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Injury Epidemiology and Risk Factors in Female Kabaddi Athletes: Insights from Event PON XXI 2024 for Enhanced Prevention and Management

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ABSTRACT

The purpose of the study. This research examines injury patterns, prevalence, and management in female Kabaddi athletes from North Sumatra during the PON XXI 2024 competition, addressing a gap in sports medicine regarding the physiological challenges faced by women in this contact sport. Kabaddi's lack of research on female athletes contributes to a significant deficit in understanding its physiological impact on women.

Materials and methods. The study utilized a quantitative descriptive design with 22 female national Kabaddi athletes from North Sumatra, employing structured surveys, clinical assessments, and systematic injury documentation for comprehensive athlete health evaluation. The methodology comprised pre-competition medical screenings, post-competition injury documentation, and follow-up on recovery and rehabilitation, utilizing advanced statistical methods including descriptive analysis, frequency distributions, and correlation investigations, with significance testing established at $p < 0.05$.

Results. Findings indicated a 100% injury rate among participants, highlighting the extreme demands of competitive Kabaddi, with the most common injuries being muscular strains (36.4%), joint sprains (27.3%), contusions (18.2%), and other soft tissue injuries (18.2%). The severity profile revealed 45.5% of injuries were mild (Grade I), 36.4% moderate (Grade II), and 18.2% severe (Grade III), with significant correlations identified between training intensity and injury occurrence ($p = 0.015$), body composition and injury susceptibility ($p = 0.025$), and age and injury risk ($p = 0.042$). Injury distribution showed lower limb injuries at 54.5%, upper limb injuries at 27.3%, and trunk/core injuries at 18.2%, with primary injury mechanisms including direct contact trauma (45.5%), overextension (27.3%), rapid directional change (18.2%), and repetitive stress (9.1%). Rehabilitation outcomes indicated an 86.4% recovery success rate, although a 13.6% recurring injury rate emphasized the need for comprehensive athlete management strategies.

Conclusions. This research challenges prevailing norms in sports medicine by promoting gender-specific injury prevention, personalized management, and thorough monitoring. The study offers crucial insights into the injury patterns of female Kabaddi athletes and advocates for tailored approaches to athlete health and performance. By examining the complex interactions among physiological factors, training demands, and injury mechanisms, the research establishes a comprehensive framework for enhancing athlete care, preventive measures, and long-term sustainability in high-intensity sports.

Keywords: sports injury epidemiology; injury risk factors; female contact sport athletes; kabaddi injury patterns; athlete health and performance; sports medicine and injury management.

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INTRODUCTION

Kabaddi, a high-intensity contact sport with roots in the Indian subcontinent, has emerged as a dynamic and challenging athletic discipline that has gained significant popularity across Asia (Dahiya & Kumar, 2023), particularly in Indonesia. This sport represents a unique athletic challenge that demands an extraordinary combination of physical strength, strategic thinking, agility, and mental resilience (Utama et al., 2022; Naik & Chinte, 2023). Unlike many traditional team sports, Kabaddi requires continuous, direct physical engagement between players, making it one of the most physically demanding competitive activities in the modern sporting landscape (Singh, 2021). For female athletes, Kabaddi presents a particularly complex and challenging athletic environment. The sport

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necessitates exceptional physical capabilities, requiring players to demonstrate explosive power, rapid decision-making, and extraordinary body control while navigating intricate defensive and offensive strategies (KS et al., 2022). Female Kabaddi athletes must negotiate a landscape of intense physical interactions, sudden directional changes, and prolonged periods of maximum physical exertion, all while confronting unique physiological and biomechanical challenges. The existing body of sports medicine research has historically been predominantly male-centric, with a significant lack of comprehensive studies focusing on female athletes, especially in contact sports like Kabaddi (Comstock & Fields, 2020; Frank et al., 2017). Previous investigations have highlighted critical differences between male and female athletes that demand specialized research attention (Ireland & Ott, 2004; Franklin, 2017). These differences encompass fundamental physiological variations, including distinct muscle fiber compositions, variations in joint flexibility and ligament structures, and the complex influence of hormonal cycles on athletic performance and injury susceptibility (Rose & Metzl, 2004; Lieber & Fridn, 2000).

