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EFFECT OF FOOTWEAR ON ANKLE PAIN AMONG YOUNG FEMALE STUDENTS

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ABSTRACT

Background: *Piriformis syndrome can be defined when a muscle called the piriformis, which is small in size and positioned deep into the buttock, causes pain because of tightness, spasm or prolonged compression. In a general population study, 2.2 – 19.5% indicated a yearly occurrence of PS, whereas 12.2 – 27% indicated a lifetime occurrence*

Objective: *The objective of this study is to determine the effect of footwear on ankle pain among young female students.*

Methodology: *This cross-sectional study was conducted in Layyah, Punjab. Sample size was 138. Age group between 18-25 years and participants were selected based on the inclusion criteria. Sampling technique was non-probability convenient sampling technique. Written consent form was taken. Data collection tool was Numeric Pain Rating Scale.*

Results: *The sample size was 138 young female students with the mean age of 21.81 ± 2.38 years. The majority of participants reported that they stood or walked 1-3 hours a day and most of them wore shoes on a daily basis. The average pain rate was 4.94 + 1.38 which showed that the level of ankle pain was mild to moderate among the participants. The correlation between type of footwear, daily duration of standing, and intensity of pain were significantly positive. High heels were related to more pain levels, whilst sneakers were related to less pain.*

Conclusion: *This study concluded that footwear and ankle pain have a significant relationship with young female students. Most of the participants had mild to moderate pain with an increased level of pain being recorded among the individuals wearing high heels. As well, prolonged standing hours and daily footwear use were observed to contribute to the severity of pain. On the contrary, sneakers were related with reduced rates of ankle pain.*

Key word: *Pain, Footwear, Students, Ankle biomechanics*

INTRODUCTON

Footwear plays a vital role in maintaining the structural alignment, functional stability, and biomechanical efficiency of the lower extremities. [1] It not only protects the foot from external factors but also influences how forces are transmitted through the body during activities such as walking, standing, and running. [2] In young female students, footwear choices are often influenced by fashion trends

and social preferences rather than ergonomic considerations, leading to the frequent use of high heels, flat shoes, and inadequately supportive footwear. [3] These choices may adversely affect foot mechanics and contribute to the development of ankle pain and instability. [4]

The human foot is a complex anatomical structure composed of 26 bones, 33 joints and numerous muscles, ligaments and tendons that work together to provide support, mobility and shock absorption. [5] It is broadly divided into the forefoot, midfoot and hindfoot. The ankle joint, formed by the articulation of the tibia, fibula and talus, plays a crucial role in weight-bearing and locomotion. [6] Surrounding this joint are important ligamentous structures, including the lateral ligaments (anterior talofibular, calcaneofibular and posterior talofibular ligaments) and the medial deltoid ligament, which provide stability during movement. [7] Additionally, muscles such as the gastrocnemius, soleus, tibialis anterior and peroneal muscles contribute to dynamic stabilization and control of ankle motion. [6] Any alteration in foot alignment or external support, such as inappropriate footwear, can disrupt this finely coordinated system.

Different types of footwear, particularly variations in heel design, have a significant impact on ankle biomechanics. [8] Common types of heels include low heels, medium heels, high heels, wedge heels and stiletto heels. [9] High and stiletto heels, in particular, elevate the heel portion of the foot, shifting the body's center of gravity anteriorly. This forward displacement increases pressure on the forefoot and places the ankle in a plantarflexed position. [10] As a result, the stability of the ankle joint is compromised, and the risk of inversion injuries increases. In contrast, flat footwear may lack adequate arch support and cushioning, leading to poor shock absorption and altered gait patterns. [11] Thus, both extremes excessively high heels and completely flat shoes can negatively affect ankle function. [3]

From a pathophysiological perspective, inappropriate footwear can lead to a cascade of biomechanical and structural changes within the foot and ankle. [2] When the foot is repeatedly subjected to abnormal loading conditions, it can result in excessive strain on muscles, ligaments and tendons. [1] For instance, prolonged use of high heels leads to shortening and tightness of the calf muscles, particularly the gastrocnemius and soleus, due to sustained plantarflexion. [12] This muscle imbalance reduces ankle flexibility and alters normal movement patterns. Similarly, inadequate arch support can cause overpronation, placing excessive stress on the tibialis posterior muscle and the plantar fascia. [13]

Ligamentous structures are also highly affected. [14]The lateral ankle ligaments, especially the anterior talofibular ligament, are commonly subjected to excessive strain during unstable foot positioning, increasing the likelihood of sprains. [15]Repeated microtrauma to these ligaments may lead to chronic ankle instability, characterized by recurrent episodes of giving way and persistent discomfort. Furthermore, poor cushioning in footwear increases ground reaction forces transmitted to the ankle joint, contributing to joint irritation and soft tissue inflammation. [16]

