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*Original Research Article*

# Effectiveness of Customized Foot Insoles in Nursing Staff with Mechanical Low Back Pain and Pronated Feet

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## ABSTRACT

**Background**: Low back pain is third most common disorder and its prevalence among the nurses is slightly higher varying between 56% and 90%.The literature reflects how excessive pronation of the foot is linked to low back pain. Previous studies also states that individuals with low back pain have diminished postural balance. Therefore there was need to quantify the effects of customized foot insoles for low back pain and pronated feet.
**Aims and Objectives**: The present study evaluates the effect of customised foot insoles on pain and balance among nursing staff with mechanical low back pain.
**Methodology**: 30 nursing staff of age 30-55 years with mechanical low back pain and pronated feet participated in the study which was a pre-test post-test experimental study design. LBP was evaluated by a visual analog scale for pain and Oswestry Disability Questionnaire. Both static and dynamic balance was evaluated using unipedal stance and Star excursion balance test respectively. Pre-test data of pain and balance was recorded without intervention. Then the customized foot insoles were given to the subjects for the duration of 4 weeks and post-test data of pain and balance was collected.
**Results**: A paired t-test was used to compare the difference in VAS, Oswestry LBP questionnaire and static & dynamic balance for pre-test and post-test. There was a significant difference in pain with ($p<0.000$) and improvement in both static balance and dynamic balance with ($p<0.001$).
**Conclusion**: Customized foot insoles reduces pain and improves balance among nursing staff with mechanical low back pain and pronated feet therefore customized foot insoles can be prescribed for patients with mechanical low back pain and pronated feet.

***Key words:*** Mechanical low back pain, pronated feet, static balance, dynamic balance and customized foot insoles.

## INTRODUCTION

Mechanical low back pain is one of the most common complaints in the society and has been identified as the most prevalent occupation-related problem in both high and low income countries. [1] About 60-80% of the general population suffers from LBP at some time during their lives. Among nurses the lifetime prevalence is higher, varying between 56% and 90%. [2]

LBP is associated with heavy manual occupations and jobs requiring manual material handling, frequent bending/twisting, static work posture**.** [3] The high rate of back disorders in nurses is associated with heavy physical workload, particularly in lifting and moving patients, and with adverse postures resulting in substantial cost to employing hospitals in terms of lost efficiency, lost time, wasted training, and claims. [1, 3,4]

Foot function has been suggested to be an etiological mechanism for the development of LBP. Excessive foot pronation is proposed to produce prolonged internal rotation of the lower limb leading to disruption in sagittal plane forward progression of the body during gait. This causes significant strain at the sacroiliac and lumbosacral joints leading to the development of LBP. Foot orthoses have traditionally been prescribed in case of excessive or prolonged foot pronation, which thereby reduces the extent and velocity of foot movement, correcting lower limb function and proximal posture. [5-10]

Excessive pronation can be corrected by foot insoles so mechanism of action of foot insoles can lead to the correction of abnormal subtalar pronation resulting in internal rotation of tibia and femur, and anterior inclination of the pelvis which in turn increases tension in the muscles of this region and rotation of the lumbar vertebra during gait. [5, 11-13]

But their mechanism of action on low back pain is still not fully clear, although certain studies have found improvement in LBP after the use of different type of orthoses. However these findings are not supported by previous systematic review and foot orthoses and insoles are currently not considered in international and national clinical guidelines for the management of non-specific LBP. [5]

Review of literature also depicts that low back pain patient's present diminished postural control, manifesting problems in balance as compared to the healthy subjects. [14] Alterations in proprioception are considered as one of the possible causes of alteration of postural balance in individuals with low back pain. [15] The maintenance and control of balance, in static or dynamic situations, is an important requirement for physical and daily activities. So well-functioning of the postural balance is essential to maintain normal daily life. [3] According to the literature studies states that patients with chronic low back pain present alteration in static and dynamic postural balance, as compared to healthy individuals. [14-17]

Hence it is evident that mechanical low back pain is a leading health problem resulting in pain & functional disability in the work, particularly in nurses during their employment years leading to limitation in productivity and medical expenses imposed upon the patient (nurses) are very high. [18]

Therefore the use of foot insoles can reduce pain, improve balance and functional ability among nurses in hospital setup. The customised foot insoles are also comparatively affordable and easier than other treatment for low back pain which would increase the working ability of nurses and thereby reducing the stress.

However foot orthoses and insoles are currently not considered in international and national clinical guidelines for the management of non-specific mechanical LBP and is still a matter of controversy due to little evidence.

