

## The Role of Heel Height on the Foot Arcus and Musculoskeletal Complaints

Adi Ahmad Gondo<sup>1</sup>, Gita Safirah Nuskin<sup>2</sup>, Andi Husnul Khatimah<sup>3</sup>, Rahmadani Rahmadani<sup>4</sup>,  
Sepdianti Lestari<sup>5</sup>

<sup>1,2,3,4</sup>Department of Physiotherapy, Faculty of Nursing Universitas Hasanuddin, Indonesia

<sup>5</sup>Department of Public Health Science, Faculty of Public Health Universitas Hasanuddin, Indonesia  
Jl. Perintis Kemerdekaan KM. 10, Makassar, South Sulawesi, 90245, Indonesia

### ABSTRACT

**Introduction:** Musculoskeletal complaints are often caused by accidents and occupational diseases. High heels that are often used by women workers in various companies can cause abnormalities in the shape of the feet. The purpose of this study was to detect the effect of using high heels on the foot arch of female workers in Makassar. **Methods:** This is a quantitative research using a cross-sectional research design. The sample in this study was 30 female workers who use high heels in Makassar who were selected using a non-probability sampling method with purposive sampling type. The data are primary data obtained through the measurement of the medial longitudinal arch with grid paper measurement which was analyzed using the Meyer line and the wet footprint examination which was analyzed by the Clarke index. Furthermore, the measurement of musculoskeletal complaint was analyzed using Nordic body map. **Results:** From research conducted on 30 respondents, more than 50% of respondents have pes cavus. The results of data analysis also showed the effect of heel height on increasing the height of the medial longitudinal arch of the sample based on the correlation of heel height and Clarke index. **Conclusion:** It found that the measurement of the soles of the feet on grid paper with the Meyer line parameter was not directly related to musculoskeletal complaints, on the contrary the Clark index could be used as a specific parameter in detecting an increase in the median longitudinal arc in the form of pes cavus.

**Keywords:** arcus, heel, planus

### Corresponding Author:

Adi Ahmad Gondo

Email: [adiaahmadgondo@gmail.com](mailto:adiaahmadgondo@gmail.com)

Telephone: +6285399292678

### INTRODUCTION

Statistics from basic health studies in Indonesia (Ministry of Health of the Republic of Indonesia, 2017) suggest that the prevalence of musculoskeletal disorder in Indonesia reached 37% of people in high-risk jobs (Widodo, Nurarinda and Mauliku, 2019). In 2018, musculoskeletal disorders constituted 272,780 (or 30%) of 900,380 causes of work accidents and occupational diseases in the U.S. private sector. This incidence increased by 6% from the previous year to 155 cases per 100,000 workers (Emmanouil and Rousanoglou, 2018). Feet are responsible for the body's foundation (base of support) and lever in activities. One of the most important areas affecting the musculoskeletal and

biomechanics of the foot is the arcus pedis or arch of the foot (Özdinc and Turan, 2016).

The arch of the foot is responsible for the absorption of ground reaction forces to give the body forward movement, to support the function of the legs as levers and support for the body (base of support) (Özdinc and Turan, 2016; Zifchock *et al.*, 2019). Arcus pedis is divided into three types, namely the medial longitudinal arch, lateral longitudinal arch, and transversus arcus. The medial longitudinal arch is one of the arches that have an important role in providing spring force when walking. The spring ligament or commonly called the calcaneonavicular ligament is the main support for the medial longitudinal arch which will provide elasticity and arc spring force during weightbearing so that the distribution of body weight is evenly distributed toward the calcaneal tuberculum and the fifth head of the metatarsal bones (Babu and Bordoni, 2020).

---

**Cite this as:** Gondo, A. A., *et al* (2023) 'The Role of Heel Height on the Foot Arcus and Musculoskeletal Complaints', *The Indonesian Journal of Occupational Safety and Health*, 12(1), pp. 136-142.

Problems in the structure and function of the medial longitudinal arch will cause foot deformities, one of which is the pes cavus. This condition occurs due to the condition of varus on the calcaneus and adduction of the front of the pedis so that the arcus pedis looks higher than normal (Budiman, Husaini and Arifin, 2016).

