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Navicular Drop Height Asymmetry as an Intrinsic Risk Factor for Lower Limb Injury in Male Recreational Athletes

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Abstract: Morphological and functional asymmetry of the lower limbs is a well-recognized factor contributing to musculoskeletal injuries among athletes across different levels. However, limited research exists on evaluating foot mobility asymmetry as a potential predictor of such injuries. This study aimed to (1) assess the frequency of foot mobility asymmetries among amateur athletes, (2) investigate the predictive value of foot mobility asymmetry (measured via navicular height drop) for injury risk, and (3) explore the relationship between foot type and injury occurrence. A cross-sectional sampling method was employed to select 45 physically active male amateur athletes (runners and team sports practitioners) from a university. Injury history was retrospectively recorded, and a modified navicular drop test was conducted to classify foot arch height. The predictive power of navicular height drop asymmetry was analyzed using ROC curves, and the relationship between foot type (neutral and defective combinations—pronated or supinated) and injury occurrence was examined using chi-square tests for independence. Multiple logistic regression was applied to calculate injury risk odds ratios across different foot type subgroups. The results revealed a significant frequency (51.1%) of participants with at least one defective foot, including 31.1% with one neutral and one defective foot and 20% with both feet defective. Navicular height drop asymmetry emerged as a valuable predictor of injuries, with a 36% asymmetry identified as the cut-off for increased injury risk (AUC = 0.832, 95% CI: 0.691–0.973, $p < 0.001$). A significant relationship was found between foot type and injury occurrence. Only one out of 22 participants with neutral feet (4.55%) experienced an injury, compared to 9 out of 14 (64.29%) with one neutral and one defective foot and 5 out of 9 (55.56%) with both feet defective. These differences were statistically significant ($\chi^2 = 16.24$, $p < 0.001$, Cramer's V = 0.60). The odds ratio for injury risk was 37.8 ($p = 0.016$) for those with asymmetry (one neutral and one defective foot) and 26.3 ($p = 0.102$) for those with both feet defective, compared to participants with both feet neutral. In clinical practice, these findings suggest that routine screenings for physically active individuals should incorporate foot mobility asymmetry assessment. However, it is essential to integrate this factor with other risk indicators. For individuals exhibiting high asymmetry, general foot defect correction programs may be beneficial, but injury prevention strategies should adopt a more comprehensive approach, focusing on overall fitness and tailored interventions for high-risk individuals.

Keywords: amateur athletes; physical activity; injury; navicular drop height; asymmetry; injury prediction; ROC curve

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1. Introduction

The human foot is designed to efficiently absorb shocks, acting as the initial element in the lower limb's shock absorption chain. This function is primarily supported by the foot's arch structure, which consists of both transverse and longitudinal arches. Of these, the medial longitudinal arch is the most crucial, as it absorbs impact and transfers energy during activities like walking, running, and jumping [1]. The functional efficiency of the foot arches is influenced by the individual bone structure, ligament integrity, and the strength of the calf and foot muscles [2]. All these elements determine the foot's mobility, defined by the vertical displacement of the medial arch between the resting position and under load [3]. Mobility is largely influenced by the position of the medial longitudinal arch, which varies among individuals. We can categorize foot types into three groups: neutral, low-arched (LA)—commonly referred to as flat or pronated foot—and high-arched (HA), associated with supination. Both LA and HA can pose potential risk factors due to their impact on mobility [4,5]. Although various factors contribute to injury occurrences, abnormal foot mobility significantly affects lower limb biomechanics and is directly linked to injury risks [6–9].

Injury occurrence is defined as complaints experienced during physical activity that result in pain and discomfort in the locomotor system, leading to temporary limitations or a complete inability to continue physical activity [10]. Both low-arched (LA) and high-arched (HA) individuals are at similar risk of injury, although LA individuals typically have more mobile feet than HA individuals [11]. Studies have confirmed that players with pronated (flat) or supinated feet have a higher risk of injury compared to those with neutral feet [4,5,11]. A pronated (planus) foot places a greater load on the medial aspect, while a supinated foot places increased stress on the lateral structures, indicating different potential injury types. Furthermore, these medial and lateral loads can be transmitted throughout the entire lower extremity, affecting knee structure and function, which may further elevate the risk of injury [12].

