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Research Article

Influence of acute heel pain on functionality, posture and foot health in adolescent basketball players

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HIGHLIGHTS

- Intense heel pain worsened functionality and foot health.
- Mild and moderate heel pain were associated with pronated foot posture.
- Intense heel pain and controls maintained a neutral foot posture.

ABBREVIATIONS

ANOVA	Analysis of Variance
FFI	Foot Function Index
FHSQ	Foot Health Status Questionnaire
FHSQ-Br	FHSQ translated and validated into Brazilian Portuguese
FPI	Foot Posture Index
VAS	Visual Analogue Scale

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BACKGROUND: Injuries to the ankle-foot complex are common in basketball, increasing pain symptoms, especially during the competitive season. However, the impact of this pain on clinical-functional factors such as posture, functionality, and foot health remains unclear.
AIM: To verify the influence of acute heel pain on functionality, posture and foot health in adolescent basketball players.
METHODS: A total of 60 teenage basketball players were divided into four groups: mild pain (n=15), moderate pain (n=15), intense pain (n=15), and a control group (n=15). Assessments included: (1) foot pain evaluation using the Visual Analogue Scale (VAS), (2) foot functionality assessment with the Foot Function Index (FFI) and foot health assessment with the Foot Health Status Questionnaire (FHSQ), and (3) foot posture evaluation using the Foot Posture Index (FPI). One-way ANOVA and Tukey's post-hoc test were used for statistical analysis ($p<0.05$).
RESULTS: Players with intense foot pain exhibited worse outcomes in pain, functionality, and health compared to those with mild or moderate pain and the control group. Regarding foot posture, the intense pain and control groups had a neutral posture, while those with mild and moderate pain displayed a pronated posture.
INTERPRETATION: Intense symptoms were associated with greater pain severity, decreased functionality, and poorer foot health. Additionally, players with mild and moderate pain had a pronated foot posture, whereas those with intense pain and the control group maintained a neutral posture. These findings highlight the need for preventive strategies to manage pain and its impact on foot function in young basketball players.

KEYWORDS: Teenager | Feet | Prone position | Function

INTRODUCTION

Basketball is a sport that demands high physical capacity, characterized by dynamic and repetitive movements such as accelerations, decelerations, jumps, turns, and frequent changes of direction [1]. These actions, often combined with collision contacts, substantially increase the risk of musculoskeletal injuries, particularly in male adolescents during periods of high training intensity and competitive exposure [2,3]. The repetitive mechanical load imposed on the lower kinetic chain requires adequate muscle strength, joint range of motion, balance, and agility to ensure safe execution of sport-specific movements [3]. When these demands exceed tissue capacity, acute pain symptoms commonly emerge as an early clinical manifestation.

In adolescent basketball players, injuries affecting the ankle–foot complex are highly prevalent, especially between 15 and 18 years of age, with reported rates reaching 39.7% [4]. The most frequent injuries include ankle sprains due to inversion mechanisms and fractures of the fifth metatarsal [5]. The occurrence of these injuries has been associated with multiple intrinsic and extrinsic risk factors, such as direct contact with opponents, playing surface characteristics, footwear type, previous injury history, ligament laxity, alterations in joint mobility, and postural characteristics of the feet [6]. In addition, playing position appears to influence static foot posture, with guards tending toward supination and pivots exhibiting greater foot pronation, which may increase susceptibility to specific ankle–foot injuries [1].

Musculoskeletal pain is a frequent symptom in athletic populations and is influenced by complex interactions between physiological, biomechanical, and psychosocial factors. In adolescent athletes, acute pain episodes are common during periods of intensified training or competition and are often tolerated to maintain sports participation [7,8]. This tendency to continue training despite acute pain may mask early signs of tissue overload, potentially leading to clinical and functional alterations along the lower kinetic chain, with negative repercussions on foot function and overall foot health [9].

