

To Study the Co-relation between Muscular Endurance of Timed Forearm Plank Test with Body Mass Index (BMI) in Sedentary Urban Females of Age Group 25 to 55

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Abstract: Background: Body Mass Index (BMI) is defined as abnormal or excessive fat accumulation that may impair health. BMI depends on various factors like physical inactivity, sedentary lifestyle, intake of fatty food, hormonal imbalance etc. It has been observed that in recent times reduced amount of physical activity tremendously impact the BMI over a period of time. Being a part of sedentary lifestyle is a vicious habit that tends to accumulate fat deposition in the body specifically in the visceral area which further compromises the musculoskeletal efficiency of the core. If this sedentary habit is not broken down in given period of time, it will cause irreversible systemic changes and at times fatal consequences like, early death. The effect of this sedentary lifestyle causes a gradual negative effect on the overall productivity of life. Time forearm plank test is the one of the best measuring tools for assessment of muscular endurance of the core musculature. It is need of an hour to use this simple yet effective measuring tool to understand its correlation to the increasing BMI. Aims And Objectives: To study the co-relation between muscular endurance of timed forearm plank test with Body Mass Index in sedentary urban females of age group 25 to 55. Materials and Methods: A total of 60 females participated into the study. Depending on the inclusion criteria (females, age group 25 to 55) and exclusion criteria (males, musculoskeletal low back pain, pregnancy, recent surgery for the limbs or back, high blood pressure, vertigo and females who were unwilling to participate in the study), 40 sedentary females were selected for the study. The importance of study was explained to the subjects. Their BMI was calculated with the help of Tanita Body Composition Monitor (Model: BC-541N). Time forearm plank test was first demonstrated to the subjects and then they were asked to perform the test. All the readings were recorded in the data chart along with the demographic data of the subjects. Conclusion: There is a moderate positive co-relation between the Body mass index and the Timed Forearm Plank Test

Keywords: Body Mass Index (BMI), Timed Forearm Plank Test, physical activity, sedentary females, muscular endurance

1. Introduction

The sedentary behaviour research network (SBRN) defined sedentary behaviour as any activity involving sitting, reclining, or lying down that has a very low energy expenditure in metabolic equivalents (MET's), and the authors consider activities that expend 1.5 MET's or less of energy to be sedentary. [1, 2] World Health Organization (WHO) also defines sedentary lifestyle as any bodily movement produced by skeletal muscles that requires energy expenditure- including activities undertaken while working, playing, carrying out household chores, travelling and engaging in recreational pursuits. It is a type of lifestyle where an individual does not receive regular amounts of physical activity. Where physical activity is considered the failure to meet the recommendation of the Centre for Disease control (CDC). [3]

According to UNESCO, 1 in 4 adults is not active enough. 60 to 85% of the population worldwide does not engage in enough activity. Making physical inactivity the fourth leading risk factor for global mortality. [4] Regular physical activity is proven to help prevent and test non-communicable diseases (NCDs) such as heart diseases, stroke, diabetes and breast and colon cancer. It also helps to

prevent hypertension, overweight and obesity and can improve mental health, quality of life and well-being. [5]

Physical activity levels are also influenced by cultural values. In most countries, girls, women, older adults, underprivileged groups, and people with disability and chronic diseases, all have fewer opportunities to access safe, affordable and appropriate programmes and places in which to be physically active. [6] It is also important that adults can be physically active and less sedentary at work. Whether working or not, in particular the older females, can benefit from regular physical activity to maintain physical, mental and social health and enable healthy ageing. [7] A study done in 2012 by Lee m et al. Stated that globally, it has been estimated that insufficient physical inactivity causes 7% of type 2 diabetes, 6% of coronary heart diseases, and 10% of colon cancer and breast cancer each. This is also responsible for 9% premature mortality worldwide in 2008. [8]

In 2018 World Health Organization (WHO) mentioned that globally around 23% of adults aged 18 and over were not active enough (where men were 20% and women were 27% [3] In addition to this, physical inactivity has a positive effect on difficulty in maintaining health weight of an individual. [9-10] Leading a sedentary lifestyle is becoming a

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significant public health issue that has been increasing rapidly in many nations. Hence the members of the World Health Organization (WHO) agreed to reduce the insufficient physical activity by 10% by 2025 The World Health Assembly.^[3]

Obesity is defined as abnormal or excessive fat accumulation that may impair health. Body mass Index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m²).^[11] WHO defines overweight as a BMI equal to or more than 25 and less than 30.

