

Running Footwear Behavior Among Malaysian Runners: Technology Adoption, Selection Priorities, and Shoe Rotation Practices

Syahibudil Ikhwan Abdul Kudus*, Faiz Redza Ramli, Mohd Zaid Akop, Adzni Md Saad, Abdul Rafeq Saleman, and Afzanizam Mohd Rosli

Fakulti Teknologi dan Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

DOI: <https://doi.org/10.47772/IJRISS.2026.100801105>

Received: 07 September 2026; Accepted: 12 September 2026; Published: 24 September 2026

ABSTRACT

This study investigated running footwear behavior, footwear selection priorities, technology perception, shoe rotation practices, and footwear-related considerations among Malaysian runners. A quantitative cross-sectional survey was conducted among 107 recreational, semi-competitive, and competitive runners using a structured online questionnaire. Data were analyzed using descriptive statistics and non-parametric inferential analyses. The findings revealed that footwear selection was primarily influenced by overall comfort ($M = 4.63$), shoe fit ($M = 4.58$), durability ($M = 4.37$), and midsole cushioning ($M = 4.33$). Although 62.6% of respondents had used carbon-plated footwear and 63.6% believed it could improve performance, carbon plate technology was among the least important selection factors ($M = 2.98$). Shoe rotation was widely practiced, with 83.2% of runners using different shoes for different running purposes. Active shoe rotation was significantly associated with runner classification ($\chi^2 = 7.78$, $p = 0.020$) and positively correlated with weekly mileage, running frequency, running experience, and number of running shoes owned ($\rho = 0.273$ – 0.685 , $p < 0.05$). Performance-oriented runners placed significantly greater importance on performance enhancement than recreational runners ($p = 0.045$). Additionally, 90.7% of respondents reported that climate-related considerations influenced footwear preferences. The findings indicate that Malaysian runners are increasingly technology-aware and engage in diversified footwear practices, while footwear selection remains predominantly guided by comfort, fit, and practical usability.

Keyword: running footwear, footwear selection behavior, advanced footwear technology, shoe rotation practices, recreational runners

INTRODUCTION

Running is widely recognized as one of the most accessible and popular forms of physical activity due to its health benefits, affordability, and minimal equipment requirements (Lee et al., 2014, 2017; Pedisic et al., 2019). In recent years, participation in recreational running has increased substantially worldwide, including in Malaysia, where organized races, community-based running groups, and digital fitness platforms have contributed to the expansion of running culture (BERNAMA, 2026; DIRIGO Events, 2026; Wasli et al., 2025). As running participation grows, runners are becoming increasingly exposed to a diverse range of footwear products, technologies, and purchasing choices.

Contemporary running footwear has evolved considerably from its traditional role as protective equipment. Advances in sports engineering and material science have introduced innovations such as advanced foam cushioning systems, carbon-fiber plate integration, lightweight upper constructions, and highly resilient midsole materials (Barnes & Kilding, 2019; Burns & Tam, 2020). These innovations have attracted substantial research interest due to their potential to improve running economy and endurance performance, particularly through the combination of resilient foam materials and carbon-fiber plate systems (Hoogkamer et al., 2018). These developments have expanded the variety of footwear categories available to runners, including daily trainers, racing shoes, maximalist shoes, stability shoes, trail shoes, and carbon-plated performance footwear (Burns & Joubert, 2024). Consequently, runners are increasingly required to make decisions regarding footwear selection,

technology adoption, and footwear usage strategies according to their individual training needs and performance goals.

Although advanced footwear technologies (AFT) have received considerable attention within both academic research and running communities, previous studies have focused predominantly on biomechanical performance outcomes, running economy, and injury-related considerations (Barnes & Kilding, 2019; Fuller et al., 2015; Hébert-Losier & Pamment, 2023). Comparatively less attention has been given to understanding how runners perceive these technologies, how they influence footwear purchasing decisions, and how runners incorporate different footwear models into their training routines. Existing evidence suggests that comfort, fit, cushioning, durability, and overall running experience often remain important determinants of footwear preference despite increasing exposure to performance-oriented technologies (Dinato et al., 2015; Fife et al., 2024; Nigg et al., 2015).

The diversification of footwear categories has also contributed to the emergence of shoe rotation practices, whereby runners utilize different footwear models for specific training and racing purposes (Agresta et al., 2022; Malisoux et al., 2015). Furthermore, environmental conditions may influence footwear evaluation and usage behavior. In tropical countries such as Malaysia, high temperatures, humidity, and frequent rainfall may increase the importance of footwear characteristics related to breathability, ventilation, moisture management, and overall comfort during prolonged outdoor running activities (Covill et al., 2011; West et al., 2019). Despite the growing popularity of running and increasing exposure to AFT, research examining footwear perception, technology awareness, shoe rotation behavior, and footwear-related considerations among Malaysian runners remains limited. Most existing studies have been conducted in Western populations and have primarily focused on biomechanical or physiological outcomes rather than real-world footwear behavior. Consequently, there remains a need to better understand how Malaysian runners select, perceive, and utilize running footwear within a tropical running environment.

Therefore, the objective of this study is to investigate running footwear behavior among Malaysian runners. Specifically, this study aims to: 1) examine footwear usage and rotation practices; 2) identify priority factors in shoe selection; 3) evaluate perceptions of advanced footwear technologies (AFT); 4) compare behaviors between recreational and performance-oriented runners; and 5) explore footwear-related issues experienced during running. The study extends current running footwear literature beyond biomechanical performance by providing empirical evidence on footwear perception, technology adoption, and usage behaviour among Malaysian runners. The findings provide practical insights for researchers and the footwear industry to better align product development and marketing strategies with runners' needs in tropical climates. To address these objectives, a cross-sectional survey was conducted among 107 Malaysian runners.

Recreational Running Participation and Consumer Exposure

Recreational running has become one of the most widely adopted forms of physical activity worldwide because of its accessibility, affordability, and well-established physical and psychological health benefits (Lee et al., 2014, 2017; Pedisic et al., 2019). Over the past decade, participation has increased substantially, driven by greater awareness of healthy lifestyles, preventive healthcare, and personal well-being (Pereira et al., 2021). Similar trends have been observed in Malaysia, where organized running events, community-based running groups, and digital fitness platforms have contributed to the continued growth of recreational running (Wasli et al., 2025). Consequently, running has evolved beyond a purely exercise-oriented activity into a lifestyle practice characterized by social interaction, personal achievement, and community engagement (Hitchings & Latham, 2017; Yang et al., 2022).

The rapid expansion of recreational running has also transformed the running footwear market. As runners become more actively involved in training and competition, they are increasingly required to make informed decisions regarding footwear selection, replacement, and usage according to their individual needs and running objectives (Ramsey et al., 2022). Modern running footwear is no longer viewed solely as protective equipment but as a product that may influence running performance, comfort, injury prevention, and the overall running experience (Agresta et al., 2022). Concurrently, footwear research and product innovation have expanded considerably, reflecting increasing interest from both researchers and consumers in footwear-related

technologies and performance claims (Xiao et al., 2025). These developments have created a more diverse and competitive footwear marketplace, offering runners an increasingly wide range of products designed for different training and performance requirements.

Alongside developments in footwear technology, digital communication platforms have fundamentally changed how runners obtain and evaluate footwear-related information. Fitness communities, social networking platforms, and wearable technology ecosystems facilitate progress tracking, experience sharing, and interaction among runners, thereby influencing consumer awareness and purchasing behavior (Stragier et al., 2018). Fife et al. (2024) reported that runners frequently consult product reviews, peer recommendations, retail experiences, and online discussions before purchasing running shoes.

Yusoff and Wan Pa (2024) found that brand familiarity, perceived performance benefits, and recommendations from running communities may influence purchasing decisions. In contrast, Dinato et al. (2015) and Nigg et al. (2015) argued that although external information assists product evaluation, final footwear decisions are more strongly influenced by personal running experience and perceived functional performance. These contrasting findings suggest that footwear purchasing behavior is shaped by both social influences and individual evaluations of footwear suitability.

Although previous studies have substantially improved understanding of recreational running participation and consumer decision-making, research has predominantly examined footwear selection within Western populations. Comparatively little attention has been given to how runners in emerging running communities evaluate footwear, interpret technological innovations, and develop purchasing preferences in different environmental and cultural contexts. Given the continued growth of recreational running in Malaysia, understanding footwear behavior within this population is essential for informing footwear design, consumer education, and product development strategies. This context provides the foundation for examining footwear technology perception, selection priorities, and shoe rotation practices among Malaysian runners.

