



## IMMEDIATE EFFECTS OF DIFFERENT HEEL SIZES ON FUNCTIONAL MOBILITY AND BALANCE IN YOUNG ADULT FEMALES

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**Abstract:** A total of 70 females of age group between 18 to 30 years, who meets the inclusion and exclusion criteria were involved in the study, they were asked to perform the Modified clinical test for sensory interaction and balance (M.CTSIB) and time up and go test (TUG) with barefoot, flat footwear, 4cm, and 7cm and 10 cm heel height and the result shows showed that there were comparable effects of barefoot, flat footwear, 4cm, 7cm and 10 cm on balance and functional mobility as there was longer TUG time and shorter M.CTSIB. Hence, it can be concluded that wearing high heels effects balance and functional mobility in females.

**Keywords - Balance , Functional mobility, Heel and balance in females, M.CTSIB and TUG test.**

### INTRODUCTION

Many women have worn high-heel shoes (HHS) at some point in their lives and many wear them daily basis, with higher prevalence between 39% and 78 % observed in institutional and clinical settings and representing a huge proportion of the female population and this usage of high heels leading to alterations in the persons balance and functional mobility.

Balance can be defined as a situation in which one's body dynamics are proportionate just to prevent the person's body from falling and also the ability uphold, attain and reinstate the body center of mass (COM) relative to the base of support (BOS). In order to achieve balance achieve balance a person needs a complex set of sensory motor control system that include the sensory input from vision, proprioception, and vestibular system; the integration of the sensory input and the motor output of the body muscles. <sup>[1]</sup><sup>[2]</sup>Whereas functional mobility is the capability of the person's body to attain the proper movement of the body with correct uprightness or integrity in the relaxed surroundings which can be hindered due to change in the body biomechanics. Alterations in mechanics is due to one of the chief cause which is high heels that add to many other causative factors in altering persons functional mobility and balance <sup>[1]</sup>.

High heel shoes (HHS) are considered by the women as an essential part of their regular outfit. All around the world each and every women once in their lives have worn high heels and some prefer to wear them regularly so as to increase their attractiveness. There was a survey conducted by the hotter shoes which suggested that to look attractive women goes to such extent that they wear different heels which extremely very high which are leading to problems such as sore foot and tired foot because of wearing them whole day. This survey also reveals that 50% of women report of ankle twist due to high heels leading to further complications such as broken ankles, twisted knees, infected blisters, bunions and torn tendons. Nearly 60% of women continue with wearing high heels even after experiences pain and different foot problems <sup>[1]</sup>.

High heels shoes will add or will lead to postural disorders such as forward head posture which is anterior positioning of the neck, lumbar hyper lordosis which is inner curving or the lower back or lumbar spine, pelvic antversion it is also known as anterior pelvic tilt in which pelvic is tilted forwardly leading to altering the body biomechanics which one of the contributing factor of increased lumbar lordosis, valgus in knee and also ankle and foot related problems which conclude that heel influence posture and body balance. <sup>[3]</sup><sup>[8]</sup>

When women wear high heels there will be insignificant heel elevation occur, this heel elevation decreases the balance and this can increase the chances of frequent falls as it extensively disturbs the constancy of the whole body. Since the elevation of (COM) increases with the HHS and (BOS) will become lesser with condensed or smaller supporting base of high heels shoes when compared with the barefoot or flat shoes, wearing high heels can embrace difficulties in maintaining balance. While the young adult females stand in high heeled shoes, this can lead to temporary postural changes such as shifting of centre of gravity(COG), increase forward head posture, valgus deformity and hallux valgus deformity which is due to more stress over first metatarsophalangeal (MTP) segment and after the heels are being removed the body attains back its original conformation. <sup>[4]</sup>

Wearing high heels shoes includes more muscular effort and lead to worsening of the balance and the functional mobility, especially when high heels reaches or attain the heel height of 10 cm, calf muscle play more significant role than vastus lateralis and tibialis anterior muscles in maintaining standing balance as they become more active to compensate the biomechanical changes occur in the body after wearing the high heel shoes. <sup>[5]</sup>

