



Beyond the Finish Line: Muscle Injuries in Athletic Competition

Rumini^{1ABCDE}, Adi S^{1ACDE}, Donny Wira Yudha Kusuma^{1BD}

¹Universitas Negeri Semarang

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Corresponding Author: Rumini, E-mail: rumini@mail.unnes.ac.id

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Abstract

Objectives. The study aimed to compare the incidence of muscle injuries in the qualifying rounds, semifinals and finals in athletics.

Materials and methods. A total of 14 male and 12 female athletes who participated in all rounds (preliminaries, semifinals, and finals) of the 100 m, 200 m, and 400 m matches were analyzed over a 4-year period starting in 2021-2024. The female athletes were aged 22.4 ± 3.81 years, with a mean height of 167 ± 8.6 cm, and weight – 64.6 ± 17.5 kg. The male athletes were aged 23.4 ± 3.82 , having an average height of 169 ± 8.3 cm, and weight – 66.4 ± 15.8 kg. A t-test was used to conduct comparative assessment of performance between finals, semifinals, and preliminaries for each gender and event. A 95% confidence interval was calculated separately for each gender, event, and round. Additionally, incidence rates were compared. The significance level was accepted at $p < 0.05$.

Results. HMI (hamstring muscle injuries) incidence rate for female qualifiers was found to be 1.50 (1.05-1.95), semifinals – 1.33 (0.79-1.88), and the final – 1.91 (1.44-2.38). LLMI (lower limb muscle injuries) incidence rate among female qualifiers was 1.50 (0.58-2.42), semifinals – 1.00 (1.00-1.00), and the final – 1.55 (1.36-1.74). HMI incidence rate in male qualifiers was 0.50 (0.08-1.28), semifinals – 0.67 (0.77-2.10), and 1.00 (0.34-1.66) in the final. LLMI incidence rate for male qualifiers was 0.40 (0.28-1.08), semifinals – 0.24 (0.55-1.05), and the final revealed 0.60 (0.08-1.28).

Conclusions. The highest incidence of muscle injury in all forms among men was observed in the all-round category. In women, hamstring muscle injuries occurred in the final, while lower limb muscle injuries were most prevalent in the preliminaries and semifinals.

Keywords: athletic, track and field, injuries, competition.

Introduction

Most injuries in athletic championships are to the thigh (26.2%), lower leg (17.3%), or knee (10.7%), with hamstring tear being the most reported injury (14.9%) (Boltz et al., 2021). Hip and thigh injuries were the most commonly injured body regions in NCAA track and field championships, with different injury types depending on the event (Hopkins et al., 2022). Track and field athletes commonly experience knee (28%) and shoulder (14%) injuries, with time loss in sporting activity being longest in the knee region (26 weeks) (Lambert et al., 2022).

Sports injuries can lead to abnormal physiological or psychological stress responses, which may challenge athletes' ability to continue their sports careers at a competitive level (Yang et al., 2022). Acute traumatic sports injuries can harm an athlete's performance based on their perception of the severity of the injury, but this decline in performance and decrease in confidence does not correlate to their desire to leave their sport or their athletic identity (Laurel et al., 2023).

Injuries in high-performance athletes can lead to forced suspension of training or competition, preventing performance improvement and decreasing career quality (Sun, 2023).

Based on previous research, (Pembayun et al., 2023) data did not have a normal distribution and no significant differences in injury management perception based on factors. Lack of skilled techniques leads to 89% of injuries and importance of mastering technical movements in track and field (Hu, 2021). No standard criteria for medical facilities for elite athletes and lack of exact procedure for treating elite athlete health problems (Rahayuni, 2020).

This study focuses on a specific athletics competition, the Central Java Open, which may not have been studied before in the context of muscle injuries. This study compares muscle injury rates between three crucial competition stages, namely the qualifying, semi-finals and finals, which could provide new insights into injury patterns in athletic competition. By understanding the risk factors that arise in different competition contexts, coaches and athletes can design more effective training and recovery strategies to achieve optimal performance. In addition, the results of this study

can contribute to the development of better sports policies related to athlete safety, as well as enrich the scientific literature on sports injuries and their influencing factors.

