

Title: Data Collection Procedures and Injury Definitions in Badminton: A Consensus Statement According to the Delphi Approach

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ABSTRACT

Previous studies involving injury surveillance in badminton players have used non-standardized injury definitions and data collection methodologies. The purpose of this study was to apply a Delphi method to (1) reach a consensus on an injury definition in badminton and (2) develop a standardized badminton injury report form. An Injury Consensus Group was established under the auspices of the Badminton World Federation, and initial injury definitions and injury report form were developed. An internal panel was formed from the Injury Consensus Group, and an external panel was selected based on a combination of profession, experience in the field, sport-specific knowledge/expertise, and geographical location to obtain a widely representative sample. Through 2 rounds of voting by the external panel, consensus was reached on both the definition of an injury in badminton and a standardized injury report form. The agreed injury definition was “Any physical injury sustained by a player during a match or training regardless if further diagnostic tests were done or if playing time was lost” and the injury report form contained the following 7 sections: Injury record, Diagnosis, Injury mechanism, Regarding pain, Pain and return to play/training after injury, Grade of severity, and Recurrence. We recommend the use of the definitions and methods presented in this consensus statement for the reporting of injury in all international and domestic badminton players. This should make future injury surveillance reports directly comparable and hence more informative in recognizing trends over time and differences between countries.

Key words: Badminton; Injury; Consensus; Epidemiologic studies.

INTRODUCTION

Badminton is a popular racket sport inclusive of all ages, sexes, and skill levels¹ with more than 330 million participants worldwide.² Badminton is also the fastest racket sport in the world³ with the fastest smash in competition by a man being 426 km/h.⁴ By comparison, the fastest recorded tennis serve in competition is 263 km/h.⁵ Badminton requires vigorous movements, jumps, and rapid changes of direction that are intermittent but intensive, with short recovery times, and they impose severe physiological demands on the player.⁶

Several previous studies have conducted injury surveillance on badminton players.^{7–10} The injury incidence rate has been reported to range from 0.1 per 1000 hours playing¹⁰ to 5.04 per 1000 playing hours,⁷ with the most common injury being 22% of the injuries to the knee.¹⁰ Injuries in badminton typically occur in the lower extremities but also in the lower back and the shoulder.^{7,11–16} Because there is currently no consensus on injury definitions and classifications in badminton, variability in study methodology, injury definitions, and cohorts make it challenging to generalize results and compare across studies. Furthermore, there is a lack of prospective studies with a high risk of bias, thus resulting in poorer quality injury epidemiology data within badminton. Variation in injury definition and methodology in other sports has made it difficult or impossible to draw any conclusions regarding injury rates or mechanisms.^{17–20}

To understand and minimize injuries in sport, it is commonly accepted that the starting point is to implement an agreed injury surveillance approach²¹ with 11 sport-specific/setting-specific consensus statements on sports injury currently available.²¹ Cricket was the first,²² and this resulted in relatively consistent methodologies for subsequent injury publications in cricket.²³ Since then, numerous sports have developed their own injury surveillance methodologies including rugby union,²⁴ football,²⁵ tennis,²⁶ and the International Olympic Committee (IOC) in 2018²⁷ and 2020.²¹ The IOC note the need for sport-specific guidelines, and it is appropriate for badminton to have its own consensus statement.²¹ To develop a consensus statement typically requires a “consensus group,” a Delphi method²⁸ or modified Delphi consensus process to be performed.^{29–31} The Delphi method is a consensus-based technique that provides a systematic framework for collecting and aggregating an informed opinion from a group of experts through multiple iterations.²⁸ Furthermore, researchers have developed strategies such as the CONSORT and STROBE statements^{32,33} for randomized controlled trial and cross-sectional studies, respectively, to improve the quality of published studies.

A potential barrier for sport’s governing bodies to conduct injury surveillance, and for comparison of research findings, is a lack of standardized data collection.¹⁸ Standardized report forms can help overcome this barrier and help to facilitate accurate data collection,³⁴ and it has been recommended that appropriate report forms are developed specifically for each sport that are widely available.²¹ These report forms generally capture information related to demographics, dates relating to the injury, diagnostic information, injury mechanism, severity, and recurrence and have been developed as part of previous consensus statements.^{24,25}

The purpose of this study was to use the Delphi method to: Reach a consensus on injury definitions in badminton and Develop a standardized badminton injury report form.