Foot health is a multidimensional construct encompassing physical, emotional, and social aspects, and it is considered fundamental for optimal sports performance [6]. Alterations in foot health, when unrecognized or inadequately managed, may predispose athletes to musculoskeletal symptoms associated with pain, compromising both performance and general well-being [2]. Evidence suggests that acute pain-related symptoms may influence foot function and are closely associated with static foot posture and sport-specific mechanical demands, particularly in high-intensity sports such as basketball [1,4,5]. However, the relationship between acute heel pain intensity and changes in foot function, static foot posture, and self-reported foot health in adolescent basketball players remains insufficiently explored.

Understanding how acute heel pain intensity is associated with foot-related outcomes is essential to support comprehensive musculoskeletal assessment and to inform preventive strategies aimed at minimizing dysfunctions and symptom progression during the competitive season. Such knowledge may assist health professionals in optimizing screening, monitoring, and evaluation approaches tailored to young athletes. Therefore, the objective of the present study was to investigate the influence of acute heel pain intensity on foot function, static foot posture, and foot health in adolescent basketball players. We hypothesized that athletes reporting higher acute heel pain intensity would exhibit reduced foot function, poorer self-reported foot health, and a higher prevalence of pronated static foot posture compared to those with mild pain or no pain.

METHODS

Study design

This cross-sectional study involved 60 adolescent basketball players who were members of the Club Athlético Paulistano, located in the western region of São Paulo. All participants were assessed during the competitive season. The adolescent basketball players were divided into four groups based exclusively on the intensity of current acute foot pain, measured at the time of assessment using the Visual Analogue Scale (VAS): basketball players with mild acute pain (n = 15), basketball players with moderate acute pain (n = 15), basketball players with intense acute pain (n = 15), and a control group of basketball players without foot pain (n = 15).

Participants

The study procedures were reviewed and approved by the Human Research Ethics Committee (registration number: 5,943,591; CAAE: 67813223.9.0000.0081), in accordance with the Declaration of Helsinki and relevant guidelines and regulations. Prior to participation, all volunteers received detailed information about the study objectives and procedures and were given the opportunity to ask questions before providing written informed consent and assent, as well as parental consent when applicable.

The eligibility criteria included: male and female adolescent basketball players aged between 12 and 18 years, regular basketball practice, minimum training frequency of twice per week, and a minimum of one year of basketball practice [2,10,11]. The presence or absence of acute foot pain was determined at the time of data collection using the Visual Analogue Scale (VAS), which ranges from 0 to 100 millimeters, where 0 represents no pain and 100 represents unbearable pain [13]. Pain was defined as acute, reflecting current symptoms at the moment of assessment, and no classification of pain duration (e.g., subacute or chronic) was applied.

Group allocation was based solely on VAS scores, as follows: control group (VAS = 0); mild pain group (VAS ≤ 30); moderate pain group (VAS between 40 and 70); and intense pain group (VAS > 70). Borderline values were allocated according to the predefined VAS intervals.

Although sections of the Foot Health and Foot Function Questionnaire include questions referring to symptoms experienced over previous periods, these instruments were used only to characterize self-reported foot health and function and were not employed for pain classification or group allocation.

The exclusion criteria were: history of drug infiltration in the feet or ankles, symptomatic musculoskeletal disorders of the lower limbs, neurological diseases affecting the central or peripheral nervous system, fractures related to congenital diseases within the last six months, vestibulocochlear disorders, neoplastic diseases, active infectious processes, cardiac arrhythmias and/or uncontrolled respiratory symptoms, convulsive or neurological syndromes, diabetic neuropathy, osteoarthritis, rheumatoid arthritis, previous lower limb surgery or planned surgery within the following 12 months, intellectual disability, and any functional limitation requiring the use of an orthosis for locomotion, in order to avoid bias in the interpretation of the assessments performed [12].