Materials and Methods

We conducted a thorough analysis of athletes who participated in running competitions. We did not include: 1) single-round disciplines and events (such as sprint and marathon), since it was not feasible to compare the results of the finals with those of earlier rounds; and 2) relay, 400-meter races, throwing, and jumping. There was no parental or public participation in this study. All injury reports were gathered manually and through Google Forms.

The same study design, injury definition, and data collection methods – all of which have been thoroughly detailed previously – were used to collect all of the data prospectively. According to de Sire (2022) injuries were classified as musculoskeletal symptoms that cropped up during training or competition and required medical attention. If an injury satisfied any of the following requirements, it was included in the analysis:

1. Took place in the sprints of 100, 200, and 400 meters.
2. Happened either during the competition or the warm-up (training injuries were not included).
3. Affected the lower leg, ankle, foot, knee, hip, groin, or thigh.
4. Were categorized as “muscle cramp/spasm” or “muscle strain/tear”.

We counted how many athletes began each round. The athletes’ performances resulted in medals obtained from the championship ranking results, and the events were semifinals and finals. Using a t-test, we compared results for each gender and event between the finals, semifinals, and preliminary rounds. For every gender, event, and round, we computed the degrees with a 95 % confidence interval independently. Incidence rates were compared. At $p < 0.05$, significance was deemed to exist.

Result

A total of 14 male and 12 female athletes who participated in all rounds (preliminaries, semifinals, and finals) of the 100 m, 200 m, and 400 m matches were analyzed over 4 years starting in 2021-2024 (Table 1-4).

Table 1. Research Profile Characteristics

Category	Age	Height	Weight	1 st Place	2 nd Place	3 rd Place	Homogeneity
Female Athletes	22.4 ± 3.81	167 ± 8.6	64.6 ± 17.5	2	6	2	0.109 > 0.05
Male Athletes	23.4 ± 3.82	169 ± 8.3	66.4 ± 15.8	5	3	6	0.925 > 0.05

Table 2. Total injury incidence rate

Variables	Number of injuries	HMI	HMI incidence rate (95% CI)	LLMI	LLMI incidence rate (95% CI)
Female					
Qualifiers	18	12 (0.535)	1.50 (1.05-1.95)	6 (0.577)	1.50 (0.58-2.42)
Semifinals	20	8 (0.516)	1.33 (0.79-1.88)	12 (0.535)	1.00 (1.00-1.00)
Final	24	21 (0.701)	1.91 (1.44-2.38)	3 (0.000)	1.55 (1.36-1.74)
Male					
Qualifiers	5	3 (0.548)	0.50 (0.08-1.28)	2 (0.548)	0.40 (0.28-1.08)
Semifinals	3	2 (0.577)	0.67 (0.77-2.10)	1 (0.500)	0.24 (0.55-1.05)
Final	9	6 (0.632)	1.00 (0.34-1.66)	3 (0.567)	0.60 (0.08-1.28)

Table 3. Comparison of Injury Incidence Rates

Variables	Sig.	Mean (lower-upper)
Relative risk of HMI occurrence		
Female Athlete		
Qualifiers vs Semifinal	0.994	0.167 (0.77-1.10)
Qualifiers vs Final	0.647	0.409 (-1.22-0.40)
Semifinal vs Final	0.378	0.576 (-1.46-0.31)
Male Athlete		
Qualifiers vs Semifinal	1.000	0.067 (-1.35-1.22)
Qualifiers vs Final	0.846	-0.400 (-1.45-0.67)
Semifinal vs Final	0.958	-333 (-1.58-0.91)
Relative risk of LLMI occurrence		
Female Athlete		
Qualifiers vs Semifinal	1.000	0.000 (-1.06-1.06)
Qualifiers vs Final	0.862	0.500 (0.83-1.83)
Semifinal vs Final	0.791	0.500 (0.65-1.67)
Male Athlete		
Qualifiers vs Semifinal	0.986	-0.267 (-1.55-1.02)
Qualifiers vs Final	0.513	-0.600 (-1.67-0.47)
Semifinal vs Final	0.344	-0.350 (-1.53-0.83)