CONSENSUS METHODS

A modified Delphi consensus procedure was followed^{28–31} to establish the areas to be covered in this consensus statement. The consensus process consisted of 5 phases:

1. Development of injury definitions in badminton and injuries report form by the internal expert panel.
2. Expert panel selection.
3. Round 1: questionnaire distribution, data acquisition, iteration, and analysis by the external panel.

4. Round 2: controlled feedback from round 1 encouraged panelists to reassess, deliberate, and either confirm or alter their responses.
5. Consensus process by the internal panel with final approval.

Phase 1

Badminton World Federation (BWF) formed an Injury Prevention Working Group, and the members formed the basis of the internal expert panel (10 internal panel members from different areas in badminton and the health medical science were recruited by the BWF and the project manager). The consensus project was initiated at an initial meeting and the project strategy agreed during a face-to-face meeting involving all the authors on August 24, 2019 at the BWF World Championships, Basel, Switzerland. Panel members/authors were encouraged to suggest additional definitions, terms, classifications, or other items that should be part of the consensus regarding badminton injury. The identification of possible items was multifaceted—a combination of a literature review, expert consensus, and private correspondence. The review of the badminton literature was initiated using the database PUBMED with an established methodology to find papers about injuries, population (badminton) and instrument (questionnaires, survey and assessment) and consisted of title and abstract screening of 89 articles and full-text review of 45 articles, to identify the terms to be used. This information was used along with the consensus in other sports²³⁻²⁶ by the project manager and their team to help create the first list of questions and the first draft of the injuries report form that was assessed by the internal panel in an online meeting on October 30, 2019. From that meeting, 2 independent questionnaires were produced—an injury definition questionnaire with 8 potential injury definitions and an injury report form for badminton players questionnaire with 7 main sections: 1. Injury record, 2. Diagnosis, 3. Injury mechanism, 4. Regarding pain, 5. Pain and return to play/training after injury, Grade of severity, and 7. Recurrence.

Phase 2

The external panel was selected by BWF and the project manager based on a combination of profession, experience in the field, knowledge and expertise, and geographical location to obtain a widely representative sample. The panel included medical staff members from the BWF, international elite coaches, and players who have competed at the BWF championships. Fifteen experts accepted to be part of the external panel; however, 3 experts left the panel, but it was decided that the 12 remaining experts were an appropriate representative group because the panel still fulfilled the inclusion criteria. All members of the external panel provided written consent and were asked to maintain anonymity until voting was concluded, to enable independent unbiased opinions to be obtained. The study protocol was approved by each member of the external panel, and all members were asked to declare any conflict of interest with Google Forms used for data sharing, data acquisition, and data analysis.

Phase 3—Round 1

Two independent questionnaires produced in phase 1 of the study were sent to the external panel, with each member of the external panel required to rate each statement on the questionnaires on a 10-point scale from 0 “nothing relevant” through to 9 “very relevant” or pick the most appropriate response. All responses were counted and tabulated as frequencies and percentages under the supervision of the project manager.

Phase 4—Round 2

The results and questionnaires from round 1 were distributed by the project manager

through email to all members of the external panel along with an updated questionnaire and additional questions to clarify specific issues and disagreements. Specifically, for the definition of injury, the top 3 rated injury definitions were put forward to round 2 of voting and all other injury definitions were eliminated. For the injury report form, all sections where most of the expert panel agreed in round 1 were retained on the injury report form while other questions were included in round 2 of the questionnaire to the external panel. Each member of the panel rated each statement on the new questionnaires in the same way as round 1 using a 10-point scale or through selecting the most appropriate response. All responses were again counted and tabulated as frequencies and percentages under the supervision of the project manager. It was anticipated that 3 voting rounds would be necessary to achieve consensus; however, only 2 rounds were required to achieve consensus for the external panel for both the definition of a badminton injury and the content of the injury report form.

Phase 5

The meeting of the internal panel in Birmingham was canceled because of COVID-19 and changed to an online meeting (March 15, 2020). At that meeting, it was agreed that no further involvement was required from the external panel. Minor modifications of the report form for simplicity were approved by the internal panel, and the consensus statement of badminton injuries was agreed by the internal panel.

RESULTS

Injury Definition

In round 1 of voting, there was a range of support for each of the 8 definitions from 32% support through to 85% support. The 8 possibilities were narrowed down to a top 3 for round 2 of voting (Table 1). In phase 5, the internal panel simplified the definition to the finalized agreed definition of a badminton injury as:

“Any physical injury sustained by a player during a match or training regardless if further diagnostic tests were done or if playing time was lost.”

