Sport injuries in professional volleyball players

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Recently there has been a considerable surge in interest in volleyball by both physiotherapists and orthopaedic surgeons. Only few previous studies specified the nature, frequency, and demographics of volleyball injuries. The study was conducted during two league seasons. After the approvals of local bioethics committee and clubs` authorities, contact with the club's doctors was established. A special survey was designed to standardize the process of acquiring data on a weekly basis. One-hundred-and-ninety-eight women and 301 men were under supervision of the research group. On average, 45% of all players (56% males and 26% females) suffered from injuries and musculoskeletal disorders over two seasons. Relatively high incidence of injuries during matches was between 17.3 and 33.8 injuries per each 1000 hours of playing. Almost 50% of musculoskeletal problems occurred in the first phase of the season. Over 50% of musculoskeletal problems were reported during trainings. The blockers are the most affected players in both sex groups. Acute injuries mainly involved knee and ankle joints, while chronic problems affected knee, shoulder, spine and abdominal muscles. Professional volleyball is not a safe sport, especially during a league season. Attention should be especially paid to ankle, shoulder and knee joints, which are the most commonly injured structures. The study revealed that blockers were the most susceptible to injuries and should be protected by special training regime. These findings can help to prepare sports medicine personnel and to guide further related research to prevent injuries among volleyball professionals.

Over the last few years, volleyball has become a very popular sport and consequently, professional volleyball leagues were established in many countries. Volleyball as a professional sport has also changed significantly in terms of, among others: heavy training regime, increased number of games and training hours, specified training techniques for different positions, more dynamic style of playing. All these changes have caused prolonged overuse of musculoskeletal system and affected considerably the rate of injuries among players. Nevertheless, there is still lack of studies analysing the frequency and circumstances of traumas in professional volleyball. Some studies among professional players suggested that ankle, hand, shoulder and elbow are the most affected parts of the body (1-4). There was only one complex study in professional volleyball league (1), the others mainly concerned youth and non-

Key words: volleyball injuries, musculoskeletal disorders, knee and ankle

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0393-974X (2020)

professional games (2, 5-10). Other studies dealt only with specific types of the injuries, which occurred during the game or training (8, 9, 11-13). A recently published study conducted during International Volleyball Federation (FIVB) tournaments showed that the ratio of injuries was very low and authors concluded, that professional volleyball players had lower injury ratio even than amateurs (14). Several studies showed higher risk of injury than reported during the FIVB tournaments (2). The aim of the study was to prospectively analyse the frequency and factors contributing to injuries during two consecutive professional league seasons.

MATERIALS AND METHODS

When Medical University of Lodz's Bioethical Committee gave their consent to perform this research, invitations were sent to all elite club authorities. Only the clubs whose authorities gave consent were included in this study. The research was a prospective study among volleyball players from both male and female elite professional Polish leagues. The study was performed during two seasons 2013/2014 and 2014/2015. The study is based on a prepared survey reported weekly by medical doctors from clubs all over Poland. Only acute injuries or musculoskeletal disorders, which excluded a player from the 100% of training load for at least 7 following days, were taken into consideration. In the first season 2013/2014 the study involved 7 out of 10 clubs from women's leagues and 11 of 12 clubs from men's leagues. In the next season 2014/2015 there were 8 out of 12 clubs from women`s and 12 out of 14 clubs from men`s leagues. The men`s league was extended in season 2014/2015 from 12 to 14 teams, as well as women`s league from 10 to 12.

Ninety-four women and 143 men in the former season and 104 women and 158 in the latter season were under control of the study. In total, in the first season there were 137 games played in women`s league and 174 games in men`s league. In the next season the numbers increased significantly – 189 games by women and 246 by men. Both groups were professional volleyball players, which means that they train at least four times per week and each training session lasts more than 90 minutes. The players train during the whole year with one or two months of holidays. Preparation period before each season starts in August, then the league season starts in October and it ends in April or May. The season is divided into three parts: the first phase (teams play against each other within a league), revenge phase (teams play for the second time with all teams) and play-offs (the best teams play in a cup and eventually one team becomes the winner).

The following data was gathered from the reports (Variables):

- age of the players,
- experience of the player (years of professional training),
- the position on the court,
- the training load before the injury (percentage of typical training),
- time of occurrence: training or game,
- type of training,
- part of a game,
- field situation, which means a type of volleyball skill (attack, block, dig, serve),
- contact or non-contact injuries,
- part of the season when the injury occurred (first matches, revenge matches, play-offs)
- protection used by the player (every kind of orthotics or physiotherapeutic support was recorded),
- the diagnosis,
- type of injury or health problems (acute or chronic),
- type and duration of the treatment,
- the duration of the rehabilitation,
- type of surface (TaraflexTM, parquet and the others).