High heels are a strong symbol of modern women's sexuality to increase women's attractiveness to men. Footwear with high heels (more than 5 cm) has a fairly high health and safety risk. Research by Hasan, Sugiharti and Rachmawati (2020) found there is correlation between wearing high heels and pain intensity on posteromedial calcaneus. Based on the study, 29% of the 1901 women in the Framingham Foot Study experienced heel pain and arc pain due to wearing high heel footwear for more than five years (Dufour *et al.*, 2009). The cause of changes in the arch of the foot is the height of the heel and the type of shoe (Polat and Yücel, 2018).

If the pes cavus arch is not treated or prevented quickly, it can affect other body structures. It is known that the foot is a means of movement of the lower extremities, which is like the foundation of a building; if the foundation is weak (indicated) pes cavus it will cause a kinematic chain (chain kinematic) so that both knees, thighs and even the back area that correlates with the superior extremities will also be affected. On the other hand, if the foundation is solid, the rest of the body will follow suit.

Departing from this, basically everyone has the potential to experience pes cavus. Therefore, we developed a program for early detection and education of the effects of using high heels for female workers in order to control the use of shoes that result in changes in the arch of the foot in the hope that they can carry out activities comfortably without surgery.

## METHOD

This study is a quantitative study using a cross-sectional research design. In this study, heel height is the independent variable, while the foot arch and musculoskeletal complaints are the dependent variable. The population in this study were female workers in Makassar using high heels. The sample selection method used is non-probability sampling with a type of purposive sampling totaling 30 female workers. Data collection was carried out at Hasamitra Credit Bank Makassar, on June 3,

2021. The data were obtained by measuring the heel height of the sample shoes using a ruler. Then proceeding with foot arch examination using grid paper measurement and wet footprint. The grid paper measurement examination was analyzed using Meyer's line, by placing the feet on the paper and giving lines based on the shape of the feet. After that the sample was directed to MTP abduction, then the line of the big toe based on the visible shape. The wet footprint examination was analyzed using Clarke index, by applying acrylic oil on the foot plantar, then the sample was directed to stand on the paper and the visible results were clarified using a pen. It was then interpreted based on the Clarke index and musculoskeletal complaints were analyzed using Nordic body map. The researcher did a history taking related to the location and grade of pain felt by the sample, then marked it on the Nordic body map score paper.

The data obtained are primary emerging from the measurement of the medial longitudinal arc. The statistical test used is the normality test using Pearson. The data collected were carried out by the Pearson test because the data were normally distributed, which aims to determine the effect of heel height on the arch of the foot. The interpretation was carried out by drawing hypotheses based on comparative tests in order to obtain a significant correlation with the effect of using heels on changes in the foot arch of female workers in Makassar. Conclusions are drawn based on the results of the test or treatment analysis, participatory observation, and data analysis obtained from reliable sources. This research was carried out after obtaining a recommendation for ethical approval from Health Research Ethics Committee Health Polytechnic Makassar No: 00792/KEPK-PTKMKS/X/ 2021.

## RESULTS

The following are the results of data analysis on 30 research samples, the analysis of the data presented was using the Pearson test because the data are normally distributed. Table 1 shows that out

**Table 1.** Distribution of The Medial Longitudinal Arc Based On The Clarke Index

	Category		
	Pes planus	Normal	Pes cavus
Right Foot n (%)	6 (20)	8 (26.7)	16 (53.3)
Left Foot n (%)	3 (10)	10 (33.3)	17 (56.7)

of 30 respondents, more than 50% had pes cavus. Then, Table 2 presents the results of the analysis of the mean and standard deviation of each variable.

Table 3 describes the calculation of the correlation between heel height and the Clarke index in female workers. The data analysis included 30 women which showed that the relationship between heel height and Clarke's index on the right leg has a significant positive correlation of 30.14% ( $p = 0.002$ ;  $r = -0.549$ ). In addition, the results of the analysis of the relationship between heel height and Clarke's index on the left leg has a significant positive correlation of 29.70% ( $p = 0.002$ ;  $r = -0.545$ ).

