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Effect of BMI on static balance and core endurance in normal young adults and overweight or obese young adults in 18-25 age group: A pilot study

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Abstract

Background: Core endurance is related to lower extremity function including balance. When an external perturbation disrupts one's balance, movement strategies act in which along with the lower limb muscles, trunk muscles are also activated to bring COG back to normal position. The purpose of this study was to find the effect of BMI on static balance and core endurance in normal young adults (18.5-22.9 kg/cm^2) and overweight and obese young adults (≥23 kg/cm^2).

Objective: To assess the endurance of core muscles of young adults using McGill's Torso Endurance Test[1] . To assess the static balance of young adults using single leg stance test. To find whether higher BMI has any effect on core endurance and static balance in individuals of young age group.

Methods: An observational cross-sectional study was conducted on 60 young adults in the age group of 18-25 of which 30 adults were with normal BMI (18.5-22.9 kg/cm^2) and 30 adults were with higher BMI (≥23 kg/cm^2). It was conducted at physiotherapy centre in a tertiary care hospital. Their BMI was noted and Single Leg Stance Test and McGill's Core Endurance Test was administered to collect the data. Data analysis was done using SPSS 16 software and unpaired t-test was used to calculate the results.

Results: The study found that with increasing BMI, the core muscles become weak and have poor endurance (p=0.001, 0.029, 0.001, 0.002 for flexor endurance, right side bridge, left side bridge and extensor endurance respectively) and because they are not activated in time due to adipose tissue infiltration, higher BMI individuals also have reduced balance (p=0.000 for single leg stance test) as compared to young adults with normal BMI.

Conclusion: According to the results of the study, young adults with higher BMI have reduced core endurance and lesser balance as compared to individuals with normal BMI.

Keywords: BMI; Core Endurance; Static Balance; Young Adults

1. Introduction

The term core has been used to refer to the trunk or the lumbopelvic region of the body.

Core stability can be defined as "the capacity of the stabilizing system to maintain the intervertebral neutral zones within physiological limits".

The stabilizing system is divided into three subsystems: active, passive and neural subsystem.

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The passive subsystem consists of the ligaments and facetal joints between vertebrae.

The active muscle subsystem allow support of body mass plus additional loads associated with resistance exercises and dynamic activities.

The active muscle subsystem consists of global and local muscles group.

The global group consists of the large superficial muscles that transfer force between the thoracic cage and pelvis and act to increase intra-abdominal pressure (rectus abdominis, internal and external oblique abdominis, transversis abdominis, erector spinae, lateral portion of quadratus lumborum).

Conversely the local group consists of the small, deep muscles that control intersegmental motion between adjacent vertebrae (multifidus, rotatores, interspinal, intertransverse).

The core muscles can be likened to guy wires, with tension being controlled by the neural system.

As tension increases within these muscles, compressive forces increase between the lumbar vertebrae; this stiffens the lumbar spine to enhance stability.

The neural subsystem monitors and adjusts muscle forces based on feedback provided by muscle spindles, Golgi tendon organs and spinal ligaments.

Core endurance is the ability to maintain a low level of support the entire time you exercise to stabilize the spine.

According to one article in **Journal of Sport and Health Sciences** [6], Endurance teats are the most reliable core stability related measurements.

Static balance: it is the ability to maintain the body in some fixed posture. It implies the ability of the body to maintain itself within the base of support (BOS).

Maintaining balance is coordinated by three systems, vestibular, proprioceptive and the visual system. Postural control requires interaction of nervous and musculoskeletal system.

When pertubations act to disrupt one's balance, three movement strategies activate to return COG back to normal position. They are ankle, hip and stepping strategies.

In these strategies along with the lower limb muscles, the core muscles are also activated to bring COG back to normal.

There are several methods of balance assessment. The single leg stance test is more sensitive in assessing normal balance according to one study conducted by Brown JE and O'Hare [12]

2. Materials and Methods

2.1. Patients

The study was conducted in physiotherapy department of tertiary care hospital with the inclusion criteria: Male and female subjects aged 18 to 25 years having BMI (Body Mass Index) in the range of 18.5 kg/m^2 to more than or equal to 23 kg/m^2 and exclusion criteria: History of low back pain.1)Any recent surgery. 2)Neurological disease, neuromuscular problems. 3)Professional Sports activity. 4)Vestibular or balance disease. 5)Pregnant and lactating women.6)Diabetic patients. 7)Alcoholics. 8)Those who are doing gym regularly for the past six months. 9)Any disease with sensory affection. 10)Those who are unwilling to participate in the study.