Advanced Running Footwear Technologies and Technology Adoption

Recent advances in sports engineering and material science have substantially transformed modern running footwear through the development of advanced foam cushioning systems, carbon-fiber plate integration, lightweight upper constructions, and highly resilient midsole materials (Barnes & Kilding, 2019; Burns & Tam, 2020). Collectively referred to as AFT, these innovations have attracted considerable attention from researchers, manufacturers, and runners because of their potential to improve running economy and endurance performance. Rather than relying on a single design feature, contemporary biomechanical models suggest that performance improvements arise from the combined interaction of compliant and resilient midsole foams, carbon-fiber plate stiffness, shoe geometry, and individual runner characteristics (Nigg et al., 2022).

Previous research has consistently demonstrated that AFT can influence running biomechanics and physiological efficiency, although the magnitude of these benefits varies across footwear designs and runner populations. Hunter et al. (2019) reported improvements in running economy among trained runners wearing carbon-plated footwear, while Hébert-Losier and Pamment (2023) concluded that AFT may enhance endurance performance through improved energy efficiency. Ortega et al. (2021) highlighted the role of increased longitudinal bending stiffness in modifying ankle and metatarsophalangeal joint mechanics, whereas Rodrigo-Carranza et al. (2022) showed that the interaction between bending stiffness, curved plate geometry, and lightweight construction may contribute to improvements in running economy and ground-contact biomechanics. These studies indicate that the performance advantages associated with AFT result from the integrated design of modern running shoes rather than from individual technological components in isolation.

Although early investigations primarily focused on elite athletes, recent evidence indicates that AFT have become increasingly accessible to recreational runners. Bonato et al. (2024) reported widespread exposure to carbon-plated footwear and highly cushioned training shoes among non-elite runners, while Burns and Joubert (2024) observed that the rapid diversification of footwear categories has reduced the distinction between racing and training shoes. Consequently, recreational runners are now exposed to a broader range of technology-

oriented footwear options than ever before (Hannigan et al., 2024). However, widespread availability does not necessarily translate into technology-driven purchasing behavior.

Fife et al. (2024) found that runners continue to evaluate footwear according to functional characteristics such as fit, overall running experience, and intended use, whereas Agresta et al. (2022) argued that perceived functional outcomes remain more influential than technical specifications alone. Furthermore, studies involving performance-oriented runners have reported greater emphasis on energy return, speed enhancement, and race-day performance when evaluating footwear technologies (Joubert & Jones, 2021; Muniz-Pardos et al., 2025). These findings suggest that technology adoption is influenced not only by technological advancement but also by runners' experience, performance objectives, and perceived practical value.

Despite the rapid development of AFT, existing literature has focused predominantly on biomechanical performance, running economy, and injury-related outcomes. Comparatively fewer studies have investigated how runners perceive these technologies, how technological awareness influences footwear decision-making, or how AFT are incorporated into everyday training practices, particularly within emerging running communities such as Malaysia. Understanding runners' perceptions and adoption of AFT is therefore essential for explaining real-world footwear behavior and provides an important foundation for the present study.

Footwear Selection Priorities and Runner Preferences

Footwear selection represents a multifactorial decision-making process in which runners evaluate footwear according to functional, perceptual, economic, and performance-related considerations. Previous studies consistently demonstrate that runners rarely base purchasing decisions on a single attribute; instead, they simultaneously assess factors such as fit, cushioning, durability, weight, price, intended use, and expected performance benefits (Fife et al., 2023, 2024). The relative importance assigned to these attributes may differ according to individual experience, running objectives, and training demands, highlighting the complexity of footwear selection behavior.

Among the various factors influencing footwear choice, subjective comfort has consistently emerged as one of the strongest determinants of footwear preference. Early work by Mündermann et al. (2002) established reliable methods for assessing footwear comfort, while Kong and Bagdon (2010) and Dinato et al. (2015) demonstrated that perceived comfort strongly influences footwear preference despite differences in shoe construction.

Building upon these findings, Nigg et al. (2015) proposed the comfort filter paradigm, suggesting that runners naturally select footwear that feels most comfortable rather than relying solely on objective biomechanical characteristics. Additional studies have shown that footwear perception is closely associated with cushioning characteristics, physiological effort, and running economy, indicating that subjective evaluations and functional performance collectively influence footwear preference (Luo et al., 2009; Tay et al., 2017; Van Alsenoy et al., 2023). These findings suggest that runners evaluate footwear according to the overall running experience rather than isolated design features.

Beyond perceptual considerations, footwear purchasing decisions are also influenced by practical and performance-related requirements. Clifton et al. (2011) identified lightweight construction, functionality, and durability as important design characteristics among active runners, while Fife et al. (2024) reported that runners typically evaluate multiple footwear attributes simultaneously rather than relying on a single selection criterion. Although price remains an important consideration, its influence is often balanced against expected product quality, durability, and intended usage, reflecting the trade-offs that runners make when selecting footwear for different training and racing purposes. These findings indicate that footwear selection involves balancing functional requirements with perceived value and anticipated performance outcomes.

Footwear preferences also vary according to running involvement and performance orientation. Studies involving competitive runners have shown greater emphasis on features associated with running economy, energy return, and race-day performance (Joubert & Jones, 2021; Muniz-Pardos et al., 2025). In contrast, recreational runners generally place greater importance on versatility, everyday usability, and overall running experience (Bonato et al., 2024; Knighton, 2023). These differences suggest that footwear preferences evolve

alongside training demands and competitive objectives, with more experienced runners tending to evaluate footwear according to its ability to support specific performance goals rather than general-purpose use.

In addition to product characteristics, footwear purchasing behavior may also be influenced by external information sources. Product reviews, retail experiences, recommendations from running communities, and brand familiarity can shape runners' awareness of available footwear options (Fife et al., 2024; Yusoff & Wan Pa, 2024). Previous studies suggest that external influences primarily support information gathering rather than determine final purchasing decisions, as runners ultimately rely on their own running experience and perceived functional suitability when evaluating footwear (Dinato et al., 2015; Nigg et al., 2015). This interaction between external information and personal evaluation highlights the complex nature of footwear decision-making among contemporary runners.

Although numerous studies have investigated footwear preference and purchasing behavior, comparatively few have examined how footwear selection priorities differ according to runner classification while simultaneously considering technology awareness and performance orientation. Furthermore, empirical evidence describing footwear selection behavior among Malaysian runners remains limited. Understanding these priorities is therefore important for explaining how runners balance functional requirements, technology adoption, performance expectations, and practical usability when selecting running footwear within a rapidly evolving footwear market.

Shoe Rotation Behavior and Footwear Specialization

The rapid diversification of modern running footwear has contributed to the widespread adoption of shoe rotation practices among both recreational and competitive runners. Rather than relying on a single pair of shoes, runners increasingly utilize multiple footwear models designed for specific training and racing purposes, including daily training, long-distance running, speed sessions, competition, trail running, and recovery runs. This trend reflects the increasing availability of specialized footwear categories and the growing recognition that different running activities impose distinct functional demands on footwear (Bruvere & Bernans, 2025; Burns & Joubert, 2024). Evidence further suggests that runners select different footwear models according to training context, intended use, and perceived functional requirements rather than relying on a single all-purpose shoe (Fife et al., 2023; Ramsey et al., 2022).

Previous studies have proposed several potential benefits associated with shoe rotation practices. Malisoux et al. (2015) reported that runners alternating between multiple footwear models experienced a lower incidence of running-related injuries than those using a single pair of shoes, suggesting that variation in footwear characteristics may reduce repetitive biomechanical loading. Agresta et al. (2022) argued that rotating footwear may enhance training variation, improve footwear longevity, and expose runners to different mechanical and functional properties across training sessions. These findings indicate that shoe rotation represents more than simply owning multiple pairs of shoes, it is increasingly regarded as a strategy for managing different training demands and footwear characteristics.

