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**Krutika Vishnu Bhoir**
Intern LSFPEF College of Physiotherapy, Nigdi, Pune, Maharashtra, India

**Dr. Pradeep Borkar**
Assistant Professor, LSFPEF' College of Physiotherapy, Nigdi, Pune, Maharashtra, India

**Correspondence**
**Dr. Pradeep Borkar**
Assistant Professor, LSFPEF's College of Physiotherapy, Pune, Maharashtra, India.

# Effect of functional mobility exercises on ankle range of motion and balance in airhostess

**Krutika Vishnu Bhoir and Dr. Pradeep Borkar**

**Abstract**
**Aim:** To find the effect of Functional Mobility Exercise on Ankle range of motion and Balance in Airhostess.
**Objective**: To find the effect of functional mobility exercise on ankle range of motion and on balance in high heel wearing population.
**Procedure:** Clearance was taken from ethical institutional committee of institute. Samples were collected by purposive sampling method with said inclusion criteria. The details of research were explained to subjects and written consent form was charted out. Total 60 subjects (n-60) between the age of 18-25 participated in study out of which 54 subjects (n-54) completed the study and 6 subjects dropped out in between the study. Testing procedure was explained as well as demonstrated to the subjects so that they become familiar with the tests. Y balance test and goniometry test was used to assess the ROM and balance. After the completion of pre assessment Functional mobility program was carried for 6 weeks. After 6 weeks post assessment was done and the values were recorded in the record sheet.
**Results:** After 6 weeks of functional mobility program post values showed extremely significant improvement with p-value of 0.0001.
**Conclusion:** This study concludes that the effect of Functional mobility training including AROM exercise, Flexibility, Strengthening and Proprioception training helped in improving ankle range of motion and balance in High heel wearing airhostess.

**Keywords:** high heel wearing airhostess**,** ankle ROM, balance, functional mobility program

## Introduction
High heel shoes are mostly considered by many women as an essential part of a fashionable outfit [1]. Research says, 77% of women wear heels for special occasions, 50% of women wear at parties, 31% of women wear them to their regular work [1]. Airhostess is one of them whose dress code extends the amount of time to wear high heeled shoes [2]. Female flight attendants are required to wear shoes with a heel height of between one and three inches [2].

The use of high heeled shoes is a habit increasingly common among adolescents, but it can trigger several changes in postural alignment, particularly in the lower limbs and spine [3]. Daily high heel use over a number of years changes their anatomical structural property [4]. As the heels get higher, pressure increases on the forefoot (3inches:76%, 2inches:57%, 1inch: 22%) and there is also increased risk of fall [1]. Postural imbalance can bring negative repercussions when its affects adolescents, because, at this stage, there is intensive growth and development of the musculoskeletal system, which, when exposed to overlaod, can cause irreversible postural deviations [3].

Standing posture is result of a dynamic state of balance between body and gravity thus the contraction of the posture muscles and continuous positioning of body segments occur during standing in order to maintain balance and to overcome the action of the gravitational force[3]. Balance describes the dynamics of body posture to prevent falling and it is ability to maintain, achieve or restore the body's centre of mass (COM) relative to the base of support (BOS) [1]. Since height of COM will be increased with higher heels and the BOS will become smaller with reduced base, wearing HHS could induce difficulties of maintaining balance [1].

Long-term wearing of HHS induces shortening of the gastrocnemius muscle and leads to Achilles tendon tightness, causing reduce in active range of motion of ankle, further affecting

the lower extremity functional mobility[1]. Functional mobility are critical components of a person's ability to perform daily activities and is also been widely used in assessing human balance and risk of fall [1].

## Materials and Methods

### Materials

- Goniometer
- Measuring tape
- Sticking tape
- Pillow
- Towel
- Marble

### Methods

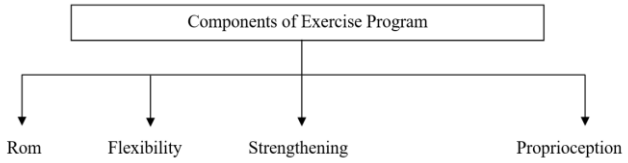
- Study design - Experimental Study
- Population – Airhostess
- Sampling method – Purposive sampling
- Location – Pune
- Sample size – 60
- Study duration – 6 weeks

