A LONGITUDINAL STUDY: FIVE YEARS OF RESEARCH ON SPORT INJURIES APPEARED IN MATCHES IN TURKISH FIRST WOMEN'S VOLLEYBALL LEAGUE

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ABSTRACT
Sport injuries frequently happened in power-based sports like the volleyball. In order to prevent injuries before they appeared, it should be known reasons and risk factors. Therefore, the aim of this research was to investigate sports injuries happened in match. In this study 200 matches were analyzed from First Women's Volleyball League during the 2011-2016 period. "Match Observation Form" developed by researcher was used. In addition the researcher, two independent expert observers in volleyball analyzed the match records and filled the forms. All forms were compared carefully. Analyzed matches, 49 sports injuries were observed. However, 61.20%(30) of all injuries were temporary injuries ensured continuing the competition by the medical care and 38.80%(19) were serious injuries hindered continuing the play. In this context, there were 0.24 injuries per match. Upper body injury rate was 40.80% (20) whereas lower body injury rate was 59.20% (29). While block was the most dangerous technique of the play at the %55.10(27) injury rates, spike, defense and other techniques had slightly lower risk at the 12.20%(6) and 32.60%(16), respectively. In other words, 67.30%(33) of the all injuries occurred in front of the net where was repeatedly performed block and spike techniques. In conclusion, injury risk was significant in volleyball. Especially, the athletes playing front area were at greater risk in comparison with back area players. Correctly jumping and landing practices should be reduced the risk. It has suggested that the relationship between the injuries and game rules related net contact and middle line.

Key Words: *Volleyball, Sport Injuries, Women, First League.*

Introduction

Volleyball is one of the most popular sports branches in the world. According to the FIVB (federation internationale de volleyball), the FIVB consists of 220 affiliated federations and governs, manages and promotes all forms of volleyball and beach volleyball worldwide through tournaments such as the World Championships, World League, World Grand Prix, World Cup, Grand Champions Cup, Club World Championships, FIVB Swatch World Tour, FIVB Swatch World Championships, Beach Volleyball Continental Cup and Beach Volleyball World Cup, Junior and Youth tournaments and, of course, the Olympics [1]. In addition to these organization promoted by FIVB, millions of people have played the game with the recreational and amateur purposes.

Tilman et al focused that the sport of volleyball sports has continued to increase in participation since its inception over one hundred years ago [2]. Nowadays, volleyball is played in big stadium instead smaller sports hall (see Figure 1: Warsaw, Poland, August 30, 2014. 62,000 fans were in attendance on Saturday night for the historic opening match of the FIVB Volleyball Men's World Championship Poland 2014 at the National Stadium in Warsaw) [3].

Figure 1. *Poland & Serbia in World Champs historic opening match*

Volleyball has been played by approximately 200 million players worldwide in approximately 170 countries. It is one of the most popular sports in the world [4]. Since volleyball is played with a few basic materials such as net and ball, it is preferred by many people for recreational purposes.

Although volleyball is a non-contact sport branch, sport injuries have appeared with high frequency. According to Reeser and Bahr, injuries are, regrettably, an unavoidable hazard of sports participation. Although volleyball and beach volleyball are by most estimates relatively safe sports – particularly in comparison to other sports such as football – epidemiologic research has revealed that volleyball athletes are at risk for certain types of injuries [5]. Numerous scientific studies related to sports injuries in volleyball have been published and different results have been reported in these studies [6-12]. Although there are many researches on sports injuries in volleyball in literature, unfortunately, there has not been standardization in determining characteristics and results of the injuries. Numerous differences of the presentation of the results related to injuries have been observed in literature, such as defining of injuries, calculating of injury rates, classifying of injury reasons, etc. Watkins and green reported 46 injuries by 86 players. They have reported an incidence of 0.53 injuries per player. They found the most common injury parts of the body as knee, ankle, and fingers and back were involved in 30, 26, 22 and 17% of injuries, respectively. Their study focused that block and spikes were the most risky techniques because of repetitively jumping and landing actions in front of the net [13].

