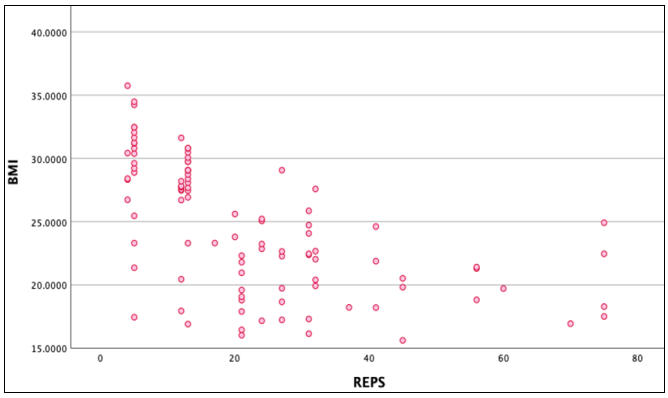

Fig 7: Scatter plot of BMI by REPS

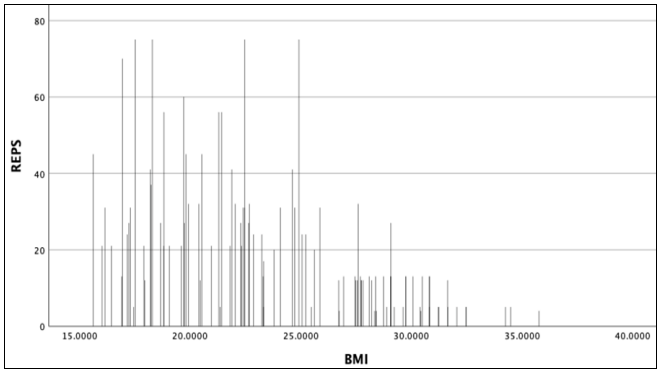

Fig 9: Simple bar of REPS by BMI

4. Discussion

The current study investigated the relationship between transverse abdominal muscular endurance and BMI among college students in Dakshina Kannada. The findings revealed a negative relationship between the two variables, indicating that as BMI increases, transverse abdominal muscle endurance decreases. This is consistent with previous research which suggests that obese individuals tend to have reduced muscular endurance and strength compared to individuals of lower weight categories.

The transverse abdominis muscle is important for core stability and lumbar biomechanics, and dysfunction of this muscle has been linked to low back pain. The results of this study suggest that maintaining a healthy BMI may be beneficial for individuals in terms of improving their transverse abdominal muscle endurance, which could potentially help reduce the risk of low back pain.

One limitation of this study is the use of convenient sampling, which may limit the generalizability of the findings to the wider population. Additionally, the study was cross-sectional in nature, which precludes the establishment of causal relationships between BMI and transverse abdominal muscle endurance. Further longitudinal studies with larger sample sizes are needed to confirm these findings and explore potential underlying mechanisms.

Overall, the current study provides preliminary evidence for a negative relationship between BMI and transverse abdominal muscle endurance among college students in Dakshina Kannada. The findings have important implications for promoting healthy weight management and reducing the risk of low back pain.

5. Conclusion

In summary, this study provides evidence of a negative correlation between BMI and abdominal muscle endurance among college students with sedentary lifestyles. The results emphasize the need for interventions aimed at improving abdominal muscle endurance, particularly among students with higher BMI, to reduce the risk of mechanical low back pain. The study recommends the partial curl-up test as a reliable and preferred measure of abdominal muscular endurance over the sit-up test. The findings underscore the significance of maintaining a healthy BMI and developing endurance of inner core muscles as part of a preventive approach to low back pain.

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