These biomechanical alterations can lead to several complications over time. Common conditions associated with inappropriate footwear include plantar fasciitis, tendonitis, ligament sprains, and chronic ankle instability. [17] Additionally, prolonged abnormal loading may contribute to degenerative changes in the ankle joint, leading to early onset of osteoarthritic symptoms. [9] Muscle fatigue, reduced proprioception, and impaired balance are also frequently observed, further increasing the risk of falls and injury. [10] In young female students, these complications can interfere with daily activities such as walking, standing for extended periods, and participating in academic or social engagements. [18]

This population is particularly vulnerable due to their active lifestyle and frequent use of diverse footwear types. University students often spend long hours walking across campuses and standing during academic activities, placing continuous demands on the lower limbs. [19] At the same time, fashion-driven choices, such as high heels and unsupportive flats, may exacerbate biomechanical stress on the ankle joint. Despite these risks, awareness regarding the long-term impact of footwear on musculoskeletal health remains limited among young female students.

Moreover, postural stability, which depends on proper alignment, muscle coordination and sensory feedback from the feet, is closely influenced by footwear characteristics. [19] Alterations in foot positioning due to inappropriate footwear can impair proprioceptive input and neuromuscular control, leading to decreased balance and increased susceptibility to injury. [20] Therefore, the relationship between footwear, ankle pain, and postural stability is multifactorial and warrants detailed investigation.

Although existing literature has explored the role of footwear in lower limb disorders, most studies have focused on athletic populations or specific occupational groups. Therefore, the present study aims to evaluate the effect of footwear on ankle pain among young female students. By identifying the relationship between different types of footwear and the occurrence of ankle discomfort, this study seeks to provide valuable insights into preventive strategies and promote awareness regarding appropriate footwear selection. The findings may contribute to improving musculoskeletal health and reducing the burden of ankle-related problems in this population.

LITERATURE REVIEW

In 2024 das kumar et al., conducted a cross-sectional study on effect of wearing high heel and flat footwear on balance and stability. They conducted that the effects of footwear on lower limb biomechanics, gait, and balance have drawn a lot of attention, especially when it comes to flat and high-heeled shoes. High-heeled shoes compromise balance and stability by increasing postural sway and shifting the point of pressure. On the other hand, it was discovered that flat shoes preserved more natural balancing dynamics and improved stability when walking and standing. [21]

A cross-sectional study conducted in 2024 by hussain et al., on prevalence of nontraumatic foot pain among urban young working women and its contributing factors. In terms of prevalence, foot and ankle pain is highly common among female populations. A cross-sectional study conducted among young working women found that nearly half of the participants experienced recurrent non-traumatic foot pain, with a significant proportion attributing their symptoms to footwear. The study also reported that high-heeled footwear was significantly associated with increased pain compared to non-heeled footwear ($p < 0.05$), indicating a strong link between footwear type and musculoskeletal discomfort. [22]

A study conducted on effects of high-heeled shoes on lower extremity biomechanics and balance in females by including 81 studies with 1,501 participants in their systematic review and meta-analysis, Zen et al., in 2023 offered more information. According to their findings, wearing high-heeled shoes improves plantar pressure and ground response forces, particularly at the forefoot, and drastically changes gait mechanics. Footwear interventions can significantly alleviate fatigue and discomfort in individuals who stand for prolonged periods, while improving foot comfort. Soft-soled shoes reduce plantar impact, whereas hard-soled shoes enhance ankle stability. postural balance is adversely affected by these biomechanical alterations which over time may increase the risk of lower extremity injuries.[23]

A study conducted to the Impact of Footwear on Posture, Gait and Balance and Health by karasawa et al., in 2022. They investigated that the difference between wearing slippers and shoes during walking in terms of balance and postural stability. The study observed that wearing slippers resulted in greater asymmetry in gait and a reduction in tilt angles, suggesting that even indoor or casual footwear can influence stability and increase fall risk in everyday life. [24]

Menz et al., in 2021 conducted a systematic search and narrative synthesis of the literature journal of foot and ankle research.That explains that casual footwear is designed to deliver both physical comforts, through features like softness and lightness, and thermal comfort, by maintaining breathability and regulating heat. Although there are perceived benefits, comfort does not mean that the footwear is biomechanical efficient. Footwear selection therefore can have notable effects on balance and postural stability. The review highlighted that poor footwear design may lead to altered gait mechanics, increased stress on

lower limb joints, and eventual development of pain and discomfort. [1]

Mohamed et al., in 2021 conducted a study on evaluated the gait and balance of young female healthcare students by contrasting the use of high heels and athletic shoes. According to the study, wearing sports shoes enhanced gait and balance metrics, as demonstrated by results on the 6-Minute Walk Test (6MWT) and the Functional Reach Test (FRT). They added that the use of high-heeled shoes had a negative influence on balance and gait when compared to SS. Wearing HH reduced the total distance walked in 6MWT for both regular and occasional users. Similarly, the reach distance in FRT was lesser when wearing HH High heels had higher detrimental impacts on regular users, underscoring the long-term consequences of such footwear choices. [25]

2.1: OBJECTIVE

The objective of this study is to determine the effect of footwear on ankle pain among young female students.