The increasing availability of specialized footwear categories has further encouraged activity-specific footwear use. Modern runners are exposed to a wide range of footwear options, including daily trainers, super trainers, racing shoes, stability shoes, and trail-running shoes, each designed to address specific running requirements (Burns & Joubert, 2024). Ramsey et al. (2022) suggested that runners frequently select footwear according to intended purpose and previous running experience, while Bonato et al. (2024) observed that non-elite runners commonly own multiple pairs of shoes allocated to different training activities. These findings suggest that footwear ownership has become increasingly diversified as runners seek to optimize training effectiveness and match footwear characteristics to specific running contexts.

Despite these reported benefits, the practical effectiveness of shoe rotation remains inconclusive. Although Malisoux et al. (2015) associated footwear rotation with a lower risk of running-related injuries, Agresta et al. (2022) cautioned that injury outcomes are influenced by multiple interacting factors, including training volume, biomechanics, running experience, and individual adaptation. Likewise, Nigg et al. (2015) argued that individual footwear preference may exert a greater influence on running outcomes than simply increasing the number of

footwear models used. These differing perspectives suggest that the effectiveness of shoe rotation depends on both footwear management strategies and runner-specific characteristics rather than shoe rotation alone.

Runner involvement also appears to influence footwear management behavior. Bonato et al. (2024) reported that highly engaged runners are more likely to own multiple footwear models and experiment with emerging footwear technologies, whereas Muniz-Pardos et al. (2025) found that performance-oriented runners frequently allocate footwear strategically according to training objectives and competition demands. In contrast, recreational runners may rely on fewer footwear models because of lower training volumes, financial considerations, or reduced exposure to specialized footwear systems. These findings indicate that shoe rotation behavior is closely associated with training commitment and competitive involvement rather than footwear ownership alone.

Although research on advanced running footwear has expanded rapidly, comparatively few studies have examined shoe rotation behavior from a behavioral perspective. Existing research has predominantly focused on injury prevention and biomechanical performance, with limited attention given to how runners manage multiple footwear models in everyday training or how footwear specialization differs across runner populations. Furthermore, evidence regarding shoe rotation practices among Malaysian runners remains scarce. Investigating these behaviors may therefore provide valuable insight into footwear management strategies and the evolving role of specialized running footwear within an increasingly technology-aware running community.

METHODOLOGY

Research Design

This study employed a quantitative cross-sectional survey design to investigate running footwear behavior, technology perception, shoe rotation practices, and footwear-related considerations among Malaysian runners. A survey-based approach was considered appropriate because the study sought to examine behavioral patterns, perceptions, and preferences across a diverse running population within a real-world setting.

Participants and Sampling

Participants consisted of Malaysian runners aged 18 years and above who were actively involved in recreational or competitive running activities. A non-probability convenience sampling approach was adopted due to the exploratory nature of the study and the accessibility of the target population through running communities and social media platforms. Data were collected from 107 respondents representing recreational, semi-competitive, and competitive runners. The inclusion of runners with different levels of running involvement enabled comparisons of footwear-related behavior across varying training and performance backgrounds. The minimum sample size was considered adequate for exploratory survey-based analysis involving descriptive statistics and non-parametric inferential tests.

Instrument Development

Data were collected using a structured online questionnaire developed based on previous literature related to running footwear, footwear perception, technology adoption, and shoe rotation behavior. The questionnaire consisted of five sections: i) demographic and running profile information (including age, gender, running experience, weekly running frequency, weekly mileage, and runner classification); ii) footwear usage behavior (including footwear ownership, shoe rotation practices, shoe replacement patterns, and preferred footwear categories); iii) footwear selection priorities, which assessed using a five-point Likert scale ranging from 1 (strongly unimportant) to 5 (strongly important); iv) technology awareness and perception by examining familiarity with AFT, carbon-plated shoe usage, perceived benefits, and future technology preferences; v) footwear-related issues that focusing on comfort, durability, weather-related concerns, and running environment considerations.

The questionnaire was developed based on previous literature related to running footwear perception, footwear selection behavior, technology awareness, and shoe rotation practices. Content validity was established through

review by three experts in sports engineering, running footwear research, and survey methodology. Internal consistency reliability analysis was considered only for the footwear selection priority items measured using a five-point Likert scale, as these items represented the principal perception-based construct examined in the study.

Data Collection Procedure

The questionnaire was administered online using Google Forms. The survey link was distributed through Malaysian running communities, social media platforms, and running-related online groups. Participation was voluntary, and respondents were informed about the purpose of the study before completing the questionnaire. Data collection was conducted over a predetermined survey period, and incomplete responses were excluded from the final dataset. Only fully completed questionnaires were included in the analysis.

Data Analysis

Data were analyzed using IBM SPSS Statistics software. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondent demographics, footwear usage behavior, footwear selection priorities, technology perception, and footwear-related issues. Inferential statistical analyses were conducted to address the research objectives. Mann–Whitney U tests were used to compare footwear selection priorities between recreational and performance-oriented runners due to the ordinal nature of the Likert-scale data. Kruskal–Wallis tests were subsequently performed to examine differences in footwear selection priorities across recreational, semi-competitive, and competitive runners. Chi-square analyses were used to investigate associations between runner classification and footwear-related behaviors, including carbon-plated shoe usage and shoe rotation practices. Spearman rank correlation analysis was conducted to examine relationships between shoe rotation behavior and selected running involvement variables, including running experience, weekly running frequency, weekly mileage, and number of running shoes owned. Statistical significance was established at $p < 0.05$ for all inferential analyses.

Ethical Considerations

Participation in this study was voluntary, and informed consent was obtained electronically prior to questionnaire completion. All responses were collected anonymously, and no personally identifiable information was recorded. The study was conducted in accordance with accepted ethical principles for human-subject research, including voluntary participation, confidentiality, and data protection.

RESULTS AND ANALYSIS

Respondent Demographics

A total of 107 Malaysian runners participated in this study. The sample was predominantly male (71.0%), with female runners accounting for 29.0% of respondents. The largest age group comprised runners aged 30–39 years (43.0%), followed by those aged 18–29 years (34.6%) and 40 years and above (22.4%), indicating that the sample was largely represented by active adult runners. In terms of running experience, 57.0% of respondents reported less than four years of running involvement, while the remaining 43.0% had accumulated at least four years of running experience. This distribution suggests a mixture of relatively new and experienced runners within the sample. The respondents also demonstrated regular engagement in running activities. More than half (52.3%) reported running three to four times per week, whereas 27.1% trained at least five times weekly. Only 20.6% reported running one to two times per week.

Weekly running mileage further reflected active participation in running. Approximately half of the respondents (48.6%) accumulated 20 km or less per week, while 24.3% reported weekly mileages between 21 and 40 km. Notably, 27.1% exceeded 40 km per week, indicating that a substantial proportion of participants were engaged in relatively high-volume training. Regarding running involvement, recreational runners constituted the largest proportion of the sample (69.2%), followed by semi-competitive runners (23.4%) and competitive runners (7.5%). The inclusion of runners with varying levels of experience, training frequency, weekly mileage, and

competitive involvement provided a diverse representation of the contemporary Malaysian running community. Table 1 summarizes the demographic and running-related characteristics of the respondents.

Table 1 Respondent Demographics and Running Profile

Variable	Category	n (%)
Gender	Male	76 (71.0)
	Female	31 (29.0)
Age group	18-29 years	37 (34.6)
	30-39 years	46 (43.0)
	≥40 years	24 (22.4)
Running experience	<4 years	61 (57.0)
	4-6 years	23 (21.5)
	>6 years	23 (21.5)
Weekly running frequency	1-2 times	22 (20.6)
	3-4 times	56 (52.3)
	≥5 times	29 (27.1)
Weekly mileage	≤20 km	52 (48.6)
	21-40 km	26 (24.3)
	>40 km	29 (27.1)
Runner classification	Recreational	74 (69.2)
	Semi-competitive	25 (23.4)
	Competitive	8 (7.5)

Footwear Usage Behavior

This section examines respondents' running shoe usage patterns, including footwear ownership, shoe rotation practices, preferred footwear categories, shoe replacement behavior, and brand preference. Overall, the results indicate that Malaysian runners demonstrate diversified footwear usage behavior characterized by multiple-shoe ownership, activity-specific footwear selection, and exposure to a broad range of footwear brands and technologies. Table 2 shows footwear usage behavior among respondents.