Taraflex™ is a kind of artificial surface made of PVC, that is applied in indoor volleyball courts. Firstly, each group was examined by Shapiro-Wilk normality test. Gender groups and following seasons were examined separately by Pearson's Chi-squared test to prove statistical significance between each group. Student-T tests and ANOVA variations tests were also performed in order to analyse the statistical

significance of the comparisons. STATISTICA® program was used to perform that evaluation.

RESULTS

The 275 players from women`s and men`s league, participated in the study over a two-year period and 222 injuries were recorded. (Table I) On average, 56% male players and 26% female players reported injuries during two seasons. Statistically significant differences in frequency of incidences between men and women in each and both seasons were observed ($p<0.05$). The average age for volleyball players was 26.7 (SD 3.7) in women`s group and 26.3(SD 4.7) in men`s group and was comparable. The injured players were on average younger in both groups (women 25.3, man 25.7), but no statistically significant difference between the injured and the uninjured players was observed in either groups.

The average height for male players was 193

Table I: *Participants and injuries in two seasons.*

	2013/2014			2014/15			Both		
	Women	Men	All	Women	Men	All	Women	Men	All
Players	94	143	237	104	158	262	198	301	499
Injuries	21	77	98	31	93	124	52	170	222

Table II. *Incidence of accidents by type of activity and number of injuries per 1000 hours.*

	Men 2013/2014	Men 2014/2015	Women 2013/2014	Women 2014/2015	Average percentage
Injuries per 1000h	14,2	15,4	6,8	8,5	100%
Match injuries per 1000h	33,8	31,4	17,3	18,1	54%
Training injuries per 1000h	8,3	9,2	3,9	5,1	28%
Injuries during preparatory period per 1000h	24,1	26,7	10,3	13,3	18%

Table III. *Occurrence of injuries by the period of season.*

	First phase	Revenge games	Play-offs
Women	46,2%	28,9%	25%
Men	48,8%	33,5%	17,7%
All	48,2%	32,4%	19,4%

centimetres (SD 6.6), and weight of 84 kilograms (SD 7.8). The average height for female players was 182 (SD 5.3) and weight of 72 kilograms (SD 4.5). The incidence of injuries was divided into three categories. In both gender groups more than 50% of all injuries happened during trainings, and this difference was significant ($p<0.05$) (Table II).

The calculations concerning the incidences rate per 1000h were performed (95% CI) (Table II). The data was divided into three groups, as previously presented. The differences between the number of training injuries and match injuries, as well as training injuries and preparatory period reached the statistical significance in both sexes and seasons ($p<0.05$). The injuries occurred most frequently in the first phase of the season, and this difference was statistically significant ($p<0.05$). (Table III)

The variations between genders and two seasons were statistically insignificant. The players were divided into three groups according to years of professional training – under 10 years of training, between 10 and 15 and over 15 years (Fig. 1). In summary no difference between the three groups was observed. In the women group, however, the differences in frequency of injuries reached statistical difference ($p<0.05$) with less experienced players being more prone to injuries.

Before the injury, 13.5% of all players used orthotic equipment, recommended by the physiotherapists, related to the body part, which was affected by the accident. The equipment such as tapes, braces and