2.2: HYPOTHESIS

2.2.1: NULL HYPOTHESIS:

There was no significant effect of footwear on ankle pain among young female students.

2.2.2: ALTERNATE HYPOTHESIS:

There was significant effect of footwear on ankle pain among young female students.

Material &Methods

3.1: Study Design:

This study design was Cross-sectional study.

3.2: Study Setting:

The Study Setting was university Faisalabad Layyah Campus.

3.3: Duration of the Study:

The study duration was 6 months after approval of synopsis.

3.4: Sample Size:

Sample size was 138 Calculated by Epitool. [2]

EPITOOLS

Home Prevalence Freedom Studies Diagnostics Sampling

Inputs

inp1	0.15
inp3	0.05
inp2	0.9
inp4	N/A

Results

Sample size required for specified inputs

Large population	138

3.5: Sampling Technique:

The sampling technique was non-probability convenient sampling technique.

3.6: Sample Selection:

3.6.1: Inclusion Criteria:

- Age is between 18-25 years.[25]
- Students currently enrolled in a college or university. [1]
- Experimental task involving standing or walking for ≥40 minute. [9]
- Individuals who regularly wear footwear (e.g., heels, flats,) for daily activities..[25]
- Participants with or without mild to moderate ankle pain . [3]

3.6.2: Exclusion Criteria:

- History of recent ankle fracture or surgery. [26]
- Any diagnosed neurological disorder affecting balance.[25]
- Known **syst**emic musculoskeletal diseases such as rheumatoid arthritis. [4]
- Use of orthotic devices or special medical footwear. [5]

- Pregnant females (due to altered biomechanics and posture). [27]

3.7: Data Collection Tools:

- Numeric Pain Rating Scale

3.7.1: Numeric Pain Rating Scale:

The Numeric Pain Rating Scale (NPRS) (an outcome measure) that is a unidimensional measure of pain intensity in adults, including those with chronic pain due to rheumatic diseases. The NPRS is a segmented numeric version of the visual analog scale (VAS) in which a respondent selects a whole number (0–10 integers) that best reflects the intensity of pain. [25]

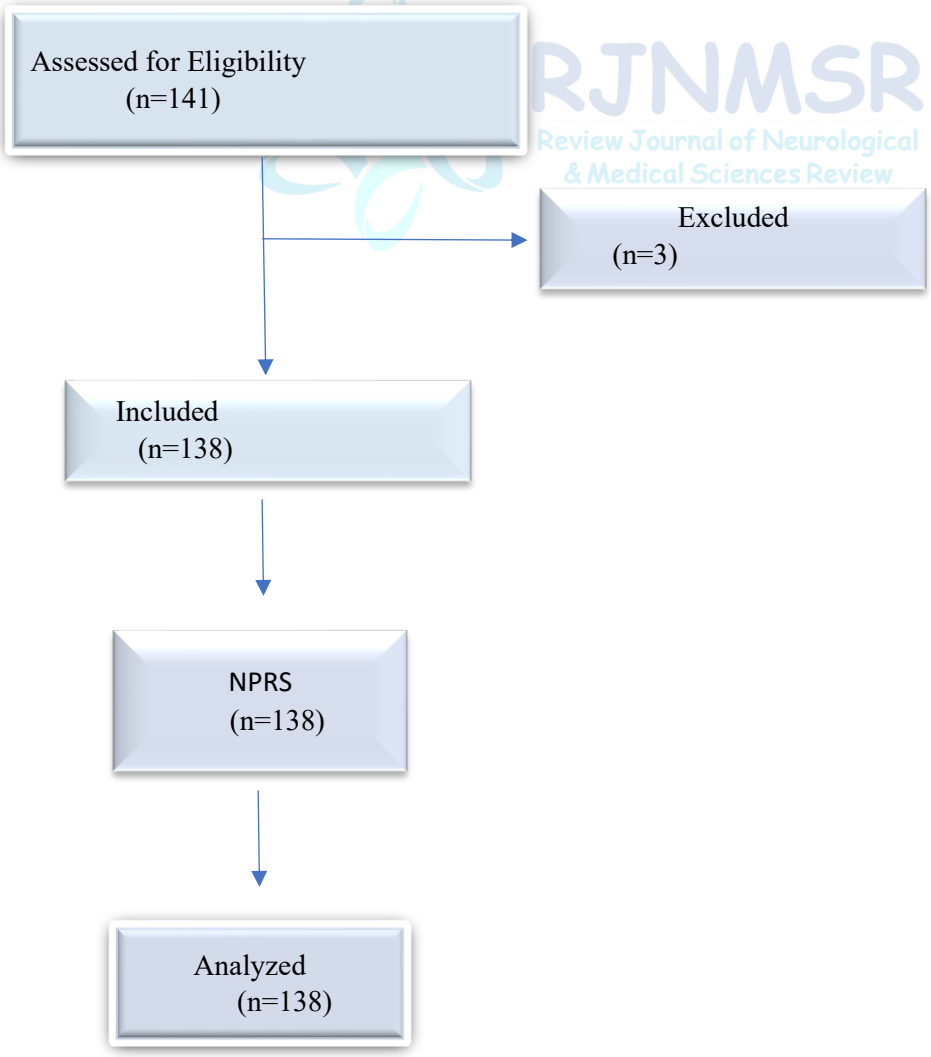
3.8: Data Collection Procedure:

