INFLUENCE OF BODY MASS INDEX PERCENTILE ON ABDOMINAL MUSCULAR STRENGTH AND ENDURANCE AMONG LATE ADOLESCENTS

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ABSTRACT:

This analytical study with stratified random sampling was made to find out the influence of body mass index percentile on abdominal muscular strength and endurance among 120 apparently healthy late adolescents in the age range of 18-20 years. Subjects who had a history of recent injury, systemic disorders and also who involves in regular sports, yoga, physical activities and non-cooperative subjects were excluded. Both, 67 boys and 53 females were recruited in this study. Their abdominal strength and endurance were measured by using four level abdominal strength tests and sit up test respectively. These two parameters were assessed for 3 trials at a time on 2 different days with an interval of 2-3 days and the data were noted. The data collected were analysed for spearman’s correlation analysis for the 120 subjects. The r and p values were found to be (-0.755, 0.000) and (-0.657, 0.000) for strength and endurance in relation to BMI percentile. To compare the 4 categories of BMI kruskalwallis was computed. The H and p values were found to be (78.257, 0.000) and (36.833, 0.000) for strength and endurance respectively. The results indicate that body mass index percentile has an inverse relationship with strength and endurance of abdominal muscles irrespective of the gender.

Keywords – Strength, endurance, 4 level abdominal strength tests, sit up test

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I. INTRODUCTION

A high level of physical fitness usually is associated with good health. Physical activity may improve physical fitness as well as clinical health status at the same time. The improvement in health may be due to biological changes, different from those responsible for the improvement in physical fitness. Earlier studies indicates that the effects of exercise on specific biologic changes thought to be linked either directly or indirectly to health status and also the improvement in physical fitness and health may occur simultaneously during physical activity.²⁵

“Physical activity,” “exercise,” and “physical fitness” are terms that describe different concepts. However, they are often confused with one another, and the terms are sometimes used interchangeably. Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure. Physical activity in daily life can be categorized into occupational, sports, conditioning, household, or other activities. Exercise is a subset of physical activity that is planned, structured, and repetitive which has a final or an intermediate objective towards improvement or maintenance of physical fitness. Physical fitness is a set of attributes that are either health-or skill-related. The degree to which people have these attributes can be measured with specific tests¹. The health
related components of physical fitness are cardio respiratory endurance, muscular endurance, muscular strength, body composition and flexibility.

Strength is one of the main fitness components, important for success in many sports, certain sports such as weight lifting, wrestling and weight throwing and so on. Strength is the ability to exert a maximum amount of force for the short period of time. Muscular strength is currently considered as a marker of health and well being predictor of mortality and expectancy of being able to live independently.\textsuperscript{5}

Endurance is the muscle ability to contact repeatedly against a load for longer duration without fatigue. Endurance can be developed only when a subject should possess strength, and not all the person possessing strength will have endurance \textsuperscript{15}. Strength and endurance plays an important role in maintaining fitness\textsuperscript{8}. Strength and endurance are interrelated\textsuperscript{3}.

Studies suggest that these parameters are associated with BMI. Body mass index is one of the body compositions, considered as reasonable assessment tool that aids in evaluation process of fat\textsuperscript{15}. BMI is the indicator of obesity and centralized obesity is more prevalent among peoples. Persons with obesity had significantly lower health related quality of life than those who have normal weight.

Abdominal muscular endurance is a pre-requisite for maintaining correct body position in many sports activities. Moffroid also indicated decreased trunk extensor endurance as a predictor of first time occurrence of low back pain\textsuperscript{10}. In the present study the author decided to recruit the late adolescents in the age of 18-20, seems to have less physical activities due to concentration towards their own carrier selection in their earlier and middle stages of adolescents.

Hence in this study the investigator attempts to determine and quantify the relationship of BMI percentile with abdominal muscular strength and endurance. By finding out the intensity of influence of BMI percentile on these parameters, may help the therapists to predict fitness related problems, set goals, design a suitable protocol and also help in creating awareness among professionals even in common layman pertaining to fitness, as it keep away the health issues as per the quote “prevention is better than cure”.

II. METHODS

In this analytical study with a stratified random sampling method; 120 apparently healthy adolescents including 67 boys and 53 girls in the age range of 18 to 20 were selected. Subjects who had a history of recent injury, systemic disorders and also who involves in regular sports, yoga, physical activities and non-cooperative subjects were excluded. First the subjects were assessed for their height and weight, followed that body mass index percentiles were calculated. Their abdominal strength and endurance were measured by using 4 level abdominal strength tests and sit up test respectively. These two parameters were assessed for 3 trials at a time but on 2 different days with an interval of 2-3 days and the data were noted.

