ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Google Scholar

Crossref doi

SLIB.UZ Scientific library of Uzbekistan

Volume 9
Issue 3
2024

ANTHROPOMETRIC STUDIES OF THE STRUCTURE OF THE FOOT

MUHAMMEDOVA MADINA

Associate Professor at Bukhara Engineering and Technology Institute, Bukhara, Uzbekistan
Phone.: (0890) 512-5070, E-mail.: mukhammedova92@mail.ru

Abstract: The study was conducted to clarify the anatomical and physiological parameters and structure of the foot. The nature of changes in the lower extremities that occur during injuries was studied and to identify the anthropo-biomechanical features of the condition of the feet. An assessment is given of the degree and functional structures of the feet in the feet under study. The research methods were the study of modern approaches to methods for studying the functional state of the foot, as well as a comparative analysis with subsequent generalization and systematization of the data obtained. The research materials were domestic and foreign journalistic research publications, reflecting the range of approaches to the study of this issue. The use of these methods made it possible to ensure the objectivity of the conclusions and results obtained.

Keywords: anthropo-biomechanical features, dynamic conditions, static conditions, anthropological analysis, static function, functional structures, foot structure.

Introduction. The human foot, like the body as a whole, is formed under the influence of many factors, such as features of intrauterine development and heredity, body type, degree of physical activity, nutrition, climate, nature of work, etc. Therefore, despite the general anatomical structure, size of the feet and the relative position of their parts can vary significantly. Insufficient consideration of the features of the shape and size of the feet, operating conditions of shoes and other factors leads to a lack of demand for manufactured shoes by most of its target group. In the mass production of shoes, data is needed that characterizes the feet of the population of each region of the country due to their differences [1, 2].

The foot contains a quarter of all the bones in the body. The normal foot consists of 26 bones of various shapes and sizes (Fig. 1.1), plus two bones: the lateral and medial sesamoids, which are located under the first metatarsal bone.

It is interesting to note that 95% of all surgeries are performed on the forefoot. Problems also occur in the posterior region and ankle joint[3].

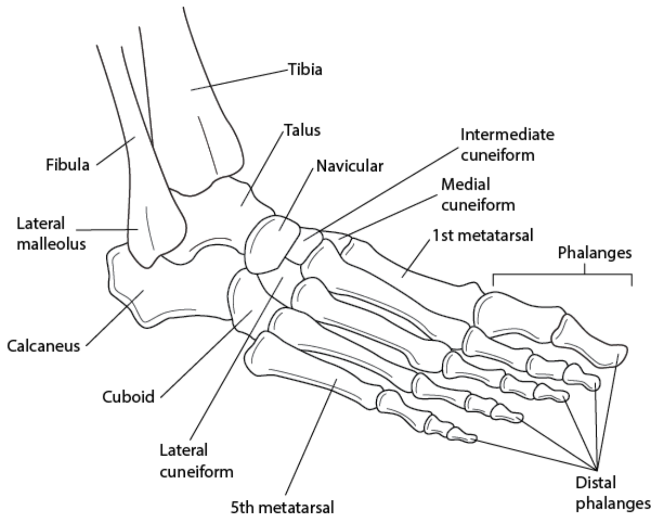

Figure 1. Foot bones.

During walking, the body's weight is transferred from the heel bone to the first and fifth metatarsals (the supporting points of the foot). These three supporting points are connected to each other by bones, ligaments and muscles and form the internal longitudinal arch, external longitudinal arch, and transverse arch of the foot[4,5,6]. The internal longitudinal arch starts from the calcaneal tuber and passes forward to the head of the corresponding metatarsal bone, through the tatus, os naviculare. ossa cuneiforme. The point of the internal longitudinal arch (maximum height of rise: 15-20 mm) is the lower surface of the scaphoid bone. The external longitudinal arch runs from the calcaneal tuberosity through the cuboid bone along the fifth metatarsal bone to its head.

