The incidence and nature of injuries in South African rugby players in the rugby Super 12 competition

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Background. There are sparse scientific data concerning the aetiology and incidence of injuries in the Super 12 rugby competition.

Aim. The aim of the study was to document the incidence, nature and risk factors associated with injuries during a Super 12 rugby competition.

Methods. Injuries, defined as injuries preventing playing or training, or requiring medical treatment, were recorded in a cohort of 75 South African Super 12 players over one season. Injury severity was graded according to sessions missed: minor (1 - 3 missed), intermediate (4 - 9) and severe (> 9).

Results. During the tournament, a total of 740 player game hours and 4 900 player training hours were recorded. The overall incidence of injuries was 55.4 injuries/1 000 player game hours, and 4.3 injuries/1 000 player training hours. The most common injury types were: ligament sprains (25.8%), musculotendinous strains/tears (24.2%). The most common injured sites were: pelvis, hip (19.3%), head and knee (12.9% each). The tackle caused 40.3%, and rucks and mauls 11.3% of injuries. Injuries sustained during training accounted for 34%, and chronic overuse injuries 9.7% of injuries.

Conclusions. There is a high injury rate during a Super 12 rugby competition. However, the majority of injuries were minor injuries. The most dangerous phase of play was the tackle. Training in tackling and rucking techniques, and rule enforcement are therefore recommended to reduce risk of injury. Injuries tended to occur late in games and early in the season, suggesting lack of physical conditioning and fatigue as possible causes of injury.

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Many epidemiological studies on injuries in rugby union have concluded that a higher level of play is associated with a higher incidence of injuries.[1-3] Possible explanations for this include increased strength and body size of players, higher level of competitiveness, longer seasons, and the fact that the ball may be in play for longer in higher levels of the game.[2,3] The Rugby Super 12 competition (which has recently been changed to a Super 14 competition involving 14 teams) is widely regarded as one of the most gruelling rugby competitions in the world, played by Australia, New Zealand and South Africa.[3] A high incidence of injuries is expected in a competition of this calibre; therefore scientific data concerning the aetiology and incidence of injuries are essential for medical staff to provide appropriate advice in order to prevent and manage injuries. However, to date, only one study documenting injuries in the Super 12 competition has been published. In this study, an overall injury rate of 120 injuries per 1 000 playing hours has been documented.[3] In one other study on professional rugby players participating in the Scottish Border Reivers club competition, the period prevalence of injuries among 30 players was 67.8/1 000 game hours.[4] The results of both these studies confirm the expected high injury rate in professional rugby players. The only other study to date on professional rugby union since its inception in 1995 is a prospective study of injuries to elite Australian rugby union players from 1994 to 2000.[5]

The Super 12 (now Super 14) competition is played between twelve professional rugby union teams – three from Australia, four from South Africa and five from New Zealand. These teams play against each other in a 'round robin' tournament, with a knockout semi-final and a final match, over a period of 14 weeks. This implies that all teams play one match per week for the duration of the competition, with only one 'bye' in between.

The aim of this study was to document the incidence and nature of injuries to players in the four South African teams competing in the Super 12 competition and to investigate possible factors associated with injury. The study is novel because there are very few injury epidemiological studies on professional rugby players.

Methods

The prospective cohort studied consisted of the player squads of 3 of the 4 South African teams that competed in the 1999 Rugby Super 12 competition. The final cohort consisted of 3 squads of 25 players each, as stipulated by the organising body of the competition. Twenty-five players participated in each training session, and 15 were on the field during each game.

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Prior to the onset of the study, approval was obtained from the Research Ethics Committee of the University of Cape Town. Approval was also granted by the South African Rugby Football Union, and the respective team managers to conduct the study. Informed consent to participate in the study was obtained from all players.

The study commenced 3 weeks before the start of the 1999 Super 12 competition. During the competition, the 3 teams were involved in 37 matches (3 pre-season, 33 round robin and 1 semi-final), which accounts for 740 player hours of game time. Training hours were calculated at 2 sessions of 2 hours each per week during competition. Pre-competition training was calculated at 3 team-training sessions of 2 hours each. A total of 4 900 player training hours were thus included in the study. Injuries were documented as injuries per 1 000 player game hours, per 1 000 player training hours, and per 1 000 hours of total exposure to games and training. Injuries that had not healed since the previous season were excluded.

An injury was defined as one which prevented a player from playing or squad training, or one that required special medical treatment (medication, suturing, radiographs). The severity of an injury was assessed by the number of games and training sessions missed due to injury. A player who was unable to participate for a week was recorded to have missed 3 sessions (2 training sessions and a game). Injuries were classified as minor if 3 or fewer sessions were missed, intermediate if 4 - 9 sessions were missed and serious if 10 or more sessions were missed. This definition was chosen to allow reasonable comparison with most other studies on elite rugby players.

