

Article Info:

Published Date: 19 October 2022

*Corresponding Author: rozali719@uitm.edu.my

A NEW BUNION SHOE DESIGN USING GEOMETRIC ANALYSIS: HALLUX VALGUS ANGLE (HVA) FOR MALAYSIAN WOMEN

**Dayang Intan Farahanies AlMurid¹, *Muhamad Rozali Othman², Muhammad Khalik
Mustafa³, Nasyirah Saleh⁴, Shuhaila Nahrawi⁵**

^{1,2,3,4,5}Department of Fashion Design, College of Creative Arts, Universiti Teknologi MARA Perak
Branch, Seri Iskandar Campus, Seri Iskandar, Perak, MALAYSIA

To cite this article (APA): AlMurid, D. I. F., Othman, M. R., Mustafa, M. K., Saleh, N., & Nahrawi, S. A new bunion shoe design using geometric analysis: Hallux Valgus Angle (HVA) for Malaysian Women . *KUPAS SENI*, 10(2), 1–10. <https://doi.org/10.37134/kupasseni.vol10.2.1.2022>

To link to this article: <https://doi.org/10.37134/kupasseni.vol10.2.1.2022>

ABSTRACT

The main of this study is to identify and come out with a new bunion shoe design using geometric analysis: Hallux Valgus angle HVA for Malaysian women. A bunion is a bulging bump that appears on the side part of the metatarsal tibiale which commonly occurs in women compared to men. There are three stages of bunion which are mild, moderate, and severe with different angles of measurement. This study seeks to identify each stage of the bunion using the geometric angle on three participants' ethics which are Malay, Chinese and Indian, and also to measure the circumference of the bunion. The method that will be used in this research is quantitative which also involves a sample size is n=150. As a result, the data shows that the highest percentage is in size seven. The circumference of size seven consists of mild 220 mm, moderate 245 mm, and severe 282 mm. The result of the circumference will be used to make the shoes last in different stages. Hence, this study will be helpful by construct a new bunion shoe design using geometric analysis (HVA) that would be a benefit for women who are suffering from bunions which can make it easier to walk in daily routines without any feeling uncomfortable or any pain on the part of their bunion.

Keywords: Malaysian women; foot deformities; geometric angle

INTRODUCTION

A bunion known medically as hallux valgus is one of the cases that could be seen in Malaysia, especially among women. As stated by Oestreich, A. E. (2013), "Bunion" originated from the Greek word for turnip, and the knock within the foot ordinarily looks red and swollen like a turnip. It affects both adult women and men, however, they are more common in women (Smith, L, 2019). Bunions begin as small bump and yet it typically deteriorates after some time depending on the individual, if the individual keeps on wearing tight or restricted shoes. Since the metatarsophalangeal (MTP) joint flexes with each progression, the greater the bunion gets, the more agonizing and troublesome strolling can turn into. A bunion structure started when the bones that make up the metatarsophalangeal (MTP) joint move crooked, the long metatarsal bone moves toward within the foot, and the phalanx bones of the huge toe edge toward the subsequent toe. The MTP joint gets bigger and distends from within the forefoot (Ohashi, H, 2021).

The causes of bunion normally make the part of joints swell and hurt, as rheumatoid joint inflammation, can prompt bunions. Furthermore, shoes that do not fit well can, as well, particularly on the off chance that they spasm to toes. Apart from that, some people are simply bound to get bunions because of how their feet are molded. Several medical scientists believed that people inherit the bone structure that causes a bunion to develop. Other factors are overpronation that having a low arch or uneven weight-bearing in the foot and tendon which makes the toe joint unstable. As stated by Zhang, Y (2018) HVA

stands for Hallux Valgus Angle which shows the severity of bunions and how it affects the daily life of a person. As for mild, in which the angle is below 25 does not need to do surgery but has to take precautions, by wearing the right shoes and to prevent it from getting severe which is the size of Hallux Valgus 41-50 degrees. It is a must to do surgery because it will affect daily life and also it could lead to major problems on the foot such as the pressure that has been put up onto the foot. However, there is a possibility, people with bunions in Malaysia hard to find the right size of shoes and suitable materials, especially for people with sensitive skin. Pain from a bunion can range from mild to severe, making it difficult to walk in normal shoes, especially high-heeled shoes (Tarantino, D, 2021). Wear a shoe that's slightly too tight or made not suitable material, and the bony bump at the inside of the big toe joint becomes inflamed and painful (Mayo Clinic, 2021). The normal sizing that can be fit or tight while wearing shoes could cause blister and redness at part of the bunion. Wearing normal shoes can affect cramping, squeezing, pressing, or irritation of the toes and feet (Silvester, R. N, 2010). The symptoms could be seen at the early stage, where a small bump will appear on the outside of the big toe as well as redness followed by soreness around it.