High heel shoes initially hampers the muscles to the body these changes and alterations in the muscle will leads to significant bodily changes. The muscles significantly get effected of become short is gastrocnemius medialis fascicles and increased stiffness over Achilles tendon which causes reduction in the active range of motion [ROM] of the foot. While in those who wear high heeled shoes regularly have high increment in the knee flexion during the stance phase of high heeled gait which further become the contributing factor knee abnormalities. chronic muscle shortening whenever there is an inclination in the shoes heels size leading to uneasiness, tiredness, cutback in shock amalgamation and increase the risk of injury. There could be chances that muscles get atrophied and also the decrease in the muscle strength of calf muscles and can also lead tom paralysis <sup>[5]</sup>

There is biomechanical and epidemiological perspective which offers the first review of the psychosexual literature. This provide necessary background in which to rest of the conclusion on was based and that is significantly proves that it has Negative health effects, and appreciate the community physical condition issue and dilemma they masquerade for society. The literature given on biomechanical changes is now clearing that wearing high heels (HHS) causes extensive kinetic and kinematic alteration or changes in the MSK system that is (musculoskeletal system), ranging from the spine to the toes. These musculoskeletal changes which occur in the body can lead to many conditions such as OA (osteoarthritis), HV and MSK pain as well as first-party injury. Although the risk of first-party injury require urgent situation department consideration and attention is at most moderate. <sup>[6]</sup>

Just around the corner on precise features of HHS gait, unaccompanied and in arrangement with amplified weight that potentially add to osteoarthritis risk in women. Specially it changes or alter the knee (flexion-extension angle) or (flexion-extension moment), and also the knee (abduction-adduction moment). Studies have suggested seeing fast aging and the development of OA. Somewhere down the line it remains unidentified that how loading changes occur, when there is regular use of HHS and its further effect on cartilage health. <sup>[7]</sup>

High heels shoes are also associated with chronic neck pain, low back pain and knee pain because high heels caused increase in the knee flexion angle, ankle flexion angle and femoral obliquity angle. This also increases the chances of fall and instability, leading to injuries such as fracture and ankle sprain. <sup>[8]</sup> It was found that temporospatial parameters and joint kinematics gets affected while wearing high heeled shoe and with increased heel height load weight, cadence decreased whereas stride length increased. Knee flexion angle also gets increased with the heel height. <sup>[9]</sup>

Due to constant wearing of high heeled shoes there is shortening of posterior leg muscle which occurs further increases the chances of ankle sprains and foot fractures. Many studies have stated that Quality of life has also been hampered of the women who regularly wear high heels shoes they have been suggested to have better long run quality of foot health they must avoid high heels shoes. <sup>[10]</sup>

Many studied state that there are more prominent effect on the foot if you increase the size so as the size of the heel increases the change in biomechanics and pain will increase and cause significant alterations. One must keep some conditions such as vertigo as these patients might have problems in dynamic and static balance. Because such balance require proper neuromuscular coordination which will be altered in these patients. <sup>[11]</sup>

Need for study: Pervious researches have shown that there is an ill effect on biomechanics on the young women using high heels regularly and also shown effect on balance and functional mobility. In previous studies these effects were determined by sensory organization test, so there is scope to do that research with modified clinical version of the sensory organization (CTSIB) and timed up and go test to see the instant effect of different high heels size on balance and functional mobility among young adults with normal BMI.

Aims- to find the effect of different heel size on standing balance and functional mobility with heel size 1cm (flats), 4cm, 7cm, 10cm on young females.

Objectives- To measure the effect of different heel sizes on TUG test in young adult females. To measure the effect of different heel size on CTSIB test in young adults.

Hypothesis- There will be significant effect of different heel size on balance and functional mobility in young adult females.

Vaniessa Dewi Hapsari & Shuping Xiong, 2016 <sup>[4]</sup> research study was done on 30 healthy women, out of 30 women 10 are experienced high heel wearer which means that they wear high heels for more than 1 year at least 4 times a week for 6 hours and another group is inexperienced wearer out of 30 only 20 women who wear high heels at least for 1 day in a week then there

functional mobility is calculated by timed up and go test and functional and reach test. Standing balance is calculated by sensory organisation test and loss of stability test. The study concluded that the results in worse functional mobility starting at 7 cm heel height. While with the heel Height increased to 10 cm.