Pre-season medical examinations by the three team doctors were performed on all players included in the study, to document previous and current injuries. New injury information collected by the doctor on an injury form included: date, player position, team, injured during match or practice session, anatomical site, type and mechanism of injury, first or recurrent injury to the same anatomical structure, and number of sessions missed as a result of the injury. The team doctors were contacted telephonically on a weekly basis during the course of the competition to confirm that all injuries were being recorded.

Statistical analysis of the data was conducted by a qualified statistician (AP) from the Department of Mathematical Statistics, Faculty of Natural and Agricultural Sciences, University of the Free State. Central tendency, variability, and other important characteristics of the questionnaire data were explored using frequency distributions, graphical tools, descriptive statistics and hypothesis testing. The chi-squared goodness-of-fit test was used to compare incidences of injuries. A 5% level of significance was used throughout the study.

Results

Injury rates

Injury rates according to exposure are shown in Table I. A total of 62 injuries were recorded in 48 players over a period of 14 weeks. Forty-one of these occurred during games, which represent 55.4 injuries per 1 000 player game hours. Training injuries constituted 4.3/1 000 player training hours, which is significantly less than those that occurred during games ($p < 0.05$), but still constitute 34% of injuries. There is no statistical difference between severity of injuries sustained during games or training ($p = 0.82$). The total injury rate for training and games was 11 injuries per 1 000 hours of exposure. If the total number of injuries sustained during games and training is expressed as injuries per player game hours, as was done in previous studies of this nature,[6,7] the overall injury rate is 84 injuries per 1 000 player game hours. Thirty-nine per cent were minor injuries, 27% were of intermediate severity and 34% were severe injuries. Injuries of intermediate and serious severity were therefore responsible for 61% of injuries recorded. Three injuries (5% of total injuries) caused players to miss the remainder of the rugby season. Of the total number of injuries recorded, 87% were first injuries and 13% were recurrent injuries to the same structure.

Positions injured

The total number of injuries per player position and the severity is shown in Table II. The column for injuries 'corrected' reflects the fact that some player positions are represented by 2 players in the team, whereas others have only 1 player. Centres

Table I. Injury rates of professional rugby union players during the 1999 rugby Super 12 tournament

	Hours' exposure	Mild injuries	Intermediate injuries	Severe injuries	Total injuries
Games	740	18 (24)*	9 (12.2)*	14 (19)*	41 (55.4)*†
Training	4 900	6 (1.2)‡	8 (1.6)‡	7 (1.4)‡	21 (4.3)†‡
Total exposure	5 640	24 (4.3)§	17 (3)§	21 (3.7)§	62 (11)§

Numbers between brackets:
*Injuries per 1 000 player game hours.
†$p < 0.05$.
‡Injuries per 1 000 player training hours.
§Injuries per 1 000 hours of total exposure to training and rugby games.

and fullbacks were the most commonly injured positions with 9.7% of injuries each, while centres and wings recorded the most intermediate and serious injuries. These results, however, fail to indicate statistical significance between the incidence of injury in different playing positions ($p = 0.712$).

Injury type

Ligament sprains (25.8%) and musculotendinous strains/tears (24.2%) accounted for 50% of the injuries recorded, which is significantly more than any other types of injury ($p = 0.000006$). Seventy-five per cent of the ligament sprains occurred during games and 25% occurred during training. Of the musculotendinous strains/tears, 40% occurred during games, and 60% during training. Other significant injuries were contusions/haematomas, lacerations and chronic overuse injuries (9.7% each). Fractures accounted for 8.1% of injuries. Dislocations/subluxations were responsible for 6.5%, and intervertebral disk herniations for 3.2% of injuries. Only one case of concussion (1.6%) was reported.

Injury site

The distribution of injuries according to anatomical site is shown in Table III.

Mechanism of injury

Contact between players accounted for 40 injuries (64.5% of all injuries). The most dangerous phase of play during matches was being tackled, accounting for 19 of the injuries sustained

Table II. Injuries to professional rugby union players by playing position

Position*	No. in team	No. of injuries	No. of injuries†	Minor	Intermediate	Serious
Centres	2	12 (2)‡	6	5	5	2
Fullback	1	6 (1)‡	6	3	2	1
Hooker	1	5 (0.9)‡	5	2	1	2
Wings	2	9 (1)‡	4.5	2	2	5
Flyhalf	1	4 (0.7)‡	4	1	0	3
Scrumhalf	1	4 (0.7)‡	4	3	0	1
Flankers	2	8 (1.4)‡	4	3	3	2
Locks	2	8 (1.4)‡	4	4	2	2
No. 8	1	2 (0.2)‡	2	0	0	2
Props	2	4 (0.7)‡	2	1	2	1
Total	15	62 (11)‡	-	24 (39%)	17 (27%)	21 (33%)

*No statistical significance between player position and incidence of injury ($p = 0.712$).
†Corrected for positions of which two exist in a team.
‡Numbers between brackets indicate injuries per 1 000 hours of exposure to rugby games and training.