The Institutional Ethical Committee had approved the research protocol.

2.2. Design

The design of this study was a Cross-sectional observational study, the subjects were allocated into normal and overweight/obese groups according to BMI. As it was a pilot study, each group consisted of 30 subjects(30 of normal BMI and 30 of overweight and obese BMI). So the total sample size was 60 subjects.

2.3. Method

To assess static balance, single leg stance test was used. Subject was asked to stand on dominant foot by placing their hands on the iliac crests with contra-lateral limb in hip flexion and knee flexion relying on medial side of dominant knee. Subject was told to with observer command, lift the stance foot heel and keep the stance position motionless while time was then recorded. Errors included hands lifted off iliac crests and compensatory adjustment such as displacement of ball of non-dominant foot. The test was executed twice and the better result was recorded. Trunk (core) muscle endurance was assessed using McGill's torso endurance test. Trunk flexor endurance test: for endurance of deep core muscles i.e transverse abdominis, quadratus lumborum, erector spinae. Test protocol and administration: The stopwatch was started as the board was moved about 4 inches (10 cm) back, while the subject maintained the 60-degree, suspended position. The goal of the test was to hold this 60-degree position for as long as possible without the benefit of the back support. The subject's time on the record sheet was recorded. Trunk lateral endurance test: also called the side bridge test, assess the muscular endurance of the lateral core muscles i.e transverse abdominis, obliques, quadratus lumborum and erector spinae. Test protocol and administration: The stopwatch was started as the subject moved into the side-bridge position. The goal of the test was to hold this position for as long as possible. Once the subject broke the position, the test was terminated. The subject's time on the record sheet was recorded. Repeated this test on the opposite side and recorded the value on the record sheet. Trunk extensor endurance test: The trunk extensor endurance test is generally used to assess muscular endurance of the torso extensor muscles i.e., erector spinae, longissimus, iliocostalis, and multifidi. Test protocol and administration: When ready, the subject lifted/extended the torso until it was parallel to the floor with his or her arms crossed over the chest. The stopwatch was started as soon as the subject assumed that position. The goal of the test was to hold a horizontal, prone position for as long as possible. Once the subject fell below horizontal, the test was terminated. Terminated the test when the subject could no longer maintain the position. The subject's time on the record sheet was recorded.

2.4. Statistical Analysis

All statistical analyses were performed using the SPSS version 16.0. Alpha level was set at 0.05 to control Type I error, and Confidence Interval was set at 95% for all statistical analysis. As data passed normality, Unpaired t-test was used.

3. Results

60 subjects participated in the study. There were 30 normal and 30 overweight/obese. Table 1 shows

Table 1 Mean and Standard Deviation

MEAN ± SD	NORMAL	OVERWEIGHT/OBESE
Age		
Body Mass Index (BMI)	20.7 ± 3.92	30.15 ± 2.95
Single Leg Stance Test	104.43 ± 40.67	53.47 ± 40.94
Flexor Endurance test	96.70 ± 58.78	51.57 ± 43.98
Right Side Bridge Test	32.57 ± 19.57	22.07 ± 16.71
Left Side Bridge Test	34.27 ± 20.90	19.70 ± 11.19
Extensor Endurance Test	50.47 ± 23.94	33.33 ± 17.38

Table 2 Unpaired t- test for Single Leg Stance Test

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
SINGLE LEG STANCE TEST	0.557	0.458	4.836	58	0.000	50.933

The above table shows that there is a significant comparison of Single leg stance (p=0.000) between normal BMI young adults and overweight/obese BMI young adults. This suggests that balance worsens with increasing BMI