The standard BMI categories are as followed;^[12]

| Categories | BMI (kg/m ²) |
|--------------------|--------------------------|
| Underweight | <18.5 |
| Normal | 18.5-24.5 |
| Overweight | 25-29.9 |
| Obese Category I | 30-34.9 |
| Obese Category II | 35-39.9 |
| Obese Category III | >40 |

BMI provides the most useful population- level measure of overweight and obesity as it is same for both sexes for all ages of adults. However it should be considered a rough guide because it may not correspond to the same degree of fatness in different individuals.

Facts about overweight and obesity^[3]:

- In 2016, more than 1.9 billion adults ages 18 years and older were overweight. Of these over 650 million adults were obese.
- In 2016, 39% of adults aged 18 years and over (39% of men and 40% of women) were overweight.
- Overall, about 13% of the world's adult population (11% of men and 15% of women) were obese in 2016.

The risk for the non-communicable diseases increases, with increase in BMI. Conversely, it is becoming increasingly clear that a continued sedentary lifestyle in overweight or obese individuals comes at a high cost, as numerous health-related variables worsen over relatively short time periods.^[13] The short term detrimental effects of cessation of exercise led to significant increase in intra abdominal fat within just 21 days.^[14]

Effect of 6 months of continued physical inactivity in sedentary individuals:

| | | |
|-----------------------|-----------------------|-------------------|
| ↑ Body weight | ↑ Total abdominal fat | ↑ LDL particle # |
| ↑ Waist circumference | ↑ Fasting insulin | ↑ Small dense LDL |
| ↑ Waist-to-hip ratio | ↓ Insulin sensitivity | ↓ LDL size |
| ↑ Visceral fat amount | ↓ Fitness (TTE) | ↑ LDL-cholesterol |

Individuals who do not currently exercise can still become even more inactive due to expected continued technological advances that almost certainly will lead to increase in daily sitting time.^[15]

Obesity is associated with decreased back and core muscular endurance in the general population.^[16] The core is considered to be like a box. The bottom of the box is

Pelvic floor, the top is the Diaphragm, the front is the Abdominals and the back is the Paraspinals and Gluteals. Deep stabilizing muscles include the Transverse Abdominals, Multifidus, Internal Oblique, Deep Transversoparaspinalis and Pelvic floor muscles which are primarily made up of slow twitch fibre.^[17] The core produces increased stability with contraction of superficial and deep muscles, made up of both slow and fast twitch muscles.^[18] Obesity leads to weaker core musculature. The visceral fat causes lengthening of the abdominal muscles and eventually becomes weak. Due to which the forces acting on the core is disturbed. When the abdominal muscles are not efficiently managing the load, the excess stability has to be provided by the rest of the structures in the core unit. This compromises on the stability, efficacy and balance. This if continued over a period of time will not only give systemic complications as mentioned above but also will cause low back pain, prolapsed of internal abdominal and pelvic organs, and breathing difficulties.^[19]

The Timed Forearm Plank Test, also known as the Prone Bridge Test, is a simple and cost effective fitness test of core muscle strength which can be easily self-administered. It can also be considered as excellent technique for strengthening the weak core muscles.^[20] The plank test measures the control and endurance of the back/core stability muscles.^[21] There are various benefits of this test like, it does not need any expenses, simple to do, it helps in strength progression by comparing to the normal values according to the subjects respective age group.