Susan L. Whitney & Diane M. Wrisley<sup>[2]</sup> research Study was conducted on 30 persons going under vestibular physical therapy. Basically it was designed to check whether there is any difference between clinical test of sensory of modified clinical test of sensory interaction and balance (CTSIB) and sensory organisation test (SOT). These tests were conducted to test static balance of individual shoes on and off and also with heels size which varies from 3-5cm. this test concluded that there is no difference in the score of CTSIB test and SOT. The modified CTSIB can be performed with or without shoes, with no difference expected in patient score and in balance dysfunction.

## METHODOLOGY

Data was collected from the offices going ladies, college students and some home makers who lie under inclusion criteria of the research with 70 Subjects (Females of age group between 18-30 years), a cross sectional study with random sampling selection criteria includes normal healthy adult women under age group of 18-30 years, Inclusion Criteria: Normal healthy females, Subjects are grouped between 18 to 30 years of age, Normal BMI females (18.5 to 24.9), Four shoes with different heel size is used 1 cm, 4 cm, 7 cm and 10 cm and they can be classified as flat, low, medium and high heel, Consent form must be signed by every participant, healthy individuals who have sufficient English and Hindi communication skills.

Exclusion Criteria: No recent injuries to lower limb such as ankle sprain and deformity of hip, knee and ankle, foot and back. One should not have any musculoskeletal problem, Over weight patient, Patient with any neurological disorder. One should not have neuromuscular disorder, H/O of any disease which is causing imbalance, H/O of dizziness or vertigo, Insufficient English and Hindi language skills, Lack of interest to participate in the study. Independent variable: Modified Clinical Test for Sensory Interaction and Balance and Timed Up and Go. Dependent variable: high heels.

## PROCEDURE

Seventy subjects were explained about the entire protocol of timed up and go and modified clinical test for sensory interaction and balance. Also explain them about the aim and objective of the study. All the subjects were selected on the basis of selection criteria (inclusion and exclusion criteria), then all the subjects were asked to sign consent forms to ensure their consent for the study. Subjects were assessed for the balance and functional mobility with barefoot, flatfoot wear and with heel sizes of (4cm, 7cm and 10cm) in which they were asked to perform TUG and MCTSIB test.

### 1: TIMED UP AND GO

In this test the chair was kept at the distance of 3 meters and 3 meters was marked after measuring the distance from the chair in a straight line. Then subject was instructed that she has to walk this 3 meter distance first she has to stand up from the chair then she has to walk and cover the entire 3 meter distance in the straight line, then she has to turn around and come back and sit down on the chair from the place she has started the test. The subject had to perform this test barefoot, 1cm (flat footwear), 4 cm high heels, 7 cm high heels and 10 cm high heels. Stop watch will be started by the time the subject stand up and the time will stop when subject came back and be seated at the same place and position from where she has started the test. Total time was noted which the subject had taken to cover the distance. No trials were given to the subject.



FIGURE: HIGH HEELS USED 4CM , 7CM AND 10CM OF SIZES OF HEELS.

### MODIFIED CLINICAL TEST FOR SENSORY INTERACTION AND BALANCE

In this test the subjects were informed that their static balance is going to be measured with M.CTSIB. In this the subject were ask to maintain four conditions with different situations such as with test barefoot, 1cm (flat footwear), 4 cm high heels, 7 cm high heels and 10 cm high heels. Subjects were asked to stand with their arms across their chest and their feet together in each of the 4 test conditions: stand on a firm surface with eyes open, stand on a firm surface with eyes closed, stand on a foam surface with eyes open, stand on a foam surface with eyes closed.

The subjects were randomised on the basic of size of heels and size of shoes they are wearing.

The type of shoe the subject wore was recorded. All subjects were tested in silent environment. No conversation was allowed during the test. The total test time was taken by each subject was around 10 minutes. The same 60\*45\*18cm high density memory foam was used for all subjects. All the subjects were performing under administration of an investigator and all the subjects were asked to stand or hold position for 30 seconds which was calculated on the stop watch. The time has to stop then and there if subjects moved their hands off their chest, moved their feet from the starting position, fell, or opened their eyes during a trial with their eyes closed. Three trials of a maximum of 30 seconds were permitted on if the subject didn't perform it in first trial for each Condition. If subjects were able to maintain standing for 30seconds on the 1st trial, they were given a score of 30 seconds. For that condition, if they were unable to maintain the position for 30 seconds on the 1st trial, then they were provided with two more additional trials for a total of three trials and the scores over the 3 trials were averaged mean were be calculated that will be the score of that individual subject. An abnormal score for each condition was considered an average score of less than 30 seconds. The modified CTSIB result was considered abnormal if the subject scored less than 30 seconds on any condition, outcome measure includes, Heel height in centimeters, functional mobility by TUG, Balance score by M.CTSIB.