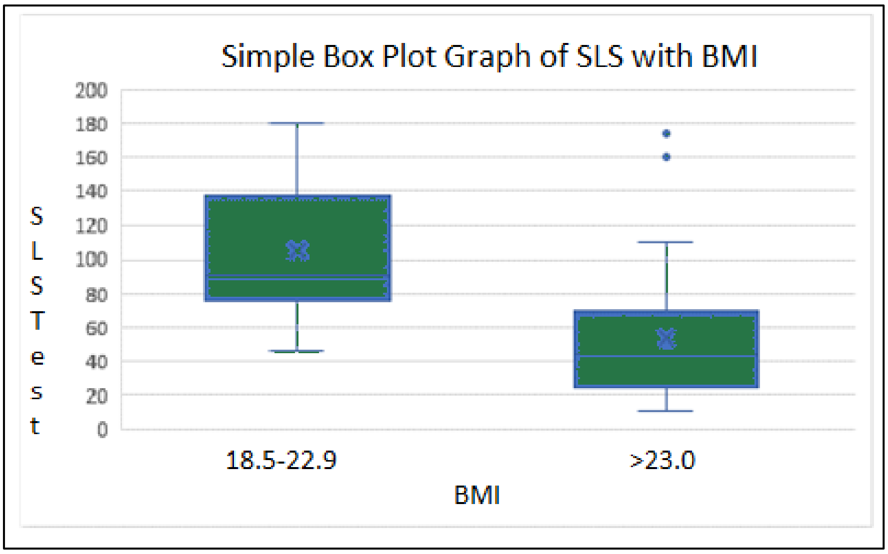

Figure 1 The above Figure is a box plot of BMI with Median of 90 secs in Single leg stance test in normal young adults and 44 secs in overweight/obese young adults

Table 3 Unpaired t- test for Flexor Endurance

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
FLEXOR ENDURANCE	5.391	0.024	3.367	58	0.001	45.133

The above table shows that there is a significant comparison of Flexor endurance (p=0.001) between normal BMI young adults and overweight/obese BMI young adults. This suggests that endurance of trunk flexors worsens with increasing BMI.

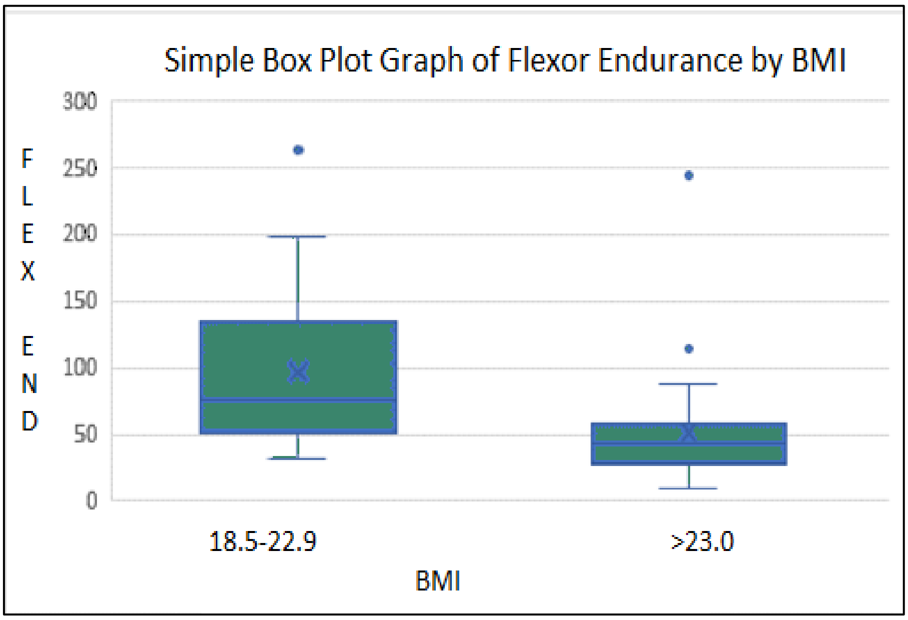

Figure 2 The above Figure is a box plot of Flexor endurance with Median of 75.50 sec and 42.50 sec for normal and overweight/obese young adults respectively

Table 4 Unpaired t-test for Right Side Bridge and Left Side Bridge

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
RIGHT SIDE BRIDGE	1.598	0.211	2.234	58	0.029	10.500
LEFT SIDE BRIDGE	9.357	0.003	3.365	58	0.001	14.567

The above table shows that there is a significant comparison of Right side bridge as well as Left side bridge (p=0.029, p=0.001) between normal BMI young adults and overweight/obese BMI young adults. This suggests that endurance of lateral trunk worsens with increasing BMI.

