Research Report

Prevalence of upper extremity musculoskeletal injuries among recreational badminton players

Dizon JMR; Dayao R; Elazegui C; Estrubo C; Sanchez C; and Uhuad C

ABSTRACT

Objectives: This study aims to investigate the prevalence of upper extremity musculoskeletal injuries among recreational badminton players and to identify factors associated with the presence of injuries. ***Methods:*** This is an analytic cross-sectional study. Eligible participants were recruited from badminton centers in Metro Manila and were asked to complete a questionnaire which was developed and tested for reliability and validity. Participants indicated whether they incurred any upper extremity musculoskeletal injuries and if these injuries may be associated with possible causes. Frequency measures were used to identify the most common type and area of injury. Chi-square test of independence was also employed to determine association between presence of injuries and identified risk factors. ***Results:*** 24.12% of the injuries in the upper extremity occurred in the shoulder and the most frequently occurring type of injury was muscle strain, found in 43.10% of the injured population. Frequency and length of play, warm up and involvement in multiple sporting activities were not associated with the presence of injury while use of one piece racquet, absence of protective equipment, and absence of previous injuries were found out to be factors associated with the presence of injury. ***Conclusion:*** Among recreational badminton players, the shoulder is the most commonly injured area and muscle strain is the most common type of injury. Risk factors associated with developing injuries are the use of one piece racquet, absence of protective equipment of any kind during play and absence of any previous injury.

Keywords: *badminton, racquet, recreational (non-MeSH), upper extremity injury (non-MeSH)*

INTRODUCTION

Badminton is a tennis-like sport which involves the use of a lightweight racquet and a shuttlecock. While basic techniques are easy to learn, in the advanced level of the sport, a lot of skills and training are needed to meet the stresses of highly complex and sequential actions wherein an individual is required to react quickly. This includes running in different directions, jumping, twisting and striking. Sudden changes in the direction during plays demand speed and coordination of movements.

The sport has taken a major comeback in the country due to the increasing number of people attracted by the sport for various reasons. One of which is fitness. Badminton requires one to learn all the basics in order to survive a match, including proper footwork, grip, swing, direction and handling of equipment.

Individuals participating in informal recreational sports such as badminton engage in a range of exercise levels from modest to vigorous either on a regular or an inconsistent basis, which do not require systematic training or the pursuit of excellence and are without the same pressure to excel against others that characterize competitive sports[1]. However, the absence of systematic training leads some recreational badminton players to adapt movements that seem to work properly at the onset, but later on lead them to injuries because of improper and inefficient techniques.

The radical increase in the number of badminton related injuries is a result of a large number of individuals playing the sport, who were mostly unfit and have not exercised for a prolonged period of time[2] The fitness of an individual includes general conditioning, aerobic fitness and muscular strength, particularly of the forearm and shoulder girdle muscle strength which is important in racket control especially during impact.[3] Deficient proprioceptive skills and weak or inflexible musculoskeletal structures may contribute to the development of injuries.

Previous studies related to badminton have shown that the lower extremities are prone to different musculoskeletal injuries, primarily ankle sprains, anterior knee pain & femoral muscle strains. A prospective study of badminton injuries by Hoy et al (1994), found that sprains, most commonly in the

ankle, accounted for 56% of badminton related injuries[4]. The upper extremities however, were not spared from injuries. Throwing or racket sports, as well as sports in which the upper extremity bears weight (eg, gymnastics), generate tremendous forces across the bones of the upper extremities associated with recognized sport-specific overuse patterns. McBryde (1999) reported that 3% of stress fractures occur in the upper extremities[5]. However, there is still limited information about upper extremity injuries in badminton. Therefore, this study aims to: (1) determine the prevalence of upper extremity musculoskeletal injuries among recreational badminton players; and (2) identify associated factors which may contribute to the prevalence of injuries

METHODOLOGY

Research Design

This was an analytic cross-sectional study.

Procedures

Badminton centers in Metro Manila identified from the website, (http://www.inquirerbadminton.com/courts/index.php)[6] were randomly selected for inclusion in this study. Permission to conduct the survey was sought from each center identified through letters and telephone communication.