### Procedure

Clearance was taken from ethical institutional committee of institute. Samples were collected by purposive sampling method with said inclusion criteria. The details of research were explained to subjects and written consent form was charted out. Total 60 subjects (n-60) between the age of 18-25 participated in study out of which 54 subjects (n-54) completed the study and 6 subjects dropped out in between the study. Testing procedure was explained as well as demonstrated to the subjects so that they become familiar with the tests. Y balance test and goniometry test was used to assess the ROM and balance. Goniometry was used to assess the ankle plantaflexion and dorsiflexion movement by keeping ankle in neutral position [8]. Y balance test was done by subjects as following [11] Stand in the centre of the Y mark Maximum reach distance was measured. Three directions: Anterior, Posterior medial, Posterior lateral. Subjects had to maintain balance during the reach test. Three trials are recorded & all failed attempts are discarded. After the completion of pre assessment Functional mobility program was carried for 6 weeks. After 6 weeks post assessment was done and the values were recorded in the record sheet.

### Outcome Measures

1. Ankle range of motion by goniometer [4]
2. Modified Star Excursion balance test(Y test) [5]




### Active Ankle & Toe Range of Motion Exercise

| Exercise | Repitions | Set | Rest interval |
|---|---|---|---|
| Active ankle pumps | 10 ($1^{ST}$ wk) | 3 | 30 sec |
| | 20 ($3^{rd}$ wk) | | |
| | 30($6^{th}$ wk) | | |
| Toe extension | 10 ($1^{ST}$ wk) | 3 | 30 sec |
| | 20 ($3^{rd}$ wk) | | |
| | 30($6^{th}$ wk) | | |

### Flexibility Exercise

| Exercise | No. of rep | No. of sets | Hold Time | Rest Interval |
|---|---|---|---|---|
| Gastronemius Stretch | 2-3 rep | 3 | $1^{st}$ - $2^{nd}$ wk - 30 sec | 20 SEC |
| | | | $3^{rd}$ - $4^{th}$ wk - 45 sec | |
| | | | $5^{th}$ - $6^{th}$ wk - 60 sec | |
| Soleus Stretch | 2-3 rep | 3 | $1^{st}$ - $2^{nd}$ wk - 30 sec | 20 SEC |
| | | | $3^{rd}$ - $4^{th}$ wk - 45 sec | |
| | | | $5^{th}$ - $6^{th}$ wk - 60 sec | |
| Prolonged Achilles Stretch | 2-3 rep | 3 | $1^{st}$ - $2^{nd}$ wk - 30 sec | 20 SEC |
| | | | $3^{rd}$ - $4^{th}$ wk - 45 sec | |
| | | | $5^{th}$ - $6^{th}$ wk - 60 sec | |

### Strengthening Exercise

**$1^{st}$ – $2^{nd}$ week**

| Isometrics | No. Of sets | Hold time | Interval time |
|---|---|---|---|
| Inversion | 3 | 10 counts | 30SEC |
| Eversion | 3 | 10 counts | 30SEC |
| Plantaflexion | 3 | 10 counts | 30SEC |
| Dorsiflexion | 3 | 10 counts | 30SEC |

**$2^{nd}$ – $4^{th}$ week**

| Isotonic | No. Of sets | Hold time | Interval time |
|---|---|---|---|
| Heel raise | 3 | 10 counts | 30SEC |
| Toe raise | 3 | 10 counts | 30SEC |
| Towel curl up | 3 | 12 rep | 30SEC |
| Marble pick up | 3 | 12 rep | 30SEC |

**$5^{th}$ – $6^{th}$ week**

| Theraband | No. Of sets | Hold time |
|---|---|---|
| Inversion | 3 | 30 sec |
| Eversion | 3 | 30 sec |
| Plantaflexion | 3 | 30 sec |
| Dorsiflexion | 3 | 30 sec |

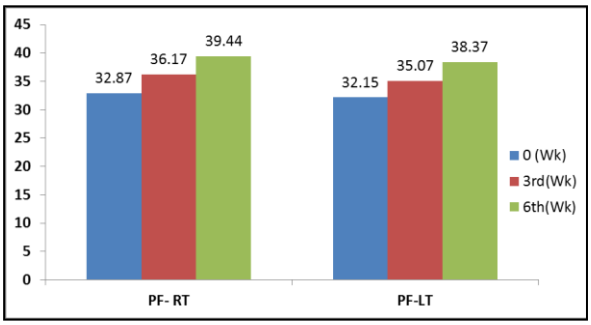
**Proprioception**

| $1^{st}$ – $2^{nd}$ week | $3^{rd}$ – $4^{th}$ week | $5^{th}$ – $6^{th}$ week |
|---|---|---|
| One leg stand with eyes open and close(1min) | One Leg Stand On Unstable Surface ( Foam Roller) | Dynamic squats on unstable surface |
| Tandem stand(1min) | Tandem Stand On Pillow | Lunges on unstable surface |
| Tandem walk(10meters) | Step Up And Down | Multidirectional reach |
| Walking forward and backward(5steps) | Lateral step up | |