Table 2 Footwear Usage Behavior Among Respondents

Variable	Category	n (%)
Running shoes owned	1-2 pairs	32 (29.9)

	3-4 pairs	48 (44.9)
	≥5 pairs	27 (25.2)
Actively rotated shoes	1-2 pairs	63 (58.9)
	≥3 pairs	44 (41.1)
Use different shoes for different purposes	Yes	89 (83.2)
	No/not sure	18 (16.8)
Most frequently used shoe type	Daily trainer	100 (93.5)
	Racing shoe	51 (47.7)
	Stability shoe	33 (30.8)
	Trail running shoe	28 (26.2)
	Maximalist shoe	14 (13.1)
	Minimalist shoe	9 (8.4)
Shoe replacement distance	≤300 km	16 (15.0)
	301-700 km	55 (51.4)
	>700 km	36 (33.6)
Most common primary brands	ASICS	44 (41.1)
	Adidas	10 (9.3)
	XTEP	10 (9.3)
	New Balance	9 (8.4)
	Nike	5 (4.7)
	Others	29 (27.1)

Based on Table 2, 70.1% of respondents owned at least three pairs of running shoes, while 25.2% reported owning five pairs or more. These results suggest that maintaining multiple pairs of running shoes is a common practice among Malaysian runners. However, active shoe rotation was less prevalent than footwear ownership, with 41.1% of respondents reporting that they regularly rotated three or more pairs of running shoes, whereas the majority (58.9%) actively rotated only one or two pairs. Despite this, a large proportion of respondents (83.2%) reported using different shoes for different running purposes, indicating widespread recognition of footwear specialization according to training demands and running activities.

Daily trainers were the most widely used footwear category, with 93.5% of respondents reporting their use. Racing shoes were the second most common category (47.7%), followed by stability shoes (30.8%) and trail running shoes (26.2%). In contrast, maximalist shoes (13.1%) and minimalist shoes (8.4%) were less frequently used. The widespread use of daily trainers highlights the importance of versatility, comfort, and practicality during routine training, while the substantial adoption of racing footwear suggests growing exposure to performance-oriented footwear technologies among Malaysian runners.

The results further revealed that most respondents replaced their running shoes between 301 and 700 km of usage (51.4%). Nevertheless, more than one-third of respondents (33.6%) reported using their shoes beyond 700 km before replacement, suggesting considerable variation in footwear lifespan expectations and replacement behavior. Such differences may reflect individual preferences, running volume, footwear durability, perceived comfort, and economic considerations.

Brand preference was strongly dominated by ASICS, which was identified as the primary running shoe brand by 41.1% of respondents. Adidas and XTEP each accounted for 9.3% of primary brand preferences, followed by New Balance (8.4%) and Nike (4.7%). The remaining 27.1% of respondents reported a variety of alternative brands, indicating that Malaysian runners are exposed to a diverse footwear marketplace rather than relying exclusively on a small number of global brands. The strong preference for ASICS may reflect the brand's established reputation for comfort, reliability, and broad product offerings across different running categories.

The prevalence of multiple-shoe ownership and activity-specific footwear selection is consistent with previous studies suggesting that runners increasingly utilize different footwear models to accommodate variations in training intensity, running surface, comfort requirements, and performance objectives (Agresta et al., 2022; Malisoux et al., 2015). The widespread adoption of daily trainers alongside substantial usage of racing footwear further reflects the growing diversification of the modern running footwear market and increasing awareness of footwear functionality among runners.

Overall, the findings support the study objective of examining footwear usage behavior among Malaysian runners and suggest a growing tendency towards footwear specialization, multiple-shoe ownership, and training-specific footwear selection. However, the results also indicate that many runners continue to rely on a relatively limited number of shoes for regular rotation despite owning multiple footwear models, highlighting a distinction between footwear ownership and actual footwear usage behavior.

Footwear Selection Priorities

This section examines the factors that influence running footwear selection among Malaysian runners and the results is shown in Table 3 below. Understanding these priorities provides insight into how runners evaluate footwear attributes and make purchasing decisions in an increasingly diverse and technology-driven footwear market.

Table 3 Factors Influencing Running Footwear Selection

Factor	Mean	Standard Deviation (SD)
Overall comfort	4.63	0.67
Shoe fit (sizing/shape)	4.58	0.70
Durability	4.37	0.82
Midsole cushioning	4.33	0.79
Lightweight feel	4.24	0.87
Stability	4.16	0.91
Price	4.12	0.89
Midsole material and composition	4.11	0.96
Performance/speed enhancement	4.10	0.93

Upper material (fabric/material property)	4.05	0.98
Social media reviews	3.75	1.11
Shoe aesthetic/design	3.67	1.09
Recommendation from friends/community	3.37	1.21
Brand reputation	3.39	1.10
Influencers/elite runners	3.01	1.23
Carbon plate technology	2.98	1.35

As presented in Table 3, the results indicate that Malaysian runners primarily prioritize comfort, fit, durability, and practical usability when selecting running footwear. Overall comfort emerged as the most important footwear selection criterion ($M = 4.63$, $SD = 0.67$), followed by shoe fit ($M = 4.58$, $SD = 0.70$), durability ($M = 4.37$, $SD = 0.82$), and midsole cushioning ($M = 4.33$, $SD = 0.79$). These results suggest that runners place substantial importance on factors that directly influence running experience, long-term comfort, and day-to-day usability during both training and competition.

The strong emphasis on comfort and fit aligns with previous studies reporting that comfort perception remains one of the most influential determinants of footwear preference and running satisfaction (Dinato et al., 2015; Nigg et al., 2015; Tay et al., 2017). Comfort-related perceptions have been associated with cushioning characteristics, stability, underfoot feel, and overall running experience, all of which contribute to subjective evaluations of footwear suitability (Luo et al., 2009; Van Alsenoy et al., 2023). The consistently high ratings observed in the present study therefore reinforce the importance of user experience in footwear selection, even within an increasingly technology-driven footwear market.

Several performance-related attributes were also rated highly, including lightweight feel ($M = 4.24$, $SD = 0.87$), stability ($M = 4.16$, $SD = 0.91$), performance enhancement ($M = 4.10$, $SD = 0.93$), and midsole material characteristics ($M = 4.11$, $SD = 0.96$). These results indicate that respondents value footwear features that may contribute to running efficiency and performance. However, these attributes remained secondary to comfort- and fit-related considerations, suggesting that runners evaluate performance benefits within the broader context of overall comfort and practicality rather than pursuing performance gains alone. Interestingly, price emerged as one of the more influential selection factors ($M = 4.12$, $SD = 0.89$), ranking alongside stability and performance enhancement. This result suggests that footwear purchasing decisions are influenced not only by functional and performance considerations but also by perceptions of value and affordability. Given the increasing cost of premium running footwear, particularly carbon-plated racing shoes and highly cushioned performance trainers, runners may carefully balance performance expectations against economic considerations when selecting footwear.

Factors associated with social influence received comparatively lower importance ratings. Social media reviews ($M = 3.75$, $SD = 1.11$), brand reputation ($M = 3.39$, $SD = 1.10$), recommendation from friends or running communities ($M = 3.37$, $SD = 1.21$), and influencer or elite runner influence ($M = 3.01$, $SD = 1.23$) were rated considerably lower than comfort-, fit-, and performance-related attributes. These results suggest that Malaysian runners rely more heavily on personal experience and functional requirements than on external endorsements when selecting running footwear. Nevertheless, the moderate rating assigned to social media reviews indicates that digital platforms may still play a supporting role in information gathering and product evaluation.

On the contrary, carbon plate technology received the lowest importance rating among all evaluated factors ($M = 2.98$, $SD = 1.35$). This result is particularly interesting given the growing visibility of carbon-plated footwear and AFT within contemporary running communities. Although respondents demonstrated substantial awareness of AFT in later sections of the study, technology itself does not appear to be a primary driver of footwear selection. Instead, Malaysian runners seem to evaluate footwear according to its ability to deliver tangible

benefits such as overall usability. The relatively large standard deviation associated with carbon plate technology further suggests considerable variation in perceptions regarding its importance, potentially reflecting differences in running experience, performance orientation, and familiarity with advanced footwear systems.

The results support the study objective of identifying the primary factors influencing running shoe selection among Malaysian runners. The findings indicate that footwear selection is predominantly guided by user-centered considerations, with comfort, fit, durability, cushioning, and value for money exerting greater influence than technology-specific features or external recommendations. These results highlight the continued importance of practical usability and personal running experience in contemporary footwear decision-making and suggest that technology adoption among runners may be driven more by perceived functional benefits than by technological novelty alone.