Most Malaysian women have unique foot shapes, particularly in the girth and width part (Goodman. B, 2011). The bunion has different stages from minor to major, moreover, the bigger the size of the bunion it can lead to a major problem. Bunions are prominent and often swollen metatarsal heads and overlying bursae, typically associated with hallux valgus, then, it will cause pain and also problems with walking and wearing normal shoes (Shariff, S. M, 2014). Furthermore, a bunion is a bump that forms on the joint at the base of your big toe which seems like a broken bone sticking out of the skin looking damaged. It is mostly caused by the pressure that has been put on the foot or wearing tight shoes that make friction between the skin and the materials.

MATERIALS AND METHOD

Data Collection

In this study, quantitative research will be conducted by survey-questionnaire to gather and analyze the information on the usability and aesthetic of bunions based on the sizes of shoes through their daily life. In quantitative research, many types of methods could be used to achieve the results. However, in this study, a survey and observation approach was applied to get the findings of the research. The total for the final survey was 150 respondents women with a bunion. These respondents were for the three main ethnics Malaysia in figure 3.3 which is Bumiputra 69.3% (n=69.3), Chinese 22.8% (n=22.8) and Indian 6.9% (n=6.9) in 2019. These respondents were from every state in Malaysia and consisted of three types of categories mild, moderate, and severe. However, due to the fact of the Bumiputra population increased by 0.2% from the year 2019 as compared to 2018 and for that, and the respondents were mostly involved in Bumiputra than other ethnicities (Department of Statistics Malaysia, 2022). To achieve the main, purpose of the study, a survey distributed has to detail each section of questions. The final survey is contained 25 questions and follows some sectors, which it is classified into four sections.

Section A is demographic information that has five questions, section B is bunion case disease has seven questions, section C is problem identification has eight questions and last section D is needed analysis has five questions. This study's demographics of age women were included from 20 years old until 60 years above. As stated by Svoboda, B, 2019 the general population is 23% of adults aged 18-65 years and 35.7% of adults more than 65 years old and as the target ages for respondents with the bunion for the final survey. Most women's bunions have occurred at the age of 60 and above and individuals with bunions only realize the symptoms at the age of 20 years old and above.

Statistical Analysis

A total of 150 respondents were mainly picked from around the state of Malaysia since the purposive sampling based on the respondents is not randomly picked but only the women with bunions could have participated as sampling. The process of collecting the data from respondents is taking a 5-month duration overall. Based on the data, the total number of respondents by ethnicity, Malay is 92% (n=138) followed by Chinese 2% (n=4). The rest is Indian 2% (n=4) and other is also 2% (n=4). The other ethnics are included Sabah and Sarawak ethnics. The total number of respondents is (n=150).

Table 1. The Radiographic Measurement in Bunion (Hallux Valgus)

CATEGORIES	HVA	IMA
MILD	<25°	<13°
MODERATE	26-40°	13-15°
SEVERE	41-50°	16-20°

To pass judgment on how serious a bunion is, clinicians take an x-ray and measure the angle between specific bones in the foot, specifically, the hallux valgus angle (HVA) which is the edge between the principal metatarsal and the huge toe, the angle point framed by the first and the second metatarsals, called as the intermetatarsal edge (IMA). The maximum furthest reaches of normal for the HVA is 15 degrees and for the IMA, 9 degrees. The bunion angle also can be checked manually (Idaho Foot & Ankle Associates, 2014).

