# Comparison of core strength between females wearing high heeled footwears versus flat footwears

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*Abstract:* Core strength is defined as an individual's ability to stabilize the torso from the hips to the shoulders for the purpose of force production, control and transfer to one or more extremities. Use of high heels has been documented since time immemorial. Women nowadays tend to neglect function of their footwear and focus more on their appearance disregarding its effect on their balance or postural stability. However, previous researchers have shown that the balance controls of a person wearing high heeled shoes are significantly altered from the naturally occurring control in barefoot condition. This study is important to be researched on because there is insufficient data on the differences in the strength of females wearing high heeled footwear when compared to the subjects wearing flat footwear. As the type of footwear that the individual wears have a significant effect on the core muscles strength as well as on their normal body mechanics. The professions involving prolonged hours of wearing high heel footwear has a negative effect on the normal body mechanics.

**Keywords:** Core strength, Plank test, BMI

## I INTRODUCTION

Core stability is defined as the capacity of body to maintain and control the position and motion of the trunk over the pelvis to allow production, transfer and control of optimum force and motion to the terminal segments of body in integrated athletic activities (Baechle TR et al. 2000). Core muscle activity are often explained because the pre-programmed integration of local, single-joint muscles and multi-joint muscles to supply stability and produce motion. This leads to a proximal to distal patterning of generation of force, proximal stability for distal mobility, and the creation of interactive moments that move and protect distal joints. Assessment of the core muscles should include evaluation of the specific functions (trunk control over the planted leg) and it should be dynamic along with that it should be tested in directions of motions (three-planar activity). Rehabilitation should include the restoring of the core itself, but also include the core as the base for extremity function (Baechle TR. 2000). High heels are long and thin and have a thinner diameter. Anatomically the base of support / centre of gravity lies at the human's center of gravity (COG) is the point where the mass of the body is centered and but after wearing high heels it becomes base of support narrows (C.Norkin). Posture in high heeled walking decreases lumbar lordosis (Edeny baaklini et al.2017). However, this body mechanics is altered when the user wears high heels. The negative side effects of wearing high heels include an increased risk of falling (A.f.tencer et al.2004). Increased risk of foot, tibia and fibula fracture (T.h.keegan et al.2004) increased peak loads on the patella femoral joint and thus a greater chance of patella femoral pain (K.y.ho et al.2012). So there is dearth of research which will provide the information regarding comparison of the core strength between the individuals wearing high heels and flat footwear. In shoes-on condition many people have what appears to be 'normal' balance but in shoes-off condition they have the 'natural' balance. With shoes the visibly faulty postural alignment can be corrected and normal' but it

can never be made natural as long as conventional shoes are worn. It is Biomechanically' equilibrium, body mechanics and weight distribution caused by shoes. Barefoot, the perpendicular line of the straight body column creates an angle of 90 degrees with the floor. On a two-inch heel were the body rigid column and forced to tilt forwards the angle reduce to 70 degrees and to 55degrees on a three-inch heel. Thus, the body to maintain an erect position, a whole series of joint adjusts. There is shortening of calf muscles in high heel wearers as reported by caspo et al in his study on muscle, tendon and High heels.21 Gefen et al explained that it is possible that this deterioration is accelerated in habitual high-heeled shoe wearers, since this shoe type constrains the gastrocnemius - soleus muscle length to be shorter than the usual. When the resulting limited passive motion is combined with decreased muscle force due to fatigue, it may limit the ability to respond to postural perturbation and to generate the forces needed to control the center of mass. Therefore, such changes may partly be responsible for the mechanism of falls among elderly women who also habitually use high-heeled shoes, and this could be investigated in future studies. Key words used are Core strength, Plank test, BMI

## II   OBJECTIVES

This study focus at comparing the core strength of the females wearing heeled footwear with those of flat footwear. This study will further help in deciding which footwear is adversely affecting the muscle strength more.

## III   METHEDOLOGY

Comparative study was done on 60 subjects which were selected by convenient sampling. The subjects were sourced from Manav Rachana International Institute of Research and Studies and K.L. Mehta Dayanand

College of Women N.I.T 3, Faridabad. The details of the procedure regarding benefits, aims and purpose of the study were explained to them. A written consent and demographic details was taken from all subjects who volunteered for the study and fulfilled the inclusion criteria which was active healthy female subjects wearing heels in weight bearing position: group A 20-30 hours in one week respectively and group B as wearing flat footwear. Heel height 2.5inches or (4cm). Age 18-28 years and body mass index 18.5-24.9 and exclusion criteria which was any history of fall or injury, limb length discrepancy. Any neuromuscular condition and subjects who had undergone an operation on the ankle, knee, hip or spine previously. A total of 80 subjects were screened out of which 60 fell into inclusive criteria and 20 were excluded because of the exclusion criteria mentioned above. Subjects were divided as follow: group 1: wearing heeled footwear for 30-40 hours per week since one year and group 2: wearing flat footwear for 30-40 hours per week since one year. Demonstration regarding plank test was given to subjects prior to examination. The subjects were given verbal instructions and one practice session of testing procedure. As soon as the subject was in the correct position, the stopwatch was started. The test was over when the subject was unable to hold the back straight or the hip was lowered. Protocol was repeated thrice and 30 seconds rest was given in between the trials. Time duration was noted. Best one of the three performances was considered. Mean values and Standard deviation of Age, Height, Weight, BMI (Independent variables) and test duration result was calculated.