Procedure for 4 level abdominal strength test (Robert hook 2008)

STEP 1: Perform a leg situp with the knee at right angle and feet held

STEP 2: Perform a leg situp with the knee at right angle and feet not held

STEP 3: Perform a straight leg situp with feet held

STEP 4: Perform a straight leg situp with feet not held

Scoring:

The criterion in the following table was used to give a score out of 4 for each sit up. The score for all 4 sit up levels were added for a total score out of 16.
SCORE | CRITERIA
---|---
0 | cannot perform
1 | difficulty performing, jerky motions, feet leave the floor
2 | use a lot of momentum to overcome 45 degrees
3 | performs with slight pause in the mid area of sit up
4 | no difficulty

**Sit ups to test abdominal muscular endurance**

The participant lies supine on the mat, keeping the hand on the shoulders and the knee flexed at an angle of 90°, classmate holds the subject’s ankles firmly for supporting and maintaining the count. The subject’s elbows have touch the knee on the same side. After each upward movement, the 2 sides of scapula have to return to touch the floor. The participant repeats this movement as many times as possible. The number of sit ups performed in 1 minute was noted. This test assesses abdominal muscular endurance.

### III. DATA ANALYSIS AND RESULT

To determine the intensity of influence of body mass index percentile on abdominal muscular strength and endurance in apparently healthy late adolescents, Spearman’s correlation coefficient was computed, by considering body mass index percentile as independent variable with strength and endurance as dependent variable.

At first the relationship between the variables was computed on the whole for about 120 subjects irrespective of the gender. The following table 1 shows the correlation coefficient between body mass index percentiles and strength. The r value was found to be [-0.755] with the corresponding p value .000 which is significant at 0.01 level. This indicates that the correlation is negative. The average score of abdominal muscular strength was 8.547

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>R</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BMI</td>
<td>120</td>
<td>57.06</td>
<td>-0.755</td>
<td>0.000</td>
</tr>
<tr>
<td>2</td>
<td>Strength</td>
<td>120</td>
<td>8.547</td>
<td></td>
<td></td>
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</tbody>
</table>

**Correlation coefficient value for BMI percentile and strength**

Similarly, the following table 2 shows the correlation coefficient between the body mass index percentile and endurance irrespective of the gender. The r value was found to be [-0.657] with the corresponding p value .000 which is also negative one and also significant at 0.01 level. The average frequency of abdominal muscular endurance was 6.874

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>R</th>
<th>p</th>
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</table>
To find out whether the gender has any influence over the strength and endurance, the relationship was analysed for both boys and girls separately. The following table 3 shows the correlation coefficient between body mass index percentile and strength for girls. The r value was found to be \[-0.628\] with a corresponding p value .000 which is significant at 0.01 level. This indicates the correlation is negative. The average score of abdominal muscular strength for girls was 8.573

### Table 3

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>R</th>
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<tr>
<td>1</td>
<td>BMI percentile</td>
<td>57</td>
<td>53.689</td>
<td>-0.628</td>
<td>0.000</td>
</tr>
<tr>
<td>2</td>
<td>Strength</td>
<td>57</td>
<td>8.573</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Correlation coefficient value for BMI percentile and strength - girls**

Similarly, the following table 4 shows the correlation coefficient between body mass index percentile and endurance for girls. The r value was found to be \[-0.388\] with a corresponding p value 0.000 which is also negative one and also significant at 0.01 level. The average frequency of abdominal muscular endurance for girls was 6.46

### Table 4

<table>
<thead>
<tr>
<th>S.NO</th>
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</thead>
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<tr>
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<td>BMI percentile</td>
<td>57</td>
<td>53.68</td>
<td>-0.388</td>
<td>0.000</td>
</tr>
<tr>
<td>2</td>
<td>Endurance</td>
<td>57</td>
<td>6.46</td>
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<td></td>
</tr>
</tbody>
</table>

**Correlation coefficient value for BMI percentile and endurance - girls**

The following table 5 shows the correlation coefficient between body mass index percentile and strength for boys. The r value was found to be-0.853 with a corresponding p value .000 which is significant at 0.01 levels. This indicates the correlation is negative. The average score of abdominal muscular strength for boys was 8.52