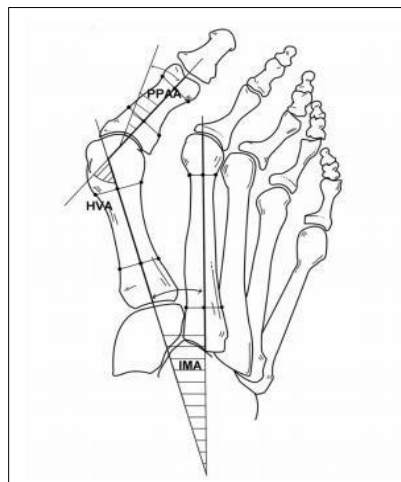


Figure 1. Hallux Valgus Angle Measurement

The figure above shows the measurement for hallux valgus angle (HVA), intermetatarsal angle (IMA), and proximal phalangeal articular angle (PPAA) using geometric. Conventional proportions of the seriousness of hallux valgus counting the hallux valgus angle (HVA) and the first intermetatarsal angle (IMA) are all around acknowledged and coordinated generally in clinical practice and careful choice making (Piqué-Vidal, C., Vila, J, 2009).



Figure 2. Process of calculation Hallux Valgus Angle

The process of the hallux valgus angle was used to determine each stage of respondents that participated in the actual survey. After the data were collected by the measure manual ways which are by printing out the picture of the respondent's bunion conditions to get the angle of the group stages their fit. This method was to identify the stage of each bunion respondent in degree.



Figure 3. Hallux Vagus Angle (HVA) manually

Physical Examine



Figure 4. Process of measuring the circumference of a bunion

Fig. 4 above shows the step of taking the bunion measurement to get the measurement of the bunion shoe design. Based on a level surface and maintaining a straight posture, wrap the measurement tape around the bunion area and measure its diameter in centimeters before converting it into millimeters to identify each respondent's measurement. The analysis of the data and the measurement's outcome were applied to develop a new circumference shoe size depending on each stage for mild, moderate, and severe.

RESULT AND FINDINGS

Effect wearing normal shoes

Bunions can frame for different reasons, yet ordinarily create because of poorly fitting footwear, for example, narrow shoe shape or high heels points. Using the normal shoe that does not fit the bunion conditions could be suffering in daily routines. Thus, those people with bunion conditions need to find the right shoe that fits their comfort. People with level feet or who have a past filled with bunions in their family are likewise increasingly inherited bunions (Williams, A, 2007). Joint conveys a great deal of weight while walking, which makes the bunions incredibly difficult whenever left untreated.

The percentages age of the respondents in Malaysia shows that those 20 to 29 years old had the highest percentage of 68.7% (n=103) in terms of the number of respondents compared to other age of the group. The second highest age group is 30 to 39 years old 10% (n=15) follow by age of 50 to 59 years old 9.3% (n=14), 60 and above 7.3% (n=11), and the lowest respondents among those age of group are 40 to 49 years old 4.7% (n=7).

Table 2. Effect of wearing a normal shoe


Respondents	Effect of wearing normal shoes
	Redness
	Swelling and soreness
	Intermittent pain
	Corn Calluses (First and second overlap)

Table 2 above shows the real condition of the respondents based on the observation that was done by the researcher. The researcher chooses four types of effects that women in Malaysia experience. Through this process, the researcher identifies all the effects from above are occur after the respondents wear the shoe in their daily routines. For the first respondent said, she had to take off her shoes right after the working

hours ended and put an extra flip-flop in her car. Thus, the duration of their working hours is too long, and need to endure the pain of their bunion. Bunions can frame for different reasons, yet ordinarily create because of poorly fitting footwear, for example, narrow shoe shape or high heels points. Using the normal shoe that does not fit the bunion conditions could be suffering in daily routines. Thus, those people with bunion conditions need to find the right shoe that fits comfortably.

Circumference of Bunion

Table 3. Circumference Result

Needs Analysis	Minimum	Mean	Maximum
Circumference of Bunion in mm	220 mm (Mild)	245 mm (Moderate)	282 mm (Severe)

Data of the result were using measurement tape for the circumference of the bunion for mild, moderate, and severe has been a record. To design the size of the ball girth for women Malaysian with bunions, this measurement is required. To obtain an exact size for this study, each respondent's measurements must be taken through data processing. The minimum represents the mild size which is 220mm, the mean is moderate 245mm and the last stage is the maximum which is severe 282mm. The measurement is from (n=150) and included all group sizes from 5 to 10.

Stages of Bunion

As a result of the percentages stage by using geometric analysis hallux valgus angle the respondent's women with bunion shown overall, 57.3% (n=86) with the highest percentages of respondent's women are at stage 2 which is moderate. Followed by 35.3% (n=53) of respondents with stage 1 is mild and the lowest percentages among all groups of the stage are severe 7.3% (n=11).