## IV   DATA ANALYSIS

Data analysis was performed using Microsoft excel 2019 for window software importing master sheet containing subject data descriptive stats was used to analyze and find out mean and standard deviation of

subjects characteristics such as plank test duration, age, height, weight and BMI .

The formula used for calculating mean

$$\overline{X} = \frac{\Sigma X}{n}$$

Where:
- x̄ (X-bar) is the symbol for the mean
- Σ (the Greek letter sigma) is the symbol for summation
- X is the symbol for the scores
- n is the symbol for the number of scores

The formula for calculating Standard Deviation is:

$$\sigma = \sqrt{\frac{\sum (X - \mu)^2}{n}}$$

where,

$\sigma$ = population standard deviation
$\Sigma$ = sum of...
$\mu$ = population mean
n = number of scores in sample.

## V   RESULT

- Comparison of core strength between females wearing high heeled footwear and flat footwear was calculated by the duration of plank test hold (in seconds) is shown below in the table 1.1 through mean and standard deviation value. And graphical representation is shown in graph 1.1
- Physical characteristics of Group A are shown in table 1.2.
- Physical characteristics of Group B is shown in table 1.3

**TABLE 1.1 (Please refer last page of this article)**

**GRAPH 1.1 (Please refer last page of this article)**

**TABLE 1.2 (Please refer last page of this article)**

**TABLE 1.3 (Please refer last page of this article)**

## VI   DISCUSSION

The study was done with keeping the individuals wearing high heeled footwears as a negative factor on the core musculature strength as a goal in mind. But the results suggest that high heeled footwear users have better core strength than the flat footwear users. The probable reason for this could be explained on the basis of physiological adaptations taking place. This can be also be explained on the basis of duration of wearing the high heeled footwear. The plank test was used to assess the core muscle strength. The large variation in the result was observed which can be explained on the basis of the individual variation, lifestyle and body mass index. This is thus observed that large difference in the core strength is present between the individuals wearing high heeled footwear and flat footwear. Hence, the type of footwear is the major factor in determining the core musculature strength.  Kisu Park, Young Kim in 2016 researches about "the effects of the height of shoe heels on muscle activation of cervical and lumbar spine in healthy women" and concluded that wearing high- heeled shoes increases the activation of cervical and lumbar musculature in healthy women. According to Mika and colleagues, even healthy people wearing high- heeled shoes experience increased back muscle activity during gait, which could promote local muscle fatigue, in turn leading to tissue deformation, such as swelling or decreased movement. In addition, these symptoms may be more remarkable while wearing stiletto type high heels with unstable balance. Their study investigated only the immediate effects of wearing high heels on walking. Thus the present study

was an attempt to find out the effect of footwears on the core strength.

# VII  CONCLUSION

This study concluded that the individual wearing high heeled footwears for regular basis and prolonged hours

have found to have a better core strength than the individual who wear flat footwear on regular basis. Thus to assess core musculature weakness the type of footwear should not be the criterion. The core strengthening should be done pertaining to individual complaints.

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## TABLE 1.1

| VARIABLES | MEAN | STANDARD DEVIATION |
|---|---|---|
| HIGH HEELED FOOTWEAR WEARING FEMALES | 52.59 | 21.47 |
| FLAT FOOTWEAR WEARING FEMALES | 36.07 | 22.94 |