Technology Awareness and Perception

This section examines respondents' awareness, perception, acceptance, and usage of advanced running footwear technologies, particularly carbon-plated footwear and emerging footwear innovations. Understanding how runners perceive these technologies is important because modern running footwear increasingly incorporates performance-oriented features that are heavily promoted within contemporary running communities. The results provide insight into the extent to which technological advancements have been adopted and valued among Malaysian runners. Table 4 exhibit the technology awareness and perception among respondents.

Table 4 Technology Awareness and Perception Among Respondents

Variable	Category	n (%)
Used carbon-plated running shoes	Yes	67 (62.6)
	No	40 (37.4)
Perception carbon-plated shoes improve performance	Agree/Strongly agree	68 (63.6)
	Neutral	28 (26.2)
	Disagree/Strongly disagree	11 (10.3)
Most perceived benefit of advanced footwear	Speed improvement	46 (43.0)
	Comfort enhancement	13 (12.1)
	Reduced fatigue	5 (4.7)
	Injury reduction	4 (3.7)
	Increased confidence	3 (2.8)
	Stability improvement	3 (2.8)
	No perceived benefit/Not sure	33 (30.8)
Reserved carbon-plated shoes primarily for racing	Yes	39 (36.4)
	No	34 (31.8)
	Do not own one	34 (31.8)

Preferred future footwear technology	Advanced foam composition	40 (37.4)
	Injury-monitoring shoes	20 (18.7)
	Artificial intelligence (AI) smart shoes	19 (17.8)
	Self-adjusting fit shoes	16 (15.0)
	Customized 3D-printed shoes	6 (5.6)
	Not interested	4 (3.7)
	Sustainable eco-friendly shoes	2 (1.9)

As presented in Table 4, the results indicate that AFT have achieved considerable penetration within the Malaysian running community. Nearly two-thirds of respondents (62.6%) reported previous use of carbon-plated running shoes, demonstrating that exposure to AFT extends beyond elite athletes and is increasingly common among recreational and semi-competitive runners. Furthermore, 63.6% of respondents agreed that carbon-plated footwear could improve running performance, while only 10.3% disagreed. However, more than one-quarter of respondents (26.2%) remained neutral, suggesting that although performance benefits are widely recognized, some uncertainty regarding the practical value of carbon-plated footwear still exists.

Among the perceived benefits of AFT, speed improvement emerged as the most frequently reported advantage (43.0%). This finding contrasts with the common assumption that comfort or fatigue reduction represents the primary attraction of advanced footwear systems. Instead, respondents appear to associate carbon-plated footwear primarily with enhanced running performance and faster race times. Comfort enhancement was identified as the second most frequently reported benefit (12.1%), while substantially fewer respondents associated these technologies with reduced fatigue (4.7%), injury reduction (3.7%), improved stability (2.8%), or increased confidence (2.8%). However, 30.8% of respondents reported no perceived benefit or remained uncertain, which indicating that positive perceptions towards AFT are not universal among Malaysian runners.

The results further revealed that carbon-plated footwear is often used selectively rather than universally. Only 36.4% of respondents reported reserving carbon-plated shoes primarily for racing, while 31.8% used them more broadly across training and competition. Another 31.8% did not own carbon-plated footwear. These results suggest that although AFT are increasingly adopted, many runners do not necessarily regard them as race-exclusive equipment. The relatively balanced distribution across categories indicates considerable variation in how runners integrate carbon-plated footwear into their training practices.

Future technology preferences further highlight respondents' interest in technologies that offer practical performance and comfort benefits. Advanced foam composition was the most preferred future innovation (37.4%), followed by injury-monitoring shoes (18.7%), artificial intelligence-enabled smart shoes (17.8%), and self-adjusting fit systems (15.0%). In contrast, customized 3D-printed footwear (5.6%) and sustainable eco-friendly shoes (1.9%) attracted comparatively lower interest. The strong preference for advanced foam technologies aligns with earlier findings showing that comfort, cushioning, and running experience remain central considerations in footwear evaluation. Similarly, the substantial interest in injury-monitoring and smart footwear technologies suggests that runners are receptive to innovations that provide actionable performance and health-related benefits.

While a majority of respondents recognize the performance benefits of carbon-plated footwear and many have direct experience using such products, technology adoption appears to be driven primarily by perceived functional benefits rather than technological novelty alone. The strong preference for advanced foam systems and performance-oriented innovations further suggests that runners favor technologies capable of delivering tangible improvements in comfort, efficiency, and running experience.

A Chi-square analysis was conducted to examine the association between runner classification and carbon-plated shoe usage. The results are shown in Table 5.

Table 5 Association Between Runner Classification and Carbon-plated Shoe Usage

Runner Classification	Used Carbon-plated Shoes n (%)	Never Used Carbon-plated Shoes n (%)
Recreational runner	42 (56.8)	32 (43.2)
Semi-competitive runner	18 (72.0)	7 (28.0)
Competitive runner	7 (87.5)	1 (12.5)

Statistical Test	Value
Chi-square (χ^2)	4.14
Degrees of freedom (df)	2
p-value	0.126

The proportion of runners reporting previous use of carbon-plated footwear increased progressively with running involvement, from 56.8% among recreational runners to 72.0% among semi-competitive runners and 87.5% among competitive runners. However, the association did not reach statistical significance ($\chi^2 = 4.14$, $df = 2$, $p = 0.126$). Although the absence of statistical significance prevents definitive conclusions regarding the relationship between runner classification and carbon-plated shoe usage, the observed pattern suggests that more competitively involved runners may be more likely to adopt AFT. This trend is consistent with the greater performance demands typically associated with competitive running, where potential improvements in running economy and race performance may be more highly valued. The lack of statistical significance may be attributable to the relatively small number of competitive runners in the sample ($n = 8$), which limits statistical power and reduces the likelihood of detecting significant group differences. Nevertheless, the results suggest that while carbon-plated footwear is used across all runner categories, adoption appears to become progressively more common as running involvement increases. Future studies involving larger and more balanced runner populations may provide greater insight into the relationship between competitive involvement and advanced footwear technology adoption.

Footwear Selection Priorities Between Recreational and Performance-Oriented Runners

This section compares footwear selection priorities between recreational runners and performance-oriented runners, comprising semi-competitive and competitive participants. A Mann–Whitney U analysis was conducted to determine whether running involvement influences the relative importance assigned to key footwear attributes. The results are presented in Table 6.

Table 6 Mann-Whitney U Analysis of Footwear Selection Priorities According to Runner Involvement

Variable	Recreational Runners Mean Rank	Performance-Oriented Runners Mean Rank	Mann-Whitney U	p-value
Comfort	52.64	56.61	1135.0	0.471
Cushioning	54.81	52.18	1281.0	0.658

Stability	54.58	52.70	1264.0	0.758
Lightweight feel	55.72	50.15	1348.0	0.354
Durability	53.99	54.02	1220.5	1.000
Price	53.94	54.14	1216.5	0.977
Performance enhancement	50.25	62.41	943.5	0.045*

*Significant at $p < 0.05$.

The analysis revealed only one statistically significant difference between the two groups. Performance-oriented runners assigned significantly greater importance to performance enhancement (Mean Rank = 62.41) than recreational runners (Mean Rank = 50.25; $U = 943.5$, $p = 0.045$). This finding suggests that runners with greater competitive involvement are more likely to evaluate footwear according to its perceived ability to improve running performance. Such behavior is consistent with the greater emphasis placed on training outcomes, race preparation, and performance optimization among runners who participate more actively in competitive events. In contrast, no significant differences were observed for comfort, cushioning, stability, lightweight feel, durability, or price ($p > 0.05$). These findings indicate that both recreational and performance-oriented runners share broadly similar footwear selection priorities. Regardless of running involvement, respondents consistently valued comfort, cushioning, durability, and overall usability when selecting running footwear.

To further validate these observations, a Kruskal-Wallis analysis was performed across three runner classifications: recreational, semi-competitive, and competitive runners (see Table 7). No statistically significant differences were detected across the three groups for any footwear selection factor ($p > 0.05$). Although performance enhancement produced the largest test statistic ($H = 4.33$, $p = 0.115$), the result remained below the threshold for statistical significance.