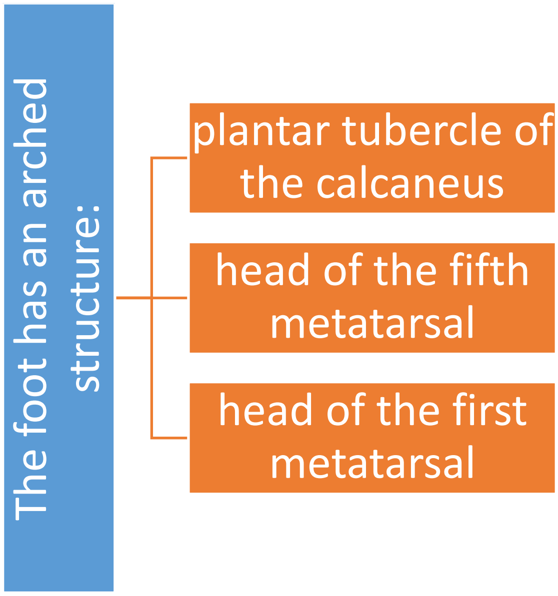

Figure 2. The foot has an arched structure.

The highest point (height of rise: 3 to 5 mm) in the external longitudinal arch is the cuboid bone. The transverse anterior arch connects the anterior supporting points of the foot, namely (relative to) the head of the first and fifth metatarsals.

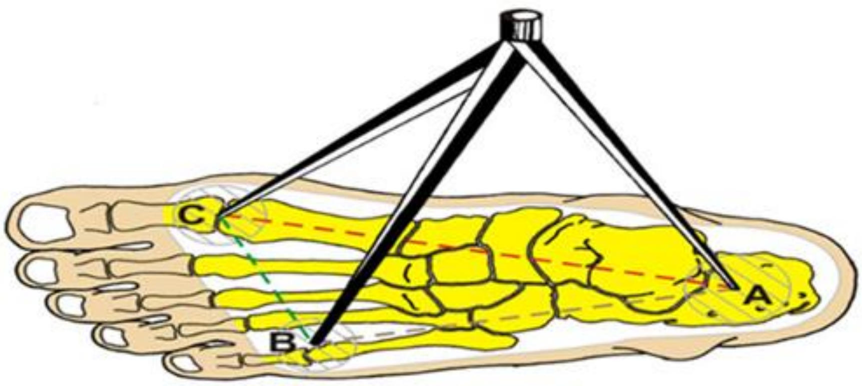

Figure 3. The location of the arches of the foot, three main points of support.

The highest point of the transverse arch is the head of the second metatarsal in adults, and in children, due to inversion of the foot, the highest point is the head of the first metatarsal bone[7,8]. The transverse posterior arch is located in the region of the three sphenoid bones and the cuboid bone.

These three points are united by a system of arches that support the plantar arch of the foot - an anterior transverse arch and two longitudinal lateral arches. The highest point of the arch is called the instep and is located between the navicular and talus bones[9,10].

Spring function - softening shocks when walking, running, jumping. It is possible due to the ability of the foot to elastically flatten under the influence of load and then regain its original shape[11]. The foot, sprung in front, outside and inside, when changing the direction of the total load and the shape of the supporting surface, is capable of changing its shape, moving in three planes, making movements like a "boat on sea waves." This is important for "catching" small soil irregularities.

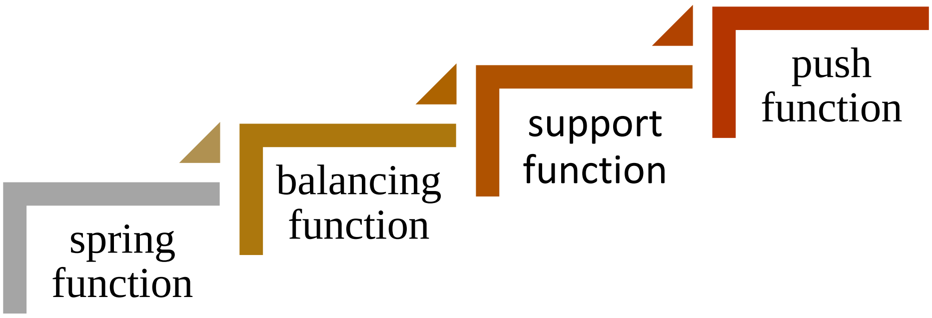

Figure 4. The foot performs four biomechanical functions.

Balancing function - regulation of a person's posture during movements[12]. It is performed due to the possibility of movement in the joints of the foot in three planes and the abundance of receptors in the ligamentous apparatus.