Table 4. Comparison between sizing and stage of a bunion

		Stage of Bunion			
Categories of respondents		Mild	Moderate	Severe	Total
Shoes size	5	8	20	0	28
	6	10	19	0	29
	7	16	13	6	35
	8	7	14	4	25
	9	7	17	1	25
	10	2	3	0	5
	Others	3	0	0	3
Total		53	86	11	150

Table 4 above shows the comparison between the sizing shoe and the stage of a bunion with seven groups of sizing. The highest percentage size 7 is from the mild group which is n=16 while the moderate stage is the highest percentage from sizing group 5. The severe stage also shows most respondents are from size 7 regardless that sizing is the highest percentage and typically people are using because it is the middle number for sizing. Also, respondents with the bunion for the moderate stage are highest compared to other stages which are n=86 and the researcher assumes that most of the respondents from the mild stage tend to get the highest chance for the next stage moderate. It might cause by choosing the type of shoe shape of the ball girth and also from inherited from family members.

Design Criteria

Nevertheless, as the data collected from the survey, the analysis shows that women with bunions still have difficulties in finding the right shoes based on UK and US sizing that exist. By using the B shape of shoes their still uncomfortable at the part of their bunion.

Table 5. Design Criteria

USABILITY	<ul style="list-style-type: none"> • Fit, wide, and comfortability shoes • Standard Sizing for bunion patient • Improves the practicality of the wide-toe box
AESTHETIC	<ul style="list-style-type: none"> • Using different material, and texture that is suitable for bunion conditions. • Stylization/Pattern design style to the modern style
TECHNOLOGY	<ul style="list-style-type: none"> • Therapeutic/Orthopaedic • Lightweight/Soft Material

Table 5 shows the design criteria based on the data from the survey n=150 that already analyze. The researcher selected the criteria which are usability, aesthetics, and technology. The usability of footwear for bunion should be wide and comfortable for the user in their daily life or working hours. It also has to be easy to wear and user-friendly based on the sizing of the shoes. Moreover, as for the aesthetics, it should be a more up-to-date design that is more stylish to the user. Lastly is the technology that could provide the device for therapeutic and orthopedic that can correct and give comfort for the abnormal foot which is a bunion. Each design criteria are data based on the survey that the researcher collects from respondents.

DISCUSSION

This study revealed that 150 women in Malaysia experienced bunion symptoms more than one year ago. Based on the research study, the data were identified from three stages of bunion percentages which are mild 35.3%, moderate 57.3%, and severe 7.3% which were collected from all around Malaysia. The findings were based on the circumference of the bunion that researchers measure on a flat surface using tape in inches and converted into millimeters. Besides that, the findings from the data show that women with bunion mostly experienced bunion symptoms for more than a year as their condition might be developed from their choice of the shape shoes used in their daily routines and also by the genetic inheritance such as by their grandmother and parents inherited. These symptoms could cause a bulging bump, redness, swelling, and also pain at the bunion part. Based on the observation of the existing bunion shoe used by the respondents in daily routine, the data identified, most of the respondent's shoes will be ripped at the side metatarsal tibiale in 6 to 10 months while from 4 months onwards the side part will be big and loose. Therefore, they have to find new shoes to solve their problems. It can be caused a lot of money for respondents to buy a new shoe that fits their condition because the questionnaire itself shows that the respondents mostly will buy lower than RM200. This study might help as it proposed the new design for women with bunions would help them to feel comfortable and affordable for their bunion condition. This is because it is one way to prevent women with bunions from hurting so much and also provide good quality for them to fit in their shoes comfortably. It also not only would be worthwhile buying nevertheless

it can be environmentally friendly due to less spent on raw materials as it used the new size of the circumference of the bunion part of shoes through the data the researcher collected.

CONCLUSION

The research shows the most common problem with bunion shoes is the size of the circumference of the bunion which causes swelling and pain at the bulging bump. Other than that, the new design bunion shoe will be an enhanced idea since the data were collected from all around the state in Malaysia to offer more like a more suitable feature. This study aimed to provide the data and information that will help the designer to get the direction of how to create an appropriate design shoe and create standard sizes for each category of bunion shoes in Malaysia. Data from the survey and observations show that the usability of the bunion patient needs to enhance the comfortable which can provide on their shoes as a daily routine.