The subject who meets the inclusion criteria was included in this study. The nature and purpose of study along with questionnaires was explained to each and every subject. Consent was taken and assessment Test was performed to confirm the condition, after this data was filled, analysed and interpreted accordingly.

3.9: Ethical Considerations:

1. The rights of the research participants will be protected, and the ethical guidelines established by the GCUF Layyah ethical committee will be adhered to.
2. All participants will be required to sign written informed consent forms, which are attached.
3. All data collecting information will be kept private.
4. All study participants will remain anonymous.
5. The participants will be made aware that there will be no danger or drawbacks to the study's methodology.
6. Participants will be made aware that they are free to leave the study at any time.

3.10: Consort Flow Diagram



3.11: Data Analysis Procedure

Data was analysed by using The Statistical Package for Social Science Software (SPSS) version 27.0 for window Microsoft, also Microsoft word and excel was used to generate graphs, tables etc. The quantitative data was presented in the form of mean and standard deviation. The categorical data was presented in the form of frequency and percentage.

RESULTS

4.1. Sociodemographic

Demographics	Age	Daily Standing Hours	Types of Footwear	Frequency of Use
Mean	21.81	1.97	2.64	1.53
SD	2.38	0.80	1.16	0.50

Table 4.1 shows the mean and standard deviation of sociodemographic including age, daily standing hours, types of footwear and frequency of use of footwear. The mean age in the study was 21.81 and standard deviation was 2.38. Statistics of daily standing hours, types of footwear and frequency of use show mean of 1.97, 2.64 and 1.53 respectively and standard deviation of this display as 0.80, 1.16 and 0.50 accordingly.

