



The Relationship of Dynamic Foot Posture with Injuries and Other Related Factors in Recreational Long Distance Runners

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ABSTRACT

Foot posture is one of the risk factors that is thought to play a role in the occurrence of running-related injuries. This research aims to see if there is an association between foot posture and running-related injuries in long-distance recreational runners. Methods A cross-sectional research was conducted on 131 recreational long-distance runners (94 men and 42 women). Foot posture was determined by Arch Index values calculated from static and dynamic footprints, then tested whether it was associated with running-related injuries. The results showed that dynamic and static foot posture were not associated with running-related injuries in recreational long-distance runners (OR=0.67(0.21-2.20), 95% CI, p=0.516), (OR=0.87(0.29-2.61), 95% CI, p=0.806). On dynamic examination, low arch and high arch foot postures were not associated with running-related injuries in recreational long distance runners (OR=0.67(0.21-2.19), 95% CI, p=0.508), (OR=0.86(0.07-10.67), 95% CI, p=1.00). Most subjects had low arch foot posture on dynamic (83.8%) and static (82.4%) examination. Running-related injuries were found to be 28.7%, with most injuries in the knee (19.5%), calf (17.9%), and sole (15.6%) areas. The conclusions and suggestions in this research are that dynamic and static foot posture are not associated with running-related injuries in long-distance recreational runners, so further prospective research needs to be done to get a clearer picture of other risk factors that cause running-related injuries.

Keywords: Dynamic Foot Posture, Static Foot Posture, Running-Related Injuries, Recreational Long Distance Runners.

INTRODUCTION

Running is a cardiopulmonary endurance sport that is increasingly popular and easy to do. The increasing popularity of running in the last decade is also accompanied by an increase in the number of running competitions held from year to year, which will be followed by an increase in the incidence of running-related injuries, especially overuse injuries. Previous research states that the incidence of running-related injuries to the lower extremities is 37% with the highest incidence of injury in women (Dempster et al., 2021).

One intrinsic risk factor that is gaining attention as a cause of running-related injuries is foot posture. Several studies have suggested that high-arch and low-arch/flat feet are associated with lower extremity injuries (Tong & Kong, 2013). Data on the prevalence of foot posture and running-

related injuries in recreational long-distance runners is still very limited. This has piqued the interest of researchers to examine dynamic foot posture in relation to running-related injuries in recreational long-distance runners.

Running is a high-intensity physical activity, which is equivalent to >6.0 METs, and is performed in high frequency and distance in long-distance and marathon runners (Riebe et al., 2018). This will be accompanied by increased injury rates, especially due to overuse injuries.

Based on consensus with a modified Delphi approach in recreational runners, running-related injuries should have 3 (three) domains, namely: physical complaints, interruption of training or competition, and the need for medical assistance (Yamato et al., 2015). The body system involved is the musculoskeletal system of the lower extremity, hip, pelvis, and lower back area resulting from running-related activities, during training or during competition, which results in training being interrupted, having to be reduced or stopped (Benca et al., 2020); (Dempster et al., 2021).

Etiology and Risk Factors

Running-related injuries can result from a variety of risk factors. The mechanism of injury is a simple conceptual model, which is divided into 4 parts, namely: (A) Loading capacity of specific structures when entering the running session; (B) Cumulation of specific structural loads per running session; (C) Reduction in specific structural capacity during the training session; and (D) exceeding specific structural capacity (Malisoux et al., 2015).

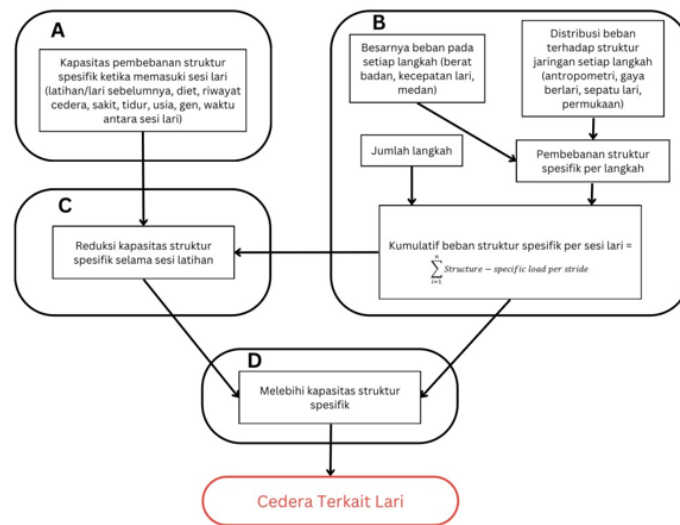


Figure 1. Conceptual framework of causal mechanisms underlying the occurrence of running-related injuries in a single running session (Malisoux et al., 2015)