Preliminary research has begun to unveil the distinctive injury patterns and physiological challenges faced by female athletes in high-intensity contact sports (Ireland & Ott, 2004; Frank et al., 2017). However, significant research gaps persist, particularly in the Indonesian context and specifically within the North Sumatra region. Most existing studies have focused primarily on Indian Kabaddi athletes, leaving a substantial void in understanding the unique experiences of female athletes in different geographical and cultural contexts (Hussain & Cunningham, 2020). This research gap extends to critical areas such as gender-specific training protocols, comprehensive injury prevention strategies, and long-term athletic health management.

The current study emerges from this critical need for comprehensive, context-specific research. By focusing on the female Kabaddi athletes of the North Sumatra team during the PON XXI 2024 competition, this research aims to address multiple crucial objectives. These include determining the precise nature and frequency of injuries, evaluating current injury management strategies, and developing evidence-based recommendations for injury prevention and athlete care. The research is grounded in a multidisciplinary approach that integrates sports medicine principles, biomechanical analysis, gender-specific physiological research, and epidemiological injury assessment methodologies (Dandrieux et al., 2023; Silvers-Granelli et al., 2020).

The significance of this study extends far beyond immediate findings. By providing detailed insights into the injury landscape of female Kabaddi athletes, the research seeks to contribute to a broader understanding of female athlete performance and well-being (Park & Kim, 2020; Gupta et al., 2020). It aims to challenge existing research paradigms, generate comprehensive data on injury prevalence and management, and ultimately support the development of more targeted, effective training and recovery protocols. The ultimate goal is to enhance athlete safety, improve performance, and support the long-term athletic careers of female Kabaddi players in North Sumatra and potentially beyond. Specifically, the research objectives are comprehensive and multifaceted. The study seeks to conduct a detailed analysis of injury prevalence, categorizing injuries by type, severity, and anatomical location. It aims to assess the current injury management protocols of the North Sumatra team, identifying potential improvements in medical support and athlete care. Furthermore, the research aspires to develop evidence-based recommendations for injury prevention, create targeted training and conditioning strategies, and propose gender-specific guidelines for Kabaddi athlete health management (Dahiya & Kumar, 2023; Dey et al., 1993). By establishing a foundational framework for future research, the study hopes to provide valuable insights into the long-term athletic health of female Kabaddi players.

MATERIALS AND METHODS

Study Participants

The study population comprised 22 female national Kabaddi athletes from the North Sumatra team who participated in the PON XXI 2024 competition. These athletes were selected through a comprehensive and purposive sampling method that ensured representation of the team's competitive roster. The participants represented a diverse range of ages, competitive experience, and skill levels, providing a robust and representative sample of female Kabaddi athletes in the region.

Demographic characteristics

Demographic characteristics were carefully documented to provide context for the research findings. The athletes' ages ranged from 19 to 32 years, with a mean age of 24.5 years, reflecting a mature and experienced competitive group. Their competitive experience varied significantly, with participants having between 3 and 12 years of active participation in competitive Kabaddi. This variation in experience allowed for a more comprehensive analysis of injury patterns across different career stages. Inclusion criteria for the study were stringent and well-defined. Participants were required to be active members of the North Sumatra Kabaddi team, have participated in the PON XXI 2024 competition, and provide informed consent for medical assessment and data collection. Athletes with pre-existing chronic conditions that could significantly impact injury susceptibility were carefully evaluated and, if necessary, appropriate accommodations were made to ensure their safe participation in the study.

Ethical considerations

Ethical considerations were paramount in the participant selection and research process. The study received approval from the institutional ethics committee, and all participants provided written informed consent. Confidentiality and privacy were strictly maintained throughout the research, with individual athlete data protected and anonymized to ensure the highest standards of research ethics and participant protection.

Statistical Analysis

The sample size of 22 athletes, while modest, was determined through careful statistical power analysis to ensure sufficient statistical significance for the research objectives. This sample size provided a robust representation of the North Sumatra female Kabaddi team, allowing for meaningful insights into injury prevalence, management, and athlete health while maintaining the practical constraints of a focused, in-depth research study.

RESULTS

Comprehensive Injury Profile Analysis

The analysis of injury prevalence and characteristics provides a comprehensive overview of the types, severity, and recovery time of injuries sustained by athletes during the competition. Table 1 presents a detailed breakdown of injury types, their respective frequencies, percentages, estimated recovery durations, and impact levels on performance.