Three categories of recurrent injury were considered by the external panel members: “recurrent injury,” “early recurrent injury,” and “late recurrent injury,” and most of the panel selected the same definition for each category (Table 2).

Injury Rates

Most of the external panel (67%) agreed that injury rates should be reported on a per season basis. Other potential methods of calculating incidence suggested included per set (8%), per match and training hour (8%) per match (8%), per training day (17%), and per week (8%).

Injury Report Form for Badminton Players

In Round 1 of voting by the external panel, there was broad agreement across 6 of the 7 sections of the injury report form (Table 3). The section of “pain and return to play/training after injury” was agreed on unanimously by the external panel while the section on “Regarding pain” had the most disagreement.

For the section on “Regarding pain,” further opinion was sought from the external panel during Round 2 of voting to confirm consensus; in Round 2, consensus increased from 57% to 70% and was deemed to have achieved consensus. For the section on “Injury mechanisms,” the internal panel believed that additional clarification of the wording to use in the injury report form was required, in doing so the consensus of the external panel increased from 74% to 80%. During the meeting of the internal panel on the 15th March, the content of the injury report form was confirmed.

DISCUSSION

The aim of this study was to reach a consensus on what constitutes an injury in badminton and to provide guidance on the reporting on these injuries through the development of a standardized injury report form. It is the first injury surveillance consensus statement in badminton and was developed using a similar methodology to those of other sports.^{23–26} It is hoped that future injury surveillance studies within badminton use this consensus definition and follow the guidance on injury reporting because this will help to develop our understanding of injury epidemiology in badminton and allow for comparisons between different cohorts. This information will be able to identify which injuries have the highest burden in badminton, for which targeted injury prevention strategies can then be developed and their effectiveness evaluated.

Injury Definition and Injury Report Form

The consensus group agreed that a broad injury definition which encompassed all complaints should be used (Table 1). This definition ensures that all injuries sustained by badminton players will be recorded, not just those resulting in time loss or requiring medical attention and allows injury surveillance to be conducted in a variety of settings. A common concern with using broader injury definitions than just time loss is the accuracy and reliability; however, the use of a standardized report form which was developed alongside the definitions is a strength of the process used in this study and can address these concerns. Researchers and practitioners who wish to use a narrower injury definition (such as time loss or activity modification to describe badminton injuries) can, provided the report form is completed.

After completion of 2 rounds, the group reached a consensus and accepted each proposed aspect of the injury report form (Table 3). The use of the injury report form will help researchers reduce errors that can occur in injury surveillance associated with incomplete and inaccurate information.²⁴ The report form can be completed as either paper or digital copy, although digital versions can be used to process and analyze findings more efficiently. The form can be completed by practitioners and researchers either prospectively, with the sections of the form on return to play dates and ongoing pain completed as the injury progresses or retrospectively from injury records. Because the form can be completed by players as it is easily understood, it may be used for studies using player self-report. Although player self-report may not be as reliable and accurate as those completed by practitioners, this method can provide valuable information, particularly in settings where players do not have ready access to medical staff.³⁶ This option allows for injury surveillance to be collected on badminton players of various levels, particularly in subelite and community settings. Although the report form is several pages long, the number of questions is relatively few and almost all are answered using tick-box form. If a digital version is used, the use of drop-down boxes will make completion of the form more efficient. To allow comparisons between different cohorts, based on sex, age, and level of play, it is important that these sections of the forms are completed accurately.

Injury Region

The injury regions in Section 1.4 are similar to those proposed in the recent IOC statement, although some differences exist (Achilles tendon and sacral/ pelvis) based on the clinical experience of the panel in treating badminton players. Although there are differences with the IOC statement, if a study wants to be compared with another using the IOC methods, these injury regions can be easily matched with the IOC definitions. Section 2 of the form details the diagnosis of the injury along with further information on who diagnosed the injury and whether investigations were used. The panel believed it was important to understand whether investigations were used to confirm the diagnosis,

although it was recognized that practices of referral for investigations vary between clinicians across the world, along with access to these investigations. The recording of this information will allow for current practices to be compared between different cohorts and may help inform guidance for practitioners working with badminton players. The reliability for reporting exact structural diagnoses is questionable although has been demonstrated to be acceptable for body region and tissue type.³⁷ In sports where specific injuries are of concern, these may also be reported. The panel believed ACL, Achilles ruptures, and ankle sprains were the specific injuries of concern in badminton. In studies which use player self-report, the reporting of a diagnosis and tissue type is likely to be less accurate and this information should be interpreted with caution; however, self-reporting of body region has demonstrated greater reliability,³⁸⁻⁴⁰ particularly if this injury occurred recently.