### Table 5

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>R</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>BMI</td>
<td>120</td>
<td>57.06</td>
<td>-0.657</td>
<td>0.000</td>
</tr>
<tr>
<td>2</td>
<td>Endurance</td>
<td>120</td>
<td>6.874</td>
<td></td>
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</tr>
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</table>
Table 5

<table>
<thead>
<tr>
<th>S.NO</th>
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<th>N</th>
<th>Mean</th>
<th>R</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BMI percentile</td>
<td>63</td>
<td>60.11</td>
<td>-0.853</td>
<td>0.000</td>
</tr>
<tr>
<td>2</td>
<td>Strength</td>
<td>63</td>
<td>8.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation coefficient value for BMI percentile and strength - boys

The following table 6 shows correlation coefficient between body mass percentile and endurance for boys. The r value was found to be [-0.828] with a corresponding p value .000 which is also negative one and also significant at 0.01 level. The average frequency of abdominal muscular endurance for boys was 7.247.

Table 6

<table>
<thead>
<tr>
<th>S.NO</th>
<th>variable</th>
<th>N</th>
<th>Mean</th>
<th>R</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BMI percentile</td>
<td>63</td>
<td>60.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Endurance</td>
<td>63</td>
<td>7.247</td>
<td>-0.828</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Correlation coefficient value for BMI percentile and endurance - boys

To compare the mean difference among the 4 categories namely underweight, normal, overweight and obese irrespective of the gender, the kruskalwallis test was computed.

The following table-7 shows the kruskalwallis analysis to compare the strength among the 4 categories of body mass index. The H value was found to be 78.257 with a corresponding P value 0.000 which is significant at 0.01 level. The average strength values were 10.9531, 10.862, 7.2594 and 4.276 for the 4 categories of body mass index respectively. The average strength value was found to be on the decreasing manner from underweight to obese.

Table-7  kruskalwallis test

<table>
<thead>
<tr>
<th>S. N</th>
<th>Category</th>
<th>N</th>
<th>Mean</th>
<th>H</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Under weight</td>
<td>32</td>
<td>10.9531</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>32</td>
<td>10.862</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Over weight</td>
<td>32</td>
<td>7.2594</td>
<td>78.257</td>
<td>0.000</td>
</tr>
<tr>
<td>4</td>
<td>Obese</td>
<td>32</td>
<td>4.276</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Difference among various categories of BMI-strength

The following table 8 shows the kruskalwallis analysis to compare the endurance among the 4 categories of body mass index. The kruskalwallis-H value was found to be 36.833 with a corresponding p value 0.000 which is significant at 0.01 level. The average endurance value also found to be on the decreasing manner from underweight to obese.
Table 8: Kruskal-Wallis test

<table>
<thead>
<tr>
<th></th>
<th>CATEGORY</th>
<th>SAMPLE SIZE</th>
<th>MEAN</th>
<th>H</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Under weight</td>
<td>32</td>
<td>9.9438</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>32</td>
<td>9.6156</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Over weight</td>
<td>32</td>
<td>4.6313</td>
<td>36.833</td>
<td>0.000</td>
</tr>
<tr>
<td>4</td>
<td>Obese</td>
<td>32</td>
<td>2.6320</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Difference among various categories of BMI-Endurance**

However, the underweight and normal weight has more or less similar values with no significant difference, whereas the obese and overweight has marked difference when comparing to other two categories.

**IV. DISCUSSION**

This study was initiated with a view to determine whether the body mass index percentile has any influence on abdominal muscular strength and endurance among apparently healthy adolescents in the age range of 18-20.

The result of this study, on the whole for 120 subjects the level of correlation of BMI percentile with abdominal muscular strength and endurance was found to be negative that is as the BMI value increases, the strength and endurance decreases accordingly for both the variables. The intensity of impact of BMI was 75% for strength and with the endurance is about 65%. This indicates though both the variables have same type of relationship, it may be noted that a slight increase with strength when comparing with endurance.

Similarly, for boys the magnitude of influence is about 85% for strength and 82% for endurance. Here also the influence of strength has slightly higher value than the endurance.

Likewise for girls the intensity of influence is about 62% for strength and 38% for endurance. The strength is being influenced intensively by BMI when comparing to endurance. This reveals that gender has an influence over strength and endurance.