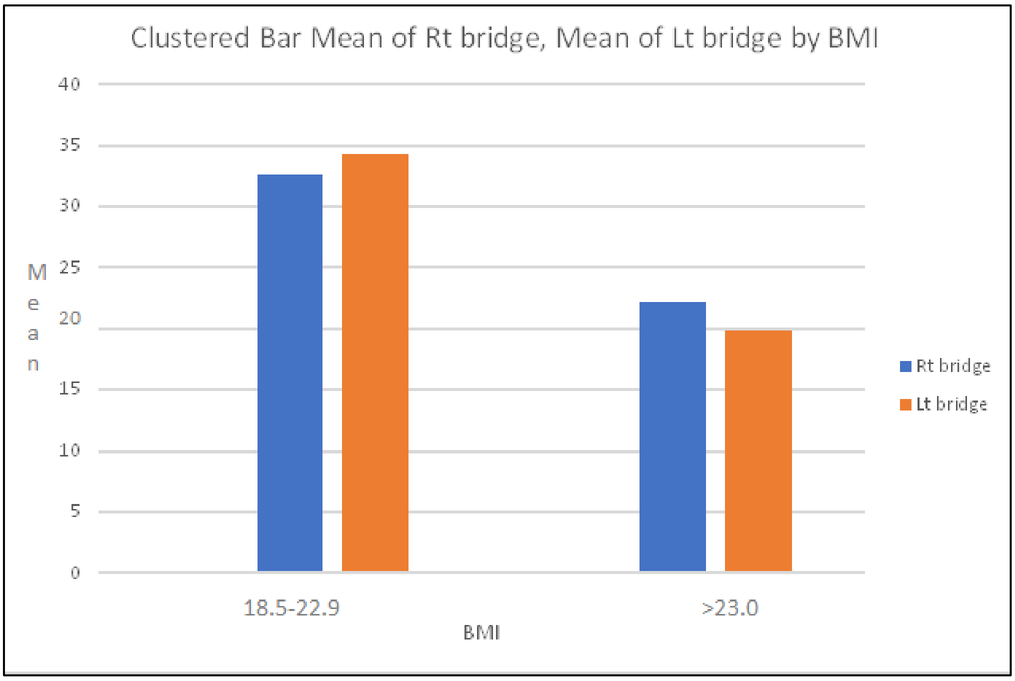

Figure 3 The above Figure is a histogram for Right side bridge and Left side bridge, with a mean value of 32 sec and 22 sec in normal and overweight/obese respectively for right side bridge and for left side bridge mean value is 34 and 15 respectively for normal and overweight/ obese young adults

Table 5 Unpaired t-test for Extensor Endurance

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
EXTENSOR ENDURANCE	1.687	0.199	3.172	58	0.002	17.133

The above table shows that there is a significant comparison of Extensor endurance (p=.002) between normal BMI young adults and overweight/obese BMI young adults. This suggests that endurance of trunk extensors worsens with increasing BMI