Meeuwisse, describes injuries in terms of dynamic and repetitive/recursive sports injuries, where exposure can alter risk factors and allow athletes to return to the cycle model repeatedly. Each athlete, has a set of intrinsic risk factors (e.g. bone strength, neuromuscular control, age, previous injuries, etc). Coupled with repeated exposure to extrinsic risk factors (equipment, environment, etc) and the same mechanism or event can result in the athlete becoming injured. Once an injury occurs, there is a retreat from further exposure, and recovery facilitates the athlete's return to sport, with

the potential for a new set of risk factors. Unfortunately, not all athletes are able to return to sport after injury. Athletes with severe injuries, or with inadequate recovery, may be excluded from potential further exposure or injury. Another possibility is that the athlete was exposed to a potential injury, but did not sustain an injury. Adaptation or maladaptation of tissues, equipment, etc. occurs that alters intrinsic and/or extrinsic risk factors. Based on the cycle model above, athletes can enter the injury chain at any point.

One of the intrinsic risk factors that may play a role in the occurrence of injuries in runners is foot posture. Foot posture is characterized by the contour of the medial longitudinal arch of the foot in the weight-bearing position, which is then divided into categories: normal (rectus), low-arch (planus), and high-arch (cavus). Foot posture examination can be performed in both static and dynamic conditions (Menz et al., 2013).

Examination of foot posture can be done through various means, including: visual estimation, anthropometric values, footprint parameters, and radiographic evaluation (Neal et al., 2014). One of the many examinations performed is using the footprint index, including: Arch Index (AI) which was first described by Cavanagh and Rogers in 1987. AI is calculated as the ratio of the area of the middle third of the sole to the area of the entire sole (excluding the toes) with higher values representing flatter feet (Neal et al., 2014) (Figure 3) Once the AI value is calculated, the footprint can be classified into: high-arch/cavus ($AI \leq 0.21$); normal arch/rectus ($AI 0.21-0.26$); and low-arch/planus ($AI \geq 0.26$).

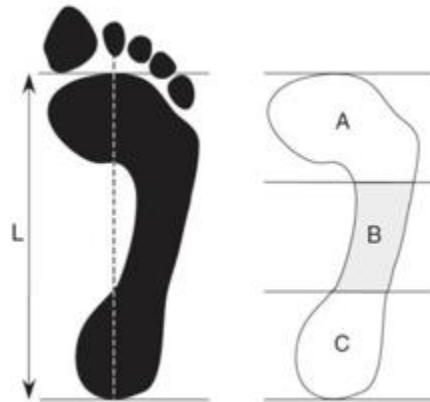


Figure 2. Footprint with reference line for calculating AI

Foot Posture and Running Biomechanics

Running, like walking, is a series of pronation and supination movements of the foot. Running is distinguished from walking by the increase in speed, or distance traveled per unit of time, and the presence of a float phase. During the running cycle, there are two float periods when neither foot touches the ground. This results in reduced time in the stance phase and increased time in the swing phase. As speed increases, a further reduction of the stance phase occurs, with the duration of the hovering phase increasing. Unlike walking, the forward momentum required for running is gained through the swinging of the legs and arms, rather than the treading of the feet. The walking and running cycles also differ in that the vertical ground reaction force per one step is greater in running than in walking and fast walking.

Foot posture is often associated with the risk of injury or pain in the feet (Tong & Kong, 2013). This can be explained because mechanically foot posture is considered to contribute to the occurrence of malalignment and pathology in the proximal foot through rotation of the tibia (internal rotation in pronated feet), as well as due to stiffness in the leg and increased vertical force loading (supinated feet). (WHO Guidelines on Physical Activity and Sedentary Behaviour at A Glance, 2020) Long-distance running activities are thought to also change foot posture and potentially lead to changes in running biomechanics. In a research conducted by Mei et al, an increase in static foot pronation was found after running 5 km on a treadmill (examination was carried out with the Foot Posture Index) (Mei et al., 2019).