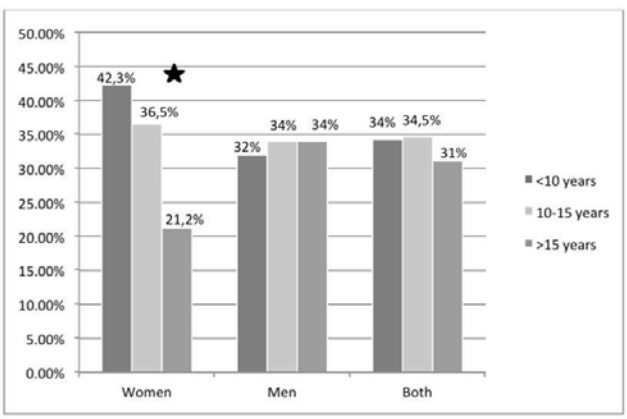

Fig. 1. *Percentage of injuries related to the experience in volleyball.*

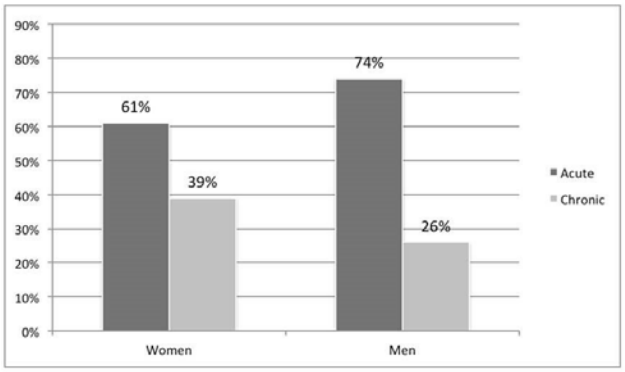

Fig. 2. *Type of musculoskeletal problem by sex.*

orthoses were recommended by physiotherapists to prevent injuries. Among the injured players, orthotic device was applied more frequently by women (31% to 8%) and it was statistically significant ($p<0.05$). No differences between injured and uninjured players were noted. One third of injured female players had reduced training loads for one month prior to the accident due to various reasons, comparing to 12% of male players ($p<0.05$). The reduced training load is described as lower than typical for this player (100%) training load prior to the accident. Only slight differences between the genders were observed in chronicity without statistical significance (Fig. 2). In both groups the alterations between the seasons were insignificant.

In general, acute injuries affected most ankles (30%), knees (22%) and hips (11%). There were differences between women and men: knee injuries were twice more common among female players, and ankle sprains more frequent in male athletes (Table IV).

The most frequent location of chronic problems among players was the knee, followed by shoulder, back and abdominal muscles. (Table V) Variations between genders were noted especially in shoulder problems, but not statistically significant. The blocker position was in both genders the most vulnerable position (Table VI).

The differences between two gender groups were not significant in terms of game situations when the accidents occurred (Fig. 3). The average duration of the treatment was 8,13 weeks (SD 7.73) for women

Table IV. *Presentation of acute injuries among men and women.*

Injured body part	Women	Men	All
Ankle	20 %	28%	30%
Knee	32%	17%	22%
Hip	17%	10%	11%
Shoulder	7%	15%	9%
Hand	4%	10%	8%
Abdominal muscles	8%	6%	7%
Back muscles	6%	4%	5%
Elbow	3%	4%	3%
Foot	1%	4%	3%
Other	2%	2%	2%

and 4.5 (SD 3.08) for men. It was significantly longer in female athletes ($p<0.05$). Most injuries were treated non-operatively 87.4%. The 17% of injuries in men and 11% in women required surgical intervention.

Non-contact mechanism was noted in 83% of the accidents, followed 197 by collision with other player in 13%, and collision with the equipment around the field (4%). Finally, the type of surface was analysed and showed statistically significant effect between men and women. (Table VII) Teraflex™ was the most dangerous surface for all the players ($p<0.05$).

DISCUSSION

The study shows a representative demographic pattern of injuries in male and female volleyball at elite level. This survey provides detailed information on injuries among professional volleyball players during two league seasons, as opposed to previous studies from the '90, which were from small, amateur leagues. (5-7, 10, 15) Our main finding was that more than half of the male athletes would suffer from trauma during the seasons.

Similar frequency was previously reported in smaller leagues (5-7), however, the number of injuries during tournaments was much lower (14). Furthermore, the most important argument for the risk in volleyball is the incidence rate. In the previous studies, the incidence rate was relatively low both during matches (3.8/1000 hours) and during the whole season (2.6/1000 hours and 1.7-4.2/1000 hours). The league season has become longer, training regime has been intensified and number of games might influence injury ratio, while tournaments are mostly two-week or three-week events.

This study also revealed that the first part of the both seasons is most affected by injuries. That is a new finding compared to previous studies. In this period nearly half of the all injuries occurred. The preparations before the season are very strenuous and are performed usually more than one month before the league starts. At the beginning of the season players may be fatigued and they may benefit special attention from physiotherapists. Interestingly the training/rest ratio is more favourable in the later parts of the season. In this survey, most of the accidents occurred during trainings; conversely recent studies showed that the number of such accidents was three times lower in practise (7, 14).