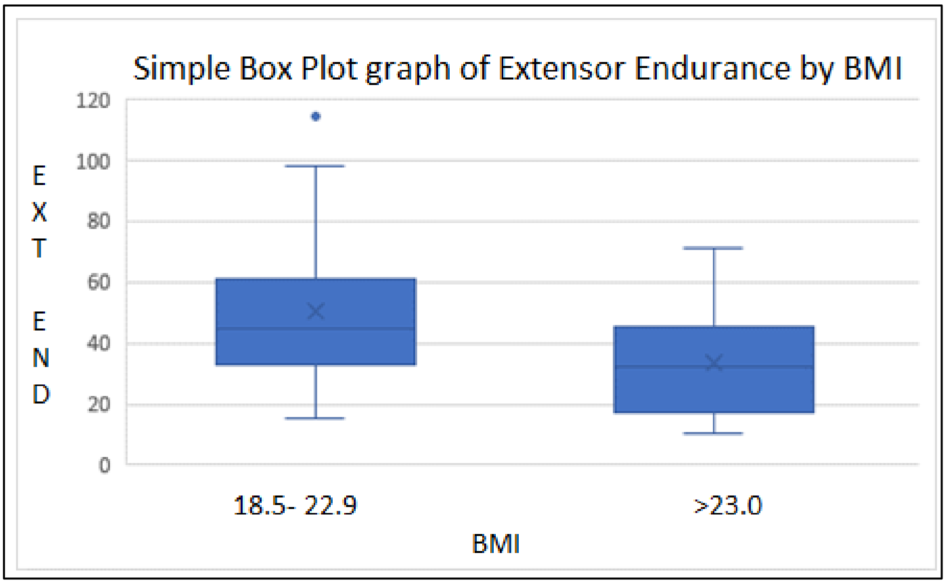

Figure 4 It is a box plot Figure of Extensor endurance, Median value being 45 sec and 32.50 sec for normal and overweight/ obese young adults

4. Discussion

This study was done to find the effect of BMI on static balance and core endurance in normal and overweight and obese young adults

Our study showed that with increasing BMI, static balance and core endurance both decreases

With increasing BMI, participants were not able to maintain single leg stance as well as various positions for core endurance for a long time

Amirhossein Barati, Afsaneh SafarCherati and Hamed Abbasi conducted a study on male students in Tehran to find out relationship between static balance and core endurance. This study showed that there is a strong correlation between core muscle endurance and static balance. Their results were in accordance with our study, that in adults with normal BMI, balance and endurance go hand in hand But their study did not include BMI as a independent variable as they selected participants with normal BMI.

A study was conducted by Sami S. AlAbdulwahab and Shaji John Kachanathu to find out the effects of BMI on foot posture alignment and core stability in a healthy adult population. Their study showed that BMI influences FPI and CS. Again this study supports our hypothesis that overweight individuals have weak core endurance

Adipose tissue accumulates at the abdominal region in obese individuals. This fatty infiltration is associated with weaker activation of core musculature. Sufficient core muscle endurance is required to maintain one's balance and co-ordination. When an external perturbation disrupts one's balance, movement strategies are activated to return COG back to normal in which the core muscles, that is the rectus abdominis and paraspinals also play a role along with the lower limb muscles. In overweight and obese young adults, the core muscles become weak and are not activated in time because of adipose tissue infiltration, therefore they are not able to maintain balance. In our study, normal young adults had good balance and good core endurance, hence this study proves that higher BMI leads to poor endurance of core muscles and hence reduced balance.

Application: The results of our study can be used to design a training program for overweight individuals aimed at improving trunk muscle endurance as well as balance training design

5. Conclusion

In young adults with **higher BMI**, there was **decreased core endurance and lesser balance** as compared to young adults with normal BMI.

5.1. Strengths

- Equal number of normal and overweight or obese subjects and also equal number of subjects in each group

5.2. Limitation

- Some exceptions in our study were: individuals with higher BMI who were actively engaged in any form of dance and exercises regularly and even though they stopped going to gym since 3 months, they had good core endurance and balance compared to other overweight individuals
- Small sample size

5.3. Suggestion

- More studies can be done in various age groups with larger sample size.
- Such a study can also be done by taking young adults of different BMI groups

Compliance with ethical standards

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Disclosure of conflict of interest

I declare that there was no conflict of interest regarding the publication of this thesis.

Statement of informed consent

All participants provided informed consent in accordance with institutional and ethical guidelines.

Statement of ethical approval

The study was conducted in accordance with ethical standards, and ethical approval was obtained from the Institutional Ethics Committee, Topiwala National Medical College, Mumbai- 400008. Approval No. TDP/1645/PT dated 17/08/2021.

Contributions

Simrankaur B. Khalsa -concept, design, definition of intellectual content, literature search, clinical studies, experimental studies, data acquisition, data analysis, statistical analysis, manuscript preparation, manuscript editing and manuscript review.

Bharati D. Asgaonkar- concept, design, definition of intellectual content, data analysis, statistical analysis, manuscript editing and manuscript review

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