Initial assessment

The initial assessment questionnaire was applied to collect information on anthropometric characteristics (age, height, body mass and body mass index) and basketball practice (time and frequency of training, as well as years of practice and musculoskeletal injuries).

Assessment of static foot posture

Assessment of static foot posture was performed using the foot posture index (FPI) [14]. This clinical diagnostic tool quantifies the degree to which the foot can be considered supinated, pronated, or normal. Assessments were made by a trained and experienced physiotherapist (2 years) who assigned values to a series of observations made for the hindfoot, midfoot and forefoot. Positive values (+2) were assigned to indicate a pronated standing posture, while negative values (–2) indicated a supine standing posture and a value of 0 indicated a neutral foot posture [15]. Basketball players were always positioned on a straight and symmetrical floor, and a 7.5 cm piece of vinyl acetate was used to keep their feet apart at a standardized distance; basketball players also held their arms at their sides and looked toward the horizon while standing still [14,15].

Assessment of foot functionality and health

Foot functionality was assessed using the foot function index (FFI) [16]. The instrument validated for Brazilian Portuguese contained 23 items about the impact of a disability on the feet. The items were divided into three domains: foot pain (nine items), difficulty (nine items) and functional limitation (five items). Each item was measured using a VAS from 0 to 10 cm. To obtain the score for each domain, the values were added and divided by the number of questions answered. The final score was obtained by adding the three domains and dividing the result by the number of domains. The score ranged from 0 to 10, and the higher the number, the worse the impact of the disability on the feet [16,17].

Foot health was assessed using the Foot Health Status Questionnaire (FHSQ), translated and validated into Brazilian Portuguese (FHSQ-Br) [18]. The instrument contained 29 questions, which were divided into 3 sections. Foot health was assessed in the first section according to four domains: foot pain, function, footwear and general foot health. Section II assessed general health status in the following domains: general health, physical activity, social capacity and vigor. Section III discussed the general demographics of basketball players. The score was calculated, scores ranged from 0, the worst foot health, to 100, the best condition [16,18].

Statistical Analysis

All statistical analyses were performed using SPSS Statistics version 24 (IBM, Chicago, IL, USA). Descriptive statistics for quantitative data were expressed as mean and standard deviation. Data normality was checked using the Shapiro-Wilk test and homogeneity of variances between groups was verified using Levene's test.

To compare the measurements of the independent variables between the groups of basketball players with and without pain symptoms, one-way Analysis of Variance (ANOVA) was used for independent measures, followed by Tukey's post-hoc analysis. For all analyzes significant differences were considered with $p<0.05$.

RESULTS

The anthropometric variables for age, height, body mass, body mass index, training frequency and practice time did not show statistically significant differences between the groups of adolescent basketball players. Only the pain symptom in the feet showed significant differences between the groups of adolescents playing basketball, as shown in Table 1.

Table 2 shows that the foot posture index assessed by the FPI of the group of basketball players with mild and moderate foot pain presented a foot posture with a tendency to pronation. When compared to the group of basketball players with intense foot pain and the control group, their feet posture tended to be neutral ($p<0.001$).

Table 3 presents that the functionality of the feet assessed using the FFI showed worsening for all groups, whereas the group of basketball players with intense foot pain showed worsening in functionality when compared to the group of basketball players with mild and moderate foot pain, as well as to the control group ($p<0.001$).

Table 4 shows that foot health assessed using the FHSQ showed worsening of foot health for all groups, with the group of clubbing practitioners with severe foot pain showing worsening in foot health when compared to the group of clubbing practitioners with mild and moderate foot pain, as well as to the control group ($p<0.01$).

Table 1. Mean, standard deviation and comparisons between the different groups of foot pain: mild, moderate and intense with the control group in the variable's anthropometric characteristics, training frequency, practice time and pain symptoms.