### DATA ANALYSIS AND RESULTS

The data was initially collected and analyzed with the help of different statistical tools. Descriptive statistic tools included and calculated with the help of mean and standard deviation and it was calculated for Age, Height, Weight, Timed up and go test and modified clinical test for sensory interaction and balance with different heel sizes (barefoot, 1cm [flat footwear], 4cm,7cm,10cm). To checkout to test for significance of balance and functional mobility with different heel height, use of analyses of variance (ANOVA) is preferred. If the calculated value exceeds the given value in the probability table which is 0.05, it is said to be insignificant.

The aim of this study is to find the immediate effects of high heels on balance and functional mobility in females. The demographic data of study population in summarized in table 1. With Mean Age, Body mass index this data is of 70 females. The balance is measured using M.CTSIB and functional mobility is measured using TUG test. These are the table showing demographic details about the mean and standard deviation of age of the subjects and standard deviation.

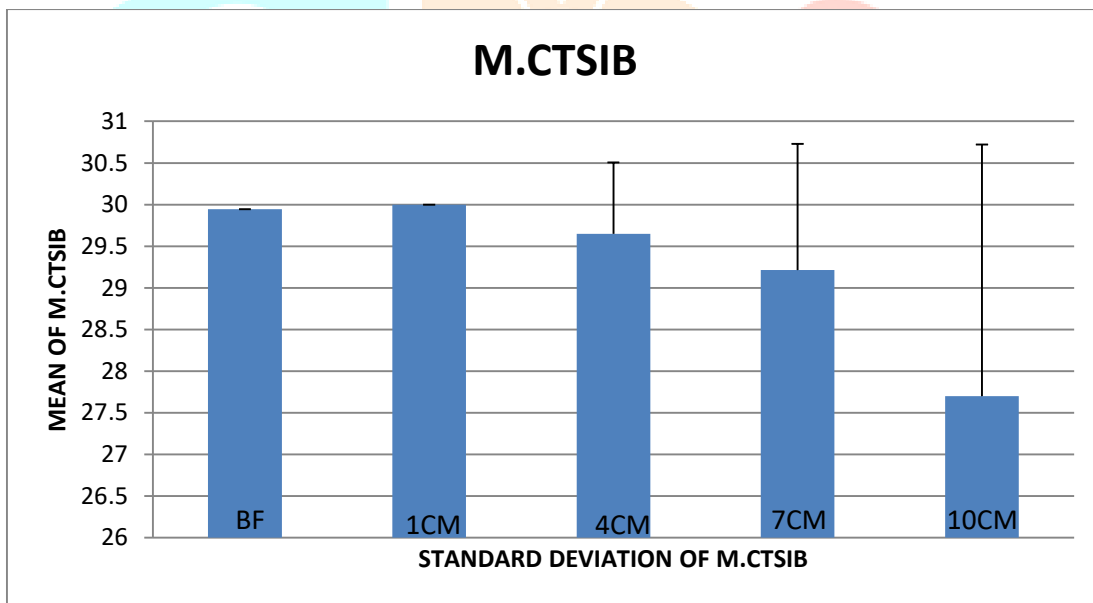
Table :demographic characteristics of subjects