From the data survey, observation and physical examine each of the respondents of their bunion condition, this study finds out that the usability of the existing product which is normal sizing shoes is not suitable for patients with bunion. Based on Shaliza Shariff (2019), the current market in Malaysia has been using standard sizes as UK and US. They also have to customize the size of shoes to get the right proportion of their feet. Using the standard size can affect the part of their bunion which is redness and blister while wearing fit and tight shoes. Furthermore, wearing the wrong size or material also could lead to cramping, squeezing, or irritation of the toes, and feet and the worst is arthritis.

ACKNOWLEDGMENT

This study was supported by the (University Teknologi MARA).

REFERENCES

- Department Of Statistics Malaysia. (2022, July 29). Current Population Estimates, Malaysia, 2022. Retrieved on August 22, 2022 from: <https://www.dosm.gov.my/v1/>.
- Frothingham. S. (2019) Bump on Big Toe: 6 Possible Causes and How to Treat. Retrieved on February 16, 2021 from: <https://www.healthline.com/health/bump-on-big-toe>
- Goodman. B (2011). Bunions Can Affect Quality of Life. Retrieved on November 9th 2021 from: <https://www.webmd.com/skin-problems-and-treatments/news/20110224/bunions-can-affect-quality-of-life#1>
- Idaho Foot & Ankle Associates. (2014). Retrieved on December 6th 2021 from <https://www.idahofootandankle.com/blog/post/watch-out-for-that-painful-bunionbump.htm>
- Mayo Clinic (2021, November 6). Bunion. Retrieved on January 16, 2022 from: <https://www.mayoclinic.org/diseases-conditions/bunions/symptomscauses/syc-20354799>
- Montiel, V., Alfonso, M., Villas, C., & Valentí, A. (2019). Medial and lateral exostoses of the distal phalanx of the hallux: A potentially painful bunion-like structure. Part 1: Incidence and clinical application. *Foot and Ankle Surgery*, 25(2), 158-164.
- Oestreich, A. E. (2013). *How to measure angles from foot radiographs: a primer*. Springer Science & Business Media.
- Ohashi, H., Nishida, K., Nasu, Y., Saiga, K., Nakahara, R., Horita, M., ... & Ozaki, T. (2021). A Novel Radiographic Measurement Method for the Evaluation of Metatarsophalangeal Joint Dislocation of the Lesser Toe in Patients with Rheumatoid Arthritis. *International journal of environmental research and public health*, 18(14), 7520.
- Piqué-Vidal, C., Vila, J. A geometric analysis of hallux valgus: correlation with clinical assessment of severity. *J Foot Ankle Res* 2, 15 (2009) doi:10.1186/1757-1146-2-15
- Shariff, S. M., Bong, Y. B., Shariff, A. A., Kouchi, M., Kimura, K., Merican, A. F. & Noor, N. M. (2014). Development of a Foot Sizing System for Malaysian Women. In 5th International Conference on 3D Body Scanning Technologies (pp. 93-98)
- Shariff, S. M., Merican, A. F., & Shariff, A. A. (2019). Development of new shoe-sizing system for Malaysian women using 3D foot scanning technology. *Measurement*, 140, 182-184.
- Silvester, R. N., Williams, A. E., Dalbeth, N., & Rome, K. (2010). 'Choosing shoes': a preliminary study into the

- challenges facing clinicians in assessing footwear for rheumatoid patients. *Journal of Foot and Ankle Research*, 3(1), 24.
- Smith, L. (2019). What you need to know about bunions. Retrieved on November 6th 2021 from: <https://www.medicalnewstoday.com/articles/310096.php>
- Svoboda, B. (2019). *Hallux Valgus*. Physiopedia. Retrieved on August 22, 2022, from https://www.physio-pedia.com/Hallux_Valgus
- Tarantino, D., Palermi, S., Sirico, F., & Corrado, B. (2021). Hallux valgus deformity: Treatment options, post-operative management, and return to sport. *Journal of Human Sport & Exercise*, 16.
- Williams, A. (2007). Footwear assessment and management. *Podiatry Management*, 26(8),16
- Zhang, Y., Awrejcewicz, J., Szymanowska, O., Shen, S., Zhao, X., Baker, J. S., & Gu, Y. (2018). Effects of severe hallux valgus on metatarsal stress and the metatarsophalangeal loading during balanced standing: A finite element analysis. *Computers in biology and medicine*, 97, 1-7.