Vanderlei et al studied on 522 volleyball players who participated in the High School Olympic Games of the State of São Paulo. A reported condition inquiry was used to gather information on injuries, such as body part affected, injury mechanism and moment, as well as individual and training data. They found the frequency of injuries as 19%. They reported that higher age, weight, height, body mass index and training duration values were associated with the occurrence of injuries. The most affected part of body was the ankle and foot with 45 injuries, 36.3%. Their study showed that the main causes of injuries were direct contact and contactless mechanisms with 61 injuries; 49.2% and 48 injuries; 38.7%, respectively [14].

Augustsson et al analyzed sports injuries in the elite male and female Swedish players in 2002-2003. During a total exposure time of 24.632 hours, 82 players reported 121 sports injuries, representing an overall incidence of 0.77 injuries per player. They reported that numerous injuries had occurred ankle, knee and back, the rates of these injuries were 23%, 18% and 15%, respectively. Their study showed that 54% of all injuries occurred during the block and spike positions [12].

It is known that all sport injures cause serious financial and psychological losses both individual and public. Injuries are disturbing especially for elite athletes. Sport injuries constantly occurred in power-based sports like the volleyball. In order to prevent injuries before they occur, it is known that reasons and risk factors. There are many studies related reasons, preventions, injury areas of body and incidence of sports injuries in volleyball. In this context, main aim of this study was to analyses sports injuries occurred in match in First Turkish Women's Volleyball League during between 2011 and 2016 years.

Material and method

Subjects: In this study, 200 matches were analyzed in the First Turkish Women's Volleyball League during the period between 2011 and 2016 years. The matches included were played in the normal season and the final-four competitions. All video-recordings of the matches were stored as three copies in order to able their viewing by the observers (the researcher and two independent volleyball experts). The study was performed among 468 players during 133.114 player hours.

The Research Questions

- What are the frequency and number of sports injuries?
- What are the rate, frequency and number of temporary sports injuries?
- What are the rate, frequency and number of serious sports injuries?
- Which techniques have higher injury risks?
- Which parts of the body are subject to sports injuries more frequently?
- Is there a correlation between match durations and number of injuries (total, temporary and serious)?
- Is there significant relationship between severity of injuries and injury sites of body?

Definition of Variables

- The severity of injuries: This has been shown in terms of absence from a match or returning to play and has been described as temporary injuries and serious injuries.

- Temporary injuries: Injuries where continuing to play the match is ensured by minor medical treatment.
- Serious injuries: Injuries that lead to an absence from a match,
- Lower body injuries: Ankle, knee and leg injuries,
- Upper body injuries: Finger, wrist, elbow, arm, shoulder, back and head injuries.

Data Collection Instruments: In order to analyze the matches "the Sports Injuries Observation Form" developed for volleyball by the researcher was used. This form contains different variables related to sports injuries such as "number of injury", "injury sites of body", "severity of injury", "techniques-related injury", "injury reason" and "match duration".

Data Collection and Analysis Procedures: In order to watch all the video-recordings of matches a media player program for Windows was used. This media player program possessed forward, reverse and pause functions. In addition to these functions the program provided slow motion viewing and zoom screen display. These functions of the media player program allowed clear viewing and enabled filling out the forms with high accuracy. Each video-recording was played back manually (frame by frame) in order to accurately observe several aspects of an injury position.

The Observers: In this study, three observers were assigned to view and fill the forms. The researcher and two independent expert observers in volleyball analyzed the video-recording of matches and filled the forms twice, one month apart from each other.