The normal values of timed forearm plank test for females are as follows:^[22]

| Fitness Assessment Rating | Time(Minutes : Seconds) |
|---------------------------|-------------------------|
| Excellent | 2:01+ |
| Above average | 1:31-2:00 |
| Average | 1:20-1:30 |
| Below average | 1:03-1:19 |
| Poor | <1:03 |

Training might delay the age-induced impairment of personal mobility associated with a reduction in physical activity.^[23] Decreased strength of the core muscles is a common finding in obese individuals.^[24] Refocusing and renewing efforts at promoting physical activity are stressed in the sustainable development goal by 2030. Unfortunately there are various worldwide variations in the level of physical activities and the means to measure them.^[25]

There is a need to assess the muscular endurance by performing timed forearm plank test which in urban sedentary females to avoid early mortality and non communicable diseases in the near future. There has been no study done so far which finds the co-relation of Timed Forearm Plank Test with Body Mass Index (BMI). All this created a need to report the level of correlation between timed forearm plank test and higher BMI in Urban sedentary females.

Our present study was conducted with an aim to evaluate the co-relation of Timed Forearm Plank Test with Body Mass Index (BMI) in sedentary urban females of age group 25 to 55.

2. Literature Survey/ Review of literature

- 1) Mark S. Tremblay, Salome Aubert et al.(2017) - Sedentary Behaviour Research Network (SBRN)
A literature review was completed to identify key terms in sedentary behaviour research. These keys terms were later reviewed and modified by committee formed by SBRN. Sedentary behaviour is defined as any walking behaviour characterised by an energy expenditure <1.5metabolic equivalents (MET's), while in sitting, reclining or lying posture. Physical inactivity for adults above 18 years of age is not achieving 150 minutes of moderate to vigorous intensity physical activity per week or 75minutes of vigorous intensity physical activity per week or an equivalent combination of moderate and vigorous intensity activity.
- 2) More active people for a healthier world-Global action plan on physical activity 2018-2030
With Vision 'More active people for a healthier world' an Mission 'To ensure that all people have access to safe and enabling environments and to diverse opportunities to be physically active in their daily lives, as a means of improving individual and community health and contributing to the social, cultural and economic development of all nations' The target of this framework action plan is 'A 15% relative reduction in the global prevalence of physical inactivity in adults in 2030. Mass awareness, public team events, prevention promotion, implementation of physical activity into routine, early detection and timely intervention are the key factors for controlling the mortality.
- 3) World Health Organization (WHO) - Physical Activity world Health Organization; 2018. Data taken from Global World Health Observatory.
Stated that, most of the world's population live in countries where overweight and obesity kills more people than underweight.BMI provides the most useful population level measure of overweight and obesity as it is the same for both the sexes and all ages of adults. The leading cause of obesity in the world is due to increase in physical inactivity due to the increasingly sedentary nature of many forms of work. Changing modes of transportation and increasing urbanization. Raised BMI is a major risk factor for non communicable diseases such as heart diseases, stroke, diabetes, musculoskeletal disorders like osteoarthritis, and some cancers like endometrial, breast, ovarian, kidney or colon.

Overweight and obesity can be reduced only when ne engages in regular physical activity (150 minutes a day spread through the week for adults). The WHO 2030 Agenda is to prevent premature mortality for such non communicable diseases through early detection, prevention and treatment of such overweight and obese population.
- 4) John M. Mayer, James L. et al. (2012) The impact of obesity on back and core muscular endurance in fire-fighters. The purpose of their study was to assess the relationship between obesity and measures of back and core muscular endurance in fire fighters. It was a cross

sectional study conducted in career fire fighter without low back pain. Obesity measures included Body Mass Index (BMI) and body fat percentage assessed with Air Displacement Plethysmography. Muscular endurance was assessed with the modified Biering Sorensen (back) and plank (core) test. They used t-test to find the relationship along with regression analysis. Out of 83 participants enrolled, 24 (29%) were obese (BMI.30) back and core muscular endurance was 27% lower for obese participants. Significant negative correlation was found for BMI and body fat percentage with back and core endurance($r=-0.42$) to -0.52). Their self reported physical exercises accounted 29-37% of variance in core muscular endurance. They concluded that obesity is associated with reduced back and core muscular endurance in fire fighters, which may increase their risk of musculoskeletal injuries. Obesity should be considered along with back and core muscular endurance when designing exercise programs for back and core prevention in fire fighters.