Table 3 also presents the calculation of the relationship between heel height and Meyer line. The results show that the Pearson coefficient is 0.028 on the right leg, and -0.031 on the left for 30 female workers. In addition, correlation percent is very small, i.e. 7% on the right leg and 9% on the left leg. The table also shows that the significance value on both legs is greater than 0.05 ( $p > 0.05$ ). This means that there is no significant relationship between heel height and Meyer line. This shows that the measurement of the sole of the foot on grid paper with the Meyer line parameter is not directly related to heel height. Meyer line is a parameter used in making shoe soles or shoe volumes that are good and appropriate for users.

Table 4 describes the calculation of the correlation between the Clarke index and musculoskeletal complaints in female workers. The data analysis included 30 women which showed

that the calculated correlation coefficient was -0.435 on the right leg, and -0.366 on the left leg. The results of the Pearson coefficient obtained show a negative correlation. The table also shows that the significance value on both legs is less than 0.05 ( $p < 0.05$ ). This means that there is a significant negative relationship between the Clarke index and musculoskeletal complaints. This shows that the measurement of the soles of the feet on grid paper with Meyer line parameters is not directly related to musculoskeletal complaints. Based on the data analysis in Tables 3 and 4, it can be concluded that the Clark index can be used as a specific parameter in detecting an increase in the longitudinal arc of the media in the form of pes cavus.

**DISCUSSION**

The musculoskeletal system is an important part of the locomotor system and consists of bones, joints and ligaments. The lower extremities play an important role in posture and gait. The foot touches the floor with the head of the fourth metatarsal bone on the anterior side and the calcaneus on the posterior side. The arch of the foot, formed by bone, tendon, muscle, and ligamentous structures, flexibly transmits body weight to the floor. The arch allows adaptation of the foot to body weight and changes in the contact surface. The structure and function of the arch of the foot depends on factors including

**Table 2.** Mean and Standard Deviation (SD) for Each Variable

	Mean ± SD
Right Heel Height	5.79 ± 1.62
Left Heel Height	5.82 ± 1.64
Clarke Index of the Right Foot	2.33 ± 0.80
Clarke Index of the Left Foot	2.47 ± 0.68
Meyer Line of the Right Foot	0.66 ± 0.24
Meyer Line k of the Left Foot	0.74 ± 0.25
Musculoskeletal Complaints	1.17 ± 0.46

**Table 4.** Results of Correlation Analysis Between Arcus Conditions and Musculoskeletal Complaints

	Musculoskeletal Complaints		
	P	r	r <sup>2</sup> (%)
Clarke Index of the Right Foot	0.016*	-0.435	18.92
Clarke Index of the Left Foot	0.047*	-0.366	13.40
Meyer Line of the Right Foot	0.862	-0.033	0.11
Meyer Line of the Left Foot	0.794	-0.050	0.25

**Table 3.** Results of Correlation Analysis Between Heel Height and Arcus Conditions Based on Clarke Index and Meyer Line

	Clarke Index			Meyer line		
	P	r	r <sup>2</sup> (%)	P	r	r <sup>2</sup> (%)
Right Heel Height	0.002*	0.549	30.14	0.881	0.028	0.07
Left Heel Height	0.002*	0.545	29.70	0.869	-0.031	0.09

bone structure, ligament stability, shoes, age, sex, and race, which affect the medial longitudinal arch of the foot (Polat and Yücel, 2018).

Lack of knowledge and awareness cause cases of musculoskeletal injury because the use of high heels is still classified tall. From the data obtained in Victoria, Australia, in 2006-2010 it was found that the number of cases of musculoskeletal injury due to the use of high heels was as many as 240 events, with the most cases being injuries to lower extremity (Williams and Haines, 2014).

During the study, the researchers found that there were various complaints from the samples related to musculoskeletal pain experienced. These conditions consist of musculoskeletal pain in the back to the lower legs that greatly interfere with daily activities.