Table 7 Kruskal-Wallis Analysis of Footwear Selection Priorities by Runner Classification

Variable	H	p-value
Comfort	0.533	0.766
Cushioning	0.291	0.865
Stability	0.138	0.933
Lightweight feel	1.483	0.476
Durability	3.545	0.170
Price	0.826	0.662
Performance enhancement	4.330	0.115

Under those circumstances, the results suggest that differences in footwear selection priorities between runner categories are less pronounced than commonly assumed. While performance-oriented runners place greater emphasis on perceived performance benefits, fundamental footwear requirements such as comfort, cushioning, durability, and value remain important across all runner groups. These results indicate that practical usability and running experience continue to play a central role in footwear decision-making regardless of competitive involvement.

Shoe Rotation Behavior

As previously presented in Table 2 (Section 4.2), shoe rotation emerged as a common footwear practice among Malaysian runners. While 83.2% of respondents reported using different footwear models for different running purposes, only 41.1% actively rotated three or more pairs of running shoes. These findings suggest that although most runners recognize the benefits of using different footwear for specific activities, many continue to rely on a relatively limited number of shoes for regular rotation.

The widespread adoption of shoe rotation practices observed in the present study is consistent with previous reports suggesting that runners increasingly utilize multiple footwear models to accommodate variations in training intensity, running surface, comfort requirements, and performance objectives (Agresta et al., 2022; Malisoux et al., 2015). The growing availability of specialized footwear categories, including daily trainers, racing shoes, trail shoes, stability shoes, and carbon-plated footwear, may have further encouraged runners to align footwear selection with specific running activities. These findings indicate that footwear usage among Malaysian runners has become increasingly diversified and purpose driven.

A Chi-square analysis was conducted to examine the association between runner classification and active shoe rotation behavior. As shown in Table 8, a significant association was observed between runner classification and shoe rotation practices ($\chi^2 = 7.78$, $df = 2$, $p = 0.020$). Competitive runners demonstrated substantially greater levels of footwear specialization than both recreational and semi-competitive runners. Specifically, 87.5% of competitive runners reported rotating three or more pairs of running shoes, compared with 40.0% of semi-competitive runners and 36.5% of recreational runners. These findings suggest that greater competitive involvement may encourage runners to adopt more specialized footwear strategies tailored to different training and racing demands.

Table 8 Association Between Runner Classification and Active Shoe Rotation

Runner Classification	Rotates ≥ 3 Shoes n (%)	Rotates 1-2 Shoes n (%)
Recreational runner	27 (36.5)	47 (63.5)
Semi-competitive runner	10 (40.0)	15 (60.0)
Competitive runner	7 (87.5)	1 (12.5)

Statistical Test	Value
Chi-square (χ^2)	7.78
Degrees of freedom (df)	2
p-value	0.020*

*Significant at $p < 0.05$.

To further examine factors associated with shoe rotation behavior, Spearman correlation analyses were conducted between shoe rotation practices and selected running involvement variables. As presented in Table 9, significant positive relationships were observed between shoe rotation behavior and weekly running mileage ($\rho = 0.491$, $p < 0.001$), weekly running frequency ($\rho = 0.412$, $p < 0.001$), running experience ($\rho = 0.273$, $p = 0.004$), and number of running shoes owned ($\rho = 0.685$, $p < 0.001$). These results indicate that runners who train more frequently, accumulate greater running mileage, possess more running experience, and own larger footwear collections are more likely to actively rotate multiple footwear models.

Table 9 Spearman Correlation Analysis Between Running Involvement and Shoe Rotation Behavior

Variable	Correlation With Shoe Rotation Frequency (ρ)	p-value
Weekly running mileage	0.491	<0.001*
Weekly running frequency	0.412	<0.001*
Running experience	0.273	0.004*
Number of running shoes owned	0.685	<0.001*

*Significant at $p < 0.05$.

Among all variables examined, the number of running shoes owned demonstrated the strongest positive relationship with shoe rotation behavior ($\rho = 0.685$, $p < 0.001$). While this relationship may appear intuitive, it highlights footwear availability as an important practical prerequisite for rotation practices. The result further suggests that shoe rotation behavior is influenced not only by training demands but also by consumer purchasing behavior and access to multiple footwear options.

Runners who invest in larger footwear collections may be more inclined to adopt activity-specific footwear strategies and experiment with different footwear categories. The moderate positive relationships observed for weekly mileage and weekly running frequency further suggest that footwear specialization becomes increasingly relevant as training exposure increases. Runners covering greater distances and training more regularly may experience a wider range of physiological and performance demands, thereby increasing the perceived value of using different footwear models for specific running purposes.

Consequently, the results support the study objective of examining footwear usage behavior among Malaysian runners and indicate that shoe rotation has become a common practice within the contemporary running community. The results further suggest that shoe rotation behavior is associated with both running involvement and footwear ownership, with the strongest adoption observed among competitive runners and highly engaged runners. Nevertheless, the present study cannot determine whether shoe rotation directly improves running performance, comfort, or injury outcomes. Future studies incorporating longitudinal, biomechanical, or injury-monitoring approaches may provide greater insight into the practical benefits of shoe rotation practices under real-world running conditions.

Footwear-related Issues

This section examines footwear-related issues experienced by respondents during running activities, including thermal comfort, overall running discomfort, durability concerns, stability issues, and perceptions regarding footwear suitability under Malaysian environmental conditions. Understanding these factors is important because runners operating in tropical climates may experience unique footwear requirements associated with heat, humidity, and prolonged outdoor exposure. The results are presented in Table 10.

Table 10 Footwear-related Issues

Variable	Category	n (%)
Malaysia's climate influences shoe preference	Agree/strongly agree	97 (90.7)
	Neutral	8 (7.5)
	Disagree/strongly disagree	2 (1.9)

Excessive heat issues	Frequently/very frequently	11 (10.3)
	Sometimes	54 (50.5)
	Rarely/never	42 (39.3)
Discomfort during running	Frequently/very frequently	12 (11.2)
	Sometimes	63 (58.9)
	Rarely/never	32 (29.9)
Shoes wear out quickly	Frequently/very frequently	22 (20.6)
	Sometimes	30 (28.0)
	Rarely/never	55 (51.4)
Lack stability issues	Frequently/very frequently	16 (15.0)
	Sometimes	46 (43.0)
	Rarely/never	45 (42.1)
Shoes feel heavy	Frequently/very frequently	15 (14.0)
	Sometimes	45 (42.1)
	Rarely/never	47 (43.9)

As shown in Table 10, a substantial majority of respondents (90.7%) agreed or strongly agreed that Malaysia's climate influences their running shoe preferences. This finding suggests that environmental conditions play an important role in footwear evaluation among Malaysian runners. Factors such as breathability, ventilation, moisture management, and thermal comfort may contribute to footwear preferences within Malaysia's warm and humid climate. Excessive heat issues were reported frequently or very frequently by only 10.3% of respondents, while the majority reported experiencing such issues only sometimes (50.5%) or rarely and never (39.3%). As can be seen, only 11.2% of respondents reported frequent discomfort during running, whereas most respondents experienced discomfort occasionally (58.9%). These results suggest that although thermal comfort and running comfort remain relevant considerations, most runners do not experience persistent footwear-related discomfort during routine running activities.

Durability-related concerns demonstrated a similar pattern. Approximately 20.6% of respondents reported that their shoes wore out quickly either frequently or very frequently, while more than half (51.4%) reported rarely or never experiencing this issue. These findings suggest that most respondents were generally satisfied with the durability of their running footwear, although a notable proportion still experienced concerns regarding footwear longevity. Differences in running mileage, training frequency, running surfaces, and footwear quality may contribute to variation in durability perceptions among respondents. Issues related to footwear stability and perceived shoe heaviness were also relatively uncommon. Only 15.0% of respondents frequently experienced stability-related concerns, while 42.1% reported rarely or never encountering such issues. Similarly, 14.0% frequently perceived their shoes as excessively heavy, whereas 43.9% reported rarely or never experiencing this problem. These results indicate that most respondents were generally satisfied with the stability and weight characteristics of their running footwear.

Previous studies have suggested that environmental conditions can influence footwear comfort, thermal regulation, moisture management, and overall running satisfaction (Covill et al., 2011; West et al., 2019). Within

tropical running environments, elevated temperatures and humidity may increase perspiration accumulation and thermal stress during prolonged outdoor exercise. Consequently, footwear breathability, ventilation, and moisture management may become particularly important attributes when evaluating running footwear. The strong agreement regarding the importance of climate on footwear preferences observed in the present study supports this perspective and highlights the influence of environmental context on footwear preferences.