Methods. In foreign practice, the most widely used is the so-called Foot Position Index (FPI)[13,14,15]. It is a clinical diagnostic tool that allows you to quantify the position of the foot and call it pronated, supinated or neutral. This diagnostic method was developed as a simple method of assessing the various characteristics of foot position to reduce them all to a single measurable result, which ultimately will indicate the position of the foot as a whole. The calculation of IPS values is made by measuring certain criteria with the patient in a standing position. The IPS was developed by reviewing the literature describing the details of the clinical examination of the foot. From these sources, 36 clinical measures were selected and then analyzed for their compatibility and usability[16,17]. To select suitable measurements, the following criteria were used: - measurements should be simple to carry out, - they should not be time-consuming, - their use should not involve the use of expensive technologies, - their results should be understandable, - the result can be presented in form of quantitative data. It was also a prerequisite to study the foot in three planes and obtain information about the forefoot, middle and hindfoot.

Results. As a result, a system was developed that proposed assessment based on 8 criteria. However, later, during testing of the methodology, this number was optimized, and today it is 6 points:

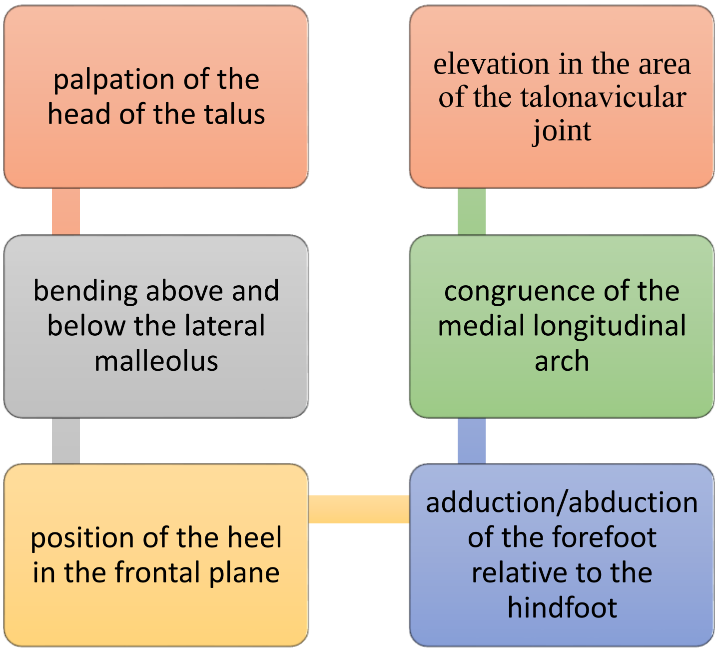

Figure 5. 6 criteria of methodological evaluation of the paw.

Assessment of foot position using this method has shown high reliability and is widely used in modern medical practice in Europe, America, and Australia.

A healthy foot sculpturally covers the unevenness of the support and a person feels the area over which he walks[18]. When the position of bones and joints changes, the ligamentous apparatus is deformed, as a result coordination of movements and stability suffer. As a result, shocks are more sharply transmitted to the joints of the lower extremities, the spine and internal organs, which contributes to the deterioration of conditions for their functioning, microtraumatization, and displacements.

Discussion. The support function is manifested in the ability of the foot to form a support for the human body, counteracting the vertical load of body weight.

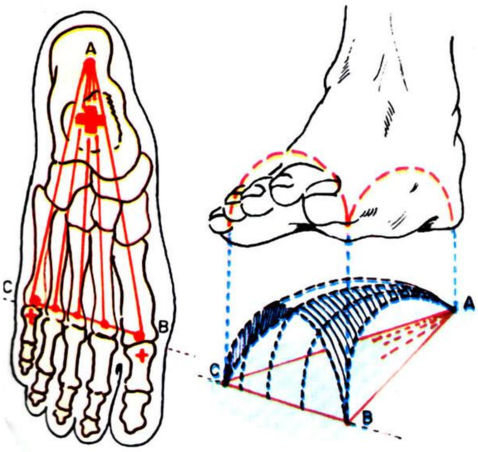

Figure 6. Schematic representation of the foot support points.

This is the most complex function of the foot, as it uses both springing and balancing abilities. During walking, all three functions of the foot are sequentially realized.

Table 1.