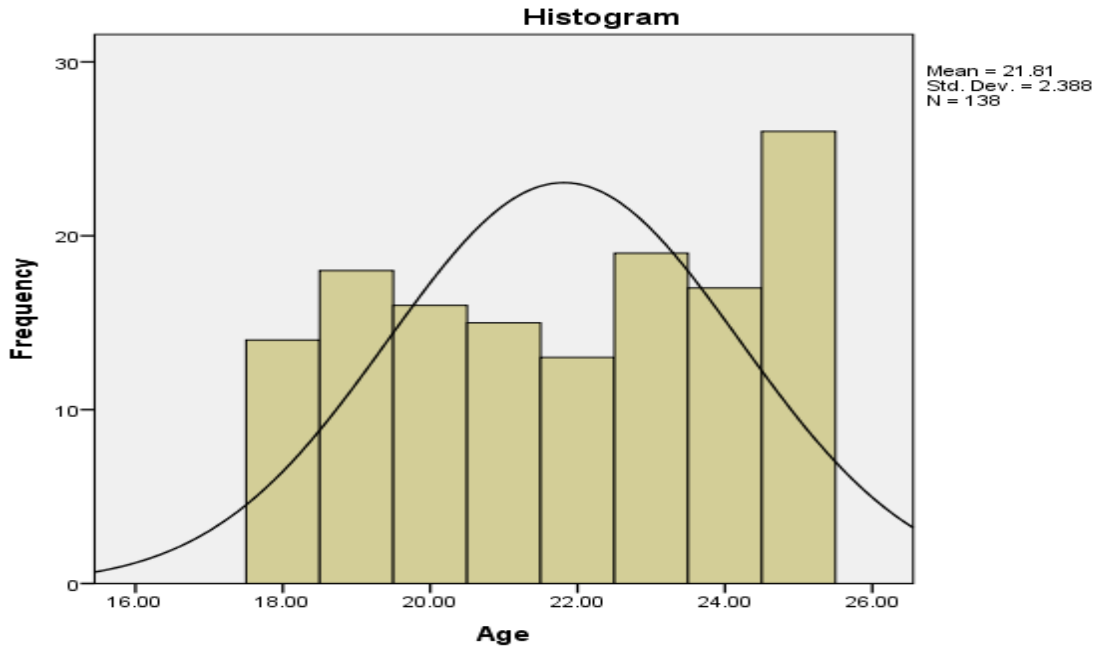


Fig. 4.1: Histogram of age statistics

4.2. Descriptive statistics of Daily Standing Hour

	Frequency	Percent	Valid Percent	Cumulative Percent
<1 Hour	46	33.3	33.3	33.3
1-3 Hour	50	36.2	36.2	69.6
>3 Hour	42	30.4	30.4	100.0
Total	138	100.0	100.0	

Table 4.2 shows the statistics of frequency and percentage of daily standing hour. A total of 138 participants were included in the study. Of this category, 50 participants (36.2) reported standing or walking 1-3 hours per day, which is the most frequent duration category. This was

followed by 46 participants (33.3) who had less than 1 hour of daily standing or walking. In the meantime, 42 participants (30.4%) indicated that they stood or walked over 3 hours a day.

4.3. Descriptive statistics of Types of Footwear

	Frequency	Percent	Valid Percent	Cumulative Percent
High Heels	32	23.2	23.2	23.2
Flat shoes	30	21.7	21.7	44.9
Sneakers	31	22.5	22.5	67.4
Sandals/Slippers	45	32.6	32.6	100.0
Total	138	100.0	100.0	

Table 4.3 shows the statistics of frequency and percentage of types of footwear. A total of 138 participants were included in the study. Most participants reported using sandals/slippers (32.6%), making them the most commonly worn footwear. This was followed by high heels (23.2%), sneakers (22.5%), and flat shoes (21.7%), showing a fairly even distribution among these types.

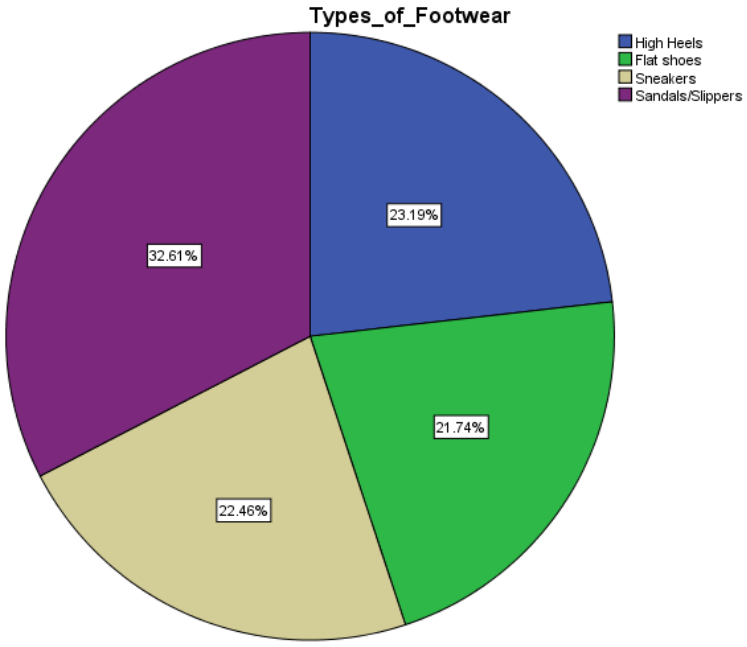


Fig. 4.2: Pie chart of Types of footwear statistics

4.4. Descriptive statistics of Frequency of Use

	Frequency	Percent	Valid Percent	Cumulative Percent
Daily	127	92.0	92.0	92.0
Occasionally	11	8.0	8.0	100.0
Total	138	100.0	100.0	

Table 4.4 shows the statistics of frequency and percentage of frequency of use of footwear. A total of 138 participants were included in the study. The majority of participants, 127 (92.0%), reported wearing their footwear on a daily basis, while only 11 (8.0%) used it occasionally. This indicates that most participants had regular and consistent exposure to their chosen type of footwear.