The arch condition in the same individual can vary between the right and left foot, leading to significant asymmetry. This asymmetry can become more pronounced after prolonged running efforts, as confirmed by studies on long-distance runners. Research by Fukano et al. (2021) showed that full marathon running induced increasing asymmetry, resulting in a lower medial longitudinal arch in runners [13]. Such asymmetry may result from the natural difference associated with the dominance of one limb, but it may also be the effect of training adaptations [14,15]. The research findings on the relationships between morphological and functional asymmetry and injury risk remain consistently inconclusive. On one hand, there is substantial evidence suggesting that asymmetry does not pose a significant injury risk [16,17]. Evidence was also presented in a systematic review [18]. In this review, overall, a moderate to lower quality of evidence for functional asymmetry as a risk factor for injury in sports was observed. Some studies also suggest that asymmetry may contribute to better performance in certain motor tasks [19,20].

Nevertheless, a large number of studies document that interlimb asymmetry may increase the risk of injury. Any alterations in the foot arch seem to indicate a potential foot defect, as well as pain and dysfunction in the musculoskeletal system [21]. However, the human body is lateralized, which causes natural asymmetry. The preferred side is often more exploited and loaded [22,23]. Regular sports practice may exacerbate asymmetries, particularly in the musculature of the dominant limb [24]. Increases in inter-limb asymmetries, referring to both the imbalance and deficits between limbs as a result of training, have been previously reported [25]. The relationship between asymmetries and injuries is typically two-directional: asymmetry may lead to injury, while an injury can negatively affect the injured limb, resulting in morphological and functional asymmetry.

The aforementioned studies primarily identified the determinants of injuries by focusing on the differences between the two feet. However, there is a lack of research addressing the differences in foot mobility, which can lead to mobility asymmetry. To date, and to the best of the author's knowledge, no studies have examined foot mobility asymmetry (measured by navicular height drop) as a potential intrinsic risk factor for lower limb injuries. Therefore, this study aimed to (1) assess the frequency of foot mobility asymmetries among amateur athletes, (2) investigate the predictive value of foot mobility asymmetry (measured via navicular height drop) for injury risk, and (3) explore the relationship between foot type and injury occurrence.

2. Materials and Methods

2.1. Ethics

Examinations were conducted in accordance with the Declaration of Helsinki, and the study protocol was approved by the ethics committee of Wroclaw University of Health and Sport Sciences (consent number 13/2022, date of approval: 28 March 2022). All participants provided their informed consent for inclusion prior to participating in this study. Each participant was informed about this study's purpose, the principles of participation, and their right to withdraw at any stage of the research. Additionally, participants were informed about their access to individual measurement results and their interpretation.

2.2. Sample Size

The sample size for the ROC analysis was calculated using the pROC R package (Version 1.18.5) [26]. Based on a total power of 80% (1—beta), an alpha level of 0.05, an area under the ROC curve (AUC) of 0.75, a null hypothesis value of 0.5, and a ratio of positive events (injury incidents) to negative events (absence of injury) of 1:2, this study required a total sample size of 45 participants.

2.3. Study Design

A cross-sectional design was employed as the sampling method. Additionally, ex-post retrospective registration of injury incidents was utilized. Examinations were conducted in 2024 at Wroclaw University of Health and Sport Sciences among first- and second-year students in the fields of Physical Education and Sport.

2.4. Participants

The invitation to participate in this study was sent to 116 male students. Considering the exclusion criteria—(1) injury history shorter than three months prior to the test, (2) deformity or lower limb surgery, and (3) pain in any part of the body that might affect the navicular drop test (stand-up for the chair)—a total of 87 respondents were enrolled to the next stage of recruitment. In addition, inclusion criteria were introduced—(1) first or second year of study with no repetitions, (2) enrollment in the Physical Education and Sport fields, (3) engagement in running or team sports as the primary physical activity, and (4) voluntary consent to participate in the research. Finally, a total of 45 participants were included in this study. The flowchart (Figure 1) presents the complete sampling procedure.