Therefore the aim of the present study is to investigate and determine the use of customized foot insoles in reducing the pain and improving the balance among nursing staff with mechanical low back pain.

Also, this study will help the clinicians to prescribe customized foot insoles to improve pain and balance in the subjects with mechanical low back pain.

## MATERIALS AND METHODS

After obtaining the approval from Research review and ethical committee from ISIC Institute of Rehabilitation Sciences, consent forms were obtained from all the participants.

**Participants**

**Study design:** Pre-test post-test experimental.

A Convenience sample of 30 nursing staff who voluntarily participated in the study (descriptive information) given in Table 1. Out of forty two subjects who were initially assessed for eligibility, twelve subjects were excluded from the study because they did not meet the inclusion

criteria. Out of thirty nursing staff that were selected according to the inclusion criteria 28 were female and 2 were male with mean age of 37.50 ±7.574 years.

***Inclusion criteria***

Subjects working as nursing staff in a hospital, age range - 30-55 years, [18] subjects with musculoskeletal or mechanical low back pain, subjects having bilateral pronated feet which was assessed through navicular drop test and any measurement greater than 10mm was considered as hyper pronated, [19] VAS score 4-7(moderate), subjects who were considered eligible after evaluating Oswestry's Disability Questionnaire (21-40% moderate disability), [11] BMI normal- 18.5 to 24.9 kg/$m^2$, both male and female nursing staff.

***Exclusion criteria***

Pregnant women, infection such as Osteomyelitis, Low back pain related to menstrual cycle, Leg length discrepancy > 5mm, [20] previous back or lower extremity surgery, if using any pain killer or medication for low back pain.

**Procedure**

The subjects were invited to participate in the study. According to the inclusion criteria the subjects were assessed & screened. The detailed information was given to the subjects about the procedure. Subject consenting to participate in the study signed the consent form. Low back pain was measured by visual analog scale and extent of disability was analyzed through Oswestry disability Questionnaire. [21] Pronated feet were assessed through navicular drop test. [19]

**Static postural balance readings were taken by single limb stance test.** [22-24]

Dynamic balance readings were taken by star excursion balance test. [22-26] Pre-test data of pain and balance was recorded intervention. Then baseline measurements and foot trace of each subject was obtained to fabricate customized foot insoles according to the foot trace of each subject.

The customized foot insoles were fabricated from microcellular rubber [27,28] with 10 mm of thickness from heel to just behind the metatarsal heads, with maximum height of the orthoses on the medial side, and a distal line joining the points just proximal to metatarsal heads and ending at the proximal edges of the first and fifth metatarsal heads. Instructions were given to the participants for wearing the customized foot orthoses for, at least, 8 h/day. [11]

After the completion of 4 weeks protocol of the customized foot insoles intervention the post-test data was recorded.

Pain was measured again by VAS [29] and extent of disability was measured by Oswestry disability questionnaire. Static postural balance readings were taken by single limb stance test. Dynamic postural balance readings were taken by star excursion balance test. [25,26]

Fig. A

Fig. B

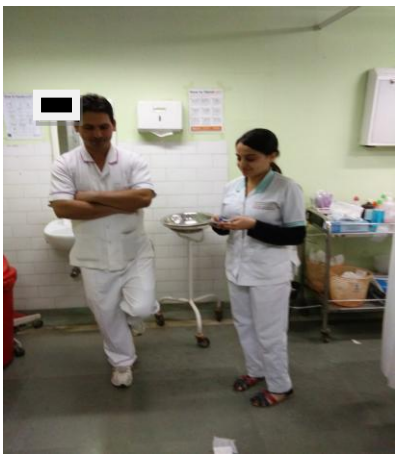


Fig. C

**Fig. A: Customized foot insoles. Fig. B: Star excursion balance test (SEBT). Fig. C: Unipedal stance test.**

**Materials**: Microcellular rubber, record sheet, weighing machine, stopwatch, marker, measuring tape.

***Data analyses:*** Data was analyzed with the help of statistical package for social sciences (SPSS) version 19. Paired sample t-tests were applied to examine pre and post test differences. Paired t- test was applied to check the difference between pre and post readings of pain, extent of disability, static and dynamic balance.

## RESULTS

**Table 1: Descriptive information of subjects among the age in years, body mass index in kg/m$^2$, pronation of right foot in mm, pronation of left foot in mm.**

| | N | Min. | Max. | Mean | S.D |
|---|---|---|---|---|---|
| Age | 30 | 30 | 50 | 37.50 | 7.574 |
| BMI | 30 | 18.7 | 24.9 | 22.957 | 1.8478 |
| Pr right foot | 30 | 10 | 14 | 11.60 | 1.003 |
| Pr left foot | 30 | 10 | 14 | 11.70 | 0.952 |

Pr- pronation, N- sample size, Min.-minimum, Max-maximum, S.D- standard deviation.