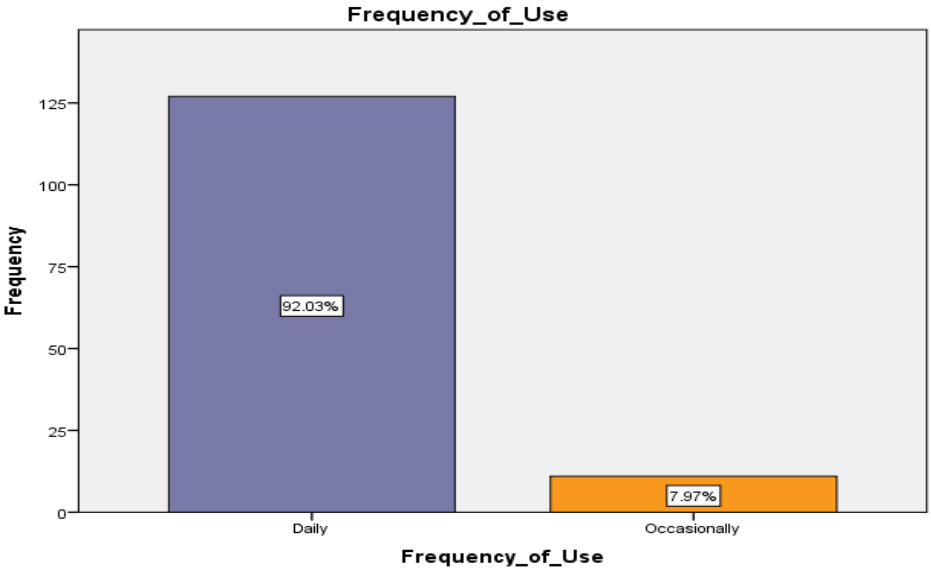


Fig. 4.3: Bar chart of Types of frequency of use of footwear statistics

4.5. Descriptive statistics of NPRS

Results show that mean and SD of NPRS is 4.94 ± 1.38.

Variables	Mean	SD
NPRS	4.94	1.38

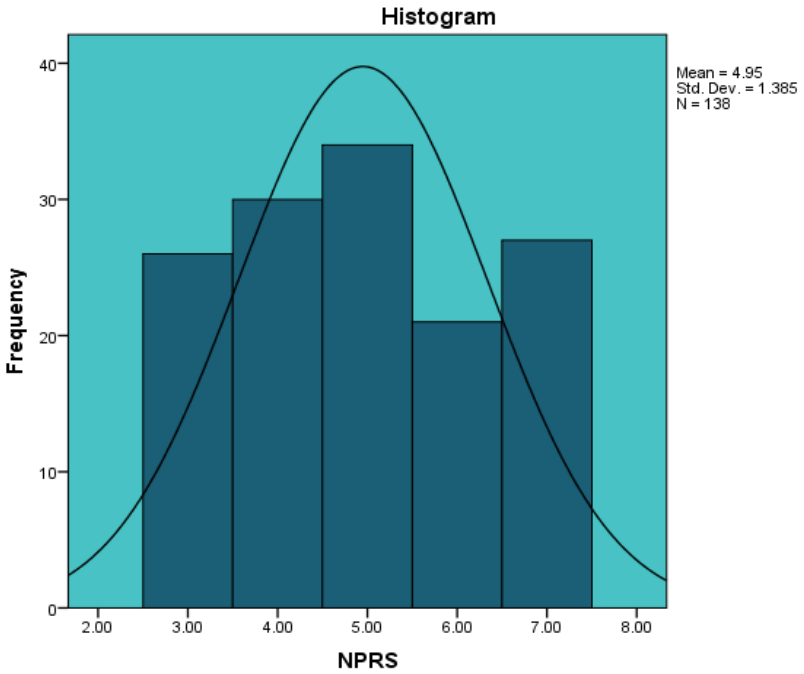


Fig. 4.4: Descriptive Statistics of NPRS

4.6. Frequency and Percentage Distribution of Numeric Pain Rating Scale

	Frequency	Percentage	Valid Percent	Cumulative Percent
3.00	26	18.8	18.8	18.8
4.00	30	21.7	21.7	40.6
5.00	34	24.6	24.6	65.2
6.00	21	15.2	15.2	80.4
7.00	27	19.6	19.6	100.0
Total	138	100.0	100.0	

This table shows the frequency and percentage distribution of the scores in pain intensity in terms of Numeric Pain Rating Scale (0-10). The largest percentage of respondents (24.6%) had scored 5 in pain, then 21.7% scored 4. These results have shown that a significant proportion of participants experienced mild to moderate pain.