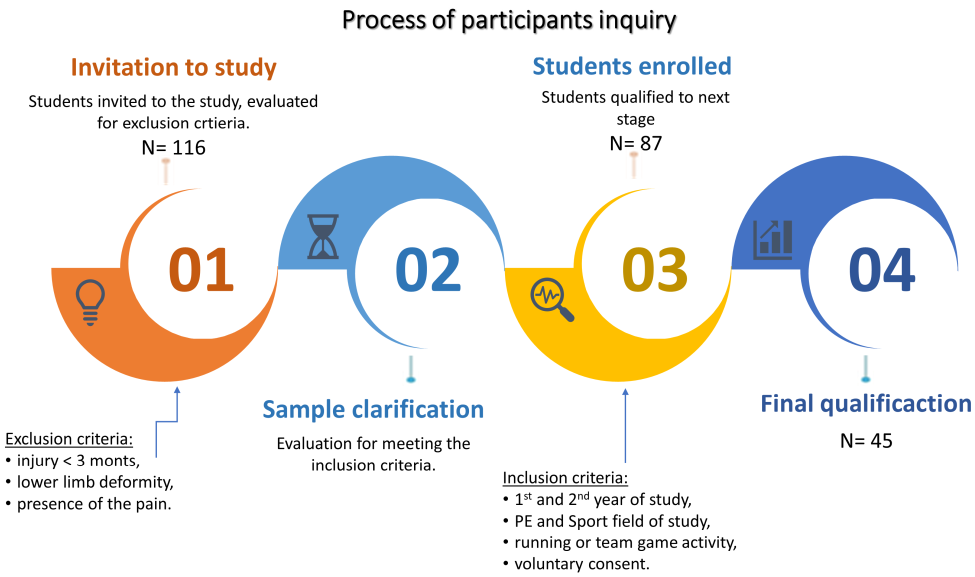

Figure 1. Flowchart: study design and data collection.

2.5. Procedure

All measurements were conducted simultaneously for each participant between 8:00 and 11:00 a.m. during breaks between academic lectures. The sequence of measurements remained constant throughout the process. All measurements were performed independently by the author of this article.

2.5.1. Anthropometric Measurements

Body height and body weight were measured using an anthropometer (SECA, Hamburg, Germany; quality control number C-2070) and the InBody230 body mass analyzer (InBody Co. Ltd., Cerritos, CA, USA), respectively. Body mass index (BMI) was calculated using the following formula:

$$\text{BMI [kg/m}^2\text{]} = \text{body weight [kg]/body height}^2\ \text{[m}^2\text{]}$$

2.5.2. Recording Injuries—Injury History Questionnaire (IHQ)

Musculoskeletal injuries were recorded to calculate injury frequency, with a focus on foot and knee injuries. The Injury History Questionnaire (IHQ) was utilized, and a detailed description of this tool has been presented elsewhere [27]. The authors assessed the IHQ as a reliable and valuable instrument, which was confirmed by a Cronbach's alpha coefficient of 0.836.

2.5.3. Sit-to-Stand Navicular Drop Test (SSNDT)

The mobility of the foot test, known as the navicular drop test (NDT), was originally developed by Brody [28]. In this study, a modified version of the original NDT, referred to as the sit-to-stand navicular drop test (SSNDT), was utilized [29]. This test measures the difference in navicular height (NH) between a subtalar neutral position and a weight-bearing position. Based on the results, the type of foot can be classified as follows: supinated foot (<5 mm), neutral foot (5–9 mm), and pronated foot (10–15 mm) [29].

The author of this article, a human anatomy teacher trained in practical and functional anatomy and palpation, conducted an intra-rater reliability test with a different group, which was published elsewhere [30]. The reliability of intra-rater measurements during within-day test–retest evaluations was assessed using the ICC(3.1) model, resulting in a good quality range of classification (ICC = 0.82, 95% CI: 0.55–0.919, F = 9.18, $p < 0.0001$).

At the beginning of the measurements, the navicular tuberosity was identified and marked with a black hypoallergenic marker on both feet of the barefoot, sitting participant. The neutral position of the subtalar joint was determined through palpation. A blank, stiff paper card was placed on the medial side of the foot, with the navicular tuberosity marked using a ruler. Navicular height (NH) was measured in a standing position, with one foot placed on a medical scale and the other on a support of equal height to the scale's platform. The participant was instructed to load the measured foot with 80% of their body weight. The height of the navicular tuberosity was marked on the card, and the sit-to-stand navicular drop test (SSNDT) was calculated as the difference between the height at rest and the height in the standing position. The SSNDT was found to be more reliable (ICC = 0.73 to 0.96) than the original variant (ICC = 0.37 to 0.68) [29]. The classification of the SSNDT was based on Brody [28]: supinated foot (<5 mm), neutral foot (5–9 mm), and pronated foot (10–15 mm). Participants were divided into three groups: both feet neutral, one foot neutral and the other not (either pronated or supinated), and both feet not neutral. This categorization was subsequently used in multiple logistic regression analysis.