- 5) K A Chase, C E Brigham et al (2019) Fitness Norms for the Plank Exercise' established the normative fitness measurements of core musculature endurance using Plank Exercises. The purpose of this study was to find if adequate strength of core musculature is critical for optimal physical performance and postural control. This study sought to determine normative fitness measurements of core musculature endurance using plank exercise. 102 collegiate male and female participants of age 18 to 25 who were self described athletes were selected. The mean time held in plank position was found out to be 1.58minutes in females and .83 minutes in males

3. Materials and Methodology

It was a co-relational study that took place in Swapnapurti housing society, Kharghar, Navi Mumbai on 23rd October 2019on 60sedentary females of age group 25 to 55.inclusion criteria was females who were willing to participate in the study with age group 25 to 55 and exclusion criteria was males participant, females with musculoskeletal low back pain, pregnancy, recent surgery for the limbs or back, high blood pressure, vertigo and females who were unwilling to participate in the study. The materials used for measuring BMI were Stedometer and Tanita Body Composition Monitor (Model: BC-541N). The materials used to assessment of timed forearm plank test was ruler, yoga mat, stopwatch and writing material

Procedure- Females were randomly selected depending on their inclusion and exclusion criteria. Ethical clearance was taken from the ethical clearance committee. Information was given to the subjects regarding the study. Written informed consent was taken from the subjects willing to participate in the study. BMI was calculated with the help of Tanita Body Composition Monitor (Model: BC-541N) and times forearm plank test was first demonstrated to the subjects and later it was individually assessed. Hold time was recorded in seconds. Initially 60 subjects were included in the study but only 40 could perform the timed forearm plank test. Written consent was obtained from the sample population. Vital

parameters checked. Evaluation Performa was administered. Body Mass Index (BMI) calculated. Timed Forearm Plank Test was administered after prior demonstration. Hold time noted.

Procedure for timed forearm plank test²⁶-

Timed forearm plank test was first demonstrated to the subjects. They were provided with a yoga mat and individual assessment was done at a time for each one of them. The subjects were instructed in plank position; elbows bent at 90 degree directly below the shoulder, hand unclasped, feet placed hip width apart with ankles at 90 degree and pelvis tilted in the neutral position. As soon as the subject lifted the torso off the yoga mat, a test examiner began timing with a stopwatch. The subject was verbally encouraged by the test examiner to hold the test position as long as possible. If the subject was unable to maintain the test position, the subject would be given a maximum of two warnings from the examiner to re-establish the position. If the subject was unable to do so, the examiner stopped the test, and time was recorded in seconds.

4. Result

The study shows mean age of all female subjects to be 35.65 years and mean BMI to be 32.01 kg/m², which falls under the obese category I range.

Percentage wise distribution of BMI categories have been shown in figure number 01. According to standard BMI categories ^[12], 22 % (n=8) of the subjects had normal BMI, 47% (n=18) were overweight, 20% (n=7) were in obese category I, 8% (n=4) were in obese category II and 3% (n=3) were in obese category III.

Fitness assessment rating has been shown in figure number 02. Based on fitness assessment rating ^[22], (n=8) were excellent, (n= 18) were above average, (n=7) were average, (n=4) were below average and (n=3) were poor.

Obese female subjects according to BMI categories had poorer core muscular endurance when checked by administering timed forearm plank test compared to normal female subjects. A negative correlation was noted between BMI and muscular endurance test like timed forearm plank test, With 1 point increase in BMI, core musculature endurance of timed forearm plank test decreased by 8.6 seconds.