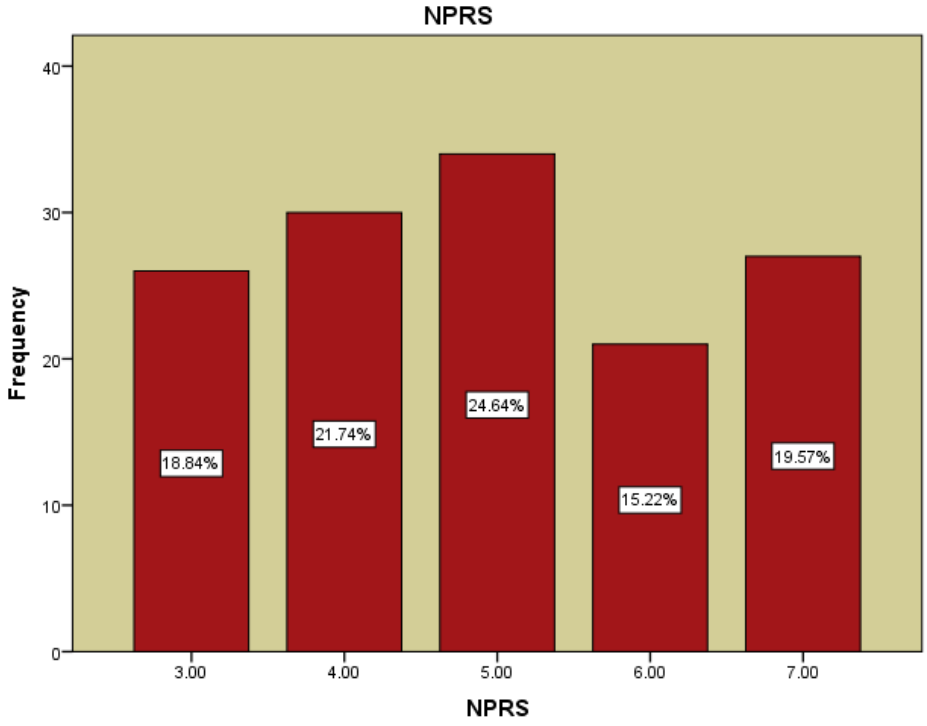


Fig. 4.5: Percentage of Distribution of Pain Intensity

4.7. Normality of NPRS

Variables	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pain Intensity	.159	138	.000	.892	138	.000

The above-mentioned table showed the normality of data. After applying test of normality data was not normally distributed with significant p-value (<0.05).

4.8. Spearman Correlation of NPRS with Study Variables

Variables	NPRS (Pain Intensity)	p-value
Daily Standing Hours	0.32	0.001
Types of Footwear	0.41	0.000
Frequency of Use	0.28	0.002

Spearman correlation analysis showed that types of footwear had the strongest positive correlation with pain intensity ($r = 0.41$, $p < 0.001$). Daily standing hours and frequency of footwear use also demonstrated significant positive correlations with NPRS, indicating that increased exposure is associated with higher pain levels.

4.9. Association of Footwear Type with NPRS (Kruskal-Wallis Test)

Footwear Type	Mean Rank (NPRS)
High Heels	89.5
Flat shoes	65.2
Sneakers	52.8
Sandals/Slippers	70.4
Test	Value
Kruskal-Wallis H	14.62
p-value	0.002

The Kruskal-Wallis test revealed a statistically significant difference ($p = 0.002$) in pain intensity among different footwear types. Participants wearing high heels reported the highest pain levels, while those using sneakers experienced the lowest pain.