2.6. Asymmetry Calculations

The standardized absolute asymmetry (AA) was calculated for the inter-foot navicular height drop. The AA score is a measure that does not consider the directionality of the asymmetry and is calculated as follows [31]:

$$AA = (|R - L|)/(1/2 \times (R + L)) \times 100$$

The result is an absolute value that represents the degree of asymmetry without indicating its direction. The classification of the AA was based on Auerbach [31]: 0–5% indicates low or negligible asymmetry, 5–10% indicates moderate asymmetry, and >10% indicates high asymmetry. High asymmetry may suggest potential biomechanical imbalances, an increased risk of injury, and structural abnormalities.

2.7. Statistics

The Shapiro–Wilk test was used to evaluate the normality of data distribution for the anthropometric measurements and the sit-to-stand navicular drop test (SSNDT), including the absolute asymmetry (AA). Descriptive statistics were presented as means, 95% confidence intervals of the mean (95% CIs), and standard deviations (SDs). The binary outcome (injuries) was presented as both numbers and percentages.

The chi-square goodness-of-fit test was employed to determine whether the frequency distribution of a binary variable differed from expectations, while the chi-square test of independence was used to study the relationship between injury occurrence and participants' foot type (categorical variable: both neutral, at least one neutral, both not neutral). The receiver operating characteristic (ROC) curve method was utilized to assess the performance of SSNDT asymmetry in detecting the risk of injury and establishing thresholds. Multiple logistic regression was conducted to compare the risk of injury among three subgroups: (a) both neutral (nn), (b) one neutral and one foot with a defect (pronated or supinated) (nd), and (c) both feet with defects (dd).

A p-value of < 0.05 was considered statistically significant. Calculations were carried out using Statistica 13.0 (StatSoft Poland, 2018, Cracow, Poland) and RStudio (PBC, Boston, MA, USA, http://www.rstudio.com/, accessed on 4 September 2024).

3. Results

The Shapiro–Wilk test was performed and indicated that the distribution of all continuous variables did not significantly depart from normality ($p > 0.05$). Table 1 presents descriptive statistics for anthropometric measurements and SSNDT results (including the absolute asymmetry index) for recreational athletes.

Table 1. Descriptive statistics of the anthropometric measurements and ICC results for SSNDT.

Measurement	Overall				Not Injured				Injured				
	Mean	95%CI		SD	Mean	95%CI		SD	Mean	95%CI		SD	*p*
Age [y]	20.50	20.19	20.80	1.01	20.36	19.95	20.76	1.09	20.78	20.33	21.22	0.80	0.193
Body height [cm]	185.02	182.96	187.08	6.85	184.60	182.15	187.05	6.57	185.86	181.68	190.04	7.55	0.567
Body weight [kg]	77.99	75.53	80.45	8.18	78.16	75.30	81.02	7.65	77.66	72.43	82.88	9.43	0.849
BMI [kg/m^2]	22.74	22.30	23.18	1.47	22.89	22.43	23.36	1.24	22.43	21.41	23.45	1.84	0.322
Foot length—right [cm]	26.82	26.32	27.31	1.66	26.72	26.07	27.37	1.74	27.00	26.15	27.85	1.54	0.604
Foot length—left [cm]	26.94	26.44	27.45	1.67	26.85	26.20	27.50	1.74	27.13	26.27	28.00	1.57	0.598
SSNDT—right [mm]	8.12	7.21	9.02	3.02	7.57	6.72	8.42	2.28	9.21	7.00	11.42	3.99	0.084
SSNDT—left [mm]	7.69	6.92	8.47	2.58	7.48	6.71	8.25	2.06	8.11	6.20	10.01	3.44	0.451
AA-SSNDT [%]	24.83	18.55	31.11	20.92	15.75	11.82	19.69	10.53	42.98	29.24	56.72	24.82	<0.001

Footnote: BMI—body mass index, SSNDT—sit-to-stand navicular drop test, AA-SSNDT—absolute asymmetry index for SSNDT.