This includes the results obtained after statistical analysis of data. The descriptive statistics of the demographic data has been given in the table 1.

Table 1 shows the descriptive data of mean age in years, BMI in kg/m$^2$, pronation of right and left foot in mm.

The mean and S.D value age of the entire population was 37.50 $\pm$7.574 years, mean and S.D values of BMI 22.957 $\pm$1.8478, mean and S.D values of pronation of right feet was 11.60 $\pm$1.003 and mean and S.D values of pronation of left feet was 11.70 $\pm$0.952.

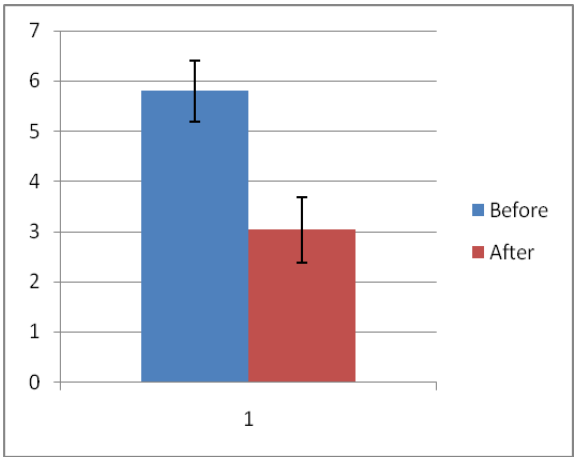
**Result of pre and post values of VAS, ODQ, UPST and SEBT is given in table.2**

Table 2 shows the comparison of pre values of mean and S.D with post values of mean and S.D with their respective t-value and p-value. The Comparison of Unipedal stance test was done in both eye open and eye closed condition measured in seconds similarly the comparison of star excursion balance test was done for both right and left extremity in centimetres.

**Table.2 Shows the comparison of pre and post values of mean and S.D with their respective t-value and p-value.**

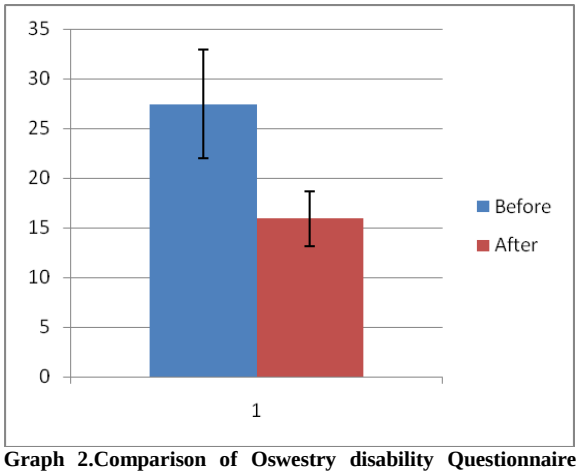
| | Pre-Mean$\pm$S.D | Post- Mean $\pm$S.D | t- value | p-value |
|---|---|---|---|---|
| VAS | 5.80 $\pm$ 0.61 | 3.03 $\pm$ 0.66 | 20.81** | 0.000 |
| ODQ | 27.44 $\pm$ 5.45 | 15.90 $\pm$ 2.75 | 14.65** | 0.000 |
| UPST (eye open) | 21.34 $\pm$ 9.68 | 29.26 $\pm$ 9.13 | -7.66** | 0.000 |
| UPST (eye closed) | 2.32 $\pm$ 1.82 | 5.26 $\pm$ 3.55 | -7.38** | 0.000 |
| SEBT (right) | 49.56 $\pm$ 10.28 | 55.54 $\pm$ 10.46 | -5.87** | 0.000 |
| SEBT (left) | 49.20 $\pm$ 10.55 | 54.75 $\pm$ 10.75 | -7.21** | 0.000 |

VAS- visual analogue scale, ODS- Oswestry disability questionnaire, UPST- unipedal stance test in eye open and eye closed case both measured in seconds, SEBT- star excursion balance test for both right and left extremity both measured in centimetres, **- Significant at 0.05%.