In relation to foot posture, in the last 50-100 years, running shoes have also undergone many dramatic changes (Nigg et al., 2015); (Sun et al., 2020). This development is inseparable from efforts to reduce the incidence of injury and improve runner performance with the support of the sports industry and academics. (Nigg et al., 2015); (Sun et al., 2020). Individuals with a plantar shape with a low-arch are thought to have greater rear foot and mid-foot mobility which allows the foot to pronate more during the stance phase of running. Motion control shoes are recommended for individuals with low-arch/pronation, as they are thought to control excessive pronation of the foot. Individuals with a plantar shape with a high arch are expected to have rigid and inflexible feet, resulting in greater ground impact force and less pronation during running. Cushioned shoes are recommended for individuals with high arch/supination, as they are thought to improve shock absorption by allowing more pronation and better cushioning to reduce ground impact.

Individuals with normal foot arches are expected to impact the ground with less force and have appropriate pronation during running. Neutral/stability shoes are thought to have moderate cushioning and motion-control characteristics, making them recommended for individuals with normo-arch foot posture types. There are many things that influence a runner's preference in choosing a running shoe, a factor cited by shoe reviewers, runners, and experts in the shoe industry as important is the feeling of running, i.e. the feeling of comfort when using the shoe (Agresta et al., 2020) (Walton & French, 2016). Other influential factors include: personal preferences, the influence of others, and the economy (Ramsey et al., 2022).

Based on the above background, the aim of this research was to analyze the relationship between dynamic foot posture and the risk of running-related injuries in recreational long-distance runners. The research also aimed to identify intrinsic risk factors related to foot posture, as well as their influence on running biomechanics and running shoe selection. In addition, this research seeks to provide an overview of the biomechanical adaptations of the foot due to distance running activities and how the use of appropriate running shoes can influence injury risk. The benefit of this research is that it contributes to understanding the biomechanical factors that influence injuries in runners, particularly in relation to foot posture. The results of this research are expected to serve as a basis for runners, coaches, and the sports shoe industry in choosing shoes that are suitable for foot posture to reduce the risk of injury. In addition, this research can also support the development of injury prevention interventions and improve running performance through a better understanding of the relationship between foot posture, running biomechanics and shoe design.

RESEARCH METHOD

The research was conducted with a cross-sectional design and data collection was carried out at the Center for Sports and Exercise Studies (CSES) IMERI FK UI, April-May 2024. The research was conducted on a population of long-distance runners, with the target population being adult long-distance recreational runners, and the reach population being adult long-distance recreational runners in the city of Jakarta in 2024.

The inclusion criteria in this research were: (1) Male and female recreational runners, aged 18-65 years with a training history of at least 1-3 times/week within 6 consecutive months, with a minimum cumulated distance per week of 10 km (kilometers); (2) Subjects have participated in running competitions of at least 10 km and a maximum of 21 km (half marathon) within the last 6 months; (3) Willing to become a research subject, undergo a foot posture examination, and fill out the questionnaire provided; (4) Subjects are in a condition that can be examined for foot posture (no injuries, deformities, and can stand or walk without pain and limping that can affect the results of the examination (footprint)); (5) Signed the research consent form.

The exclusion criteria in this research were: (1) Subjects with foot or leg pain, resulting in inability to stand or walk with normal stride (e.g. limping) (2) Subjects with a history of significant leg injury, or a history of surgery affecting leg posture prior to the examination; (3) Subjects with leg length discrepancy (LLD) of more than 2 cm; (4) Subjects who performed trail running (on mountains or on uneven surfaces) more than 2 times in 1 month; (5) Performed exercise of more than 5 km, 24 hours prior to the examination.

The minimum sample size required was 113 runners and sampling was done consecutively within a 6-week period. The instruments used were measuring tape, Omron HBF-375 Karada Scan Body Composition Scale, Harris mat foot imprinter measuring 36 cm x 15 cm manufactured by Diabetic Foot Care India Pvt Limited, paid computer application SketchAndCalc™ area calculator to calculate the footprint area which will be used to calculate the Arch Index (AI) value, A3 paper cut to 36 cm x 15 cm, scanner machine and questionnaire.