Indicators of variation	L 1	Onp 2	Ovs 3	Osg 4	Shn 5	Cº 6
Maximum	290	290	290	380	113	45
Minimum	28,5	220	230	290	10	7
Push variation	261,5	70	60	90	103	38
Mean linear deviation	32,10	12,30	10,84	15,84	8,71	5,93
General set variance	3 732,82	218,77	183,05	399,22	309,49	59,73
Sample dispersion	3 861,53	226,31	189,36	412,99	320,16	61,79
Common mean-squared deviation	61,10	14,79	13,53	19,98	17,59	7,73
Sample standard deviation	62,14	15,04	13,76	20,32	17,89	7,86
Coefficient of variation	25%	6%	5%	6%	18%	41%
Vibration coefficient	104%	28%	22%	26%	105%	199%
Arithmetic mean value	251,37	254,03	267,47	348,33	98,33	19,07

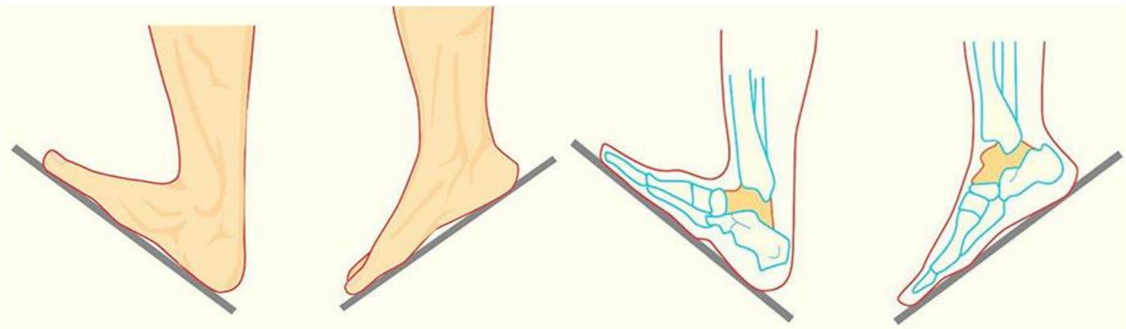

Figure 7. Movement phases in the jog function.

The push function allows a person to make forward movement in any direction. The kinetic energy generated when walking, jumping or running is transferred to the foot at the moment the heel touches the support, is stored in it during the roll to the toe, and is again transferred to the body at the moment the foot lifts off the support.

The entire biomechanical component of the foot is realized in the ankle joint. From a biomechanical point of view, the ankle joint belongs to kinematically closed pairs[19,20]. A special feature of the ankle joint is that it is subject to forceful closure under the influence of body weight. The ankle joint has one degree of freedom and allows only one rotational movement around the frontal axis; flexion and extension are possible. Flexion is considered to be the lowering of the sole; in functional anatomy this movement is called plantar flexion. Extension, accordingly, is the raising of the rear of the foot upward, dorsiflexion, familiar to us from functional anatomy. The most typical human movement associated with loading the foot is walking.

Conclusion. As a result of the analysis of the foot, it was established that the foot is important for a person when moving. Full foot bones are a guarantee of proper walking, arching of the foot, and proper distribution of pressure on the foot when walking.

References

1. Kalinina M.L., Shekhtman A.G., Zheleznov L.M. Functional methods of investigating feet in modern medical practice//Sovremennye problemy nauki i obrazovaniya. 2015. No. 3.

2. Sitdikov F. G., Arslanov V. A., Galiakhmetova G. M., Galiakhmetov R. G. Fizicheskoe razvitie podrostkov s razlichnym sostoyaniem svoda stopy //Novye issledovaniya. 2009. No. 4 (21).

3. Evtukhova L. A., Ignatenko V. A. Methodology issledovaniya sostoyaniya stopi i podgotovlennosti ee svoda k razlichnym nagruzochnym regimem//Problemy zdorovya i ekologii. 2015. No. 1 (43).

4. Perepelkin A. I., Gavrikov K. V., Mandrikov V. B., Klauchek S. V., Shklyar A. L. Method of determining the resource function of stopy with the use of biological feedback //Vestnik novykh meditsinskikh tekhnologii. Electronic search. 2011. #1.Djuraev A., Mukhammedova M.O., Uzakova L.P., Mansurova M.A. Results of the full-factor experiments of prophylactic footwear construction recommended for patients with insular diabetes//Journal of Physics: Conference Series 1889 (2021) 052021/IOP Publishing/ doi:10.1088/1742-6596/1889/5/052021.

