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Designing and Conducting an Injury Study in Amateur Badminton Players

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Abstract: This study aims to examine sports injuries among amateur badminton players engaged in recreational activities, establishing a foundation for developing effective injury prevention and training programs. We assessed 504 amateur badminton players (302 males, 202 females) competing in the 2023 National Badminton Tournament in South Korea. This study focused on players involved in doubles matches, omitting singles competitors. Participants were divided into categories based on competitive and training sessions to document the location and type of injuries sustained. During competitions, the most frequently injured body parts were the waist (11.92%), ankle (11.66%), and knees and shoulders (11.53% each). In training sessions, injuries primarily affected the back and knees (12.43%) and shoulders (12.21%). The most common types of injuries during competitions were to muscles (35.60%), ligaments (29.32%), and tendons (12.04%), and during training to muscles (39.91%), ligaments (26.68%), and tendons (13.23%). Injuries resulting from player-to-player contact represented 19.44% of cases, while those involving non-player elements such as facility equipment accounted for 16.47%. There is a critical need to develop targeted injury prevention programs for amateur badminton players to mitigate injuries and enhance performance, thereby helping prevent the progression to chronic injury stages.

Keywords: badminton; injury; prevent; performance; player

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1. Introduction

Participation in sporting activities, including lifestyle sports, enhances quality of life by promoting health and fulfilling social roles through the use of leisure time for physical fitness [1,2]. These activities are typically organized within club settings, which are prevalent due to the numerous benefits derived from engaging in group sports rather than individual activities. Badminton, in particular, enjoys widespread popularity both in Korea and globally, with a significant number of active participants [3].

Racquet sports like badminton are often considered to be relatively safe due to their limited physical contact compared to other sports, which ostensibly lowers the risk of injury. Nevertheless, badminton, the fastest of the racquet sports, involves predominantly overhead shots and demands high levels of aerobic stamina, agility, strength, speed, and accuracy. It is a skill-intensive sport requiring fine motor coordination and precise racquet movements [4]. Despite its perceived safety, the dynamic and vigorous nature of badminton leads to a significant incidence of injuries. This sport requires extensive physical manipulation, including twisting, turning, and jumping, to accommodate the rapid changes in the speed and direction of the shuttlecock [5]. Research indicates that strains are the most prevalent injury among elite badminton players, with the most affected areas being the lower back, shoulders, thighs, and knees [6]. In younger players, soft tissue sprains and

strains constitute the majority of injuries (64%), with one-third of these injuries occurring in the lower body, especially the knees, followed by the lower back. This group faces a 57% injury risk [7]. Lower extremity injuries are particularly common (54.3%), with foot injuries alone accounting for 22.9%. Muscle strains are the most frequent type of injury, representing 51.4% of cases. Smashes and lunges are often implicated in injuries to both upper and lower extremities. Notably, elite athletes report that a majority of injuries occur during the first third of the game (46.2%) [8]. Recent studies corroborate that injuries are most likely to happen in the early phases of a match and detail the specific injury sites in elite athletes. However, the mechanisms and specific injury sites in badminton's general player population remain poorly understood. Consequently, further experimental and observational studies are essential to explore injury patterns and improve diagnosis in this demographic. Such research is crucial to assist the public in safely engaging with badminton and in preventing chronic injuries.

These injuries not only diminish the performance of elite athletes but also adversely affect the sustained engagement of the general public in badminton. This can culminate in a decline in sports participation. While the post-injury rehabilitation phase is important to ensure continued participation and performance in badminton, it is the prevention of injuries before rehabilitation that is crucial. To do this, it is important to recognize and manage the site, tissue, and cause of injuries in amateur badminton players. Therefore, the objective of this study is to explore sports injuries among amateur badminton players involved in recreational activities. The findings aim to provide a foundation for developing effective injury prevention and training programs.

2. Methods

2.1. Participants

This study involved 504 amateur badminton players (302 males, 202 females: a person who plays in a badminton club without being registered with the Korean Sport and Olympic Committee) who were set to compete in the 2023 national badminton tournament in South Korea. Prior to participation, the aims of this study and the procedures involved were clearly outlined to the players. Following this, consent forms were distributed, which addressed the use of personal data and confirmed that participation was voluntary. All the study participants provided written informed consent for both participation and the use of their data for research purposes. This study adhered to the ethical guidelines of the Declaration of Helsinki.