Table V. *Presentation of chronic health problems among men and women.*

Chronic problems	Women	Men	All
Back pain	15%	28%	25%
Knee	30%	24%	24%
Shoulder	35%	13%	20%
Abdominal muscles	10%	18%	15%
Ankle	7%	10%	9%
Hip	2%	6%	6%
Others	1%	1%	1%

Table VI. *Percentage of injuries by position on the field.*

Position on the court	Women	Men	All
blocker	44%	36%	38%
receiver	12%	28%	27%
opposite	13%	18%	17%
setter	21%	10%	11%
libero	10%	7%	8%

Table VII. *Percentage of injuries by type of surface.*

Surface	Taraflex™	Parquet	Others
Women	56%	15%	29% ★
Men	68%	28%	4% ★
All	65%	25%	10% ★

★ = $p<0.05$

The high percentage of women players who did not completely participate in the training load and then suffered from an injury is not surprising. During the season, sometimes coaches do not have any other choice so they decide to take the player who is not yet perfectly healed but could guarantee results. As a result, women statistically suffer from long-term chronic injuries more often than men.

Teams are usually prepared for acute traumas; however, they are inevitable. They relate to all kinds of activities that are performed in volleyball: jump, attack, block. Chronic injuries result from repetitive micro-traumas, which could be related to specific types of injuries, such as back pain or jumper's knee. In this study the differences between men and women were observed. Chronic health problems were previously described among men (6, 7), but they were not examined in the group of women. Women mostly suffered from shoulder problems, whereas men from back pain (16, 17).

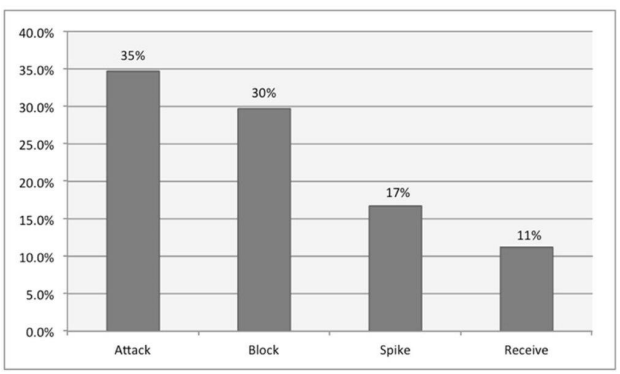

Fig. 3. *Percentage of injuries by game situations.*

Among women the problem could be associated with overtraining or lack of specific training of the shoulder muscles. The sources of these injuries are repetitive movements during attack, so the muscles might be too weak to withstand the force, or they may fatigue from performing the same kind of movement repeatedly (18).

This study also suggests that the position on the court might predispose to trauma. There may be "dangerous" and "safe positions", as previously reported (2, 7). Blockers were the most exposed to injury since they work very hard during the game: they jump in every attacking play; they also block in defensive play, and they quickly move parallel to the net. Setters and opposites are obliged to perform the

two most dangerous elements of the game-attack and block. Therefore, they are involved in the most crucial situations on field. Women's setters might suffer from overload, because in female league there are not so many experienced players in this position, so the best ones play too many matches without any rest.

Attack and block game situations were the most dangerous elements of volleyball in this study responsible for 65% of injuries. They are the most dynamic and powerful parts of volleyball. Both include three phases: jump, hit and landing. Jump and landing refer to lower extremities. Jump is associated with muscle tears, landing with ligament injuries. Hit is related to all types of accidents among upper extremity. Moreover, both elements are performed by all players except for libero. Thus, attack and block should be of special interest to coaches and physiotherapists because the improvement in technique might result in lowering the number of injuries.

The duration of rehabilitation was alarming, shorter and more dynamic than in other leagues (2, 14). Yet another interesting difference between this study and the others is that the injuries resulting from contact with another player represent a small minority, while in other studies the number of these accidents is much higher (2, 14).

Due to widespread use (68% of practise time is spent by player) of the Taraflex™ surface more accidents will take place on this field. Other types of surfaces are mixtures of Taraflex™ and concrete, or concrete with another surface above. Yet, the types of surface should be considered in future investigations, especially in the leagues, where league's authorities do not require TaraflexTM.

This study has some limitations: the data collection depended on contact established with club's doctors. There were also a few clubs (4 from women and 2 from men) leagues that were not included in the study. The previous medical history of players was not taken. The study is not comparable to other studies when different methods of data collection were used.

The risk of injury during a league season is higher than previously reported during the tournaments. On average, 56% of male and 26% of female players reported injuries and musculoskeletal disorders during two seasons. The risk and the pattern of injuries vary according to the player's sex, phase of the season and position on the court. Match injuries rates were 3 times higher than practise rates. Over 50% of musculoskeletal problems, however, were reported during practise. Almost 50% of musculoskeletal problems occurred in the first phase of the season. The blockers are the most affected players in both the sexes. The differences between the sexes were real and should be taken into serious consideration.

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