Table III. Injuries to professional rugby union players by anatomical site and severity

Region	Total No. of injuries	Game injuries	Training injuries	Minor	Intermed.	Serious	% of total injuries
Head	8 (1.4)*	8 (10.8)†	-	6	1	1	12.9
Neck	3 (0.5)*	1 (1.4)†	2 (0.4)‡	3	0	0	4.8
Shoulder	4 (0.7)*	3 (4)†	1 (0.2)‡	1	2	1	6.5
Arm/hand	3 (0.5)*	3 (4)†	-	0	2	1	4.8
Trunk	3 (0.5)*	3 (4)†	-	1	0	2	4.8
Back	2 (0.3)*	-	2 (0.4)‡	0	2	0	3.2
Pelvis/hip	12 (2.1)*	4 (5.4)†	8 (1.6)‡	6	2	4	19.3
Thigh	7 (1.2)*	4 (5.4)†	3 (0.6)‡	2	2	3	11.3
Knee	8 (1.4)*	8 (10.8)†	-	3	1	4	12.9
Lower leg	4 (0.7)*	3 (4)†	1 (0.2)‡	1	2	1	6.5
Ankle	7 (1.2)*	3 (4)†	4 (0.8)‡	1	3	3	11.3
Foot	1 (0.2)*	1 (1.4)†	-	0	0	1	1.6
Total	62 (11)*	41 (55.4)†	21 (4.3)‡	24	17	21	99.9

Numbers between brackets:
*Injuries per 1 000 hours of total exposure to training and rugby games.
†Injuries per 1 000 player game hours.
‡Injuries per 1 000 player training hours.

during games (46.3% of game injuries, or 25.7 injuries/1 000 player game hours), which is also statistically very significant ($p < 0.00001$). Rucks and mauls were responsible for 7 game injuries (17% or 23 injuries/1 000 player game hours), while tackling caused 6 injuries (14.6% or 8.1/1 000 player game hours) during games. The tackle was therefore responsible for 40% of total injuries recorded, representing 33 injuries/1 000 player game hours. Six chronic overuse injuries (9.7% or 1 injury/1 000 player hours of exposure) were recorded during the competition. The distribution of injuries during games by mechanism is shown in Fig. 1.

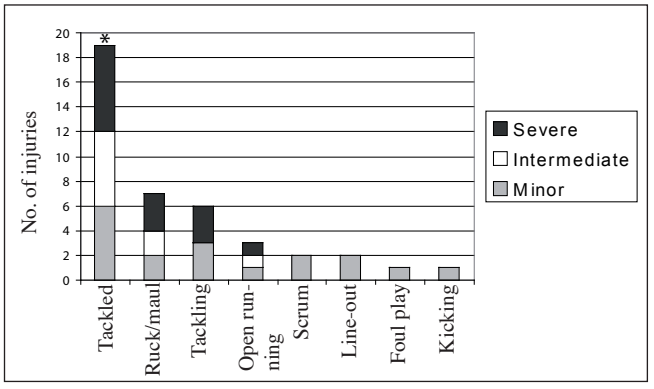

*Fig. 1. Mechanism of injury to professional rugby union players during matches (*p < 0.05).*

Time of injury

Of the 41 match injuries, 2.4% occurred during the first 20 minutes of play, 36.6% during the second 20 minutes, 31.7% during the third 20 minutes and 29.3% during the final 20 minutes. The low incidence of injury in the first quarter is statistically significant ($p = 0.000003$). Thirty-one per cent of recorded injuries occurred during the pre-competition preparation phase. Match injuries equal 133/1 000 for pre-competition preparatory matches, which are significantly more than the 59/1 000 for the first third, 32/1 000 for the middle third and 59/1 000 for the final third of the competition ($p < 0.000001$). Pre-season training alone was responsible for 38% of injuries sustained during training, which is significantly more than in any other part of the season.

Discussion

The need to limit injuries in rugby union has been expressed in the literature. Identification of mechanisms of sporting injury can facilitate specific interventions and has been shown to ultimately lead to a decrease in the incidence of injury.[6,8] Therefore, accurate data on the incidence, nature and factors associated with injury in first-grade and professional rugby are essential.[1,3,6,9] The available research is often of limited value because of differences in study design, such as methods of data collection, definition of injury, and differences in expression of injury rates.[1,9,10] Apart from the variety of study designs used in previous epidemiological studies on amateur rugby,[1,2,4,6-12] the only four studies to date that included professional rugby, also differed vastly in study design, thus complicating comparison and acquisition of collective data on injuries in professional rugby union.[3-5,9]

Controlling the cohort of players studied proved to be a difficult task, as experienced in previous studies.[3] Injury rates per time of exposure to rugby were therefore studied, rather than the number of injuries documented in a cohort of players.