MEASURES	MEAN ± STANDARD DEVIATION
AGE	22.9±2.9
BMI	21.0 ± 1.8

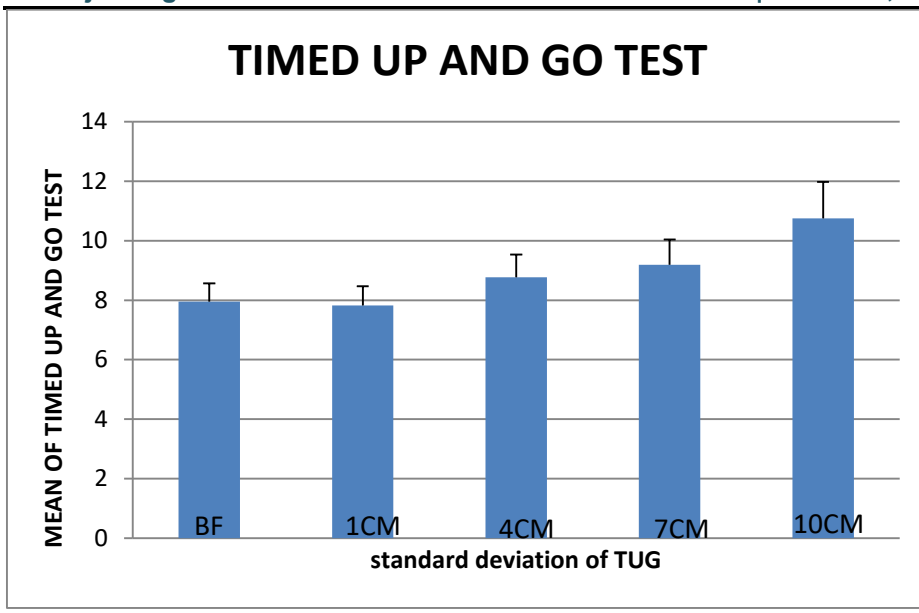
The mean and standard deviation of M.CTSIB & TUG tests were calculated in barefoot, flatfootwear, 4cm, 7cm and 10cm height are as follows:

TABLE : MEANS AND STANDARD DEVIATION OF M.CTSIB & TUG TESTS AT DIFFERENT HEEL HEIGHTS:

TESTS	BAREFOOT	FLAT FOOTWEAR	4CM HEIGHT	7CM HEIGHT	10CM HEIGHT
	MEAN ±SD	MEAN ± SD	MEAN ± SD	MEAN ± SD	MEAN ± SD
TUG	7.9547 ± 0.615704	7.8272 ± 0.642734	8.772 ± 0.769028	9.1885 ± 0.849797	10.750 ± 1.227038
M.CTSIB	29.9 ± 0	30 ± 0	29.64 ± 0.858834	29.212 ± 1.517028	27.698 ± 3.021686



GRAPH OF FIGURE : Showing average of modified clinical test sensory interaction and balance test show there is decrease in the time holding of modifies clinical test of interaction and balance. Barefoot and 1 cm foot wear shows least variance by as the heel size grows there is significant increase in the balance time and maximum decrease in the 10 cm of the heel size.



GRAPH OF FIGURE : Showing average of timed up and go  
 As shown in the graphs of figure 4.2 which is showing the mean and standard deviation of the data of timed up and go test there is increase in the time taken by the individual as the heel size increases which is significantly displayed that in barefoot mean value is 8 and 1cm shows 7.9 as a mean value whereas maximum amount of difference started as the heel size increases like in 7cm and 10 cm maximum amount of difference is seen.

**M.CTSIB**  
**VARIANCE IN BETWEEN THE 5 HEELS SIZE GROUPS**

**SUMMARY**

Groups	Count	Sum	Average	Variance
bf (Avg.)	70	2096	29.9	0.1
1cm (Avg.)	70	2100	30.0	0.0
4cm (Avg.)	70	2075.33	29.6	0.7
7cm (Avg.)	70	2044.88	29.2	2.4
10cm (Avg.)	70	1938.92	27.7	9.1

**ANOVA**

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	251.6760903	4	62.919023	25.45541	0.00	2.3978
Within Groups	852.7483614	345	2.4717344			
Total	1104.424452	349				

Timed up and go: (table)

#### VARIANCE IN BETWEEN THE 5 HEELS SIZE GROUPS

##### SUMMARY

Groups	Count	Sum	Average	Variance
Bf	70	556.83	8.0	0.4
1cm	70	547.91	7.8	0.4
4cm	70	614.04	8.8	0.6
7cm	70	643.2	9.2	0.7
10cm	70	752.56	10.8	1.6

##### ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	389.872141	4	97.46803529	130.0652255	0.0	2.397828
Within Groups	258.535454	345	0.749378128			
Total	648.407595	349				