The types of data used in this research are primary data and quantitative data used in this research are data from age, gender, body mass index, understanding of foot posture, accuracy of running shoe selection, results of the calculation of static and dynamic footprint Arch Index (AI) values, and running-related injuries. Data collection was carried out according to the protocol that had been made and tested first, and had passed the ethical review with number: KET-264/UN2.F1/ETIK/PPM.00.02/2024 on February 16, 2024.

At the time of recruitment, data was collected through an online questionnaire in the form of a google form, data collection of body weight and height measured directly using a weight scale and stadiometer to calculate body mass index (BMI), and direct collection of static and dynamic footprint data using a Harris mat. The static and dynamic footprints obtained were analyzed using the SketchAndCalc computer application to calculate the Arch Index (AI) value to further determine the type of foot posture of the research subject. Data analysis was carried out with SPSS software licensed by the Faculty of Medicine, University of Indonesia.

RESULT AND DISCUSSION

Data collection was conducted offline at CSES, with 131 subjects who filled out the recruitment form in advance online via google form, and 8 who came directly to CSES without filling out the recruitment form online. Three subjects who did not meet the inclusion criteria were excluded. The total data analyzed further was 136 subjects.

Based on the results, the mean age of the research subjects was 35.11 ± 8.81 years. The mean body mass index (BMI) of the research subjects was 24.43 ± 3.67 kg/m². There were more runners with male gender (69.1%) than female (30.9%).

Based on the dynamic foot posture examination using a footprint calculated by the Arch Index value, it was found that the number of subjects categorized as low arch was more (83.8%) than in the static foot posture examination (82.4%). Subjects categorized as high arch were equally numerous in both dynamic and static examinations (2.9%). Based on the category of problematic foot posture (low arch and high arch) or not (normal arch), it was found that most subjects had dynamic foot posture in the problematic category, (86.8%) slightly more than in the static foot posture examination (86%).

Subjects who understood their respective foot posture before the footprint examination was carried out were only 19.1%. Based on the accuracy of choosing running shoes with foot posture, subjects who chose the right shoes with their foot posture were only 2.2%. Subjects who experienced running-related injuries, no one chose the right shoes according to their foot posture (0%), and subjects who did not experience running-related injuries only 3 people (3.1%) chose the right shoes, the remaining 94 people (96.9%) chose the wrong shoes.

Based on injury history, those with a history of injury more than 6 months ago were 27.9%, and those without a history of injury more than 6 months ago were 72.1%. Of the subjects who were injured in the past 6 months, 38.5% had a history of injury more than 6 months ago, more than the subjects who were not injured.

Table 1. Basic characteristics of the research subjects

Characteristics	With Running-Related Injuries	No Running-Related Injuries	Total N = 136
	N = 39 (28,7 %)	N = 97 (71,3 %)	
Age (years)	32,82 ± 8,54	36,03 ± 8,79	35,11 ± 8,81
IMT	25,18 ± 3,27	24,12 ± 3,79	24,43 ± 3,67
Gender			
Male	31 (79,5%)	63 (64,9 %)	94 (69,1%)
Female	8 (20,5%)	34 (35,1 %)	42 (30,9%)
Dynamic foot posture	34 (87,2%)	80 (82,5 %)	114 (83,8%)
Low arch	4 (10,3%)	14 (14,4 %)	18 (13,2%)
Normo arch High arch	1 (2,6%)	3 (3,1 %)	4 (2,9%)
Static foot posture	34 (87,2%)	78 (80,4 %)	112 (82,4%)
Low arch Normo arch	5 (12,8%)	15 (15,5 %)	20 (14,7%)
High arch	0 (0%)	4 (4,1 %)	4 (2,9%)
Foot posture (dynamic)			
No problem	4 (10,3%)	14 (14,4 %)	18 (13,3%)
Trouble	35 (89,7%)	83 (85,6 %)	118 (86,8%)