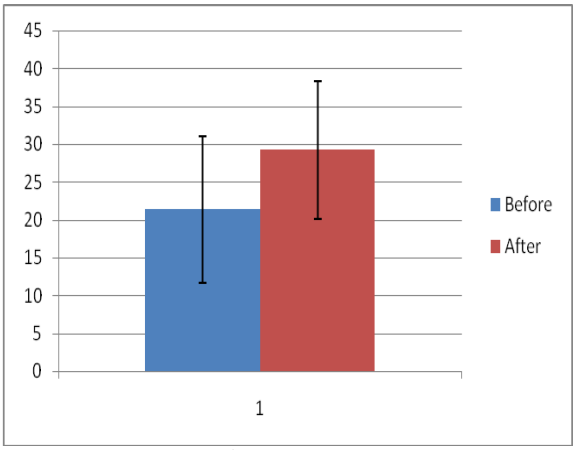

**Graph 1.Comparison of VAS values before and after the intervention.**

There was a significant improvement in pre and post VAS Scores with pre test mean S.D value 5.80 $\pm$ 0.61 to post test mean S.D value of 3.03 $\pm$ 0.66.



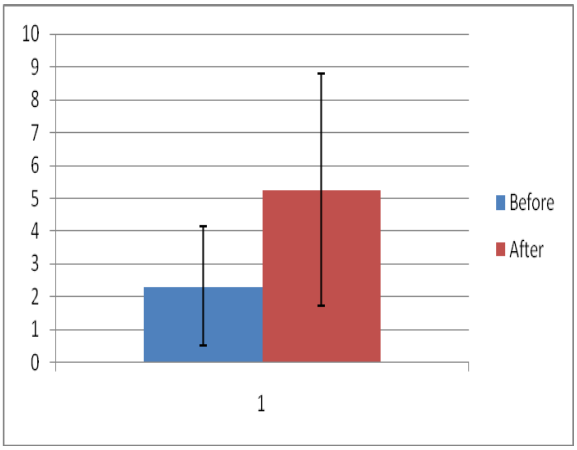

**Graph 2.Comparison of Oswestry disability Questionnaire values before and after the intervention.**

There was a significant improvement in pre and post ODS Scores with pre test mean S.D value 27.44 $\pm$ 5.45 to post test mean S.D value 15.90 $\pm$ 2.75.



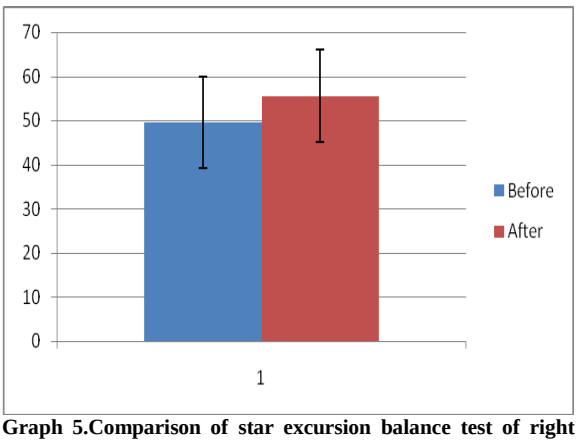

**Graph 3.Comparison of Unipedal stance test in eye open condition values before and after the intervention values in seconds.**

There was a significant improvement in pre and post UPST Scores with pre test mean S.D value 21.34 ± 9.68 to post test mean S.D value 29.26 ± 9.13



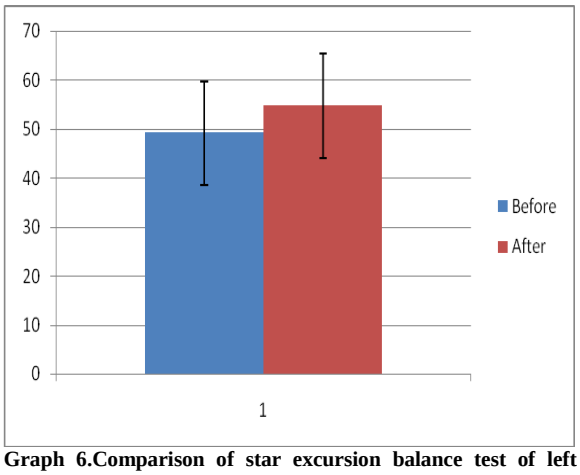

**Graph 4.Comparison of Unipedal stance test in eye closed condition values before and after the intervention values in seconds.**

There was a significant improvement in pre and post UPST Scores with pre test mean S.D value 2.32 ± 1.82 to post test mean S.D value 5.26 ± 3.55.




**Graph 5.Comparison of star excursion balance test of right extremity values before and after the intervention values in centimetres.**

There was a significant improvement in pre and post SEBT Scores with pre test mean S.D value 49.56 ± 10.28 to post test mean S.D value 55.54 ± 10.46.