Table 1. Detailed Injury Prevalence and Characteristics

Category	Subcategory	Number of Cases	Percentage	Mean Recovery Time	Impact Level
Injury Type	Muscular Strains	8	36.4%	4-6 weeks	High
	Joint Sprains	6	27.3%	5-7 weeks	Moderate-High
	Contusions	4	18.2%	2-3 weeks	Low-Moderate
	Soft Tissue Injuries	4	18.2%	3-5 weeks	Moderate

Table 2 presents a detailed analysis of injury severity and recovery metrics among the athletes. The severity of injuries is categorized into three grades based on the extent of tissue damage, ranging from mild (Grade I) to severe (Grade III). Each severity grade is associated with specific recovery durations and varying levels of performance disruption. The data provide insights into the distribution of injury severity, highlighting the proportion of cases in each category and their respective impacts on athletic performance and rehabilitation timelines.

Table 2. Injury Severity and Recovery Metrics

Severity Grade	Criteria	Cases	Percentage	Average Recovery Duration	Performance Impact
Grade I (Mild)	Minimal tissue damage	10	45.5%	2-3 weeks	Minimal disruption
Grade II (Moderate)	Partial tissue disruption	8	36.4%	4-6 weeks	Moderate disruption
Grade III (Severe)	Complete tissue rupture	4	18.2%	8-12 weeks	Significant disruption

Table 3 provides an overview of the anatomical distribution of injuries, categorizing them based on affected body regions and specific areas. The data highlight the prevalence of injuries in different anatomical locations, particularly in the lower limbs, upper limbs, and trunk/core regions. Additionally, the table includes an assessment of biomechanical stress levels associated with each injury site, offering insights into the physical demands placed on various body parts during competition.

Table 3. Anatomical Location of Injuries

Body Region	Specific Areas	Number of Injuries	Percentage	Biomechanical Stress Level
Lower Limb	Quadriceps	5	22.7%	High
	Hamstrings	4	18.2%	High
	Ankle	3	13.6%	Moderate-High
Upper Limb	Shoulder	3	13.6%	Moderate
	Wrist	2	9.1%	Low-Moderate
Trunk and Core	Lower Back	3	13.6%	Moderate
	Abdominal Region	2	9.1%	Low-Moderate

Table 4 presents an analysis of injury mechanisms, identifying the primary causes and scenarios leading to injuries during competition. The data categorize injuries based on their underlying mechanisms, such as direct contact trauma, overextension, rapid directional changes, and repetitive stress. Additionally, the table highlights the associated risk factors, providing insights into the most common and high-risk situations that contribute to injury occurrence among athletes.

Table 4. Injury Mechanism Analysis

Mechanism of Injury	Specific Scenario	Number of Cases	Percentage	Risk Factor
Direct Contact Trauma	Player-to-Player Collision	10	45.5%	Very High
Overextension	Extreme Range of Motion	6	27.3%	High
Rapid Directional Change	Sudden Movement During Raiding	4	18.2%	Moderate-High
Repetitive Stress	Cumulative Micro-traumas	2	9.1%	Low-Moderate

Table 5 explores the correlation between athlete characteristics and injury susceptibility, highlighting key factors that may influence the likelihood of injury. The data examine variables such as age, competition experience, body composition, and training intensity, along with their statistical significance in relation to injury occurrence. Additionally, potential mitigation strategies are outlined to help reduce injury risks and improve athlete performance through targeted interventions.

Table 5. Correlation Between Athlete Characteristics and Injury Susceptibility

Characteristic	Injury Correlation	Statistical Significance	Potential Mitigation Strategies
Age	Moderate positive correlation	$p = 0.042$	Tailored training programs
Competition Experience	Weak negative correlation	$p = 0.078$	Advanced conditioning
Body Composition	Strong correlation	$p = 0.025$	Personalized nutrition plans
Training Intensity	High positive correlation	$p = 0.015$	Periodized training approach

The injury profile analysis reveals that all 22 athletes sustained at least one injury during the competition period, indicating a 100% injury incidence rate. The most common injury type was muscular strains (36.4%), followed by joint sprains (27.3%), contusions (18.2%), and soft tissue injuries (18.2%), with recovery times ranging from 2 to 12 weeks depending on severity. The majority of injuries were classified as mild to moderate, with 45.5% falling under Grade I and 36.4% under Grade II, while severe injuries (Grade III)

accounted for only 18.2% of cases. Anatomically, injuries were more prevalent in the lower limbs, particularly in the quadriceps (22.7%) and hamstrings (18.2%), highlighting the high biomechanical load on these areas during competition.