Characteristics	With Running-Related Injuries N = 39 (28,7 %)	No Running-Related Injuries N = 97 (71,3 %)	Total N = 136
Foot posture (static)			
No problem	5 (12,8%)	10 (10,3%)	19 (14%)
Trouble	34 (87,2%)	87 (89,7%)	117 (86%)
Injury history			
Yes	15 (38,5%)	23 (23,7%)	38 (27,9%)
No	24 (61,5%)	74 (76,3%)	98 (72,1%)
Understanding of foot posture			
Understand	6 (15,4%)	20 (20,6%)	26 (19,1%)
Don't understand	33 (84,6%)	77 (79,4%)	110 (80,9%)
Appropriateness of Shoe selection			
Exactly	0 (0%)	3 (3,1%)	3 (2,2%)
Inappropriate	39 (100%)	94 (96,9%)	133 (97,8%)

Running-related injuries were found in 28.7% of all subjects. The three most common areas of injury/complaints encountered in this research were the knee area at 19.5%, the calf area at 17.9%, and the sole of the foot at 15.6%.

Table 2. Most common injury/complaint areas

Area Characteristics Injury/complaint	Total (n=128)
Knees	25 (19,5%)
Calves	23 (17,9%)
The sole of the foot	20 (15,6%)
Ankle	15 (11,7%)
Lower back	13 (10,2%)
Shins	10 (7,8%)
Thighs	8 (6,3%)
Pelvis	7 (5,5%)
Toe	4 (3,1%)
Groin	3 (2,3%)

Bivariate tests conducted in an effort to prove the hypothesis found that dynamic and static foot postures were not associated with running-related injuries in recreational long-distance runners (OR=0.67(0.21-2.20), 95% CI, p=0.516), (OR=0.87(0.29-2.61), 95% CI, p=0.806).

In the dynamic examination, low arch and high arch foot postures were not significantly associated with running-related injuries in recreational long distance runners (OR=0.67(0.21-2.19), 95% CI, p=0.508), (OR=0.86(0.07-10.67), 95% CI, p=1.00). On static examination, it was also found that low arch and high arch foot postures were not significantly associated with running-related injuries in long distance recreational runners (OR=0.76(0.26-2.27), 95% CI, p=0.629), (OR=0.75(0.58-0.97), 95% CI, p=0.544).

Table 3. Relationship between Foot Posture and Running-Related Injuries

	Running-Related Injuries		Total	P-value	OR (95% CI)
	Injury n (%)	No Injury n (%)			
Dynamic Foot Posture					
Trouble	35 (29,7%)	83 (70,3%)	118	0,516 ^{cs}	0,67 (0,21-2,20)
No problem	4 (22,2%)	14 (77,8%)	18		
Static Foot Posture					
Trouble	34 (29,1%)	83 (70,9%)	117	0.806 ^{cs}	0,87 (0,29-2,61)
No problematic	5 (26,3%)	14 (73,7%)	19		
Dynamic Foot Posture					
Low arch	34 (29,8%)	80 (70,2%)	114	0,508 ^{cs}	0,67 (0,21-2,19)
High arch	1 (25%)	3 (75%)	4	1,00 ^{fs}	0,86 (0,07-
Normal arch	4 (22,2%)	14 (77,8%)	18		10,67)
Static Foot Posture					
Low arch	34 (30,4%)	78 (69,6%)	112	0,629 ^{cs}	0,76 (0,26-2,27)
High arch	0 (0,0%)	4 (100%)	4	0,544 ^{fs}	0,75 (0,58-0,97)
Normal arch	5 (25%)	15 (75%)	20		

cs) Chi square test

fs) Fisher's exact test

Discussion

In this research, 136 subjects were analyzed, with a mean age of 35.11 ± 8.81 years. This finding is in line with research conducted in New York, which found that the mean age of recreational long-distance runners was 37.4 years, higher than the mean age of elite long-distance runners, which was 23 years (Chowdhary et al., 2024).

The mean Body Mass Index (BMI) in the subjects of this research, namely: 24.43 ± 3.67 kg/m² and mostly male, namely: 69,1%. This finding is almost similar to the findings in a research conducted on long-distance runners participating in the Injubliana marathon, Slovenia, which obtained a mean BMI of 23 kg/m². When compared to sprinters, generally the BMI of long-distance runners is smaller than that of sprinters, this is because muscle mass plays an important role in the performance of sprinters, while for long-distance runners, endurance is more dominant (Stachoń et al., 2023).