An initial questionnaire composed of open-ended questions was developed and distributed to individuals presently engaged in the sport. Based on their answers, a closed-ended questionnaire was then formulated and assessed for construct and content validity. A group of ten individuals composed of badminton coaches, athletes and recreational players were asked to provide comments, suggestions and revisions regarding the set of questions presented. Further revision of the questionnaire was done. Reliability testing of the questionnaire was also conducted by having 20 badminton players answer the questionnaire and after two days, were phone interviewed using the same set of questions to determine consistency of responses. After validity and reliability testing of the questionnaire was done, the final questionnaire was ready for distribution.

Convenience sampling method was used to identify possible subjects. Individuals who were engaged in recreational badminton for at least 6 months were included in the study. Subjects were excluded if they: (1) were elite badminton players who were part of the national team, (2) had formal training which includes summer clinics and professional training in badminton, and (3) had a history of upper extremity injury, surgery or trauma not related to badminton.

Participants were oriented on the objectives of the study and were given a brief explanation regarding the questionnaire. They were also informed that participation in the study was strictly voluntary. After the orientation, the survey questionnaires including the consent forms were distributed and then collected immediately after they were filled up.

Statistical Analysis

Frequency counts were used to identify the most common type and area of injury. Data were cross tabulated among those players with injuries and among those who did not have any injury as to the following factors: frequency of play, length of play, warm-ups, type of racquet used, and if they engage in other sports aside from badminton. The chi-square test of independence was used to determine whether there is an association between these factors and the presence of injuries.

RESULTS

A total of 375 subjects were included in the study, 177 (47.2%) males and 198 (52.8%) females. The chi square test for homogeneity was used to determine if the injured and non-injured groups were similar on important subject characteristics such as gender, handedness, age, and length of play (Table 1). The critical value for the chi-square at the set significance level for a 2 by 2 matrix (one degree of freedom) is x^2= 3.841455. Any value higher than this rejects the null and indicates a significant difference between the compared conditions.

Gender	***Injured***		***Not Injured***	
Male	95	25.33%	82	21.87%
Female	108	28.8%	92	24.53%
	x^2 = 0.002		p = 0.9643	
Handedness	***Injured***		***Not Injured***	
Right Handed	184	49.07%	148	39.47%
Left Handed	17	4.53%	18	4.80%
	x^2 = 0.355		p = 0.5513	
Age group	***Injured***		***Not Injured***	
15-25 years old	77	20.53%	72	19.20%
26-36 years old	66	17.60%	74	19.73%
36-50 years old	60	16.00%	28	7.47%
	x^2 = 10.09*		p = 6.4415×10^{-3}	
Length of playing	***Injured***		***Not Injured***	
< 2 hours	179	47.73%	154	40.07%
≥ 2 hours	24	6.4%	18	4.8%
	x^2 = 0.063		p = 0.8018	

Table 1. Subject characteristics

In general, the injured and non-injured groups were homogeneous in terms of gender, handedness and length of play, but differ in age distribution.

The most frequent type of injury was muscle strain as shown in Figure 1.

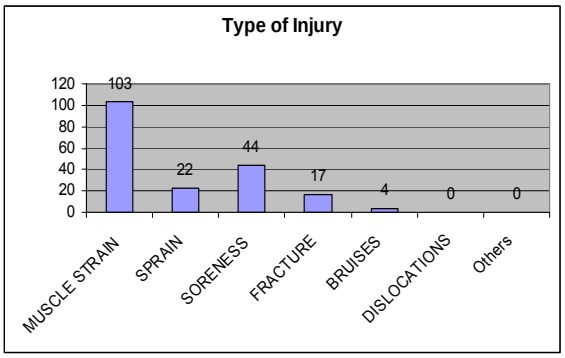

Figure 1. Most common injury reported

In addition, the most frequent area affected by injury was the shoulder as shown in Figure 2.