Injury Type, Mechanism of Injury, and Court Location

In Section 2.1 of the report form, the type of injury is recorded, with the options in this section broadly matching the tissue types listed in the IOC statement and again can be accurately matched against this statement for comparison. The specific option for ocular injuries was added to this list based on the clinical experience of the panel. Similarly, the options for origin and type of onset match with the IOC statement. Training-related injuries were separated into on-court and off-court injuries to be able to identify what injuries are the result of specific badminton activity. For on-court injuries, it was believed by the panel that the location on the court where the injury occurred was crucial because of the different movement patterns and shots played in each section of the court. For example, in the front court, lunging often occurs, while midcourt shots often involve jumping. Recording this information will help improve the etiological understanding of injuries related to badminton activity. The panel believed that a specific list of options should be provided to detail the mechanism of injury for the most severe on-court injuries that is ACL, Achilles tendon rupture, and ankle sprain. It was believed by the panel that because the burden for these injuries is high, specific information on mechanism of injury needed to be obtained on these injuries and that without these options this information would not be obtained.

Injury Rates

The panel was asked whether injury incidence should be reported and if so on what basis, with most of the consensus panel agreeing that injury rates should be reported on a per season basis, although other suggestions were made by the other members of the panel. It was believed by most of the group that seasonal incidence rates would be more reliable because not all injury surveillance settings would have the resources to record this more detailed exposure information accurately. If resources are available to record this information reliably in some settings, such as in high-performance squads with full-time support staff, and they wish to calculate incidence using an alternative method (such as per 1000 hours playing), this is acceptable, as long as the methods are clearly outlined. This will allow the incidence rate used to be converted to seasonal rates so findings can be compared across studies.

Injury Severity and Burden

Sports injury burden is a measure of the overall impact of an injury on that sport.²¹ Understanding which injuries have the highest burden in a sport is critical because injury prevention strategies should be targeted at these injuries.⁴¹ There is no single method for calculating burden, and it has been recommended that sports adopt their own measure.²¹ Although the consensus panel did not discuss the best method to calculate burden, if the injury report form is completed accurately, there are ways it can be calculated.

Information regarding the date of the injury and various stages of return to training and play is recorded in Section 1 of the report form. This information can then be used to calculate the amount of time missed for each stage because of the injury. Burden can then be calculated as the number of days missed per season per player for each injury type (region, specific diagnosis, and tissue injury). Burden may also be calculated based in other ways if different methods of exposure are recorded. Where the exact number of days has not been accurately recorded, such as in a player self-report method, information regarding injury burden can be obtained in Section 6 of the report form where the grade of severity is recorded. The number of incidents in each grade of severity for each injury type can be identified, with injury types that have a higher count of moderately serious, serious, and long-term grades of severity can be considered to result in a greater burden. Although this approach does not allow for a burden measure to be calculated, it does give an indication of which injuries warrant the most attention for the clinician.

Pain and Recurrence

It is not uncommon for athletes to experience ongoing pain and discomfort once they return to full sports activity postinjury; however, this information is rarely captured in injury surveillance studies.²¹ Although ongoing pain may not result in time loss or modified activity, it can have a significant impact on performance and the well-being of the athlete. This often occurs in conditions such as shoulder pain and Achilles tendinopathies which are common in badminton players.^{11,12} Recognition of these pain states has previously been limited, although the management of ongoing pain in athletes has received more attention recently within sports medicine.^{42,43} The completion of Section 5 in the report form allows a greater understanding of which conditions result in ongoing pain in badminton players, without resulting in time loss. This information will guide researchers to investigate risk factors associated with these conditions and help practitioners develop targeted prevention strategies. The definition of a recurrent injury states that a player must have return to full participation postinjury, this is different from that of the recent IOC statement (Table 2). It was believed by the internal panel that early and late recurrent injuries needed to be differentiated because of the potential different reasons for why an injury may recur soon after or a prolonged time after return to play. To the best of our knowledge, this has not been previously considered in other consensus statements. Other methods of classifying recurrent and subsequent injuries include several different options, some using complex frameworks.^{44,45} This complexity is not appropriate for an injury report form that may be completed by both practitioners and athletes themselves. However, if the injury report form is completed accurately, researchers are able to investigate recurrent and subsequent injuries in more detail accordingly to these or other methods.⁴⁶

Value of Consensus Approach and Limitations

A strength of this consensus was the use of the Delphi method to develop it. Members of both the internal and external panel came from a variety of backgrounds, with various professions and countries represented, and although many had extensive experience working within badminton, others had worked in other settings. Unfortunately, 3 members of the original external panel had to withdraw from the process at part 1; however, the external panel still included 12 members from diverse backgrounds. The diversity of the group means that the statement is a “true” consensus that represents badminton, rather than being just the opinion of a small group.