Reliability of Data Collection and Correctness of Form Completion: Triple-blind crosscheck: The researcher and the other observers have viewed the recordings and filled the forms twice, one month apart from each other. Each observer (the researcher and two expert observers) carefully compared his own first and second forms. As a result of these comparisons, first and second forms of the researcher showed 98.21% accuracy. Similarly, first and second forms of the other observers had 98.91% and 99.05% accuracy, respectively. Each observer has viewed the recordings of positions with conflicting codes again and corrected the missing codes. Thanks to these individual crosschecks, each observer ensured 100% consistency of his own first form with his second form. After these individual crosschecks, a triple comparison was performed among corrected individual forms of the observers. The triple comparison had 99.82% accuracy. All observers viewed the recordings of positions with conflicting codes again and corrected the missing codes. At the end of these crosscheck procedures, 100% consistency among all forms filled and corrected by the observers (researcher and two expert observers) was ensured.

Data Analysis: Descriptive statistics were calculated for the variables such as mean, standard deviation, percentage and frequency. The Pearson coefficient was used to measure correlations between match durations and total number of injuries, number of temporary injuries, and number of serious injuries. All of these data were treated as continuous variables. Chi-square test was performed on the injury sites of body, and on severity of injury. p-value was accepted for statistical significance at $p \leq 0.05$.

Results

In this study, it was found that 49 injuries among 468 players occurred during 133.114 player hours in 200 matches. Overall duration of matches was found as 85.33±25.85. The mean and standard deviation results related to matches and injuries are shown in Table 1.

Table 1. General descriptive statistics for matches and injuries

	n	min	max	mean	sd
Match Durations	200	71	157	85.33	25.85
Total number of injuries	49	0	3	0.26	0.55
Temporary injuries	30	0	2	0.16	0.44
Serious injuries	19	0	1	0.09	0.29

A total number of 49 injuries were observed for the 468 players in 39 different teams, representing an incidence of 0.10 injuries per player. However, incidence of temporary injuries was 0.06 and incidence of serious injuries was 0.04 per player. Analysis of the results was carried out for playing hours (1000 hours),

and the incidence of injuries was found as 0.37/1000 hours, temporary and serious injuries incidence were found as 0.23 and 0.14, respectively.

Correlations between match durations and total number of injuries, number of temporary injuries, and number of serious injuries are given in Table 2. These analyses indicated that there was not any correlation between match durations and the total number of injuries ($r=0.07$, $p>0.05$). Similarly, no correlation was found between match durations and the number of temporary injuries ($r=0.06$, $p>0.05$).

Table 2. Correlations between match durations and total number of injuries, number of temporary injuries, and number of serious injuries

	n	r	p-value
Total number of injuries	49	0.07	0.32
Temporary injuries	30	0. 06	0.43
Serious injuries	19	0.05	0.47

*Correlation is significant at the 0.05 level

The results related to distribution of 49 injuries in sets are given in Table 3. The second and first sets hosted more injuries, 34.70% and 24.50%, respectively. Contrarily, 16.30% and 6.1% of all injuries were lower than those that appeared in the third and fifth sets, respectively.

Table 3. Table of injuries among sets of matches

	n	%
First sets	12	24.50
Second sets	17	34.70
Third sets	8	16.30
Fourth sets	9	18.40
Fifth sets	3	6.1
Total	49	100

While Temporary injuries were found as 61.20% of all injuries, serious injuries were found as 38.80%. Distribution of injury severity is shown in Table 4.

Table 4. Table of severity of injuries

	n	%
Temporary injuries	30	61.20
Serious injuries	19	38.80
Total	49	100

The rates for lower body injuries were higher than the rates for upper body injuries. Distributions of injury sites of bodies are given in Table 4.

Table 4. Result of injury site of the body

	n	%
Lower body injuries	29	59.20
Upper body injuries	20	40.80
Total	49	100

Block positions in front of the net were found as the most risky actions in the matches. Distributions of techniques related to injuries are shown in Table 5.

Table 5. Result of technique-related injuries

	n	%
Spike	6	12.20
Block	27	55.10
Defense and others	16	32.70
Total	49	100

Chi-square (2X2) test performed has shown that there is a significant relationship between severity of injuries and injury site of the body. Ratio of serious injuries that appeared in the lower body was significantly higher than those in the upper body, [X^2 (1) = 1.09, p=0.02].