The studied group is internally consistent in terms of age and anthropometric measurements, as confirmed by the standard deviations. The average BMI value falls within the normal body weight category. The navicular drop test places the average participant in the neutral foot category for both the right and left feet; however, the standard deviations indicate significant variability in the results, highlighting individual differences. Asymmetry was the most variable measure, indicating substantial inter-individual differences. There were no statistically significant differences ($p > 0.05$) between both groups (not injured and injured), except asymmetry in navicular height drop ($p < 0.001$).

Out of 15 men who suffered from musculoskeletal injuries, 12 participants (26.7%) reported injuries to the right lower limb, while 5 participants (11%) indicated injuries to the left lower limb. Two participants (2.4%) reported injuries to both feet.

An analysis of foot types revealed that 22 individuals (48.9%) had both feet classified as neutral, 14 individuals (31.1%) had one neutral foot and one with a defect (either pronated or supinated), and 9 individuals (20%) had both feet with defects. Regarding the right foot, 26 individuals (57.8%) were characterized by a neutral foot, 14 (31.1%) by pronation, and 5 (11.1%) by supination. In contrast, for the left foot, the counts and percentages were as follows: 31 individuals (68.9%) neutral, 10 (22.2%) pronated, and 4 (8.9%) supinated.

The next step of the analysis was to assess the performance of the absolute asymmetry of SSNDT in predicting the risk of injuries. ROC curves were generated, and the area under the curve (AUC), along with accompanying statistics, was calculated. The results are presented in Table 2. As shown, the performance of the AA-SSNDT in detecting the risk of injury is highly effective, with an AUC of 0.832, which is statistically significant ($p < 0.001$). The calculated cut-off point for the percentage of asymmetry at which the risk of injury increases was 36%. The ROC curve is presented graphically in Figure 2.

Table 2. Cut-off points (Youden) and respective areas under the curve (AUC) for sit-to-stand navicular drop test asymmetry (AA-SSNDT).

Cut-Off Point	Youden Index	AUC	SE	95% CI		*p*
36	0.63	0.832	0.072	0.691	0.973	<0.001

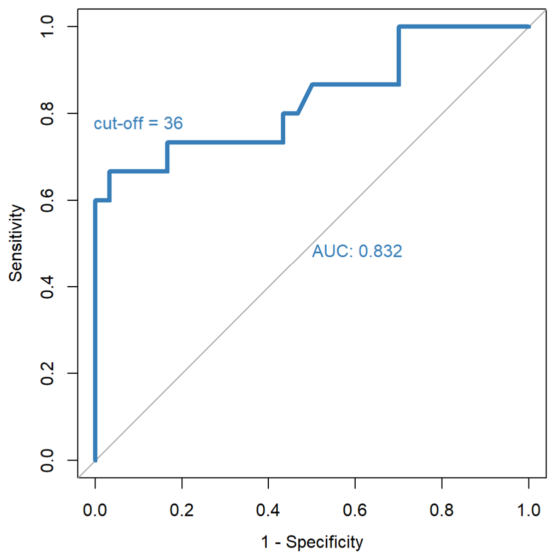

Figure 2. The receiver operating characteristic curve for AA-SSNDT.

The final part of the analysis involved comparing the risk of injury among subgroups with different foot types. Three subgroups were identified: both feet neutral (nn), one foot neutral and the other with a defect (either pronated or supinated) (nd), and both feet with defects (dd). The proportions of participants from these subgroups within the injury categories are presented in Figure 3.

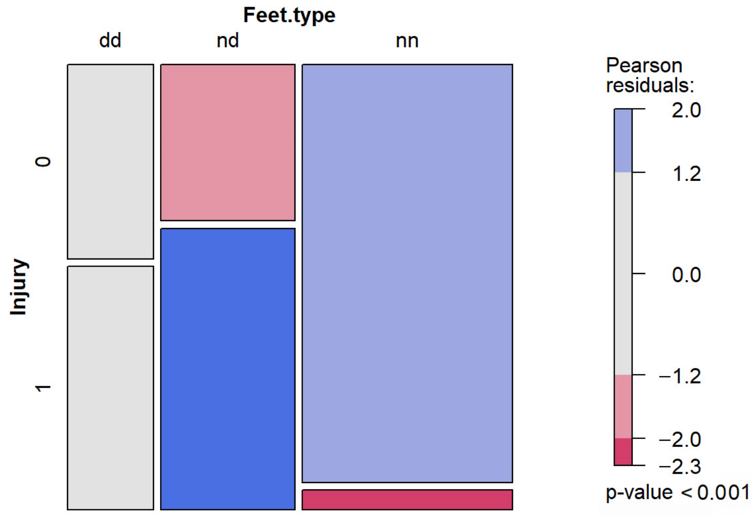

Figure 3. Mosaic plot presenting proportions of the injured and not injured participants from three subgroups: both feet neutral (nn), one foot neutral and second defective (nd), and both feet defective (dd).