## Results and Interpretation

**Table 1:** Freidman test used for Pre-test and Post-test value for PF-Rom

| | Mean | | | N | Standard deviation | | | P-value | Chi- square | Mean difference |
|---|---|---|---|---|---|---|---|---|---|---|
| ROM | 0 (Wk) | 3rd(wk) | 6th(wk) | | 0 (wk) | 3rd(wk) | 6th(wk) | | | |
| PF- RT | 32.87 | 36.17 | 39.44 | 54 | 5.491 | 5.811 | 6.173 | 0.0001 | 101.111 | 6.57 |
| PF-LT | 32.15 | 35.07 | 38.37 | 54 | 5.492 | 6.392 | 6.132 | | 102.111 | 6.25 |




### Graphical Interpretation

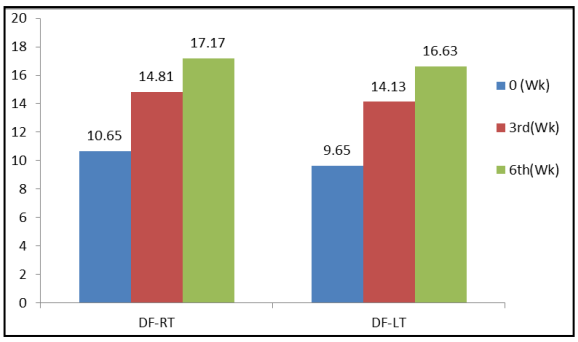
This graph shows changes in post values of PF- ROM compared with pre values. Y axis shows difference in ROM in degree and X-axis shows pre value and post value of ROM.

### Graphical result

The result obtained for Chi-square for ROM suggests considered extremely significant improvement in 'p' value obtained ($p<0.0001$) and the Chi-square obtained 101.111 with 2 degree of freedom.

**Table 2:** Freidman test used for Pre-test and Post-test value for DF-ROM

| | Mean | | | N | Standard deviation | | | P-value | Chi- square | Mean difference |
|---|---|---|---|---|---|---|---|---|---|---|
| ROM | 0 (Wk) | 3rd(Wk) | 6th(Wk) | | 0 (Wk) | 3rd(Wk) | 6th(Wk) | | | |
| DF- RT | 10.65 | 14.81 | 17.17 | 54 | 1.818 | 1.683 | 1.476 | 0.0001 | 105.009 | 4.6 |
| DF-LT | 9.65 | 14.13 | 16.63 | 54 | 1.817 | 1.626 | 1.418 | | 105.507 | 4.65 |




### Graphical Interpretation

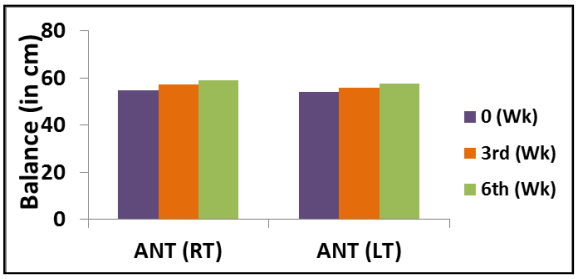
This graph shows changes in post values of DF- ROM compared with pre values. Y axis shows difference in ROM in degree and X-axis shows pre value and post value of ROM.

### Graphical result

The result obtained for Chi-square for ROM suggests considered extremely significant improvement in 'p' value obtained ($p<0.0001$) and the Chi-square obtained 105.009 with 2 degree of freedom.