## GRAPH 1.1
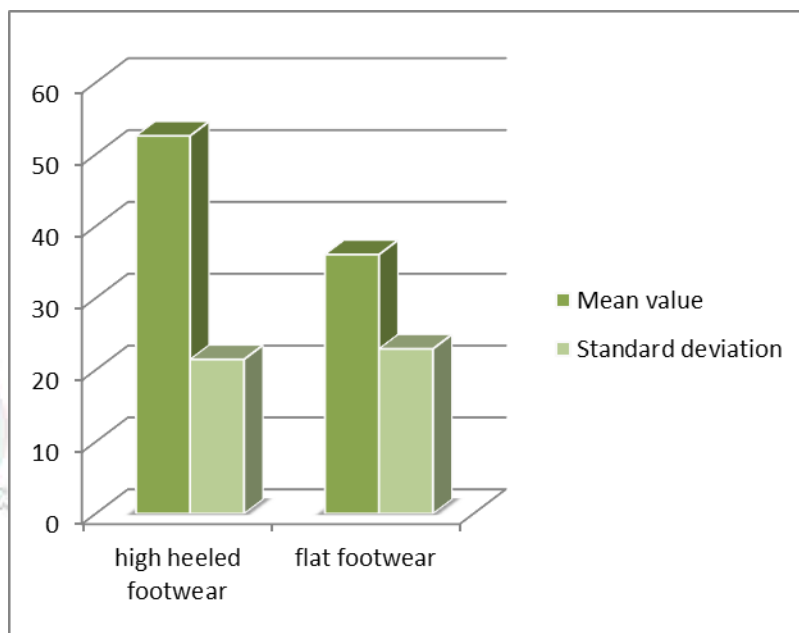


## TABLE 1.2

| Variables | Mean | Standard Deviation |
|---|---|---|
| Age | 19.33 | 0.80 |
| Height (in cm) | 157.5 | 6.59 |
| Weight (kg) | 50.83 | 7.42 |
| BMI (kg/m2) | 21.33 | 1.57 |

## TABLE 1.3

| Variables | Mean | Standard Deviation |
|---|---|---|
| Age | 21.16 | 1.57 |
| Height (in cm) | 159.96 | 5.72 |
| Weight (kg) | 56.13 | 5.88 |
| BMI (kg/m2) | 21.94 | 1.89 |

# MASTER CHART

## (For high heeled footwear wearing females)

| S.No. | Age | Height(cm) | Weight(kg) | BMI(kg/m2) | Plank Trial 1 | Plank Trial 2 | Plank Trial 3 | Best of trails (in seconds) |
|---|---|---|---|---|---|---|---|---|
| 1 | 19 | 162 | 51 | 19.4 | 43.7 | 22.6 | 36.4 | 43.7 |
| 2 | 19 | 162 | 50 | 19.1 | 22.1 | 16.2 | 17.8 | 22.1 |
| 3 | 20 | 158 | 56 | 22.4 | 33.9 | 37.5 | 30.7 | 37.5 |
| 4 | 22 | 154 | 48 | 20.2 | 72 | 43 | 62 | 72 |
| 5 | 18 | 161 | 65 | 24.8 | 37 | 29 | 24.5 | 37 |
| 6 | 18 | 161 | 42 | 20.5 | 34.4 | 26.9 | 22 | 34.4 |
| 7 | 19 | 161 | 42 | 21.3 | 55.6 | 42.9 | 30 | 55.6 |
| 8 | 19 | 170 | 53 | 22.6 | 57.3 | 52.3 | 42.2 | 57.3 |
| 9 | 20 | 161 | 57 | 22 | 46.8 | 31.9 | 20.1 | 46.8 |
| 10 | 19 | 158 | 49 | 19.6 | 88 | 43.4 | 53.2 | 88 |
| 11 | 19 | 170 | 42 | 19.5 | 55.7 | 39.3 | 40.6 | 55.7 |
| 12 | 19 | 161 | 57 | 22 | 44 | 33 | 18.4 | 44 |
| 13 | 20 | 170 | 68 | 23.5 | 56.6 | 46.9 | 25.7 | 56.6 |
| 14 | 19 | 158 | 54 | 21.6 | 85 | 54.9 | 33 | 85 |
| 15 | 20 | 170 | 50 | 21.3 | 80 | 53.3 | 42.6 | 80 |
| 16 | 19 | 158 | 55 | 22 | 47.2 | 17.3 | 8.3 | 47.2 |
| 17 | 20 | 155 | 42 | 19.5 | 17.5 | 12.2 | 17.6 | 17.6 |
| 18 | 19 | 154 | 48 | 20.2 | 34.6 | 24.3 | 23.2 | 34.6 |
| 19 | 20 | 162 | 59 | 22.5 | 33.2 | 15.2 | 14.3 | 33.2 |
| 20 | 19 | 152 | 56 | 24.2 | 30 | 24 | 25.9 | 30 |
| 21 | 19 | 149 | 38 | 22.5 | 37.2 | 54.2 | 35.2 | 54.2 |
| 22 | 19 | 152 | 66 | 23.5 | 53.6 | 38.7 | 24.1 | 53.6 |
| 23 | 19 | 152 | 53 | 22.9 | 32.5 | 41.8 | 30.1 | 41.8 |
| 24 | 18 | 149 | 48 | 21.6 | 85 | 57.3 | 82 | 85 |
| 25 | 18 | 149 | 42 | 18.9 | 73 | 86 | 76 | 86 |
| 26 | 19 | 149 | 44 | 19.8 | 96 | 82 | 82 | 96 |
| 27 | 19 | 154 | 50 | 21.1 | 43.9 | 19.6 | 23 | 43.9 |
| 28 | 18 | 149 | 47 | 21.2 | 79 | 60 | 32 | 79 |
| 29 | 19 | 152 | 44 | 19 | 61 | 53.7 | 39 | 31 |
| 30 | 19 | 152 | 49 | 21.2 | 17.3 | 29 | 28.3 | 29 |
| Mean | 19.13333 | 157.5 | 50.83333 | 21.33 | 51.77 | 39.61333 | 34.67333 | 52.593333 |
| S dev | 0.805536 | 6.591661 | 7.425556 | 1.576314 | 21.64922 | 18.09403 | 18.73369 | 21.476296 |