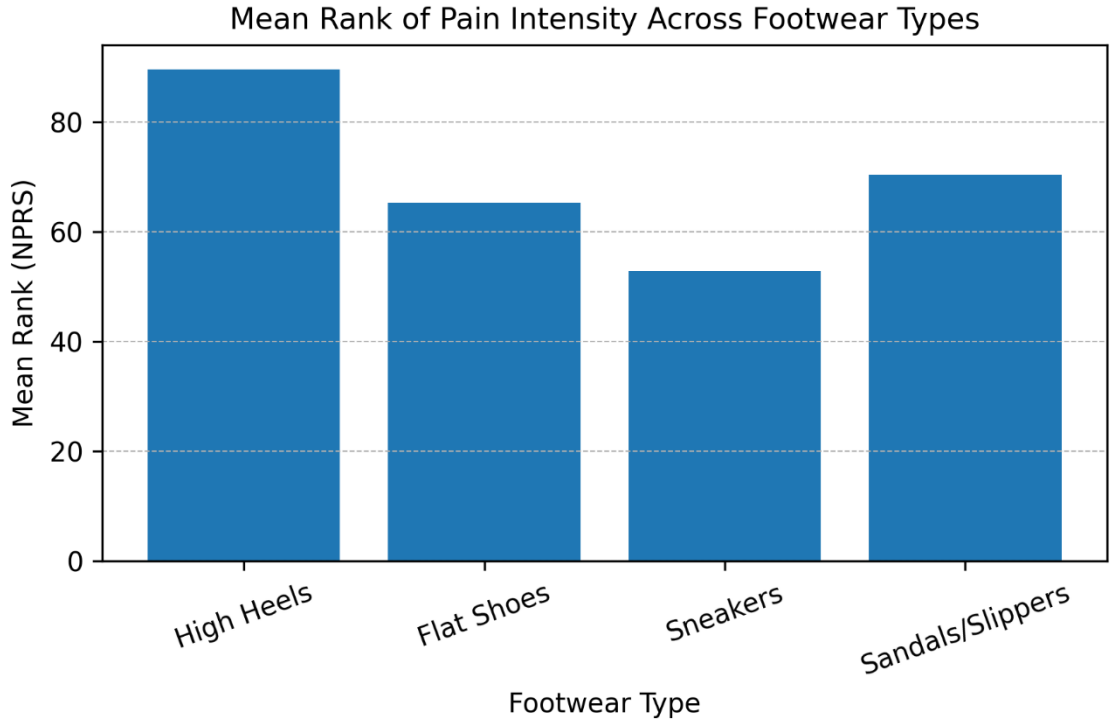


Fig. 4.6: Association of Footwear Type with NPRS

DISCUSSION

The present study was conducted to determine the effect of footwear on ankle pain among young female students. The results of the present research indicated a significant correlation between the ankle pain and the type of shoes used, the time spent standing daily, and the number of times the shoes are used per day.

The average age of the participants was 21.81 ± 2.38 years in this study, which means that the sample mostly included young people who are usually active and often exposed to various types of footwear. The majority of participants indicated that they stood or walked 1-3 hours a day, with a significant proportion also standing over 3 hours. This period of prolonged standing can be the cause of increased mechanical stress on the ankle joint, and

consequently result in pain. These results are in line with the other literature, which has suggested that the weight-bearing activities prolong the strain on the musculoskeletal system, and they lead to discomfort of lower limbs.

When it comes to the distribution of footwear, the most widely used type was the sandals/slippers followed by the high heels, sneakers and flat shoes. Sandals/slippers can be regarded as comfortable, but they might not have the right amount of arch support and cushioning, which may adversely impact foot biomechanics. Interestingly, a significant percentage of participants also said that they wore high heels which are well known to have negative influence on posture and gait. The average pain intensity that the participants reported in this study was 4.94 -1.38 on the Numeric Pain Rating Scale, which means that most of the participants have experienced mild-moderate ankle pain. This is also supported by the frequency distribution of which most of the participants indicated that they had pain scores ranging between 4 and 6. These results are in accordance with the study by Khan et al. (2024), which indicated a high incidence of non-traumatic foot pain in the young female population, with footwear being a major contributing factor. [22]

The correlation analysis revealed that the type of footwear and the level of pain in the ankle have a significant positive association ($r = 0.41$, $p < 0.001$) with some type of footwear being more likely to be a cause of ankle pain. Also, the length of standing time and frequency of use were also significantly correlated with pain, suggesting that both the duration and frequency of use of footwear significantly contribute to the development of symptoms. These results substantiate the idea that cumulative mechanical loading and repetitive stress are the main factors in musculoskeletal pain.

These findings were further reinforced by the results of the Kruskal-Wallis test that showed that the difference in levels of pain among the different types of footwear was statistically significant ($p = 0.002$). The maximum level of pain was reported by participants who wore high heels with the minimum level of pain reported by those who used sneakers. This is attributable to the biomechanical changes that result due to the high heels, whereby the high heels shift the center of gravity of the body forward and increase the load on the forefoot leading to instability and further strain on the ankle joint. Sneakers, on the contrary, are generally more effective in cushioning, shock absorbing, and providing support to the arch, which in turn decreases the amount of stress on the ankle.

The results of this research are in agreement with other researchers. It was found that high-heeled footwear substantially changes the gait mechanics and elevates the plantar pressure, which contributes to discomfort and risk of injury. [23] Likewise, Mohamed et al. (2021) discovered that athletic shoes enhanced balance and gait functioning compared to high heels among young female students. [25] Besides, Kumar et al. (2024) showed that high heels can have a negative effect on balance and stability, and can further increase the risk of musculoskeletal issues. [21]

The findings of this study point to the fact that inappropriate footwear, especially high heels and unsupported footwear are significantly related to increased ankle pain in young female students. Prolonged standing, the frequent use of such footwear, and the absence of the ergonomic support seem to worsen the situation.

5.1: Conclusion:

This study concluded that footwear and ankle pain have a significant relationship with young female students. Most of the participants had mild to moderate pain with an increased level of pain being recorded among the individuals wearing high heels. As well, prolonged standing hours and daily footwear use were observed to contribute to the severity of pain. On the contrary, sneakers were related with reduced rates of ankle pain. Overall, the findings highlight the importance of appropriate footwear selection. Raising awareness about appropriate footwear can be used to decrease the risk of ankle pain in this population.

5.2: Limitations:

This study had following limitations:

- small sample size used in the study.

- Study was conducted in limited area.
- Ergonomic factors were not assessed.
- NPRS scale was subjective bias.

5.2: Recommendations:

- The awareness programs should be raised among university students.
- Adequate rest intervals between prolonged standing and continuous walking should be done.
- Comparison studies should be carried out, as this study only observed the prevalence.

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