**Table 3:** Freidman test used for Pre-test and Post-test value for Balance (Ant)

| Balanace | Mean | | | N | Standard deviation | | | P-value | Chi- square(r) | Mean difference |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0WK | 3RD WK | 6TH WK | | 0WK | 3RD WK | 6TH WK | | | |
| ANT(RT) | 54.72 | 57.22 | 59.02 | 54 | 7.467 | 7.467 | 7.467 | 0.0001 | 108.000 | 4.3 |
| ANT(LT) | 53.97 | 55.77 | 57.57 | 54 | 8.609 | 8.61 | 8.61 | | | 3.6 |




This graph shows changes in post values of Balance (ANT) compared with pre values. Y axis shows difference in Balance in cm and X-axis shows pre value and post value of Balance

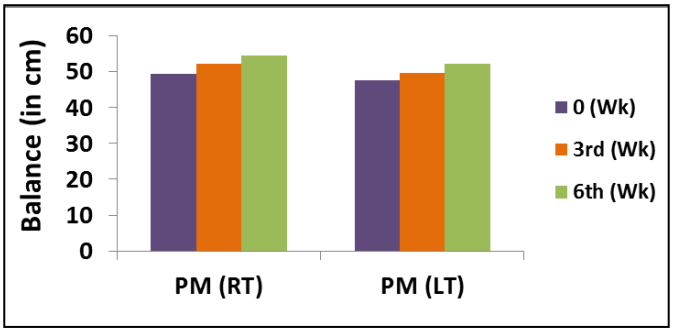
### Graphical Result

The result obtained for Chi-square for Balance suggests considered extremely significant improvement in 'p' value obtained ($p<0.0001$) and the Chi-square obtained 108.000 with 2 degree of freedom.

## Graphical Interpretation

**Table 4:** Freidman test used for Pre-test and Post-test value for BALANCE (PM)

| Balanace | Mean | | | N | Standard deviation | | | P-value | Chi- square(r) | Mean difference |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0WK | 3RD WK | 6TH WK | | 0WK | 3RD WK | 6TH WK | | | |
| PM (RT) | 49.33 | 52.33 | 54.53 | 54 | 12.12 | 12.12 | 12.12 | 0.0001 | 108.000 | 5.2 |
| PM(LT) | 47.78 | 49.78 | 52.18 | 54 | 12.45 | 12.45 | 12.45 | | | 4.4 |




**Graphical Interpretation**

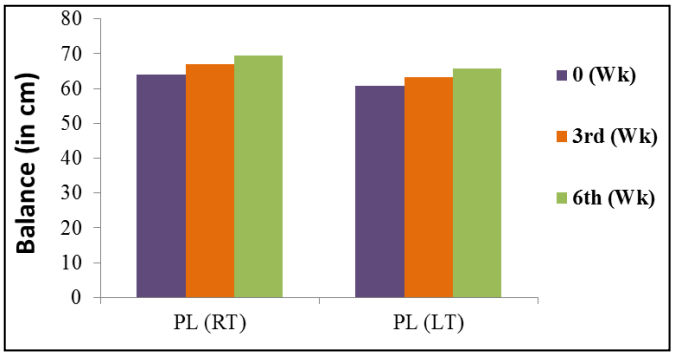
This graph shows changes in post values of Balance (PM) compared with pre values. Y axis shows difference in Balance in cm and X-axis shows pre value and post value of Balance

**Graphical Result**

The result obtained for Chi-square for Balance suggests considered extremely significant improvement in 'p' value obtained ($p<0.0001$) and the Chi-square obtained 108.000 with 2 degree of freedom.

**Table 5**: Freidman test used for Pre-test and Post-test value for Balance (Pl)

| Balanace | Mean | | | N | Standard deviation | | | P-value | Chi- square(r) | Mean difference |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0WK | 3RD WK | 6TH WK | | 0WK | 3RD WK | 6TH WK | | | |
| PL(RT) | 64.12 | 67.12 | 69.42 | 54 | 6.631 | 6.631 | 6.631 | 0.0001 | 108.000 | 5.3 |
| PL(LT) | 60.9 | 63.3 | 65.8 | 54 | 7.413 | 7.413 | 7.413 | | | 4.9 |




**Graphical Interpretation**

This graph shows changes in post values of Balance (PL) compared with pre values. Y axis shows difference in Balance in cm and X-axis shows pre value and post value of Balance

**Graphical result**

The result obtained for Chi-square for Balance suggests considered extremely significant improvement in 'p' value obtained ($p<0.0001$) and the Chi-square obtained 108.000 with 2 degree of freedom.

**Discussion**

Functional mobility is an ability of an individual to initiate control or sustain active movements of the body to perform simple to complex motor skills [3]. The use of high heeled shoes in Airhostess is a factor that can cause temporary or permanent bodily adjustments, depending on the time and frequency of use of this footwear and predisposes to poor posture especially in spine and lower limb [3].