Table 6. Results of the relationship between severity of injuries and injury site of the body

Groups		Injury site of the body		Total	x^2	df	p
		Lower	Upper				
Injuries	Temporary	53.30%(16)	46.70% (14)	30	1.09	1	0.02*
	Serious	68.40% (13)	31.60% (6)	19			
	Total	59.20% (29)	40.80% (20)	49			

*Correlation is significant at the 0.05 level

As a result of this test, it was clearly shown that lower body injuries are more dangerous for players because of the high ratio of those that cause absence from matches.

Discussion

Incidence, type, prevalence, epidemiology, severity, reasons, risk factors and causation were the most common subjects researched on sports injuries related to volleyball [2,4,6,7,9,13]. In addition to these studies, causal comparative researches were conducted between volleyball and different types of sports [15-19]. We focused on injury incidence, injury sites of the body, severity of injury, technique-related injuries, injury reasons and match durations in this study. Correlation between match durations and number of injuries (total, temporary and seriously) and significance of relationship between severity of injuries and injury sites of the body are the other issues emphasized in the present study.

A total number of 49 injuries were observed for the 468 players in 39 different teams, representing an incidence of 0.10 injuries per player. However, incidence of temporary injuries was 0.06 and incidence of serious injuries was 0.04 per player. Previous studies have reported similar and different findings on incidence of injuries per player. Kugler et al reported 1294 sports injuries among 625 indoor volleyball players. They found an overall incidence of 0.22 injuries per player per year [20]. Their findings are nearly similar to our findings. On the other hand, Aagaard and Jorgensen previously reported a rate of injuries corresponding to 1.5 injuries per player for Danish volleyball players [11]. Beneka et al reported 248 injuries over a total exposure time of 110.596 h, representing an overall incidence of 0.60 injuries per player [21]. Zetou et al studied on 114 Greek players from first and second leagues and reported that 363 injuries occurred, during a total exposure time of 134.200 h/year for 5 years, representing an overall incidence of 0.63 injuries per player [22]. Aagaard and Jorgensen, Zetou et al and Beneka et al found higher injury results than those found in our study [11, 21, 22]. It might be considered that differences of results between our study and other studies are due to differences of league levels, and using different study methods in the studies. Some previous studies related to sports injuries which focus on the relationship between sports injuries and performance levels are reported these relationship. According to these studies, elite players have relatively lower injury rates than amateurs or un-elite players [21, 23-25]. These factors might partly explain the differences in the researches results.

We found that analysis of the results was carried out for playing hours (1000 h), and the incidence of injuries was found as 0.37/1000 hours, temporary and serious injuries incidence were found as 0.23 and 0.14,

respectively. When the literature analyzed for incidence/1000 hours, it was found different results. It is reported incidence of injuries as 1.7 per 1000 player hours [7]. Incidence of acute injuries was reported as 2.0 per 1000 hours by Verhagen et al [4]. Similary, Beneka et al reported 2.4 injuries per 1000 hours of training and games per player [21]. These results were extremely higher than our results. It might be considered that the studies have performed under different conditions such as wide range of ages, the various categories involved and under changed game rules. In addition to these factors, we performed our study only in competitions conditions. It is suggested that development of training techniques and capability of players might reduce the injury incidences.

In our study, correlations between match durations and total number of injuries, number of temporary injuries, and number of serious injuries were analyzed. The result of these analyses indicated that there was not any correlation between match durations and the total number of injuries ($r=0.07$, $p>0.05$). Similarly, no correlation was found between match durations and the number of temporary injuries ($r=0.06$, $p>0.05$). Although there are no studies in which the correlation between volleyball injuries and match durations has been analyzed, a number of authors have suggested that there is a correlation between activity/training/match durations and sport injuries related to fatigue [9, 12, 21, 24, 26].