The dynamic and static foot postures obtained based on the Arch Index (AI) values are mostly low arch (83.8%, 82.4%), followed by normal arch (13.2%, 14.7%) and high arch (2.9%, 2.9%). Based on the Arch Index value, dynamic and static foot postures were further divided into problematic foot postures (low arch and high arch) and non-problematic foot postures (normal arch). Dynamic and static problematic foot postures were found to be 86.8% and 86%. This finding is in line with research conducted in India which examines the difference between static and dynamic footprints, where in the research they found that the AI value was significantly greater in dynamic footprints (0.23 ± 0.04) compared to static footprints (0.22 ± 0.05) with a p value of 0.011 (Mukhra et al., 2020). This is because in the stance phase when walking there is a phase of resting on one foot so that the force imposed on the foot is greater than when standing with both feet.

Running-related injuries were found to be 28.7% with the most common injury/complaint areas found were complaints in the knee area (19.5%), followed by complaints in the calf area (17.9%), and

the soles of the feet (15.6%), supported by the findings of Van Poppel et al., in his research which found the most injured areas were in the knees, thighs and calves (van Poppel et al., 2014). Kakouris et al., in their systematic review, found the highest prevalence of injuries in the knee, lower leg and foot / toe areas (Kakouris et al., 2021).

In a research conducted at Ningbo University, China, found that foot pronation after running a medium distance (5 km) is an early indicator of increased load on the lower extremity joints (Mei et al., 2019). This is in line with other research which states that, runners with high arch feet have a higher incidence of ankle, bone, and lateral side injuries. Runners with low arch feet have a higher incidence of knee, soft tissue, and medial side injuries. This is related to the change in the inclination angle at the subtalar joint in low arch feet which results in eversion of the subtalar joint and the distal component of the tibia undergoing internal rotation, and further increases valgus of the knee and internal rotation of the femur, resulting in a greater load on the medial side of the knee.

In the population, generally the most common foot posture is a foot posture with a normal arch or normal arch such as research findings in a population of medical students at the University of Indonesia aged 17-21 years (normal arch 89%, low arch 4%, and high arch 7%) (Wicaksono et al., 2021). Another research on flat feet in a random population in Spain, also found that flat feet were found in 26.62%, assessed using footprints using Clarke's angle, Chippaux-Smirak Index and Stahell arch Index (Pita-Fernandez et al., 2017).

In contrast to the findings in the general population, in this research the foot posture of long-distance recreational runners in both static and dynamic examinations was mostly low arch foot posture. This may be influenced by the different ways of analyzing foot posture used in both studies conducted by previous studies even though they both use footprints.

Another thing that may be related to the finding of many low arch foot postures in long-distance recreational runners in this research is that: long-distance running or prolonged fingering may affect foot posture, although these studies assessed the condition of foot posture immediately after a long-distance run was performed (Cowley & Marsden, 2013); (Fukano & Iso, 2015); (Jastifer, 2022); (Mei et al., 2019). In a research conducted on subjects who participated in the Plymouth Half Marathon, a navicular drop of 5 mm was obtained in both feet and in the Foot Posture Index-6 (FPI-6) examination the foot posture changed towards a pronated position after the subject ran a half marathon which was thought to be fatigue in the muscles and soft tissues that support the medial longitudinal arch of the foot (Cowley & Marsden, 2013). Another research found that after running 35 km on the road, there was a significant decrease in dorsal height, navicular height, and arch height ratio in the research subjects (Fukano & Iso, 2015).

Existing studies have shown changes immediately after long-distance running, but no prospective studies have been conducted on long-distance runners to assess whether these immediate changes can permanently change the foot posture of runners after years of long-distance running. From the results of this research, it was found that most of the research subjects were recreational long-distance runners with low arch foot posture, 83.8% (dynamic) and 82.4% (static). Aside from the direct impact of long-distance running on foot posture changes, there are several

other possibilities that also influence the findings of the research, such as: the length of running experience and training volume of the runners that we did not assess in this research.

Based on the results of bivariate data analysis, it was found that neither dynamic nor static foot posture was significantly associated with running-related injuries in long-distance recreational runners. This may be because there are other risk factors that may contribute to the occurrence of running-related injuries in recreational long-distance runners other than foot posture.