The social and scientific relevance of these findings is discussed. Concern is expressed about the expectation to wear high-heeled shoes in some work and social situations and access by children (Barnish and Barnish, 2016). However, due to paucity of research on the relationship between frequency of high heel use and harmful health effects, it is unclear whether this subset of the population is at higher risk for knee OA because of high heel uses (Carlson, 2020).

### The Effect of High Heels on the Arch

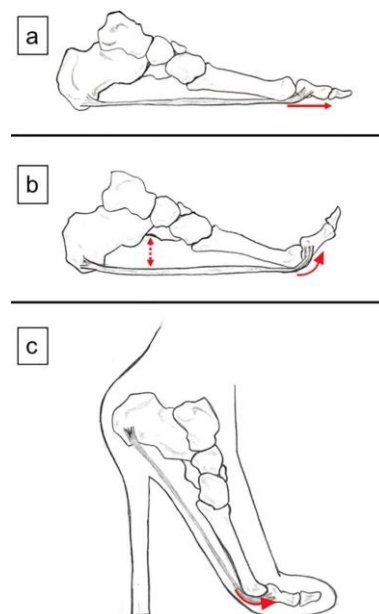
Instability of the foot as a support for the body can be caused by the presence of a pes cavus. Long-time use of high heels can exacerbate foot health problems wherein muscle tone is susceptible, tired quickly, leg cramps and pain, especially when standing for a long time or when doing activities using the feet. High-heeled footwear increases the problem of keeping stability. A study shows that normalized tour distance reduced drastically as heel height expanded. This is accompanied by a normalized excursion distance that decreases significantly as heel height increases (Zhang, Li and Zhang, 2017).

When using a high heel, the plantar fascia (supporting tissue for the medial longitudinal arch) connects the calcaneus with the proximal metatarsophalangeal (MTP) joint, when the proximal MTP joint flexes it causes the plantar fascia to appear stretched and tightened, as well as an increase in the medial longitudinal arch. using a high heel changes from the normal anatomy, where the proximal MTP joint is passively flexed due to the use of a high heel (Zeidan *et al.*, 2020).

The results of the Pearson test in this study are in line with the research of Zeidan *et al.* (2020) that there is an increase in the medial longitudinal arch which is influenced by the use of high heels. The use of a heel causes a mechanism in the form of a windlass effect in the long term. The windlass effect is a condition in which the plantar fascia supports the foot during activity and provides information about the biomechanical stresses placed on the plantar fascia. The windlass mechanism shows anatomical changes caused by the plantar fascia experiencing tightness (Zeidan *et al.*, 2020).

Beside the plantar fascia of ankle, the plantar fascia muscle also performs a critical position. The plantar intrinsic muscle groups are actively managed by way of the central apprehensive gadget (CNS) and form the layer of tension load-bearing elements of the Longitudinal Arch Load-Sharing device simply deep to the plantar fascia. The abductor hallucis, and the other plantar intrinsic muscle tissues which span the longitudinal arch, serve to actively stiffen the longitudinal arch while ground reaction force (GRF) loads increase on the plantar foot to prevent immoderate longitudinal arch pulling down in the course of weightbearing activities (Kirby, 2017).

A study that analyzes the influence of high heeled shoes in foot's medial longitudinal arch in adolescents showed the comparison before and after the use of high heel for 30 minutes. The research sample was divided into two sample groups, the control group and experimental group. A difference



**Figure 1.** Arch anatomy when using high heels (Zeidan *et al.*, 2020)

was noticed only on left foot in the control group by using Chippaux-Smirak Index (ICS) as the measuring instrument. Although there wasn't any significant difference in medial longitudinal arch, it must be remembered that other dynamic components and the prolonged use of high heel require more study and research (João *et al.*, 2012).

Another study by Polat and Yucel supports the results of this study, that regular wearing of high heels leads to increased structural changes in the medial longitudinal arch. Polat and Yucel's study using the staheli and chipaux smirak arch index with a sample of 1356 women showed a correlation of heel height with an increase in foot arch (Polat and Yücel, 2018).