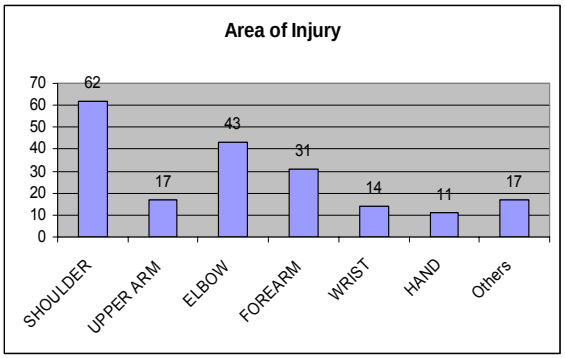

Figure 2. Most common area of injury

Chi-square tests of independence were also done on all of the possible factors to determine if they are associated with the occurrence of an injury (Table 2). The p value was set at 0.05 for all of the statistical tests done and the critical value for the chi-square at the set significance level for a 2 by 2 matrix (one degree of freedom) is x^2= 3.841455. Any chi-square value higher than the critical value rejects the null hypothesis and indicates an association between the factor in question and the presence of upper extremity musculoskeletal injury. Conversely, any value lower than the critical value accepts the null hypothesis that there is no association.

Based on the results of the chi-square tests, subjects who have used a 1-piece racquet, do not use protective equipment, and have not had any previous injuries are more likely to have upper extremity musculoskeletal injuries at the time of the study compared to those who used 2-piece racquet, utilized protective equipment, and have previous history of injuries to the upper extremity.

DISCUSSION

This study found that upper extremity musculoskeletal injuries were prevalent among

Frequency of play	***Injured***		***Not Injured***	
1-2 times a week	151	40.27%	115	30.67%
3 or more times a week	52	13.87%	57	15.2%
x^2 = 2.204			p = 0.1377	
Length of play	***Injured***		***Not Injured***	
1-2 hours per day	170	47.73%	154	41.07%
> two hours per day	24	6.4%	18	4.8%
x^2 = 0.083			p = 0.1977	
Warm up	***Injured***		***Not Injured***	
Warm up (+)	184	49.07%	144	38.4%
Warm up (–)	19	5.07%	28	7.47%
x^2 = 3.46			p = 0.05287	
Racquet type	***Injured***		***Not Injured***	
1-piece	170	45.33%	164	43.73%
2-piece	33	8.8%	8	2.13%
x^2 = 11.713*			p = 6.2065 x 10^{-4}	
Protective Equipment	***Injured***		***Not Injured***	
Using protective equipment	50	13.51%	12	3.24%
Not using protective equipment	157	42.43%	151	40.81%
x^2 = 17.251*			p = 3.275 x 10^{-4}	
Involved in other sports	***Injured***		***Not Injured***	
Playing other sports	149	39.73%	115	30.67%
Not playing other sports	54	14.4%	57	15.2%
x^2 = 1.609			p = 0.2046	
Previous Injury	***Injured***		***Not Injured***	
Presence of injury	6	1.6%	29	7.73%
Absence of injury	197	52.53%	143	38.13%
x^2 = 21.273*			p = 9.24 x 10^{-6}	

Table 2. Risk factors associated with presence of injuries

recreational badminton players. The most common area injured was the shoulder, followed by the elbow and the forearm. The area with the least injury was the hand. The results were similar to the study of Azarbal et al in 2003, where the shoulder was the most commonly affected part on the upper extremity, and rotator cuff inflammation was the most common injury among players in all levels. Shoulder impingement was also reported to occur when the arm is maximally abducted and extended as seen in a tennis serve or overhead smash[8]. Also, out of 124 badminton players evaluated, 17.7 % had the history of medial elbow injury and 9.7 % had the history of lateral elbow injury[7].

The throwing activity is a unilateral action that subjects the arm, especially the shoulder, to stresses of great intensity. Repetitive overhead motions such as hitting an overhead smash especially in racquet sports including tennis and badminton put a lot of strain in the shoulder[7] Using a faulty technique predisposes the joints to atypical stresses resulting to trauma to the joint and adjacent tissues. Untrained individuals tend to generate power from the shoulder and the elbow instead of the wrist. This could explain why the shoulder is the most common area injured in badminton among recreational players.