Among the 22 nn participants, only one (4.55%) suffered from a musculoskeletal injury. In the nd group, 9 out of 14 participants (64.29%) reported injuries, while, in the dd group, 5 out of 9 participants (55.56%) suffered injuries. The differences between groups were statistically significant, as confirmed by the chi-square test of independence ($\chi^2 = 16.24$, $p < 0.001$, Cramer's V = 0.60).

Multiple logistic regression was then employed to calculate the odds ratio for injury risk among the subgroups, with the nn participants serving as the reference group. The Wald statistic (W = 10.03, $p = 0.007$) confirmed a significant influence of the foot type variable in explaining the risk of injury among the subgroups. Both subgroups with foot defects exhibited a significantly higher risk of injury compared to the nn group. Specifically, for individuals with one neutral foot and one defective foot (nd), the odds ratio (OR) was 37.8 ($p = 0.016$), while, for those with both feet defective (dd), the OR was 26.3 ($p = 0.102$) compared to participants with both feet neutral.

4. Discussion

The findings of this study showed that asymmetry in foot mobility, characterized by one foot being neutral and the other having a defect, was observed in 31.1% of participants, while 48.9% had both feet classified as neutral, and 20% had defects in both feet. Absolute asymmetry in foot mobility (the difference in navicular height drop between the right and left foot) was found to be a strong predictor of injury, confirming its potential in detecting injury risk. There is a significant relationship between foot type (both neutral, one neutral, and one defective, or both defective) and injury occurrence. Amateur athletes with asymmetry, where one foot is neutral and the other has a defect, have over 30 times the risk of injury compared to individuals with both feet neutral and an even higher risk than those with both feet exhibiting pronation or supination.

The frequency of athletes with neutral feet in comparison to other foot types aligns closely with the results reported by Algaba-Del-Castillo et al. (2023), who found neutral feet in 50% of amateur athletes, while pronation was observed in 13.3% and supination in 36.7% [32]. However, that study did not provide information about the combinations of foot types. In contrast, the present study combined pronation and/or supination of each foot into a common subgroup referred to as "defective feet", making direct comparison unavailable. Nonetheless, the occurrence of both feet being defective (pronated or supinated) observed in this study is consistent with rates found in youth populations, both those that are physically inactive and those that are active [33,34]. Additionally, the presence of both defective feet was found to be more frequently associated with injuries than having just one defective foot. Injuries were more common in individuals with supinated feet (30.08%) compared to 20.7% for pronated feet and 19.8% for neutral feet [34]. These proportions are also consistent with findings from other studies [35,36]. An important consideration is whether foot defects in adulthood are permanent or subject to change, which could potentially reduce the risk of injuries. Research by Kim et al. and Sulowska-Daszyk et al. suggests that, once a deformity has been established and maintained for an extended period, it is unlikely to change [37,38].

The main aim of the present study was to evaluate the relationship between navicular height drop asymmetry (assessed with the sit-to-stand navicular drop test, SSNDT) and injury, specifically focusing on the performance of the asymmetry index in predicting injuries. The SSNDT's ability to predict the risk of lower limb injuries has been demonstrated in numerous studies across various sports disciplines [11,30,39]. The use of the ROC curve method has proven effective for identifying injury risk for each foot, establishing threshold points at specific values [40]. Most studies indicate that a pronated foot position correlates with an increased risk of injury [30,41]. Some studies attempt to explain this phenomenon, suggesting that possible mechanisms related to musculoskeletal injuries could include low muscular strength of the calf muscles, which are responsible for supporting the medial arch, as well as reduced neuromuscular coordination [42]. This study, utilizing ROC curve analysis, revealed a valuable and reliable cut-off point of 36% absolute asymmetry, indicating an increased risk of injuries (AUC = 0.832, $p < 0.001$). However, the unique methodology employed for assessing asymmetry in foot mobility and the ROC curve approach limits direct comparisons of our findings with other studies due to the scarcity of similar analyses.