### **The Effect of High Heels on the Arch can Affect Musculoskeletal Complaint**

This change in the height of the arch of the foot affects the tissues that support the arch and the tissues that are connected to it. Excessive contraction of the gastrocnemius muscle and tension of the tibialis anterior muscle means abnormal work of the lower extremity muscles will have an impact on the trunk. In this condition, musculoskeletal complaints are exacerbated by excessive BMI, static work positions, long working hours, and poor exercise habits. The working factor is static position. Shoe characteristic variables consist of shoe type, duration of shoe use, and suitability of shoe size while the unrelated factor is age (Amaliyah, Ma'rufi and Indrayani, 2020).

High heels are one type of heels that are commonly used by women. Judging from the purpose these have a personal nature, because each woman has a different goal in terms of wearing high heels. Some wear high heels to make the body look level, some wear high heels to look sexy, some wear high heels to make their body look more attractive, and so on. However, behind the different goals, there is basically the same goal, which is to meet beauty standards (Macpal and Azhar, 2020).

Female workers in general are always required to look good and neat, because, along with the times, the competition is getting tougher so that workers are required to work professionally. These demands usually come from several companies that require female workers to always use high heels during working hours (Maharani, Wahyuni and Widjasena, 2021). However, compared to the bad impact that high heels will cause, it seems that the attractiveness factor is not enough and not

comparable to maintaining the habit of using high heels. In spite of the symbolic strength and the imaginary of seduction and femininity, the pain of this accent seems more crucial for women whilst selecting their shoes. In truth, they prefer flat, secure footwear of their day by day existence, even though they want to use high-heels shoes (Broega, Righetto and Ribeiro, 2017).

Specific studies looking at the impact of soft tissue stiffness on the plantar stress distributions and the inner load switch among bony shape display that the flatfoot results in an extra in depth stress-shielding map with massive values of stress performing on the medial plantar fascia (Filardi, 2018).

Cha (2021) found that wearing excessive heels for a long time could adversely have an effect on the human body. Wearing high heels for a long term reduced pelvic variety of motion (ROM), while static stability and factor discrimination (2PD) expanded. it might affect the general body capabilities by means of increasing the muscle tone of the plantar flexors and irritating dynamic stiffness at the same time. The scientific importance lies in the reality that wearing high heels for lengthy intervals could adversely affect the human frame.

It is also essential to research the connection between foot posture and plantar arch among wearers and non-wearers of high heel footwear. A observation that tested this challenge among adolescents found that there's no correlation between foot posture and the form of plantar arch, despite the fact that these variables are inspired via high-heeled shoes (Pezzan, Sacco and João, 2009).

The next results also found a relationship between heel height and Mayer line. Meyer line is a parameter used in making shoe soles or shoe volumes that are good and appropriate for users. In high heel shoes, the sole tends to narrow. Shoe soles or shoe volumes that are not appropriate for the user have an effect on changes in the arch of the foot and musculoskeletal complaints (Melvin, 2014).

Musculoskeletal complaints such as increased pain intensity in the posterior and medial calcaneus areas will also be very likely to occur (Sugiharti, 2020). However, there is no research that states that there is a significant relationship between the measurement of the sole of the foot on the grid paper and the Meyer line parameter that is not directly related to heel height.

Research conducted by Woźniacka *et al.* (2019) showed that a moderate increase inside the

longitudinal arch of the foot, even inside a common range not taken into consideration pathological, inflicts a noticeable trade in the distribution of leg load both between the limbs and the between the back and front legs. Excessive arches of the legs also can affect the whole body, inflicting an outstanding potential for body malalignment.

The research conducted also found a significant negative relationship between the Clarke index and musculoskeletal complaints. Research which is in line with this study by Polat and Yücel (2018) also explains that heel height increases ankle plantar flexion. These changes result in shortening of the plantar flexor muscle group, especially the gastrocnemius muscle. This muscle shortening can cause various musculoskeletal complaints due to muscles prone to fatigue, the knee joint functions to support body weight more so that it forces the joint to bend to balance tense muscles, and various other conditions (Polat and Yücel, 2018).