Table 4. Similarity of Injury Averages

Category	Sig.	Conclusion
Female	0.119	Does not have a significant difference
Male	0.384	Does not have a significant difference

Discussion

This research contributes to the literature on injury management in competitive sports, particularly in competition. It can provide practical guidance for coaches, managers, and athletes to improve athlete health and performance. The rate of muscle injury between the semi-finals and finals in track and field may differ due to various factors such as the intensity of competition, athlete fatigue, and the specific demands of each event. Research has shown that muscle injuries are common in track and field competitions, with a significant proportion affecting the thigh and lower leg (Bernuzzi et al., 2014; Edouard et al., 2016; Palmer et al., 2022). Additionally,

injury patterns vary between different athletic disciplines, with sprints, hurdles, jumps, and combined events being particularly prone to thigh muscle injuries (Edouard et al., 2016, 2020; Pinheiro et al., 2022). Moreover, male athletes have been found to have a higher risk of muscle injuries compared to female athletes, especially in explosive power events (Edouard et al., 2016). These findings suggest that the transition from semi-finals to finals, characterized by increased pressure and exertion, may contribute to a higher rate of muscle injuries in track and field athletes.

Higher physical intensity during finals matches may contribute to higher injury rates, as starters need to be physically prepared for greater match demands (Palmer et al., 2022). Higher physical intensity is associated with increased lower-body neuromuscular fatigue, which can lead to injuries (Meng & Qiao, 2023; Piedra et al., 2021). Psychosocial factors like perceived availability of informational support and time out of sport are associated with lower re-injury risk in competitive athletes (Gledhill & Craig, 2021). Stress and anxiety are significant factors influencing the risk of injuries, injury frequency, and injury severity in athletes (Chyi et al., 2023).

Women are more prone to injuries than men due to biological, anatomical and mechanical differences as well as social and economic factors that affect the level of risk (Kutaish et al., 2022). Female athletes have higher rates of severe injuries especially in lower extremities such as ankle and knee with gender-related anatomic/biomechanical disparities in the anterior cruciate ligament being a major contributor to this trend (Bradsell & Frank, 2022). Research about female service members indicates higher reported injury rates for women than men due to possible differences in fitness levels and injury reporting behavior among basic trainees (Schram et al., 2022).

Hamstring muscle injuries (HMI) occur more frequently than lower leg muscle injuries due to various factors highlighted in the research. Studies have shown that HMI are prevalent in sports like football and athletics, with risk factors including high-speed running exposure, previous injury history, and inadequate rehabilitation (Chu & Rho, 2016; Haddad et al., 2023; Moreno-Perez et al., 2024). The morphological and biomechanical characteristics of the hamstrings, such as heterogeneous loads under tension, gradient compliance between tissues, and multi-functional movement risks, contribute to the susceptibility of these muscles to injury, particularly near tendon-bone junction sites (Shi et al., 2022). Additionally, inadequate decision-making, nonadherence to rehabilitation practices, and insufficient evidence-based management strategies may also play a role in the increased incidence and recurrence of HMI in athletes, emphasizing the need for better injury prevention and rehabilitation protocols in sports medicine.

Injury management at the semifinal and final stages is crucial, as only two-thirds of athletes return to play at the same level as pre-injury (Carmont et al., 2020). In-competition injury during a combined events competition was associated with lower odds of winning a medal, suggesting injury prevention could contribute to improved performance success (Edouard et al., 2021).

To reduce the risk of injury in the semifinals and finals, several strategies can be implemented based on the findings from the research papers. Strength training

has been recognized as an effective method to minimize the risk of sports injuries (Gonzalo-Skok, 2022). It is also crucial to consider the scheduling of matches to prevent players from experiencing fatigue and potential injuries due to prolonged play durations (Tristan et al., 2006). Furthermore, implementing proper warm-up routines and injury prevention programs, especially those tested for effectiveness, can significantly reduce the risk of injuries during crucial matches (Maćznik et al., 2021). By combining these approaches, athletes can enhance their physical resilience and decrease the likelihood of injuries during the intense competition of semifinals and finals.