When the results related to distribution of 49 injuries analyzed, the second and first sets hosted more injuries, 34.70% and 24.50%, respectively. Contrarily, 16.30% and 6.1% of all injuries were lower than those that appeared in the third and fifth sets, respectively. Although there are no studies in the literature that can be compare completely with this point in our study, it might be thought that players might not be completely ready for high-power game actions in the first sets in case of inappropriate warm-up. Because of this reason, injury rates might be found relatively higher. Inappropriate warm-up periods were reported as one of the major injury reasons in some studies [21,27].

Generally, sports injuries were categorized as minor, moderate and major injuries in literature. This categorization was used in recent researches performed on different sports branches [15,21,28]. In contrast with this classification, we have categorized severity of the injuries as temporary and serious injuries appropriate for analyses of volleyball injuries in matches. The main criteria we have emphasized in classifying the injuries were to be able to continue the match or not by minor medical treatment. In our study, while temporary injuries were found as 61.20% of all injuries, serious injuries were found as 38.80%. Beneka et al reported that the rates for mild, moderate and major injuries are 24%, 58.4% and 15.4%, respectively [21]. Another results reported by Yang et al have shown that 40% of acute injuries are minor or moderate [29].

Anatomic sites and body parts occurred injuries has been the subject of focus in recent studies. According to recent studies lower body parts are the most common injury sites for players. In our study the rate of lower body injuries was 59.20% and the rate for upper body injures was 40.80%. Similarly, Beneka et al found the rate of lower body injuries as nearly 63% (ankle:38,9%, knee: 24.4%) [21]. Previous studies reported that nearly more than half of all injuries have appeared on the lower body of players [4,7]. In addition to these studies, Junge et al have found out that 80% of all injuries were lower body injuries [30].

Relationship between the severity of injuries and the injury sites of the body was significant in our study. Ratio of serious injuries that occurred in the lower body were significantly higher than those that occurred in the upper body, [X^2 (1) = 1.09, $p=0.02$]. Similarly, It is reported that players who suffered lower body injuries were absent from volleyball for longer periods than those players who suffered upper body injuries [4].

We found that the most risky technique was “block” in our study. Distributions of technique-related injuries shows that 67.30% of all injuries occur during actions performed in front of the net (block: 55.10%, spike: 12.20%). Similar results have been reported in many studies related to the risk of techniques in volleyball. Bahr and Bahr have reported that injuries may be related to a specific court position. According to their findings 89% of injuries occur at the net. Ankle injuries occur mainly during landing after blocking; most other injuries are associated with take-off, landing or the actual spiking motion during attack [7]. Bahr et al also focus on the fact that, in their different studies, one of the main reasons for injuries that occur at the net is contact with an opponent player or team mate in the repetitive jumping position for block and spike [7,24,31].

In conclusion, volleyball sport has significant injury risks involved in different types of injuries at various severity levels. Especially, the players in the front area (2, 3 and 4 numbers areas) are at greater risk than those in the back area (1, 5 and 6 numbers areas). The results of all these studies show that the rates for lower body injuries are significantly higher than upper body injury rates and then these injuries are more serious. Furthermore, potential net actions, especially block technique, are the most risky positions for

players. Although volleyball is a non-contact sport theoretically, intensive effort actions repeated in front of the net might increase the risk in all injures in volleyball. In order to reduce the risk of injuries, preventive applications might be exerted. For example, "rule changes related to net contact and regarding middle line where players may land on an opponent's or team mate's foot", "using preventive knee, elbow, shoulder and ankle equipment", "receiving a post-injury medical treatment that ensures complete recovery", "performing functional strength training", "performing correct specific jumping and landing practices", and "issuing written and/or practical injury prevention programs to players". These applications may reduce the risk of injuries in volleyball. It has also been suggested that there might be a relationship between the injuries and game rules related to net contact and middle line. Future studies should address the relationship between injuries and official game rules.

Notes on Contributor

Eren Uluöz received his Bachelor's in Physical Education and Sports at Çukurova University (2007), and doctorate in Physical Education and Sports at Çukurova University (2015). He is currently employed as a Specialist in the Training Program for Trainers-Volleyball in School of Physical Education and Sports at Çukurova University.

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