## CONCLUSION

Based on the research that has been carried out and the results of the discussions that have been presented, it can be concluded from the results of data analysis using the Pearson test with normal distributed data that there is an effect of heel height on increasing the height of the medial longitudinal arch of the sample based on the correlation of heel height and the Clarke index. The results of data analysis also show that there is an effect of using high heels with musculoskeletal complaints based on the Clarke index classification. However, this study showed no association between detection using Meyer's line and heel height in increasing the height of the medial longitudinal arch. For the next research, measurement using digital footprint is the author's recommendation. This is done to minimize the occurrence of direct contact in the era of the COVID-19 pandemic. By using digital footprint also will make the measurement process easier and minimize errors that often occur through manual measurement. In addition, it is hoped that further research will be carried out regarding the treatment of individuals with pes cavus.

## ACKNOWLEDGMENT

The researchers would like to thank the parties who have helped in the process of completion of this article. In addition, we would like to thank the

Hasanuddin University Research and Community Service Institute (LPPM) for trusting us to develop our research.

## REFERENCES

- Amaliyah, M., Ma'rufi, I. and Indrayani, R. (2020) 'Characteristics of Shoes with Musculoskeletal Complaints on Foot and Ankle of Sales Promotion Girl', *Jurnal Kesehatan Masyarakat*, 15(3), pp. 372–381.
- Babu, D. and Bordoni, B. (2020) 'Anatomy, Bony Pelvis and Lower Limb, Medial Longitudinal Arch of the Foot', in *StatPearls*, pp. 1–8.
- Barnish, M. S. and Barnish, J. (2016) 'High-Heeled Shoes and Musculoskeletal Injuries: A Narrative Systematic Review', *BMJ Open*, 6(1), pp. 1–8.
- Broega, A. C., Righetto, M. and Ribeiro, R. (2017) 'Female High Heel Shoes: A Study of Comfort', *IOP Conference Series: Materials Science and Engineering*, 254(23), pp. 0–6.
- Budiman, A., Husaini and Arifin, S. (2016) 'Relationship Between Age and Workload Index with Fatigue in Workers at PT Karias Tabing Kencana', *Jurnal Berkala Kesehatan*, 1(2), pp. 121–129.
- Carlson, E. (2020) *Risk of Knee Osteoarthritis Associated with High Heel Use Risk of Knee Osteoarthritis Associated with High Heel Use, WWU Honors Program Senior Projects*. Western Washington University.
- Cha, Y. J. (2021) 'Effects of Wearing Raised-Heel Insoles for 60 Days on Physical Functions: Focusing on Adult Males in Their Twenties', *Journal of Men's Health*, 17(4), pp. 198–206.
- Dufour, A. B. et al. (2009) 'Foot Pain: Is Current or Past Shoewear a Factor?', *Epidemiology of Rheumatic Disease*, 61(10), pp. 1352–1358.
- Emmanouil, A. and Rousanoglou, E. (2018) 'Effect of High-Heeled Shoes on Postural Control in the Upright and the Leaning Body Stance', *Physical Medicine and Rehabilitation Research*, 3(5), pp. 1–5.
- Filardi, V. (2018) 'Flatfoot and Normal Foot a Comparative Analysis of the Stress Shielding', *Journal of Orthopaedics*, 15(3), pp. 820–825.
- Hasan, M., Sugiharti, I. A. and Rachmawati, D. A. (2020) 'Hubungan Penggunaan High Heels Terhadap Intensitas Nyeri Daerah Calcaneus Dan Perubahan Range of Motion Pada Ankle', *Journal of Agromedicine and Medical Sciences*, 6(2), pp. 82–86.