The findings from this study may only apply to the Central Java Open or similar athletic competitions in the same geographic area or context. Generalization of these results to other competitions or in other venues may require additional research. Competitions such as the Central Java Open may have certain environmental or organizational factors (e.g., weather conditions, facilities, or race regulations) that may affect muscle injury rates. This study may not be able to consider all these contextual factors in detail.

Conclusion

The highest rate of muscle injury in men in all forms of injury was in the allround. In women, hamstring injuries occurred in the final, and lower limb injuries in the preliminaries and semifinals. The most common injury is a hamstring muscle injury. However, the difference in injury incidence rates between the rounds was insignificant. This study highlights several factors that may contribute to the high injury rate in the final stage, such as the higher intensity of competition, physical fatigue that begins to accumulate, or psychological factors that affect athlete performance.

Conflict of interest

All authors declare no conflict of interest.

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За фінішною межею: М'язові травми у змаганнях з легкої атлетики

Руміні^{1ABCDE}, С. Аді^{1ACDE}, Донні Віра Юда Кусума^{1BD}

¹Семарангський державний університет

Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 5 с., 4 таб., 32 джерела.

Мета дослідження. Мета дослідження полягала в порівняльному аналізі поширеності м'язових травм у кваліфікаційних раундах, півфіналах та фіналах змагань серед спортсменів з легкої атлетики.

Матеріали та методи. Загалом було проаналізовано дані 14 спортсменів-чоловіків та 12 спортсменок-жінок, які брали участь у всіх раундах (попередніх, півфінальних та фінальних) змагань з бігу на 100 метрів, 200 метрів та 400 метрів впродовж 4-річного періоду, починаючи з 2021-2024 років. Вік спортсменок-жінок становив $22,4 \pm 3,81$ роки, середній зріст – $167 \pm 8,6$ см, а вага – $64,6 \pm 17,5$ кг. Вік спортсменів-чоловіків становив $23,4 \pm 3,82$ роки, середній зріст – $169 \pm 8,3$ см, а вага – $66,4 \pm 15,8$ кг. З метою проведення порівняльної оцінки результатів між фіналом, півфіналом та попередніми змаганнями для кожної статі та виду спорту використовувався t-критерій. 95 %-й довірчий інтервал розраховували окремо для кожної статі, виду спорту та раунду змагань. Крім того, порівнювалися показники поширеності травматизму. Рівень значущості становив $p < 0,05$.

Результати. Показник поширеності травм підколінного сухожилля серед спортсменок-жінок у відбіркових змаганнях становив 1,50 (1,05-1,95), у півфіналах – 1,33 (0,79-1,88) та у фіналі – 1,91 (1,44-2,38). Рівень поширеності травм м'язів нижніх кінцівок серед спортсменок-жінок у відбіркових змаганнях становив 1,50 (0,58-2,42), у півфіналах – 1,00 (1,00-1,00), а також у фіналі – 1,55 (1,36-1,74). У спортсменів-чоловіків показник поширеності травм підколінного сухожилля у відбіркових змаганнях становив 0,50 (0,08-1,28), у півфіналах – 0,67 (0,77-2,10) та 1,00 (0,34-1,66) у фіналі. Показник поширеності травм м'язів нижніх кінцівок серед спортсменів-чоловіків у відбіркових змаганнях становив 0,40 (0,28-1,08), у півфіналі – 0,24 (0,55-1,05), а у фіналі склав 0,60 (0,08-1,28).

Висновки. Найвищий показник поширеності м'язових травм всіх типів серед чоловіків спостерігався в категорії багатоборства. У жінок травми підколінного сухожилля зустрічалися на етапах фіналу, тоді як травми м'язів нижніх кінцівок були найбільш поширеними у попередніх та півфінальних змаганнях.

Ключові слова: спортивний, легка атлетика, травми, змагання.

Information about the authors:

Rumini: rumini@mail.unnes.ac.id; <https://orcid.org/0000-0001-5715-990X>; Physical Education Department, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia.

Adi, S: adis@mail.unnes.ac.id; <https://orcid.org/0000-0001-8450-2005>; Physical Education Department, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia.

Kusuma, Donny Wira Yudha: donnywirayudhakusuma@mail.unnes.ac.id; <https://orcid.org/0000-0001-6235-3256>; Physical Education Department, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia.

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