Participant characteristics are detailed in Table 1.

Table 1. Characteristics of the participants.

	Total (n = 504)	**Male (n = 302)**	**Female (n = 202)**	***p*-Value**
Age (years)	45.22 ± 10.05	45.31 ± 9.95	45.09 ± 10.23	0.812
Height (cm)	168.32 ± 12.37	174.01 ± 5.51	159.80 ± 14.69	<0.001
Weight (kg)	68.90 ± 13.69	77.01 ± 10.60	56.76 ± 7.36	<0.001
Careers (years)	9.57 ± 10.13	10.64 ± 12.10	7.98 ± 5.76	<0.001
mean ± SD				

2.2. The Measurement Tool

The injury sites and tissues examined in this study were selected following a consensus meeting involving five experts, which included two professional badminton coaches and three university professors. The measurement tool used in this study is a modification of the injury form originally used in the study by Lim et al. [9]. Prior to finalizing the form, a preliminary survey was conducted to remove any questions that were irrelevant or lacked validity, thereby enhancing the quality of the data collection process. Both singular

and multiple entries for injury sites and tissues were permitted, with each participant contributing to one unique entry to prevent record duplication and ensure data reliability.

2.3. The Examined of Injury Site and Tissue

For this research, players participating in the 2023 national badminton tournament in South Korea—who were involved in doubles matches, excluding those in singles—were grouped into either competitive or training categories to facilitate the recording of injury sites and tissues. The recorded data were categorized as follows: head (including head, neck, and face injuries), trunk (sternum, ribs, clavicle, abdomen, back, waist, pelvis), upper extremity (shoulder joint, scapula, upper arm, elbow joint, forearm, wrist joint, hand, finger), and lower extremity (hip joint, thigh, knee joint, calf, ankle joint, foot, toe). Additionally, the data were further analyzed to determine the proportion of injuries at each site and tissue, segregated by gender.

2.4. The Injury Causes

The injury causes were classified into contact and non-contact categories, with subsequent analysis of injury types and proportions also stratified by gender.

For contact injuries, we analyzed whether the injury was caused by contact with a player, contact with equipment, or both. For non-contact injuries, we categorized them as sliding, falling down, falling off, landing error, and unreasonable movement.

2.5. Statistical Analysis

Results are presented as mean ± standard deviation and cases (%). Data analysis was conducted using SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA) and Excel 2020 (Microsoft Corp., Redmond, WA, USA). The overall physical characteristics of the participants are shown as mean (M) and standard deviation (SD). One-way ANOVA was used to assess gender differences in participant characteristic variables. Participants' injuries were categorized by site, tissue, cause, and type, including contact and non-contact injuries. Frequencies were calculated and are presented as the number of occurrences and percentages (%). The threshold for statistical significance was established at $p < 0.05$.

3. Results

3.1. Site of Injuries during Competition and Training

The results detailing the injury sites during competition are presented in Table 2, while those from training sessions are in Table 3.

Table 2. Site of injuries during competition.

	Total (*n* = 504)	**Male (*n* = 302)**	**Female (*n* = 202)**
Head	16 (2.07)	7 (1.44)	9 (3.16)
Face	40 (5.18)	18 (3.70)	22 (7.72)
Neck	35 (4.53)	24 (4.93)	11 (3.86)
Sternum	1 (0.13)	0 (0.00)	1 (0.35)
Ribs	9 (1.17)	7 (1.44)	2 (0.70)
Clavicle	3 (0.39)	1 (0.21)	2 (0.70)
Abdomen	2 (0.26)	1 (0.21)	1 (0.35)
Back	5 (0.65)	5 (1.03)	0 (0.00)
Waist	92 (11.92)	59 (12.11)	33 (11.58)
Hip	28 (3.63)	16 (3.29)	12 (4.21)