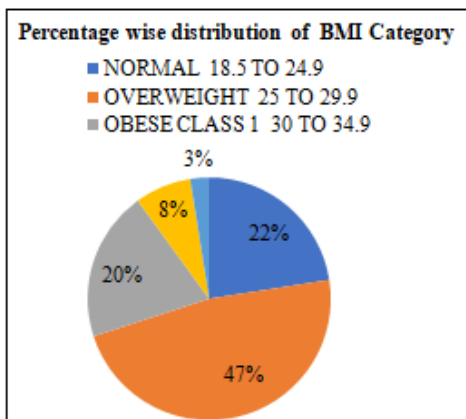


Figure 1

Interpretation- The figure 02 indicates that the female subjects falling under normal BMI category (18.5 to 24.9) were 22%, overweight category(25to 29.9) were47%, Obese category 1(30to34.9) were 20%, Obese category 2(35 to39.9)were 8 % and Obese category3(40<) were 3%

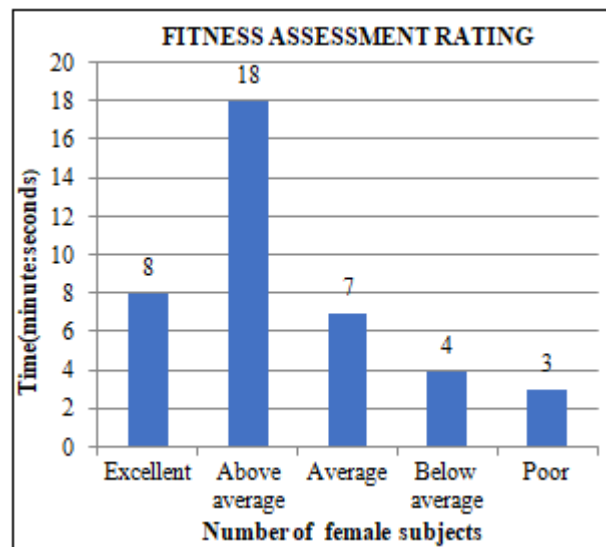


Figure 2

Interpretation- The figure 03 indicates fitness assessment rating for female subjects under Excellent were (n=8), above average were (n=18), average were (n=7), below average were (n=4) and poor were (n=3).

5. Discussion

The findings of the study indicated that obesity has a significant negative impact on core muscular endurance when checked with timed forearm plank test in sedentary females of age 25 to 55. Several factors may explain the poorer core muscular endurance in obese females. First, the biomechanical strategies required for the muscular endurance test like timed forearm plank test used in the study are likely impacted by the body mass. The timed forearm plank test depends on gravity's action on body mass on the entire load and the ability to support body loads that need to be supported against gravity. The negative significant relationship between BMI and core muscular endurance indicate that body mass play a larger role in timed forearm plank test testing. Other conceivable explanation for the poorer muscular endurance in obese female subjects include possible differences between obese and normal individuals in physiology and morphology of the core muscles, general fitness levels, perceived exertion levels on fitness exercise, along with possible negative influence of other co morbidities associated with obesity.

The present study's findings on the relationship of the body mass and core muscular endurance with timed forearm plank test in sedentary females appear to be similar to the relationship observed in the general population. We uncovered 2 previous studies that assessed relationship between core muscular endurance tests and body mass in general population ^[17, 18]. In one of the two studies, ^[17, 18] significant moderate negative correlation between

measures of Body Mass Index(BMI) and core muscular endurance tests were observed.

In the current study, 47% of sedentary females were overweight, 20% were in obese category I, 8% were in obese category II and 3% were in obese category III according to BMI categories. These findings are consistent with previous study^[11] of obesity in sedentary females which reported 48% of sedentary females were overweight, 24% were in obese category I, 12% were in obese category II and 5% were in obese category III. In this study, poor body mass index was correlated with high BMI ($r=0.36$, $p<0.01$).

6. Conclusion

Obesity as measured by increases BMI is associated with decreased core muscular endurance of timed forearm plank test in sedentary females. There is a moderate negative correlation between the Body mass index and the Timed Forearm Plank Test. Timed forearm plank test can be incorporated into regular exercise program by the sedentary females for improving their core muscular endurance. This will ensure that the females are improving on BMI category as well.

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