Anthropometric variables	Group of mild pain (n=15)	Group of moderate pain (n=15)	Group of intense pain (n=15)	Control Group (n=15)	p
Age (years)	15.0±1.0	14.0±0.9	14.1±0.7	1.6±1.6	0.136
Stature (m)	1.79±0.9	1.73±0.8	1.77±0.7	1.71±0,3	0.361
Body Mass (kg)	69.3±1.8	66.9±2.6	66.0±2.3	59.6±2.9	0.103
Body Mass Index (kg/m²)	21.5±2.2	22.0±3.4	21.0±2.7	20.0±3.1	0.499
Practice time (years)	3.9±1.9	3.2±2.2	3.1±2.1	3.0±1,9	0.437
Training Frequency (h/week)	4.9±0.2	4.7±0.7	5.0±0.3	4,6±0.8	0.328
Pain (VAS)	2.0±0.4	4.3±0.4	7.4±1.2	0,3±0,2	<0.001*

* One-way ANOVA test, considering statistical differences p<0.05.

Table 2. Mean, standard deviation and comparisons between the different groups of foot pain: mild, moderate and severe with the control group in changes in foot posture, assessed by the foot posture index (FPI).

Foot Posture Index - FPI	Group of mild pain (n=15)	Group of moderate pain (n=15)	Group of intense pain (n=15)	Control Group (n=15)	p
Total score (right)	6.0±1.3	6.4±1.5	4.4± 2.6	5.1±1.7	<0.001*
Total score (left)	6.6±1.2	5.9±2.6	4.8±2.8	5.0±1.5	<0.001*

* One-way ANOVA test, considering statistical differences p<0.05.

Table 3. Mean, standard deviation and comparisons between the different groups of foot pain: mild, moderate and severe with the control group in terms of foot functionality, assessed by the foot function index (FFI).

Foot Function Index - FFI	Group mild pain (n=15)	Group of moderate pain (n=15)	Group of intense pain (n=15)	Control Group (n=15)	p
Pain	2.0±0.4	4.3±0.4	7.4±1.2	0.3±0,2	<0,001*
Function	1.4± 0.81	2.1± 0.94	2.4±1.3	0.95±0.4	0.008*
Limitation of activities	1.6± 0.7	2.0± 1.0	3.0±1.2	0.37±0.7	<0.001*
Total Score	1.3± 0.8	1.7± 0.8	2.5±0.4	0.6±0.3	<0.001*

* One-way ANOVA test, considering statistical differences p<0.05.

Table 4. Mean, standard deviation and comparisons between the different groups of foot pain: mild, moderate and severe with the control group in foot health, assessed by the foot health status questionnaire (FHSQ).

Foot health Status Questionnarie - FHSQ	Group of mild pain (n=15)	Group of moderate pain (n=15)	Group of intense pain (n=15)	Control Group (n=15)	p
Foot pain	2.0±0.4	4.3±0.4	7.4±1.2	0,3±0,2	<0.001*
Foot functionality	2.1± 0.3	2.5± 1.5	2.8±0.8	1.3±0.3	<0.001*
Shoes	3.9±0.9	3.9±1.3	3.8±1.0	1.5± 0.4	<0.001*
General health	1.0± 0.6	1.2± 0.1	1.1±0.3	1.0±0.1	0.308
Foot health	2.3±0.7	3.3±0.9	3.7±1.1	1.4±0.6	<0.001*
Current health	2.8±0.1	2.8±0.2	2.9±0.1	1.5±0.2	<0.001*
Sociability	1.4± 0.8	1.7± 0.8	2.5±0.4	0.6±0.3	<0.001*
Vigor	1.4± 0.8	1.7± 0.8	2.5±0.4	0.6±0.3	<0,001*
Total	1.4± 0.8	1.7± 0.8	2.5±0.4	0.6±0.3	<0,001*

* One-way ANOVA test, considering statistical differences p<0.05.