**Graph 6.Comparison of star excursion balance test of left extremity values before and after the intervention values in centimeters.**

There was a significant improvement in pre and post SEBT Scores with pre test mean S.D value 49.20 ± 10.55 to post test mean S.D value 54.75 ± 10.75.

## DISCUSSION

The purpose of the study was to evaluate the effect of customised foot insoles on pain and balance among nursing staff with mechanical low back pain.

The results suggested that subjects with mechanical low back pain and pronated feet were benefited from orthotic intervention of customized foot insoles with a significant improvement in post-intervention pain score mean= 5.80 ± 0.61, p-value=0.000 as compared to pre-intervention score 3.03 ± 0.66, which indicates significant reduction in pain. This is supported by earlier study done by Alex B et al on the relationship between foot motion and lumbopelvic-hip function. [8] Chuter V et al. found that excessive foot pronation is proposed to produce prolonged internal rotation of the lower limb and disrupt sagittal plane forward progression of the body during gait. This causes significant strain at the sacroiliac and lumbosacral joints contributing to the development of LBP. [5] The use of customized foot insoles corrects the pronation of the foot which in

turn corrects the disrupted alignment of lower limb thereby reducing the stresses on lumbar spine and reducing lower back pain.

The mean of Oswestry disability questionnaire without intervention was 27.44 ± 5.45 after the completion of four weeks intervention the mean value showed significant improvement in reduction of pain and difficulty in performing activity of daily living assessed through Oswestry disability questionnaire with a mean of 15.90 ± 2.75. According to the study done by Mendez et al. on the short term effect of custom-made foot orthoses in subjects with excessive foot pronation and lower back pain. Subjects in experimental group using insoles showed significant reduction in pain leading to reduction in disability which was assessed through Oswestry disability questionnaire as compared to the subjects of control group not using the insoles. [11]

Braga B.A et al. found that LBP patients have poorer postural stability than the healthy subjects and had alterations in static balance. [14] According to study done by M M Ibrahim et al. sensory dysfunction may increase the threshold to movement detection at the level of the ankle joint, ankle muscle input possibly; cutaneous input from the foot sole contributes to the control of human erect posture which suggest that when the proprioceptive system shows differences in sensory discrimination in chronic low back pain patients compared to healthy subjects. [15] Therefore present study was done to evaluate the changes in static as well as dynamic balance evaluated by unipedal stance test and star excursion balance test respectively [30] after the intervention of customized foot insoles. The result indicates that there was a significant improvement in static balance with mean 21.34 ± 9.68 without intervention to mean 29.26 ± 9.13 post intervention. Earlier the subjects had a greater body sway while performing single leg stance test and most of the subjects felt they will just fall if stand unsupported whereas after the intervention of foot insoles the subjects felt much stable there was reduction in body sway also. Similarly there was improvement in dynamic balance with mean 49.56 ± 10.28 without intervention to mean 55.54 ± 10.46 post intervention. The subjects were able to reach a longer distance and cover a longer excursion on star excursion balance test without feeling the pain in lower back which earlier prevented the subjects from reaching a longer distance over the star excursion grid before the intervention of foot insoles.

Hence pain and balance are interlinked reduction in pain among the subjects lead to improvement in both static and dynamic balance after the intervention of customized foot insoles.

Therefore the experimental hypothesis which states that the customized foot insoles will have significant effect in reducing pain and improving balance in nursing staff with mechanical low back pain & pronated feet is supported by the present study. Thus on the basis of present study and previous study it can be concluded that customized foot insoles can be considered as clinical guidelines for the management mechanical LBP and pronated feet. Hence clinicians can prescribe customized foot insoles to improve pain and balance in the subjects with mechanical low back pain.

***Limitations of the study***

This study was performed on limited sample and duration of study is short.

***Future Directions***

Longitudinal studies can be conducted including variable & different population to standardize the effectiveness of customized foot insoles in a better way so that insoles can be prescribed without any limitation regarding the type of population as clinical guideline.

## CONCLUSION

The study implies that customized foot insoles reduces pain and improves balance among nursing staff therefore it can be concluded that customized foot insoles can be prescribed for patients with mechanical low back pain and pronated feet.

### *Clinical Implications*

The findings of the study suggest that customized foot insoles is effective in reducing pain thereby functional disability and improving static as well as dynamic balance in nursing professionals with mechanical low back pain and pronated feet.

Therefore, it proves that the customized foot insoles is an effective prescription as an internal shoe modification in case of moderate mechanical low back pain in nursing professionals having pronated feet.

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