## (For flat footwear wearing females)

| S.No. | Age | Height(cm) | Weight(kg) | BMI(kg/m2) | Plank trial1 | Plank trial2 | Plank trail3 | Best trial (in seconds) |
|---|---|---|---|---|---|---|---|---|
| 1 | 22 | 162 | 64 | 24.4 | 46.8 | 30.1 | 29.4 | 46.8 |
| 2 | 23 | 161 | 60 | 23.1 | 27 | 20.3 | 30.6 | 30.6 |
| 3 | 23 | 158 | 61 | 24.4 | 55.8 | 45.7 | 38.3 | 55.8 |
| 4 | 21 | 149 | 47 | 21.2 | 21 | 16.3 | 17.5 | 21 |
| 5 | 21 | 165 | 57 | 20.9 | 10.7 | 8.7 | 12.5 | 12.5 |
| 6 | 21 | 167 | 50 | 18.6 | 20.1 | 17.7 | 4.7 | 20.1 |
| 7 | 22 | 166 | 53 | 19.2 | 127 | 55.8 | 50 | 127 |
| 8 | 19 | 155 | 52 | 21.6 | 11.3 | 17.4 | 13 | 17.4 |
| 9 | 19 | 158 | 50 | 20 | 26.2 | 17.6 | 12.4 | 26.2 |
| 10 | 20 | 166 | 62 | 22.5 | 66 | 39 | 33.2 | 66 |
| 11 | 20 | 155 | 54 | 22.5 | 24.5 | 15.8 | 15.7 | 24.5 |
| 12 | 22 | 150 | 55 | 24.4 | 26.2 | 15.8 | 19.8 | 26.2 |
| 13 | 22 | 156 | 52 | 21.4 | 26.3 | 15.7 | 18.4 | 26.3 |
| 14 | 20 | 152 | 50 | 21.6 | 24.3 | 16.5 | 19.6 | 24.3 |
| 15 | 20 | 149 | 46 | 20.7 | 23.6 | 20.4 | 18.2 | 23.6 |
| 16 | 21 | 161 | 63 | 24.3 | 16.5 | 8.8 | 10.3 | 16.5 |
| 17 | 20 | 167 | 57 | 20.4 | 14.5 | 11.9 | 13.6 | 14.5 |
| 18 | 24 | 161 | 57 | 22 | 12.1 | 10.2 | 11.6 | 12.1 |
| 19 | 21 | 160 | 63 | 24.6 | 45.4 | 38.8 | 26.6 | 45.4 |
| 20 | 21 | 170 | 62 | 21.5 | 28.5 | 28.2 | 38.7 | 38.7 |
| 21 | 22 | 156 | 60 | 24.7 | 62 | 19.1 | 36.4 | 62 |
| 22 | 21 | 161 | 49 | 18.9 | 42.1 | 35 | 29.6 | 42.1 |
| 23 | 22 | 167 | 53 | 19 | 38.2 | 28.3 | 18.8 | 38.2 |
| 24 | 22 | 168 | 68 | 24.1 | 50.9 | 36.2 | 28.9 | 50.9 |
| 25 | 22 | 157 | 47 | 19.1 | 32 | 26.2 | 24.3 | 32 |
| 26 | 20 | 161 | 55 | 21.2 | 58.8 | 46 | 35 | 58.8 |
| 27 | 20 | 155 | 52 | 21.6 | 11.3 | 17.4 | 13 | 17.4 |
| 28 | 22 | 164 | 64 | 23.8 | 15.5 | 19.9 | 19.2 | 19.9 |
| 29 | 21 | 164 | 62 | 23.1 | 25.1 | 30.2 | 27 | 30.2 |
| 30 | 21 | 158 | 59 | 23.6 | 52.7 | 55.1 | 13.8 | 55.1 |
| Mean | 21.16667 | 159.9666667 | 56.1333333 | 21.94666667 | 34.74666667 | 25.47 | 22.67 | 36.07 |
| S dev | 1.157104 | 5.724120505 | 5.88066512 | 1.896616871 | 23.53924005 | 12.98093859 | 10.4003574 | 22.94389025 |