DISCUSSION

The present study aimed to examine the influence of acute heel pain intensity on foot function, static foot posture, and foot health in adolescent basketball players. The results indicated that basketball players reporting mild and moderate acute pain more frequently presented a pronated static foot posture, whereas those with intense acute pain and the control group predominantly exhibited a neutral static foot posture. In addition, acute heel pain intensity appeared to influence self-reported foot health, which was more impaired in athletes with intense pain compared to those with mild or moderate pain and those without pain.

Foot posture has been widely investigated in basketball practice due to its relationship with musculoskeletal injury patterns [1,6,19]. In the present study, assessment using the FPI indicated that acute heel pain intensity may influence static foot posture, particularly in athletes reporting mild and moderate pain, who showed a greater prevalence of pronation. This influence should be interpreted as an association observed within a cross-sectional design and not as evidence of a direct causal mechanism. Previous evidence, such as the study by Lopezosa-Reca et al. [1], suggests that foot pronation in basketball players, especially pivots is strongly influenced by sport-specific mechanical demands and prolonged static positioning during gameplay, rather than pain itself. Therefore, the influence observed in the present study likely reflects the interaction between acute pain symptoms and pre-existing sport-related postural characteristics. Similar influences of sport-specific demands on static foot posture have also been reported in other modalities, such as running, although with discipline-specific characteristics [19].

Although this study did not directly assess injury mechanisms or biomechanical risk factors, the findings suggest that acute heel pain may influence plantar load distribution and static foot posture as a short-term adaptive response. Athletes with mild and moderate acute pain tended to present a pronated posture, which may represent a transient compensatory strategy influenced by discomfort during weight-bearing activities [9]. Conversely, in athletes with intense acute pain, the predominance of a neutral posture may reflect a different protective strategy, potentially aimed at minimizing pain during stance and gait, as suggested by Horii et al. [20]. These interpretations remain hypothetical and should be considered cautiously, highlighting the need for biomechanical studies specifically designed to investigate how acute pain influences foot posture and loading patterns.

Another relevant finding relates to foot function, which was negatively influenced by acute heel pain intensity. Athletes reporting pain demonstrated lower functional scores, suggesting that acute pain may influence the execution of functional activities, affecting both sports participation and daily living tasks [21]. However, due to the cross-sectional nature of the study, the direction of this influence cannot be determined. These results reinforce the importance of monitoring foot function in adolescent basketball players, particularly during periods of increased training load.

In addition, the present study demonstrated that acute heel pain exerted an influence on self-reported foot health, especially in domains related to general health and social interaction. These findings suggest that even acute pain episodes may influence perceived well-being and social aspects of foot health. Pain in athletes is recognized as a multifactorial phenomenon influenced by physical, psychological, and social factors [22]. Although biopsychosocial variables were not directly assessed, they may partially contribute to how acute pain influences functional performance and self-perceived health in athletic populations [8].

Overall, the results highlight that acute heel pain may influence multiple dimensions of foot-related outcomes, including static foot posture, foot function, and self-reported foot health. These influences should be interpreted within the limits of an observational cross-sectional design, without inferring causality. Health professionals may use this information to support early identification and monitoring of athletes experiencing acute heel pain, rather than to predict injury risk or long-term consequences.

Some limitations of this study should be acknowledged. The absence of instruments designed to assess psychological or behavioral factors limits the understanding of how these variables may influence pain perception and foot health. In addition, the cross-sectional design precludes conclusions regarding temporal or causal influences between acute pain, foot posture, and function. Future studies should adopt longitudinal designs and include biomechanical and biopsychosocial measures to better clarify how acute heel pain influences foot-related outcomes over time in adolescent basketball players.

CONCLUSION

Basketball players with intense acute heel pain showed poorer foot function and self-reported foot health than players with mild or moderate pain and those without pain. Regarding static foot posture, athletes with intense pain and those in the control group predominantly exhibited a neutral posture, whereas players with mild and moderate acute pain more frequently presented a pronated static foot posture.

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