Malisoux in his conceptual model of the determinants of running-related injuries divides them into 4 parts, namely: the loading capacity of specific structures when entering a running session, the cumulation of specific structural loads per running session, the reduction in specific structural capacity during training sessions, and the presence of training loads that exceed specific structural capacity (Malisoux et al., 2015). In this research, the foot posture itself was included in the cumulation of specific structural loads per running session, including body mass index (BMI) and running shoes. The amount of load on each stride and the distribution of the load over the tissue structure of each stride, along with the increasing number of strides, will contribute to the increasing cumulative structure-specific load per running session. If this is coupled with poor recovery and a history of previous injury, it can result in a reduction of specific structural capacity during training sessions, which then results in an overload of running specific structural capacity leading to running-related injuries.

Based on the concept initiated by Meeuwisse, injury is a combination of various risk factor exposures, including intrinsic, extrinsic, and inciting events that occur recursively and dynamically. Foot posture itself is part of the intrinsic risk factors. Beyond the cumulation of specific structural loads per running session and the intrinsic risk factor of foot posture, there are other factors that also influence the occurrence of running-related injuries, which were not assessed in this research, such as extrinsic risk factors, training history (training volume), recovery (diet, sleep, time between running sessions), running experience and inciting events.

Good recovery time between workouts, diet, sleep, and previous running experience are other factors related to the prevention of running-related injuries. In the process of loading exerted during training, musculoskeletal structures undergo adaptations that are influenced by various factors such as time between training or competitions, running experience, previous injuries, menstrual patterns, diet, sleep, oral contraceptive use, participation in other sports activities, gender and age (Malisoux et al., 2015).

Based on the results of the research, it was found that most (80.9%) long-distance recreational runners did not understand their foot posture, which would certainly affect runners' preferences in choosing running shoes used daily. The selection of running shoes based on foot posture has not been a consideration for runners in choosing running shoes, although the use of proper running shoes in accordance with foot posture in reducing the risk of running-related injuries has been supported by several written studies. Research found that the risk of injury was generally lower in participants with pronated feet who used motion control shoes (HR=0.34; 95% CI 0.13-0.84), and runners with pronated feet who used standard shoes had a higher risk of injury compared to runners with neutral feet (HR=1.80; 95% CI 1.01-3.33) (Malisoux et al., 2016).

Of the total 136 runners who became research subjects, only 2.2% chose the right type of shoe according to their foot posture. This is thought to be influenced by several factors, such as: the availability of motion control shoes which are difficult to find in the running shoe market in Indonesia, most types of shoes sold on the market are stability and cushioned shoes, and runners have other reasons/preferences in choosing shoes such as comfort, recommendations, or economic factors as mentioned by Ramsey in his research on the reasons runners choose shoes (Ramsey et al., 2022). The list of running shoe types based on foot posture (motion control shoes, stability, and cushioned shoes) that researchers use is only available on big brand running shoes, while in this research not a few runners use domestically made running shoes for which there is no reference type classification. For these reasons, no further analysis was conducted on the relationship between the variables of understanding foot posture and the accuracy of running shoe selection on running-related injuries.

CONCLUSION

In conclusion, this research found that the majority of recreational long-distance runners exhibited foot posture with low arches in both static (82.4%) and dynamic (83.8%) examinations. Despite this, most runners (80.9%) were unaware of their foot posture, and only a small proportion (2.2%) selected shoes that were appropriate for their foot posture. Running-related injuries were reported by 28.7% of runners, with the most common complaints occurring in the knee (19.5%), calf (17.9%) and sole (15.6%).

Analysis showed no significant association between foot posture - either static or dynamic - and the occurrence of running injuries. Similarly, certain types of foot posture such as low arch and high arch showed no significant correlation with injury risk. These findings suggest that factors beyond foot posture may have a greater impact on injury risk among recreational runners. Future research should explore the interaction between foot posture, shoe selection, biomechanics, and other intrinsic and extrinsic risk factors. In addition, this research contributes to the development of customized injury prevention strategies and highlights the importance of educating runners on proper shoe selection and injury prevention measures to improve their performance and safety.

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