The most frequent injury mechanism was direct contact trauma from player-to-player collisions (45.5%), followed by overextension due to extreme range of motion (27.3%) and sudden directional changes (18.2%). Key risk factors contributing to injuries included high training intensity ($p = 0.015$), body composition ($p = 0.025$), and athlete age ($p = 0.042$), while competition experience showed a weak negative correlation with injury occurrence. Regarding recovery outcomes, 86.4% of athletes achieved full recovery, whereas 13.6% experienced prolonged or recurrent injuries. These findings emphasize the need for injury mitigation strategies, such as periodized training programs, personalized nutrition plans, and improved rehabilitation methods, to reduce injury risk and enhance athlete performance during competitions.

DISCUSSION

The comprehensive analysis of injury patterns among female Kabaddi athletes from the North Sumatra team reveals a complex and multifaceted landscape of physical challenges unique to this high-intensity sport. The study's findings demonstrate a remarkable 100% injury rate during the PON XXI 2024 competition, highlighting the extreme physical demands inherent in Kabaddi, particularly for female athletes. This unprecedented injury prevalence underscores the critical need for specialized injury prevention and management strategies tailored specifically to the unique physiological characteristics of female athletes in this demanding sport (Frank et al., 2017; Park & Kim, 2020).

Muscular strains emerged as the predominant injury type, accounting for 36.4% of all documented cases, which aligns with and extends existing research on contact sports injuries (Female Athlete Issues for the Team Physician: A Consensus, 2024). These findings suggest that the explosive, high-intensity nature of Kabaddi places extraordinary stress on athletes' muscular systems, particularly in the lower limb regions (Agrawal, 2011; Singh, 2021). The concentration of injuries in the quadriceps and hamstrings reflects the sport's unique biomechanical requirements, characterized by rapid directional changes, sudden accelerations, and complex physical interactions between players (Risberg et al., 2018; Cheung et al., 2012; Lorenz & Reiman, 2011). This pattern diverges from injury profiles in other contact sports, emphasizing the distinctive physical challenges specific to Kabaddi.

The severity gradient of injuries provides crucial insights into the sport's physical demands. While 45.5% of injuries were classified as mild (Grade I) and 36.4% as moderate (Grade II), the presence of severe (Grade III) injuries in 18.2% of cases raises significant concerns about athlete safety and long-term athletic sustainability (Soligard et al., 2019). The average recovery periods, ranging from 2-12 weeks depending on injury severity, highlight the substantial physical and psychological challenges athletes must navigate (Buchheit et al., 2023; McAllister et al., 2023; Pozzato et al., 2023). The rehabilitation success rate of 86.4% is encouraging, yet the 13.6% recurring injury rate indicates the need for more comprehensive, individualized approach to athlete management and recovery.

Comparative analysis with existing literature reveals both similarities and unique characteristics of injury patterns in female Kabaddi athletes. The strong correlation between training intensity and injury occurrence ($p = 0.015$) suggests that current training methodologies may require substantial reevaluation. Body composition emerged as a significant predictor of injury susceptibility ($p = 0.025$), indicating the critical importance of personalized nutritional and conditioning strategies (Buchheit et al., 2023; Eckard et al., 2023). The moderate positive correlation with age ($p = 0.042$) further emphasizes the need for age-specific training and injury prevention protocols.

The anatomical distribution of injuries presents a nuanced picture of the sport's physical challenges. Lower limb injuries dominating at 54.5%, with significant involvement of the quadriceps, hamstrings, and ankle, reflect the sport's unique movement patterns. The substantial upper limb and trunk injuries (27.3% and 18.2% respectively) highlight the comprehensive physical engagement required in Kabaddi. Direct contact trauma as the primary injury mechanism (45.5% of cases) underscores the sport's inherently high-risk nature, particularly for female athletes who may have different physiological responses to physical stress compared to their male counterparts (Pozzato et al., 2023).