Table 2. *Cont.*

	Total (n = 504)	Male (n = 302)	Female (n = 202)
Shoulder	89 (11.53)	59 (12.11)	30 (10.53)
Scapula	10 (1.30)	6 (1.23)	4 (1.40)
Upper arms	5 (0.65)	3 (0.62)	2 (0.70)
Elbow	64 (8.29)	42 (8.62)	22 (7.72)
Forearm	8 (1.04)	6 (1.23)	2 (0.70)
Wrist	52 (6.74)	31 (6.37)	21 (7.37)
Hand	4 (0.52)	1 (0.21)	3 (1.05)
Finger	14 (1.81)	6 (1.23)	8 (2.81)
Pelvic	11 (1.42)	7 (1.44)	4 (1.40)
Thigh/groin	29 (3.76)	21 (4.31)	8 (2.81)
Knee	89 (11.53)	59 (12.11)	30 (10.53)
Calf	53 (6.87)	32 (6.57)	21 (7.37)
Ankle	90 (11.66)	62 (12.73)	28 (9.82)
Foot	15 (1.94)	10 (2.05)	5 (1.75)
Toe	8 (1.04)	4 (0.82)	4 (1.40)
Total	772 (100)	487 (100)	285 (100)
	Case (%)		

Table 3. Site of injuries during training.

	Total (n = 504)	Male (n = 302)	Female (n = 202)
Head	15 (1.66)	9 (1.62)	6 (1.73)
Face	44 (4.88)	16 (2.88)	28 (8.09)
Neck	26 (2.89)	16 (2.88)	10 (2.89)
Sternum	1 (0.11)	0 (0.00)	1 (0.29)
Ribs	9 (1.00)	9 (1.62)	0 (0.00)
Clavicle	2 (0.22)	0 (0.00)	2 (0.58)
Abdomen	3 (0.33)	2 (0.36)	1 (0.29)
Back	112 (12.43)	72 (12.97)	40 (11.56)
Waist	8 (0.89)	5 (0.90)	3 (0.87)
Hip	35 (3.88)	19 (3.42)	16 (4.62)
Shoulder	110 (12.21)	77 (13.87)	33 (9.54)
Scapula	7 (0.78)	6 (1.08)	1 (0.29)
Upper arms	3 (0.33)	1 (0.18)	2 (0.58)
Elbow	83 (9.21)	59 (10.63)	24 (6.94)
Forearm	3 (0.33)	0 (0.00)	3 (0.87)
Wrist	72 (7.99)	40 (7.21)	32 (9.25)
Hand	5 (0.55)	3 (0.54)	2 (0.58)
Finger	23 (2.55)	9 (1.62)	14 (4.05)
Pelvic	16 (1.78)	7 (1.26)	9 (2.60)
Thigh/groin	24 (2.66)	18 (3.24)	6 (1.73)

Table 3. *Cont.*

	Total (n = 504)	Male (n = 302)	Female (n = 202)
Knee	112 (12.43)	79 (14.23)	33 (9.54)
Calf	56 (6.22)	27 (4.86)	29 (8.38)
Ankle	107 (11.88)	69 (12.43)	38 (10.98)
Foot	15 (1.66)	9 (1.62)	6 (1.73)
Toe	10 (1.11)	3 (0.54)	7 (2.02)
Total	901 (100)	555 (100)	346 (100)
Case (%)			

During competitions, the most frequently injured body parts were the waist (11.92%), ankle (11.66%), and both knees and shoulders (11.53%). For males, the primary sites were the ankle (12.73%), waist, shoulder, and knee (12.11% each), whereas for females, the waist (11.58%), shoulder, and knee (10.53% each) were predominant.

In training contexts, the back and knee (12.43%) and the shoulder (12.21%) were most susceptible to injuries. Among males, injuries were most common at the knee (14.23%), shoulder (13.87%), and back (12.97%). Females most frequently experienced injuries to the back (11.56%), ankle (10.98%), and both the shoulder and knee (9.54%).

3.2. Tissue of Injuries during Competition and Training

The results of tissue injuries during competition are shown in Table 4, and the results from training are presented in Table 5.

Table 4. Tissue of injuries during competition.