Standing in high heel generates postural adaptations' due to change of the position of the feet and the location of the CG [3]. Soleus and gastronemius muscles are use to lift your heel up while walking, running and to stand on your tip toes or to jump [10]. Achilles tendon attaches to these muscles and its susceptible to injury and strain when calf is tight [10].

The change of foot position associated with increased plantar flexion induced by HH caused increased recruitment of motor units in gastronemius muscle as the heel height increases [3]. The manifestation of these postural changes associated with continued use of high-heeled shoes in adolescence may result in a loss in growth and delayed motor development, as this phase corresponds to the period of maturation of the musculoskeletal system [3]. Standing with high heeled shoes generates postural adaptations due to the change of the position of the feet and the location of the CG [3].

The heels provoke first the elevation of the calcaneus bone associated to the flexion of the tibiotalar joint [3]. Changing the alignment of the ankles causes elevation and forward displacement of the CG, causing postural imbalance, promoting adaptive postural adjustments for balance recovery and to maintain the upright posture [3]. The foot is the first body segment that undergoes modifications due to the high heel [3]. This kind of footwear favors the supination of the foot, reducing the width of the plantar arch, increasing plantar pressure on the forefoot, and the higher the heel, the lower is the pressure on the hind foot and the higher the pressure on the forefoot [3].

Purpose of present study was to investigate the effects of Functional mobility exercise on ankle ROM and Balance in High Heel wearing population. The graph shows the pre and post-test readings with p value of 0.0001 for ROM and Balance, which reflects significant increase in ankle ROM & Balance. In this program Active ROM has helped to maintain physiological elasticity and contractility along with it sensory feedback from participating contracting muscles [9]. As well as it develop co-ordination and motor skills for functional activities [9].

Flexibility is related to the extensibility of muscle tendon unit that cross a joint, based on their ability to relax or deform and yield to a stretch force [9]. By stretching muscle gets elongated & stretch force is transmitted to the muscle fibre via connective tissue in and around the fibres [9]. The primary effect and outcome measure from stretching exercise in program helped to restore and increase extensibility of muscle tendon unit and therefore regain or achieve the flexibility and ROM required for necessary or desired functional activities[9].

Potential benefit was gained from strengthening program brought about increase strength of connective tissues, tendons, ligaments and intramuscular connective tissue[9]. Along with it possible improvement in balance was also seen with enhanced physical performance during daily living [9].

Proprioception is fundamental for kinaesthesia and balance control [12]. In other way it plays vital neurosensory role in subject's motor skills and is a key factor in the ability to perform tasks with dexterity, mastery and proficiency[12]. It is body's perception of where it is in space relative to its environment. [12] Receptors in muscles, tendon, ligament, capsule and skin send information into CNS, where it is processed before impulses triggering a response occur[9]. Proprioception exercises for posture and balance help to improve ankle stability [9].

The final result showed a significant improvement in selected

population. This was due to the combination of utilization of elastic energy and the stretch reflex potentiation of muscle activation. All exercises in program provided greater advantage on ankle range of motion and balance.

**Conculsion**

From the analysis of data, the following conclusions were drawn:

This study concludes that the effect of Functional mobility training including AROM exercise, Flexibility, Strengthening and proprioception training helped in improving ankle range of motion and balance in High heel wearing population. Therefore, the result and analysis of the data concluded that 6 weeks of functional mobility training improves ankle Rom and Balance.

**Limitation of study**

- Sample size
- Feasibility
- Availability of subjects
- Other parameters like posture disorders, gait pattern alteration, could not be assessed

**Recommendation and Scope of Study**

- Further the study can be conducted for the balance by assessing in 8 directions by using Star excursion balance test.
- This study can be conducted on a larger population along with same outcome measures.
- Other components such as posture assessment, gait evaluation, deformities due to high heels etc can also be assessed with the help of different parameters.

**Clinical implication**

- Functional mobility program can be used at regular basis.
- It can be used in rehabilitation of lower limb injuries with return back to their functional activities

**Acknowledgement**

The satisfaction that accompanies the successful completion of any task would be incomplete without mentioning of people whose ceaseless co-operation, guidance and encouragement crown all the efforts with success. I offer my regard to all those who supported me in any respect during the completion of the study. Last, but not the least, I express my sincere thanks to all the subjects who participate and gave their full co-operation for the study.

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