- João, S. M. A. *et al.* (2012) 'Análise do Arco Longitudinal Medial em Adolescentes Usuárias de Calçados de Salto Alto', *Fisioterapia e Pesquisa*, 19(1), pp. 20–25.
- Kirby, K. A. (2017) 'Longitudinal Arch Load-Sharing System of the Foot', *Revista Española de Podología*, 28(1), pp. e18–e26.
- López-López, D. *et al.* (2018) 'The Influence of Heel Height Related on Quality of Life on the Foot in a Sample of Women', *Revista da Associação Médica Brasileira*, 64(4), pp. 324–329.
- Macpal, S. and Azhar, F. (2020) 'High Heels sebagai Agensi bagi Tubuh Wanita', *Anthropos: Jurnal Antropologi Sosial dan Budaya (Journal of Social and Cultural Anthropology)*, 5(2), p. 196.
- Maharani, A. M., Wahyuni, I. and Widjasena, B. (2021) 'Hubungan Sikap Kerja Berdiri, Karakteristik Pekerja, dan Penggunaan High Heels terhadap Tingkat Kelelahan Kerja pada Sales Promotion Girls (SPG) di Swalayan Kota Semarang', *Jurnal Kesehatan Masyarakat (Undip)*, 9(6), pp. 741–746.
- Melvin, J. M. A. (2014) *The Effects of Heel Height, Shoe Volume and Upper Stiffness on Shoe Comfort and Plantar Pressure*. Dissertation. Salford: School of Health Sciences, University of Salford.
- Özdinc, S. A. and Turan, F. N. (2016) 'Effects of Ballet Training of Children in Turkey on Foot Anthropometric Measurements and Medial Longitudinal Arc Development', *Journal of the Pakistan Medical Association*, 66(7), pp. 869–874.
- Pezzan, P. A. O., Sacco, I. C. N. and João, S. M. A. (2009) 'Foot Posture and Classification of the Plantar Arch among Adolescent Wearers and Non-Wearers of High-Heeled Shoes', *Revista Brasileira de Fisioterapia*, 13(5), pp. 398–404.
- Polat, S. O. and Yücel, A. H. (2018) 'Wearing High-Heeled Shoes Increases the Foot Arch Angle Inducing Measurable Changes in the Musculoskeletal System', *Journal of Back and Musculoskeletal Rehabilitation*, 31(6), pp. 1119–1129.
- Sugiharti, I. A. (2020) 'Hubungan Penggunaan High Heels Terhadap Intensitas Nyeri Daerah Calcaneus Dan Perubahan Range of Motion Pada Ankle', *Journal of Agromedicine and Medical Sciences*, 6(2), pp. 82–86.
- Vittala, G. *et al.* (2021) 'The Correlation between Body Mass Index and the Type of Foot Arches with the Risk of Hallux Valgus in Children Aged 13–14 Years Old', *International Journal of Research in Medical Sciences*, 9(3), pp. 680–684.
- Widodo, R. S., Nurarinda, W. and Mauliku, N. E. (2019) 'The Correlation Age, Body Mass Index, Work Period and Work Position With Musculoskeletal Disorders in Workers Packing Part of PT. Sanbe Farma Unit II in 2019', *The 3rd International Seminar on Global Health*, 3(1), pp. 330–334.
- Williams, C. M. and Haines, T. P. (2014) 'An exploration of emergency department presentations related to high heel footwear in Victoria, Australia, 2006-2010', *Journal of Foot and Ankle Research*, 7(1), pp. 2–7.
- Woźniacka, R. *et al.* (2019) 'The association between high-arched feet, plantar pressure distribution and body posture in young women', *Scientific Reports*, 9(1), pp. 1–10.
- Zeidan, H. *et al.* (2020) 'The Shape of the Transverse Arch in High Heels While Standing', *PLoS ONE*, 15(6), pp. 1–14.
- Zhang, B., Li, S. and Zhang, Y. (2017) 'Evaluation of Dynamic Posture Control when Wearing High-Heeled Shoes using Star Excursion Balance Test', *Physical Activity and Health*, 1(1), pp. 1–7.
- Zifchock, R. *et al.* (2019) 'The Relationship between Foot Arch Flexibility and Medial-Lateral Ground Reaction Force Distribution', *Gait and Posture*, 69(January), pp. 46–49.