Timed up and go test shows variance in each heel sizes as barefoot and 1 cm has no variance the value is 0.4. Whereas with the heel height increase to 4 cm the variance is 0.6 which is increased by 0.2 from 1cm and barefoot. Whereas there in 7cm there is increase in variance by 0.7 and in 10 cm there is variance of 1.6 which significantly showing the huge variance from barefoot and 1 cm of heel height. In Modified clinical test of sensory interaction and balance there is slight difference in barefoot and 1cm variance that is 0.1 and 0.0. In 4 cm shows significant variance of 0.7 value which shows significant change in from barefoot and 1cm. in 7 cm there is 2.4 and in 10cm it is 9.1. All these value of variance in ANOVA shows high level of variance by increasing heel size there is increase in the variance.

So, the result shows that there is significant effect on functional mobility and balance as the heel size increases in the young adult females as timed up and go increases as the heel size increases and Modified clinical test for sensory interaction and balance decreases as the heel size increases.

#### DISCUSSION AND CONCLUSION

The aim of the study is to see, immediate effect of HHS on balance and functional mobility in females. M.CTSIB test was used to measure balance while TUG test was used to measure functional mobility with barefoot, flat footwear, 4cm heel height, 7cm heel height and 10cm heel height individually. The current study shows that TUG increases with the increase in heels height and they shows significant difference exist between each and the ( $p=0.0$ ) and f critical value (2.3978) is less than f value (130.0652) will shows that the result is significant TUG. The value of variance is keep on increasing in timed up and go maximum level of variance is in 7cm and 10 cm. In case of M.CTSIB there is decrease in time average score with increase in heels height and alteration in condition there is significant difference exist as ( $p=0.0$ ) and f critical value (2.397) is less than f value (25.455) will shows that the result is significant MCTSIB.

The previous studies of Vaniessa Dewi Hapsari & Shuping Xiong, 2016<sup>[1]</sup> have shown that there will increase in the time of TUG with increase in heels size<sup>[1]</sup>. There will scoring given on the basis of balance of 30 second on different conditions with different heels sizes in M.CTSIB of Susan L. Whitney & Diane M. Wrisley<sup>[2]</sup> which shows that there will change or decrease in the time of balance maintenance with increase in heel size and with increase of difficulty level of conditions and they will require more trial to give average scoring for the test. Additionally these findings are in accordance with the previous studies that reported that the balance and mobility get worsen with increasing heel height but there is no difference seen in the barefoot and 1cm.

So this concludes that there is significant change in the functional mobility and static balance as heel size increases mainly the more change comes in 7 cm and 10 cm heels size. More over if we compare barefoot with 1cm it shows that barefoot and 1cm leads to provide the best balance and mobility. If somebody wants to wear heels they can wear it of 4cm not beyond that because that will cause change in the biomechanics of the body such as increased lumbar lordosis and pelvic anteversions, patellofemoral joint stress and pain which might lead to osteoarthritis also stress over Achilles tendon and calf muscle is in constant active state lead to muscular fatigue and muscle soreness which can cause huge problem in the body and can cause different conditions.

clinical implication of the study: this study may help in considerations that need to be taken for the proper usage of the high heels, one should not wear heels beyond 4 cm. If there is increase in the high heels in 7cm and 10cm there will be different critical conditions such as sore calf, foot pain, ankle sprains.

So one should wear high heels occasionally only if required and proper foot management should be done by the user this will decrease the chances of complications related to high heels.

Limitations: The only limitations present in the following study Different styles of female foot wear could not be compared, the foot wear were not customized so there may be fitting issue which may influence balance and functional mobility.

Further scope of study: This study have further scope as in M.CTSIB analysis and change was not seen condition wise it was taken with the average of each condition, there are chances that they can check for alteration in balance with different conditions with different heel sizes and also enhanced technology instruments will be taken in use, type of heel should be checked and most important subjective measures; like fear of falling, body discomfort should be checked.

## CONCLUSION

The current study showed that there were comparable effects of barefoot, flat footwear, 4cm, 7cm and 10 cm on balance and functional mobility as there was longer TUG time and shorter M.CTSIB. Hence, it can be concluded that wearing high heels effects balance and functional mobility in females.

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