5. Mukhammedova M. O., A. Djuraev, L. P. Uzakova, M. A. Mansurova. Development of effective construction and selection of material for prophylactic footwear for patients with diabetes // Cite as: AIP Conference Proceedings 2700, 050020 (2023); https://doi.org/10.1063/5.0138708 Published Online: 09 March 2023.

6. Belova L. A., Bek N. V., Zaxojaya T. S., Belousova O. E., Tixonova N. V.. Texnologicheskie resheniya proektirovaniya ortopedicheskoy obuvi s uchetom biomexaniki dvigateli// Vestnik texnologicheskogo universiteta. 2015. T.18, №5

7. Kolesnikova N.A. Sozdanie meditsinskoy obuvi na osnove dannyx o morfologii jenskix stop// Dissertatsiya na soiskanie uchenoy stepeni nomzoda texnicheskix nauk. Moskva 1972. 171s.

8. Belgorodskiy V.S. Razrabotka metodov i sredstv povysheniya komfortnosti obuvi// Dissertatsiya na soiskanie uchenoy stepeni nomzoda texnicheskix nauk. Moskva 2001 yil.

9. C. H. M. van Shie, magistr, PhD va A. J. M. Diabetik Foo biomexaniklari // Boulton, MD, FRCP. Kimdan: Diabetik oyoq, tahrirlangan: A. Veves, J. M. Giurini va F. V. LoGerfo © Humana Press Inc., Totowa, NJ.

10. Kochetkova T.S., Klyuchnikova V.M. Antropologicheskie i biomexanicheskie osnovy konstruirovaniya izdeliy iz koji//Legprombitizdat, Moskva 1991 yil.

11. Maksimova I.A. Analiz konstruktsiy maloslojnoy ortopedicheskoy obuvi va lechebno-profilakticheskix prisposobleniy// Uchebnoe posobie, MGUDT, M,2001, s.115.

12. Rumantseva E. G. O biomexanike nijnix konechnostey cheloveka// E. G. Rumantseva, O. N. Bartosh, V.V, Kostyleva – M.: Dizayn va texnologii. 2010. № 15. s. 32-34.Butterworth P.A., Landorf K.B., Smith S.E., Menz H.B. The association between body mass index and musculoskeletal foot disorders: a systematic review// Obes. Rev., 13 (2012), pp. 630-642.

13. Butterworth P.A., D.M. Urquhart, K.B. Landorf, A.E. Wluka, F.M. Cicuttini, H.B. Menz. Foot posture, range of motion and plantar pressure characteristics in obese and non-obese individuals// Gait Posture, 41 (2015), PP. 465-469.

14. Muhammedova M.O., Yoqubov M.E. Factory vliyayushchie na kachestvu formarovaniyu kojevenno-obuvnyx izdeliy//«Innovatsionnye idei i razrabotki talantlivoy molodeji v usloviyax modernizatsii texniki va texnologi xlopkoochistki, textilya, legkoyshkenkenkochlennostiche konferentsiya1, polishkennostiuchya1- 2018 g. -S.162-164.

15. Muxammadova M.O., Zidullaeva X.S. Vliyanie obuvi na oporno-dvigatelnyy apparat cheloveka//«Innovasionnye idei i razrabotki talantlivoy molodeji v usloviyax modernizatsii i texnologiy xlopkoochistki, textilya, legkoy promyshlennosti, poligrafii promyshlennosti konferentsiya, poligrafii promyshlennosti, poligrafii »Tashkno-18 dekabr 18-18.1- 64 -166.

16. Muxammedova M.O., Samadova N.U. Tuproq kuchlanishining qayta taqsimlanishiga tagliklarning ta'sirini eksperimental aniqlash // "Zamonaviy ishlab chiqarishning muhandislik-texnologik muammolarining innovatsion yechimlari" xalqaro ilmiy konferentsiyasi. Buxara 2019.PP.533-535.

17. Muhammedova M.O. Razrabotka teoriticheskix va metodologik asosiy koeffitsientlar samarali meditsina profilaktikasi obuvi uchun katta shakar diabetom va s travmami golenostopnogo sustava// Mejdunarodnyy nauchnyy jurnal «Vestnik nauki» Том № 2 (59) 02-fevral. 364-370.Mukhammedova M.O. Results of the full-factor experiments of prophylactic footwear construction recommended for patients with

insular diabetes// Spanish international scientific online conference "Prospects and main trands in modern science".Pages 149-154.

CONTENTS