The second most commonly injured area is the elbow. Excessive strain imposed in the forearm muscles caused by incorrect forehand and backhand technique is the most common cause of elbow injuries specifically, lateral epicondylitis[9]. Backhand lateral epicondylitis results from stress to the extensors of the forearm attached to the outer side of the elbow. Additional stress is placed on the

extensor muscles if the player does not have strong finger flexors. Leading with the elbow on the backhand stroke is a technique error most frequently associated with injury. As the head of the racket accelerates to meet the ball, it travels faster than the elbow. When the ball is struck, the impact causes immediate racquet deceleration and the force of impact is transmitted to and absorbed by the elbow[9]. Forehand lateral epicondylitis affects the flexor muscles which are strained when the wrist is allowed to flex too much during the stroke. Players who exaggerate different spins on the ball may be prone to this problem.[9]

Muscle strain is the most common type of injury incurred by the subjects in this study. Strains are classified as overuse injuries. As in the case of recreational players, "overuse injuries may occur when training or activity demands exceed physiologic ability[10]". When individuals exert much force in exhibiting the skills required to play the sport but are not physically prepared to do so, they suffer from such injuries. Insufficient recovery period after an intense exercise could also result to overuse injuries such as strains.

In the previous study by Jorgensen in 1987, increased exposure or frequency of playing badminton in elite players predisposes them to injuries[11]. However, this study found that frequency of playing badminton was not associated with upper extremity musculoskeletal injuries in recreational players.

Many studies emphasized the importance of a comprehensive and appropriate warm-up and cool-down program to reduce injuries; and that stretching is a basic component of preparing one's body prior to an exercise or game. However, it has found no association between the occurrence of upper extremity injuries in recreational badminton players and the incorporation of warm-up in their routine. Though the figures failed to show statistical significance, it is worth noting that 49% of those who were injured engaged in warm-up exercises. It is possible that although these individuals performed warm-ups, which are mostly stretching exercises, the technique and the parameters they used were not appropriate to the demands of the sport, thus resulting to the occurrence of injuries.

The use of one-piece racquets is significantly associated with incidence of injury as compared with two-piece racquets. One-piece racquets are relatively lighter than the two-piece racquets. One-piece rackets can also absorb more shock since the string tension can be adjusted to a higher value than the latter[12]. Higher string tension would require greater control. Recreational players, who make use of the shoulder instead of the wrist to generate power, would tend to hit the shuttlecock with much force. The force absorbed by the racquet when hitting the shuttlecock is transmitted to the upper extremities, thus, with insufficient muscular control, as seen among untrained individuals, injury occurs. Low tension strings stretch more when they contact the shuttlecock, and then quickly snap back to their initial length. This "trampoline effect" (also known as resilience or rebound) adds power to the shot. Higher tension strings have less stretch left in the string to provide trampoline effect. This could explain why the use of one-piece racquets may predispose players to upper extremity injury more than the use of two-piece racquets.

The absence of any protective equipment is significantly associated with the occurrence of injuries. External supports to limit excessive movements or improper forms could help decrease occurrence of injuries by redirecting the forces transmitted to the muscles and by increasing or decreasing the lever arm. Protective equipments such as elbow bands, athletic tape or splints are some of the common external supports used to help reduce injuries.

Lastly, one of the most important factors associated with injury is the presence of a past injury. Ironically, the study showed that significantly, majority of the individuals found to have upper extremity injuries have had no previous injuries. It is possible that the majority of this population are novice players engaging in the sport for the first time and are not physically fit to play.

CONCLUSION

To conclude, the most common upper extremity musculoskeletal injury among recreational badminton players is muscle strain and the most frequently affected body part is the shoulder. Factors associated with badminton-related upper extremity injuries in recreational players are: (a) the use of one-piece racquets, which are relatively lighter and flexible but with higher tension, demanding less force and greater control and are therefore inappropriate for recreational players**,** (b) not using protective equipment and (c) absence of previous injury such that subjects without prior injuries are more inclined to have badminton-related injuries. With this information, specific exercises and preventive measures could be designed to limit the occurrence of badminton related injuries in the upper extremities.

Limitations and Recommendations

The study was only able to consider badminton centers in Metro Manila. The researchers would like to recommend the conduct of the research on a larger, randomly selected samples to achieve external generalizability. Furthermore, cohort studies will be better able to identify risk factors

better for the development of sports injuries as temporal sequence of exposure factors and incidence of injuries will be established. Future studies may also focus on determining other factors-related badminton injuries such as detailed assessment of the racket used as to the string tension or grip size and motion analysis for the strokes, smashes and faulty biomechanics.