Foot mobility symmetry is an essential component of proper body posture and plays a significant role in the effectiveness of sports tasks. This influence is manifested in various ways, particularly through its relationship with proper movement patterns, which directly impact agility, speed, and coordination [43]. The results of the present study align with several other works. Tenriwulan et al. (2021) reported significant differences in navicular drop height between sides during foot rotation in both healthy runners and those with a history of lower limb injuries (24% and 30.5%, respectively) [44]. The primary factor related to the navicular height drop appears to be injury, which significantly alters the normal range of the drop, identified as being between 1.5% and 4.0% between both feet [45]. In this study, the observed difference was even smaller; however, this included the entire group, comprising healthy and injured participants, as well as those with neutral and defective feet. Nevertheless, the findings of this study contrast with previous research [46,47], which reported no significant side-to-side kinetic differences between injured and non-injured runners.

In the present study, recurring injuries were not examined. Such analyses are, however, lacking. Future research should include analyses to determine whether an injury caused a reduction in foot mobility, which in turn may have led to a subsequent injury. These analyses must account for a continuous study design and the recording of injuries after the measurements (prospective injury recording).

The practical value of this study on lower limb asymmetry and its relationship with injuries is significant, particularly given the prevalence of sports participation among amateur athletes engaged in running and team sports. From a practical perspective, our results suggest that foot mobility asymmetry is not only a factor related to injuries but may also impact the efficiency of various sports tasks, such as reactive agility and change of direction speed, as supported by other studies. Biomechanical research indicates that preplanned change-of-direction movements place less load on the knee compared to reactive movements requiring sidestepping, thereby reducing the risk of lower limb injuries [48–50]. In contrast, factors that increase injury risk include unplanned one-leg landings, sudden jumps, or lateral slides. These behaviors are associated with a lower center of gravity, increased knee flexion, and the control required for stopping movements. The mechanistic explanation may involve insufficient foot performance when defects (such as over-pronation or over-supination) compromise normal shock-absorbing functions. Additionally, if the central nervous system fails to provide adequate muscle coordination, shorter stopping times can lead to higher impulsive forces and generate significant multi-planar loads on the knee joint, resulting in an increased risk of injury [51–53].

The strength of this study lies in confirming the usefulness of navicular drop height as a marker of injury risk among young amateur athletes, primarily runners and team sport players, and demonstrating the utility of the asymmetry index in predicting injury risk. While these findings are valuable, certain limitations should be acknowledged. Firstly, the study participants represented a limited range of sports disciplines, primarily focusing on runners and team sport players. Secondly, the research was restricted to male individuals of a similar age, around 20 years old. While this homogeneity has its advantages, it would be beneficial for future studies to include female athletes as well as younger and older participants. Moreover, similar research should be extended to professional athletes. Thirdly, the injury history was collected retrospectively. Future studies should consider a prospective approach to gather more accurate data. Another limitation is the lack of consideration for additional injury risk factors, such as warm-up routines, training frequency and intensity, and the time of day. Including these factors could provide a more comprehensive understanding of injury risks. Finally, another limitation is the cross-sectional design of this study. The mechanisms behind the observed associations can be bidirectional. Additionally, one should have a distance from the optimism of the ROC curve results presented in this paper (e.g., high AUC values). The results may be different, taking into account external validation of the models.

5. Conclusions

The findings of this study suggest that foot mobility asymmetry may not be a definitive intrinsic risk factor for injuries among male amateur athletes. However, the presence of asymmetry—where one foot is neutral and the other is pronated or supinated—could contribute to an elevated risk of injury, although this risk is less pronounced compared to individuals with both feet neutral or both feet defective. The practical implications highlight the potential of using SSNDT asymmetry as a valuable, though not exclusive, indicator of musculoskeletal injury risk. Measuring navicular height drop and calculating asymmetry is a straightforward, efficient, and cost-effective method that can be implemented at any level of athletic competition, provided the examiner is well-trained in anatomy. This role is typically suited for physiotherapists or knowledgeable coaches. Furthermore, athletes exhibiting asymmetry greater than 36% should be particularly aware of their heightened potential for foot injuries. There is also a need for further investigation into the injury risks associated with specific body regions, such as the hip, knee, and tibiofibular syndesmosis, to enhance preventive strategies

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Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

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Conflicts of Interest: The author declares no conflicts of interest.

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