	Total (n = 504)	Male (n = 302)	Female (n = 202)
Skin	48 (6.28)	22 (4.69)	26 (8.81)
Muscle	272 (35.60)	166 (35.39)	106 (35.93)
Tendon	92 (12.04)	58 (12.37)	34 (11.53)
Bone	39 (5.10)	19 (4.05)	20 (6.78)
Ligament	224 (29.32)	149 (31.77)	75 (25.42)
Cartilage	63 (8.25)	41 (8.74)	22 (7.46)
Joint	26 (3.40)	14 (2.99)	12 (4.07)
Total	764 (100)	469 (100)	295 (100)
Case (%)			

Table 5. Tissue of injuries during training.

	Total (n = 504)	Male (n = 302)	Female (n = 202)
Skin	69 (7.74)	31 (5.71)	38 (10.89)
Muscle	356 (39.91)	208 (38.31)	148 (42.41)
Tendon	118 (13.23)	84 (15.47)	34 (9.74)
Bone	29 (3.25)	13 (2.39)	16 (4.58)
Ligament	238 (26.68)	161 (29.65)	77 (22.06)
Cartilage	65 (7.29)	45 (8.29)	20 (5.73)
Joint	17 (1.91)	1 (0.18)	16 (4.58)
Total	892 (100)	543 (100)	349 (100)
Case (%)			

The tissues most frequently injured during competition were muscles (35.60%), ligaments (29.32%), and tendons (12.04%). In males, the most frequently injured tissues were muscles (35.39%), ligaments (31.77%), and tendons (12.37%), whereas in females, they were muscles (35.93%), ligaments (25.42%), and tendons (11.53%).

During training, the tissues most commonly injured were muscles (39.91%), ligaments (26.68%), and tendons (13.23%). For males, the injuries predominantly affected muscles (38.31%), ligaments (29.65%), and tendons (15.47%). For females, the most commonly injured tissues were muscles (42.41%), ligaments (22.06%), and skin (10.89%).

3.3. Causes of Injuries

The results concerning the causes of injuries related to contact are presented in Table 6, and the causes associated with non-contact injuries are detailed in Table 7.

Table 6. Causes of injuries due to contact.

	Total (*n* = 504)	**Male (*n* = 302)**	**Female (*n* = 202)**
Contact with players	98 (19.44)	60 (19.87)	38 (18.81)
Contact with others	83 (16.47)	45 (14.90)	38 (18.81)
Both	7 (1.39)	4 (1.32)	3 (1.49)
None	316 (62.70)	193 (63.91)	123 (60.89)
Total	504 (100)	302 (100)	202 (100)
	case (%)		

Table 7. Causes of injuries due to non-contact.

	Total (*n* = 504)	**Male (*n* = 302)**	**Female (*n* = 202)**
Sliding	105 (17.89)	60 (17.14)	45 (18.83)
Falling down	53 (9.00)	24 (6.86)	29 (12.13)
Falling off	0 (0.00)	0 (0.00)	0 (0.00)
Landing error	81 (13.75)	58 (16.57)	23 (9.62)
Unreasonable moving	201 (34.13)	128 (36.57)	73 (30.54)
None	149 (25.30)	80 (22.86)	69 (28.87)
Total	589 (100)	350 (100)	239 (100)
	case (%)		

Player-to-player contact was responsible for 19.44% of injuries, while non-player interactions, such as with facility equipment, accounted for 16.47%. Among males, player-to-player contact led to 19.87% of injuries and non-player contact to 14.90%, whereas for females, both player-to-player and non-player contact resulted in injuries in 18.81% of cases.

Injuries not involving contact were predominantly due to unreasonable movements, with 201 cases (34.13%), followed by sliding with 105 cases (17.89%), and landing errors contributing to 81 cases (13.75%).