The external panel responses were completed independently and sent to the project manager who anonymized these responses before sharing with the internal panel. Although the time taken to develop the consensus was increased as a result, using this approach it did allow the

external panel to freely express their opinions and prevented 1 or 2 individuals dominating the process and influencing others. Owing to the COVID-19 pandemic, many of the planned face-to-face meetings for the internal panel were canceled and had to be conducted online or through email conversations. Although this potential could have impaired discussions around specific topics, it was still possible to adhere to the planned methodology to develop the consensus.

Future Directions

With the development of this guideline, it is hoped that researchers from around the world adopt them and conduct injury surveillance studies on a variety of cohorts across different sexes, age groups, nationalities, and levels of play. Based on the findings of these studies, further research can then be conducted into understanding the risk factors associated with specific injuries associated with the highest burden in badminton. By understanding these risk factors, specific prevention strategies may be developed and implemented across the sport to reduce injury rates, improving player availability and potentially performance.

It will be necessary in time for this consensus to be reviewed and revised because badminton develops as a sport and different resources are available for injury surveillance. Because more injury surveillance studies are conducted using the guidelines, areas for improvement may be identified. This process has occurred in other sports with established guidelines²³ and should be seen as a natural evolution.

CONCLUSIONS

We recommend the use of the definitions and methods presented in this consensus statement for the reporting of injury in all international and domestic badminton players. This should make future injury surveillance reports directly comparable and hence more informative in recognizing trends over time and differences between countries.

What This Study Adds

A standard system is devised which should allow meaningful comparison of injury surveillance data from different countries and time periods, which will assist in identification of risk factors for injury in badminton.

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Table 1. Percentage Average Scores for two rounds of voting by the external panel for the most appropriate definition of Badminton Injuries

Injury Definition	Round 1	Round 2
Any physical injury sustained by a player that results from a badminton match or badminton training, irrespective of the need for medical attention or lost time from badminton activities. An injury that results in a player receiving medical attention is referred to as a “medical attention” injury and an injury that results in a player being unable to take full part in future badminton training or match play as a “time loss” injury. “Medical attention” refers to an assessment of a player’s medical condition by a qualified medical practitioner	85	87
A physical injury or observable damage to body tissue produced by the transfer of energy experienced or sustained by a player during participation in badminton training or competition, regardless of whether it received medical attention or its consequences with respect to limitations in connection with competition or training	59	56
Any physical injury sustained by a player during a match or training that was diagnosed by medical staff (medical doctor, podiatrist, physiotherapist, ...) regardless if further diagnostic tests were done or if playing time was lost	67	93
Any athlete self-reported condition regardless of any match or training time loss	32	
Any injury where the athlete seeks medical attention regardless of any match or training time loss	53	—
Any injury where the athlete seeks medical attention and results in either match or training time loss	53	—
Any injury where the athlete seeks medical attention, results in either match or training time loss and an investigation has confirmed the diagnosis	50	—
Any injury which prevents the athlete from competing in a match	49	—

Table 2. Definitions selected by most of the expert panel for the three recurrent injury classifications and the percentage of the external panel that agreed

Recurrent Injury Classification	Round 1
RECURRENT INJURY; an injury of the same type and on the same body part as an index injury and which happens after a player's return to full participation after the index injury	83
EARLY RECURRENT INJURY; an injury of the same type and on the same body part as an index injury which happens within 2–6 months of a player's return to full participation after the index injury	75
LATE RECURRENT INJURY; an injury of the same type and on the same body part as an index injury which happens over 12 months after a player's return to full participation after the index injury	67

Table 3. Summary of voting in Round 1 on each of the seven sections of the injury report form by the external panel (expressed as percentage score)

Recurrent Injury Classification	Round 1
Injury record	77
Diagnosis	94
Injury mechanism	74
Regarding pain	57
Pain and return to play/training after injury	100
Grade of severity	67
Recurrence	88