Our study result is supported by Josecastropinero who attempts to derive percentile values for muscular strength by using field test in children aged 6-17 years the influence of body weight and the muscular strength across the age group was also examined the subjects were categorized, according to the BMI category. They concluded overweight and obese group had worse scores than underweight and normal weight counterparts, whereas the underweight group had a similar performance to the normal weight group.

Robert Podstawski studied the relationship between body mass index and endurance-strength abilities in 19-23 years old. The research conducted on first year female students. They indicated the overweight and obesity negatively influence the level of endurance-strength abilities.

Prakruti K Motka studied the abdominal muscle strength and its correlation with the BMI 60 participants with the age group of 18-25 years their results showed that negative correlation between BMI and abdominal muscle strength in females not in males. In our study both the gender have negative correlation but the intensity varies. The boys possess much higher values than the girls. Noha Abdel Kader in his study quoted that BMI had a positive correlation with strength and negative correlation with endurance but their sample were in the age 10-13 years while this study was on late adolescents.

Juheekim studied the relationship of physical fitness to prevalence and incidence of overweight among school children and compiled data for a cross-sectional analysis on 6297 students, 5-14 years of age. Their results showed that inverse relationship between physical fitness and overweight.
Wendy L. Gillieard developed abdominal muscle test, using 4 levels of difficulty to assess abdominal muscle strength, was validated by examination of the functional interrelationship between the individual muscles during the abdominal muscle test, and by determining the relationship between the abdominal muscle test level of difficulty and electromyographical activity. They suggest that the abdominal muscle test is valid and suitable indicator of ability to develop voluntary abdominal muscle tension and it is useful for assessing abdominal muscle functional ability. The 4 level tests for abdominal muscle strength which is described by Robert hook (2008), possessing meager literature in terms of reliability. Hence in this present study, the author made a pilot study on a sample of 10 adolescents in the same age group as similar to that of the study sample. It was observed from the pilot study that no difficulty was experienced by the subjects as well as the investigator and also this tool is simple cost effective. Since the H.A. Quinney quoted the curl up test is reliable and a highly valid tool, for abdominal endurance. The investigator used the curl up test in this present study. However, the present study results reveal that the inverse relationship between BMI percentile with strength and endurance irrespective of the gender. The average strength and endurance values for 4 categories were on the increase from obese to underweight. Among the 4 BMI categories the underweight and normal have similar values. The other two categories had fewer score than these two.

V. CONCLUSION
The body mass index percentile has an inverse relationship with both strength and endurance of abdominal muscles irrespective of the gender. Though, the underweight and normal weight possesses no difference, it is better to keep a normal body mass index values to be fit.

REFERENCE
2. Gail I. Hal et al., Relationship of timed sit-up tests to isokinetic abdominal strength, Research quarterly for exercise and sport, V63, 80-84, 1999
5. Jose Castro-Pino et al., Percentile values for muscular strength field tests in children aged 6 to 17 years: Influence of weight status, Journal of strength and conditioning research, Vol-23(8), 2295-2310, 2009
6. Juhee Kim et al., Relationship of physical fitness to prevalence and incidence of overweight among schoolchildren, Obesity research, vol.13, 2005
8. Karen L. Baldauf et al., Clinical assessment of trunk flexor muscle strength in healthy girls 3 to 7 years of age, Physical therapy, Vol. 64, 1984
12. Mohdepajouatan et al., Obesity effect on isometric strength of the trunk extensors 2016
13. Nancy D, The association between weight perception and BMI among high school students, Obesity research, Vol 12(11), 2004
17. H.A. Quinney et al., A field test for the assessment of abdominal muscular endurance in professional ice hockey players, The journal of orthopedic and sports physical therapy, 1984 v6, 30-33
20. Robert podstawski et al., Relationship between BMI and endurance - strength abilities assessed by the 3 minute burpee test, International journal of sports medicine, v33(1), 2013
21. Robert wood-4 level abdominal strength test - topend sports
22. Stephanie Windisch et al., relationships between strength and endurance parameters and air depletion rates in professional firefighters, Germany health insurance, 7:44590, DOI-10, 1038, 2017
23. Toshikazeko et al., lumbar trunk muscle endurance testing: an inexpensive alternative to a machine for evaluation, vol-77-1996
25. William J. Haskell, physical activity and exercise to achieve health related physical fitness components vol-100, no.2 209, 1985