REFERENCES

1. Maron BJ, Chaitman BR, Ackerman MJ, de Luna AB, Corrado D, Crosson JE, et al. Recommendations for Physical Activity and Recreational Sports Participation for Young Patients With Genetic Cardiovascular Diseases. *Circulation.* 2004;109:2807-2816. Available from http://circ.ahajournals.org/cgi/content/full/109/22/2807.
2. Gross, Michael T et al. Comparison of Ball-and-Racquet Impact Force Between Two Tennis Backhand Stroke Techniques. Journal of Orthopedic and Sports Physical Therapy, Vol 31, Number 5. May 2001. pp 247-254
3. Guilas AA Lagman RZ, Go JD, Liao L. et al: Study on the Effects of Playing Surface and Shoes on Occurrence of Chronic or Repetitive Lower Extremity Musculoskeletal Injuries among Badminton Players Participating in UAAP. unpublished journal
4. Hoy K, Lindblad BE, Terkelsen CJ, Helleland HE. Badminton Injuries – A Prospective Epidemiological and Socioeconomic study. British Journal of Sports Medicine. Vol. 28, Number 4. pp 276-279. December 1994
5. McBryde AM Jr: Stress Fractures in Athletes. Internet of Journal of Sports Medicine 1975, Vol. 3 Number 5. pp. 212-217.
6. Inquirer Badminton Online. Available from http://www.inquirerbadminton.com/courts/index.php.
7. Azarbal, Adybeik, D. Ettehad, H. Kia, M,A: A Survey of Elbow Injuries in Badminton Players. Journal of Orthopedic Surgery. Vol. 2 Issue 1, 2003.
8. Ingber RS: Shoulder Impingement in Tennis/Racquetball Players Treated with Subscapularis Myofascial Treatments. Archives of Physical Medicine Rehabilitation; 81. pp. 679-682. 2000
9. Cailliet R: Soft tissue pain and disability, ed 2. FA Davis, Philedelphia, 1988
10. Ng, CW, Overuse Sports Injuries: Diagnosis & Management. The Singapore Family Physician. Vol.30 Number 4 pp. 56-62, December 2004
11. Jørgensen U, Winge S: Epidemiology of Badminton Injuries. Internet Journal of Sports Medicine. Vol. 8 Number 6. pp. 379-382, 1987.
12. Changes in string tension affect racket performance. Available from:www.AshawayUSA.com /pages/badtip2.html.
13. Simons SM, Foot Injuries of the Recreational Athlete. The Physician and Sports Medicine. Vol 27 - No. 1 - January 1999.
14. Weldon, Gail M.S., ATC. Treatment and Prevention of Tennis Elbow. Sports Science Exchange Vol 1, Number 8, Oct 1988.
15. O'Connor FG, Howard TM, Fieseler, CM, Nirschl, RP: Managing Overuse Injuries: A Systematic Approach, The Physician and Sports Medicine. Vol 25-No 5, 1997.
16. DiFiori JP: Overuse Injuries in Children and Adolescents. The Physician and Sports Medicine. Vol 27 - No. 1 - January 1999.
17. Cervoni TD, Martire JR, Curl LA, McFarland EG: Recognizing Upper-Extremity Stress Lesions. The Physician and Sports Medicine. Vol 25 - No. 8 - August 1997.
18. Arthur C. Rettig**:** Athletic Injuries of the Wrist and Hand Part II: Overuse Injuries of the Wrist and Traumatic Injuries to the Hand The American Journal of Sports Medicine 32: pp. 262-273 (2004)
19. Prevention of Tennis Injuries. Available from: http://www. sportsinjuryclinic. net/cybertherapist/bysport/ tennis.htm; 2002
20. A comprehensive study of sports injuries in the U.S. Available from:http://www. American sports data. com/sports injury2.asp.
21. Azarbal, M. Adybeik D. Ettehad H. Kia M. A Survey Of Elbow Injuries In Badminton Players. The Internet Journal of Orthopedic Surgery ISSN:1531-2968.Available from: http://www.ispub.com/ostia/index.phpxmlFilePath=journals/ijos/front.xml
22. Contemporary Ergonomics 2000 Taylor & Francis P.T. McCabe; M.A. Hanson; S.A. Robertson pp. 385-397.
23. Arnheim, Daniel D. & Prentice, Will E. Principles of Athletic Training, 9th Ed. McGraw-Hill Co., Inc, 1997. pp 577-578.