4. Discussion

Badminton involves singles and doubles matches characterized by jumps, lunges, rapid directional changes, and swift arm movements, which frequently lead to injuries across various body parts [10]. Once injured, players often find it challenging to return to the sport and are at a high risk of recurrent injuries if they do not take adequate precautions [11]. Research indicates that during competitions, injuries are most prevalent at the waist, followed by the ankle, knees, and shoulders, whereas during training, the back, knees, and shoulders are most affected. Studies of elite badminton players have highlighted that

injuries to the lower limbs are most common during international competitions, followed by injuries to the feet and upper limbs [8]. At the European Senior Championships, injuries were predominantly reported in the knees, legs, and shoulders of participants [12]. The average age of the 469 badminton players studied was 19.2 years, ranging from 13 to 52 years; about 60% of the injuries occurred in players under 20 years of age, with the knees being particularly vulnerable [13]. Consistent with prior findings, this study found that the knees and ankles of the lower limbs and the shoulders and waist of the upper limbs were most susceptible to injury. Ankle and knee injuries, particularly common in players who frequently jump, often involve ankle sprains during plantar-flexed and inverted movements, primarily during landing or turning [14,15]. Moreover, non-contact injuries were also noted, occurring through improper movements and sliding. While singles players experience injuries primarily from non-contact mechanisms, doubles players sustain more injuries through interactions with other players than from any external contacts.

The most frequently injured body tissues during both competition and training are muscles, ligaments, and tendons. Høy et al. examined 2620 badminton players with an average age of 31 years and reported that the most common injuries were sprains (56%), Achilles tendon ruptures (13%), and ankle ligament ruptures (23.2%) [16]. Guermont et al. studied elite badminton players and found that musculotendinous injuries were the most prevalent, accounting for 51.4% of injuries [8]. Among Swedish players, ligament sprains are the predominant knee injury, whereas patellar tendinopathy is more common among Malaysian players [4]. Badminton is characterized by high-intensity activity punctuated by brief rest periods, demanding rapid movements and agile footwork. This regimen of repetitive motions significantly stresses both upper and lower limbs, elevating the risk of both acute and chronic injuries of various severities [17]. The lower extremity musculature plays a crucial role, as it frequently executes fast, powerful movements using body weight during gameplay [15]. Such repetitive actions lead to muscle and joint fatigue and increased laxity in the musculoskeletal system, which includes muscles, tendons, and ligaments, thereby heightening the risk of injury [18]. The findings of this study, along with previous research, indicate that muscles, ligaments, and tendons are the tissues most commonly injured in amateur badminton players, underscoring the need for a systematic and scientifically based injury prevention program that focuses on strengthening these peripheral muscles and enhancing stability.

The study identified the ankles, knees, and shoulders as the most commonly injured sites for both male and female athletes. Additionally, injuries to the waist during competition were noted among female athletes, and back injuries were observed during training for both genders. A retrospective study of elite badminton players in Hong Kong found that sprains were prevalent, particularly in the lower back, shoulders, thighs, and knees [6]. The researchers attributed the frequent lumbar facet problems to repetitive lumbar extension during overhead and jump smashes in badminton, suggesting that these movements reflect the specific loading patterns on the lumbar spine [19]. The occurrence of pain in the back, hips, knees, or feet is notably higher among athletes performing overhead movements. Pain in the elbows and/or shoulders often co-occurs with back and hip pain, more so than with knee and foot pain [20]. Following seven conditioning sessions over three weeks, a world-class badminton player reported reduced knee pain and exhibited improved performance and cardiorespiratory fitness during agility tasks [21]. The study also indicated that amateur badminton players, due to their relatively low training volume and less professional training regimen, may face a higher risk of injury compared to elite players. Therefore, it is essential for amateur players to receive proper training to minimize injury risks and to facilitate rehabilitation of injured sites.

5. Conclusions

Previous research, including our study, has established that injuries in badminton players typically occur in both the upper and lower extremities. In the upper extremities, the most frequently affected areas are the shoulders and the lower back, whereas the knees

and ankles are the predominant injury sites in the lower extremities, with ligament sprains and muscle injuries being the most common types of tissue damage. Given the nature of badminton, which demands high-intensity actions such as jumping, landing, rapid directional changes, and high-impact movements, there is a compelling need for injury prevention training to mitigate the risk of injuries. Consequently, developing an injury prevention program for amateur badminton players is essential to prevent injuries and enhance performance, preventing the progression to chronic injuries.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app14125194/s1. File S1: Recording sheet for amateur badminton players' injuries status.

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