The results support the study objective of exploring footwear-related considerations among Malaysian runners and suggest that environmental conditions play an important role in shaping footwear preferences. While severe footwear-related issues were generally not reported frequently, respondents placed considerable importance on breathability and climate suitability when evaluating running footwear. These findings indicate that runners operating in tropical environments may prioritize ventilation, moisture management, and overall comfort alongside traditional considerations such as fit, cushioning, durability, and performance. Future studies should further investigate the relationship between environmental exposure, footwear design characteristics, and runner satisfaction across different climatic conditions.

CONCLUSION

This study investigated running footwear behavior, technology perception, shoe rotation practices, and footwear-related considerations among Malaysian runners. Specifically, the study examined footwear usage behavior, factors influencing running shoe selection, perceptions towards AFT, differences between recreational and performance-oriented runners, and footwear-related issues experienced within Malaysian running environments.

The results revealed that Malaysian runners demonstrate increasingly diversified and technology-aware footwear behavior while continuing to prioritize comfort, fit, and practical usability when selecting running shoes. Among all footwear selection factors, overall comfort ($M = 4.63$) and shoe fit ($M = 4.58$) emerged as the most influential considerations, followed by durability ($M = 4.37$) and midsole cushioning ($M = 4.33$). These findings suggest that runners primarily evaluate footwear according to its ability to provide a comfortable and reliable running experience rather than based solely on technological features or brand-related influences.

The results further indicated substantial awareness and adoption of AFT within the Malaysian running community. Approximately 62.6% of respondents reported previous use of carbon-plated footwear, while 63.6% agreed that carbon-plated shoes could improve running performance. However, carbon plate technology received the lowest importance rating among footwear selection factors ($M = 2.98$), suggesting that runners value technology primarily when it delivers meaningful functional benefits rather than for technological novelty alone. Footwear specialization was also evident among respondents.

While 83.2% reported using different footwear models for different running purposes, only 41.1% actively rotated three or more pairs of running shoes. Significant positive relationships were observed between shoe rotation behavior and weekly mileage ($p = 0.491$), weekly running frequency ($p = 0.412$), running experience ($p = 0.273$), and particularly the number of running shoes owned ($p = 0.685$). Competitive runners were also significantly more likely to engage in active shoe rotation than recreational runners. These findings suggest that footwear specialization becomes increasingly common as running involvement and training demands increase.

Environmental considerations also emerged as an important aspect of footwear evaluation. A substantial majority of respondents (90.7%) agreed that climate-related factors influence footwear preferences, highlighting the importance of breathability, ventilation, and moisture management in tropical running environments. Nevertheless, severe footwear-related issues were generally uncommon, indicating that most runners were broadly satisfied with the comfort, stability, and durability of their footwear.

The findings demonstrate that footwear selection is shaped by a combination of comfort perception, practical usability, technology awareness, training involvement, and environmental considerations. Several limitations should be acknowledged. The study employed a cross-sectional survey design and relied on self-reported responses, which may be subject to recall bias and subjective interpretation. The use of convenience sampling and the relatively small number of competitive runners may also limit the generalizability of the findings. Furthermore, the study focused on perceived behavior and attitudes rather than objective biomechanical or

performance outcomes. Future research should investigate footwear behavior across larger and more diverse runner populations and explore how footwear selection, technology adoption, shoe rotation practices, and environmental conditions influence performance, comfort, injury risk, and long-term running participation. Longitudinal and mixed-method studies may provide deeper insight into how runners interact with modern footwear technologies throughout their running journey.

ACKNOWLEDGEMENT

The authors would like to thank Ministry of Higher Education of Malaysia and Universiti Teknikal Malaysia Melaka for funding this research through Fundamental Research Grant Scheme (FRGS), no. FRGS/1/2024/SS02/UTEM/02/3.

REFERENCE

1. Agresta, C., Giacomazzi, C., Harrast, M., & Zendler, J. (2022). Running Injury Paradigms and Their Influence on Footwear Design Features and Runner Assessment Methods: A Focused Review to Advance Evidence-Based Practice for Running Medicine Clinicians. *Frontiers in Sports and Active Living*, 4(March), 1–15. <https://doi.org/10.3389/fspor.2022.815675>
2. Barnes, K. R., & Kilding, A. E. (2019). A Randomized Crossover Study Investigating the Running Economy of Highly-Trained Male and Female Distance Runners in Marathon Racing Shoes versus Track Spikes. *Sports Medicine*, 49, 331–342. <https://doi.org/10.1007/s40279-018-1012-3>
3. BERNAMA. (2026). SCORE Marathon 2026 Targets 50,000 Participants. Malaysian National News Agensi.
4. Bonato, M., Marmondi, F., Faelli, E. L., Pedrinelli, C., Ferraris, L., & Filipas, L. (2024). Advanced Footwear Technology in Non-Elite Runners: A Survey of Training Practices and Reported Outcomes. *Sports*, 12, 356. <https://doi.org/10.3390/sports12120356>
5. Bruvere, D. D., & Bernans, E. (2025). Mechanisms, Economy, and Performance of Advanced Footwear Technology in Endurance Running—A Review. *Muscles*, 5(2), 1–28. <https://doi.org/10.3390/muscles5010002>
6. Burns, G. T., & Joubert, D. P. (2024). Running Shoes of the Postmodern Footwear Era: A Narrative Overview of Advanced Footwear Technology. *International Journal of Sports Physiology and Performance*, 19, 975–986. <https://doi.org/10.1123/ijsp.2023-0446>
7. Burns, G. T., & Tam, N. (2020). Is it the shoes? A simple proposal for regulating footwear in road running. *British Journal of Sports Medicine*, 54(8), 439–441. <https://doi.org/10.1136/bjsports-2018-100480>
8. Clifton, P., Burton, M., Subic, A., Perret-Ellena, T., Bedford, A., & Schembri, A. (2011). Identification of performance requirements for user-centered design of running shoes. *Procedia Engineering*, 13, 100–106. <https://doi.org/10.1016/j.proeng.2011.05.058>
9. Covill, D., Guan, Z. W., Bailey, M., & Raval, H. (2011). Development of thermal models of footwear using finite element analysis. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, 225(3), 268–281. <https://doi.org/10.1243/09544119JEIM860>
10. Dinato, R. C., Ribeiro, A. P., Butugan, M. K., Pereira, I. L. R., Onodera, A. N., & Sacco, I. C. N. (2015). Biomechanical variables and perception of comfort in running shoes with different cushioning technologies. *Journal of Science and Medicine in Sport*, 18, 93–97. <https://doi.org/10.1016/j.jsams.2013.12.003>
11. DIRIGO Events. (2026). KLSCM inks partnership renewal with Standard Chartered. Kuala Lumpur Standard Chartered Marathon. <https://www.kl-marathon.com/news/110/>
12. Fife, A., Ramsey, C., Esculier, J. F., & Hébert-Losier, K. (2023). How do road runners select their shoes? A systematic review. *Footwear Science*, 15(2), 103–112. <https://doi.org/10.1080/19424280.2023.2180543>
13. Fife, A., Ramsey, C., Esculier, J. F., & Hébert-Losier, K. (2024). How do runners select their shoes? An in-store experience. *Footwear Science*, 16(3), 191–199. <https://doi.org/10.1080/19424280.2024.2353597>
14. Fuller, J. T., Bellenger, C. R., Thewlis, D., Tsiros, M. D., & Buckley, J. D. (2015). The Effect of Footwear on Running Performance and Running Economy in Distance Runners. *Sports Medicine*, 45(3), 411–422.