The research unveils critical implications for athlete management, training methodologies, and sports medicine approaches specific to female Kabaddi athletes. The findings challenge existing one-size-fits-all training paradigms, advocating for highly personalized, data-driven approaches to athlete preparation, injury prevention, and rehabilitation (Singh, 2021; Asha & N, 2022). The strong correlations between training intensity, body composition, and injury susceptibility call for a holistic approach that integrates biomechanical assessment, nutritional strategies, and individualized conditioning programs (Vetter & Symonds, 2024; Howe et al., 2024; Bukhary et al., 2023).

Limitations of the study must be acknowledged. The relatively small sample size of 22 athletes, while providing valuable insights, necessitates further research with larger, more diverse populations. The geographic specificity to the North Sumatra team limits the broader generalizability of findings, suggesting the need for multi-regional and potentially national-level studies. These limitations, however, do not diminish the study's significant contributions but rather highlight avenues for future research.

The broader implications extend beyond immediate injury management. The research provides a critical foundation for understanding the unique physiological challenges faced by female Kabaddi athletes (Shepherd et al., 2016). It challenges existing paradigms in sports medicine, emphasizing the need for gender-specific approaches to athlete training, monitoring, and support. The findings have potential implications not just for Kabaddi, but for understanding high-intensity contact sports more broadly, particularly from a female athlete perspective.

Future research directions emerge clearly from this study. There is an urgent need for longitudinal studies tracking athlete health over extended periods, comprehensive biomechanical analyses of Kabaddi-specific movements, and development of sport-specific injury prevention protocols. The integration of advanced technologies such as biomechanical motion analysis (Adnan et al.,

2018), personalized physiological monitoring (Michalopoulos et al., 2016), and data-driven training optimization represents a promising path forward for athlete management in Kabaddi and similar high-intensity sports (KS et al., 2022; Read et al., 2020).

CONCLUSION

This comprehensive investigation elucidates the profoundly significant patterns of injury that are observed among female athletes participating in the highly competitive sport of Kabaddi during the PON XXI 2024 competition, revealing an alarming injury incidence rate that stands at a staggering 100%. The injuries that were identified as the most prevalent within this cohort of athletes comprised muscular strains, which accounted for 36.4% of the total injuries recorded, followed by joint sprains at 27.3%, contusions at 18.2%, and a variety of other soft tissue injuries also at 18.2%. A thorough analysis of the data collected indicates that factors such as high training intensity, body composition characteristics, and the age of the athletes are significantly correlated with an increased risk of sustaining injuries. The primary mechanisms identified as contributory to these injuries included instances of direct contact trauma, which constituted 45.5% of the cases, overextension of muscles and joints at 27.3%, and rapid directional changes that accounted for 18.2%. Despite the recovery rate reaching an encouraging 86.4%, the alarming recurring injury rate of 13.6% serves to underscore the pressing necessity for a more holistic and comprehensive approach to injury management within this athletic demographic.

The implications derived from this study serve to underscore the critical importance of the development and implementation of personalized strategies aimed at injury prevention and effective management, particularly in the context of high-intensity contact sports such as Kabaddi, where the risk of injury is inherently elevated. This research fundamentally challenges the prevailing paradigms within the field of sports medicine by emphasizing the urgent need for training programs that are specifically tailored to the unique physiological and psychological needs of female athletes, alongside enhanced mechanisms for injury monitoring and the application of evidence-based interventions that are designed to not only improve athletic performance but also ensure the sustainability of athletes' health over the long term.

The findings presented in this study possess considerable potential to exert a meaningful influence on the development of policies governing athlete health, the establishment of evidence-based training programs, and the formulation of more effective rehabilitation interventions tailored specifically for female athletes. Furthermore, this research lays the groundwork for broader inquiries, including longitudinal studies aimed at comprehensively assessing the long-term effects of injuries sustained in this sport and optimizing strategies for injury prevention in the future.

In light of the ongoing efforts to advance knowledge within this particular field of study, we extend a formal invitation to fellow researchers and practitioners to actively contribute their insights, share their experiences, and provide valuable recommendations that could serve to enrich the findings of this study while simultaneously driving innovation in the realms of injury prevention and management for female athletes engaged in contact sports.

CONFLICT OF INTEREST

The research and the composition of this scholarly article have been conducted in a manner that is entirely devoid of any potential conflicts of interest that could compromise the integrity or objectivity of the findings presented herein.

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