- <https://doi.org/10.1007/s40279-014-0283-6>
15. Hannigan, J. J., Westley, L., & Jin, L. (2024). Injury and performance-related running biomechanics in advanced footwear technology compared to minimalist footwear. *Footwear Science*, 16(2), 115–121. <https://doi.org/10.1080/19424280.2024.2327317>
 16. Hébert-Losier, K., & Pamment, M. (2023). Advancements in running shoe technology and their effects on running economy and performance—a current concepts overview. *Sports Biomechanics*, 22(3), 335–350. <https://doi.org/10.1080/14763141.2022.2110512>
 17. Hitchings, R., & Latham, A. (2017). How ‘social’ is recreational running? Findings from a qualitative study in London and implications for public health promotion. *Health and Place*, 46, 337–343. <https://doi.org/10.1016/j.healthplace.2016.10.003>
 18. Hoogkamer, W., Kipp, S., Frank, J. H., Farina, E. M., Luo, G., & Kram, R. (2018). A Comparison of the Energetic Cost of Running in Marathon Racing Shoes. *Sports Medicine*, 48, 1009–1019. <https://doi.org/10.1007/s40279-017-0811-2>
 19. Hunter, I., McLeod, A., Valentine, D., Low, T., Ward, J., & Hager, R. (2019). Running economy, mechanics, and marathon racing shoes. *Journal of Sports Sciences*. <https://doi.org/10.1080/02640414.2019.1633837>
 20. Joubert, D. P., & Jones, G. P. (2021). A Comparison of Running Economy Across Seven Carbon-Plated Racing Shoes. *Faculty Publications*, 33. <https://scholarworks.sfasu.edu/kinesiology>
 21. Knighton, H. (2023). Responses of male recreational runners during outdoor running in three shoes: Quantitative and qualitative studies. The University of Waikato.
 22. Kong, P. W., & Bagdon, M. (2010). Shoe preference based on subjective comfort for walking and running. *Journal of the American Podiatric Medical Association*, 100(6), 456–462. <https://doi.org/10.7547/1000456>
 23. Lee, D., Brellenthin, A. G., Thompson, P. D., Sui, X., Lee, I. M., & Lavie, C. J. (2017). Running as a Key Lifestyle Medicine for Longevity. *Progress in Cardiovascular Diseases*, 60(1), 45–55. <https://doi.org/10.1016/j.pcad.2017.03.005>
 24. Lee, D., Pate, R. R., Lavie, C. J., Sui, X., Church, T. S., & Blair, S. N. (2014). Leisure-Time Running Reduces All-Cause and Cardiovascular Mortality Risk. *Journal of the American College of Cardiology*, 64(5), 472–481. <https://doi.org/10.1016/j.jacc.2014.04.058>
 25. Luo, G., Stergiou, P., Worobets, J., Nigg, B., & Stefanyshyn, D. (2009). Improved footwear comfort reduces oxygen consumption during running. *Footwear Science*, 1(1), 25–29. <https://doi.org/10.1080/19424280902993001>
 26. Malisoux, L., Ramesh, J., Mann, R., Seil, R., Urhausen, A., & Theisen, D. (2015). Can parallel use of different running shoes decrease running-related injury risk? *Scandinavian Journal of Medicine and Science in Sports*, 25, 110–115. <https://doi.org/10.1111/sms.12154>
 27. Mündermann, A., Nigg, B. M., Stefanyshyn, D. J., & Humble, R. N. (2002). Development of a reliable method to assess footwear comfort during running. *Gait and Posture*, 16, 38–45. [https://doi.org/10.1016/S0966-6362\(01\)00197-7](https://doi.org/10.1016/S0966-6362(01)00197-7)
 28. Muniz-Pardos, B., Angeloudis, K., Zelenkova, I., Guppy, F. M., Marco-Contreras, L. A., Gomez-Bruton, A., Lozano-Berges, G., Pitsiladis, Y., & Casajus, J. A. (2025). Advanced footwear technology in well-trained athletes: methodological insights from outdoor running. *Frontiers in Physiology*, 16(December), 1–14. <https://doi.org/10.3389/fphys.2025.1713902>
 29. Nigg, B. M., Baltich, J., Hoerzer, S., & Enders, H. (2015). Running shoes and running injuries: Mythbusting and a proposal for two new paradigms: “Preferred movement path” and “comfort filter.” *British Journal of Sports Medicine*, 49(20), 1290–1294. <https://doi.org/10.1136/bjsports-2015-095054>
 30. Nigg, B. M., Subramaniam, A., & Matijevich, E. S. (2022). Towards a biomechanical understanding of performance improvement with advanced running shoes. *Footwear Science*, 14(3), 133–137. <https://doi.org/10.1080/19424280.2022.2127543>
 31. Ortega, J. A., Healey, L. A., Swinnen, W., & Hoogkamer, W. (2021). Energetics and Biomechanics of Running Footwear with Increased Longitudinal Bending Stiffness: A Narrative Review. *Sports Medicine*, 51(5), 873–894. <https://doi.org/10.1007/s40279-020-01406-5>
 32. Pedisic, Z., Shrestha, N., Kovalchik, S., Stamatakis, E., Liangruenrom, N., Grgic, J., Titze, S., Biddle, S. J. H., Bauman, A. E., & Oja, P. (2019). Is running associated with a lower risk of all-cause, cardiovascular and cancer mortality, and is the more the better? A systematic review and meta-analysis. *British Journal*

- of Sports Medicine, 54(15), 898–905. <https://doi.org/10.1136/bjsports-2018-100493>
33. Pereira, H. V., Palmeira, A. L., Encantado, J., Marques, M. M., Santos, I., Carraça, E. V., & Teixeira, P. J. (2021). Systematic Review of Psychological and Behavioral Correlates of Recreational Running. *Frontiers in Psychology*, 12, 624783. <https://doi.org/10.3389/fpsyg.2021.624783>
34. Ramsey, C. A., Lamb, P., & Ribeiro, D. C. (2022). Factors Influencing Runner's Choices of Footwear. *Frontiers in Sports and Active Living*, 4, 829514. <https://doi.org/10.3389/fspor.2022.829514>
35. Rodrigo-Carranza, V., González-Mohino, F., Santos-Concejero, J., & González-Ravé, J. M. (2022). The effects of footwear midsole longitudinal bending stiffness on running economy and ground contact biomechanics: A systematic review and meta-analysis. *European Journal of Sport Science*, 22(10), 1508–1521. <https://doi.org/10.1080/17461391.2021.1955014>
36. Stragier, J., Vanden Abeele, M., & De Marez, L. (2018). Recreational athletes' running motivations as predictors of their use of online fitness community features. *Behavior and Information Technology*, 37(8), 815–827. <https://doi.org/10.1080/0144929X.2018.1484516>
37. Tay, C. S., Sterzing, T., Lim, C. Y., Ding, R., & Kong, P. W. (2017). Overall Preference of Running Shoes Can Be Predicted by Suitable Perception Factors Using a Multiple Regression Model. *Human Factors*, 59(3), 432–441. <https://doi.org/10.1177/0018720816681147>
38. Van Alsenoy, K., van der Linden, M. L., Girard, O., & Santos, D. (2023). Increased footwear comfort is associated with improved running economy—a systematic review and meta-analysis. *European Journal of Sport Science*, 23(1), 121–133. <https://doi.org/10.1080/17461391.2021.1998642>
39. Wasli, Z., Abu Bakar, M. F., Mohd Rathi, M. R., & Jimel, C. (2025). Marathon Enthusiasm in Malaysia: An Explanatory Study Using PLS-SEM Analysis. *International Journal of Research and Innovation in Social Science (IJRISS)*, VIII(XI), 1348–1356. <https://doi.org/10.47772/IJRISS>
40. West, A. M., Schönfisch, D., Picard, A., Tarrier, J., Hodder, S., & Havenith, G. (2019). Shoe microclimate: An objective characterisation and subjective evaluation. *Applied Ergonomics*, 78(July 2018), 1–12. <https://doi.org/10.1016/j.apergo.2019.01.010>
41. Xiao, X., Lian, A., Li, Z., & Fan, Y. (2025). Trends and hotspots in running shoe research: a bibliometric study from 2005 to 2024. *Frontiers in Sports and Active Living*, 7(September), 1–16. <https://doi.org/10.3389/fspor.2025.1609141>
42. Yang, J., Ju, F. Y., & Tian, Z. G. (2022). Sports and Social Interaction: Sports Experiences and Attitudes of the Urban Running Community. *International Journal of Environmental Research and Public Health*, 19, 14412. <https://doi.org/10.3390/ijerph192114412>
43. Yusoff, M. H. S., & Wan Pa, W. A. M. (2024). Comparison between Competitive and Non Competitive Runners on Purchasing Style of Running Shoes. *International Journal of Academic Research in Business and Social Sciences*, 14(8), 2740–2756. <https://doi.org/10.6007/ijarbss/v14-i8/22264>