In this study, 55.4 game injuries per 1 000 hours of player game time have been recorded, compared with the higher rate of 120 game and training injuries per 1 000 hours of player game time in the other study on the Super 12.[3] A more comparable 69 injuries per 1 000 hours of player game time was recorded among Australian elite players from 1994 to 2000. The injury rates in the Australian study before professionalism (1994 - 1995) and after (1996 - 2000) were 47/1 000 player game hours and 74/1 000 player game hours respectively.[5] In the injury survey in club rugby in the Scottish Border Reivers district, an incidence of 29.9 injuries per 1 000 playing hours was documented among professional rugby players during the 1997/8 season, compared with a lower incidence of 15.8 injuries per 1 000 playing hours for amateur (senior club) players participating in the same competition. In the same district, the incidence of injuries during the 1993/4 season (amateur era) was only 12.1 injuries per 1 000 playing hours.[4] The latter two studies clearly show a trend of higher injury rates in professional compared with amateur players. In a study comparing the three popular codes of football in Australia, an overall injury rate of 62 injuries/1 000 player hours was documented among first-grade amateur players and 53 injuries/1 000 player hours in all grades of amateur rugby union.[7] In the study among first-grade amateur players in the ACTRU competition, an injury rate of 48.8/1 000 player game hours was recorded.[6] The high incidence of injuries in professional rugby was confirmed in this study, but an expected higher injury rate than in amateur rugby could not be confirmed. Lower injury rates have been recorded in other contact sports. Swedish elite ice hockey recorded 12.7 game hours per injury[13] and in soccer only 3.13 injuries/1 000 player game hours have been recorded in a semiprofessional squad over one season.[14]

Only 39% of injuries in this study were of a mild nature (unable to play for a week or less). This was lower than the 69.6% recorded in the other Super 12 study[3] and the 58.7% of mild injuries recorded in the ACTRU competition.[6] The reason for this may be under-reporting because of players' reluctance to report mild injuries, as experienced subjectively by the team doctors involved. The number of injuries sustained during training was low if expressed per hours of exposure to training, but still made up 34% of all injuries recorded. This rate, as well

as the 26% training injuries rate recorded before in the Super 12 study, indicates an exceptionally high rate of training injuries, and does not support the postulate that training sessions appear to be a safe activity in rugby.[6] Unlike rugby games, training sessions can be controlled to a large extent. Further research in the nature and circumstances surrounding training injuries could result in measures to reduce injuries during training sessions.

Recurrent injuries to the same anatomical structure were responsible for 13% of injuries. This compares well with the 15% of recurrent injuries recorded in the ACTRU competition.[6] These are, however, much lower percentages than the 56% of recurrent injuries recorded among professional rugby players competing in the Border Reivers district club competition. The high level of recurrent injuries in this study was attributed to the lack of a pre-season break from the sport, overtraining and early return to play after injury.[4] The reason for the large discrepancy between recurrent injury rates is unclear. The cumulative effect of recurrent injury and its long-term sequelae needs to be studied over time. Premature degeneration of the cervical spine has already been documented in rugby players.[15,16] In a study documenting the influence of rugby injuries on players' subsequent health and lifestyle, a small proportion of players have been found to suffer significant after-effects of rugby injuries. At least a further 20 years' follow-up has been proposed to determine further long-term sequelae.[17]

This and other studies have failed to reach a conclusion regarding the injury risk of specific playing positions. Most injuries are sustained in open play and ruck/maul situations, which are largely uncontrolled phases and not position-specific. The value of attempting to determine the playing position with the highest injury risk is therefore questionable.

This study and others have demonstrated convincingly that the tackle is the most dangerous phase of the game. Being tackled is more dangerous than tackling in most studies consulted.[1-6,10-12,15] Whereas safety in rucks and mauls can be controlled to an extent by applying stricter laws, it will be difficult to make the tackle much safer through law changes without changing the nature of the game. A study examining the nature and circumstances of tackle injuries in rugby union concluded that a high number of injuries in the tackle occurred when the player was going to ground. Tackle injuries were also most often associated with tackles to the trunk from the front. It was suggested that players be coached in falling technique and in tackling technique from the front, or that law changes are introduced to reduce the likelihood, or prohibit front-on tackles to the trunk.[18]

The high incidence of ligament sprains and musculo-tendinous strains/tears correlates well with data in other comparable studies.[2,3,5,6] The high number of injuries to the head and lower limb also confirms findings in previous studies.[2,3,5-7] All lacerations documented in this study occurred to the head region, as also recorded in two previous studies.[5-7] As also recorded in previous studies, joints of the lower limb were responsible for the most acute, serious injuries.[1-3,5]

The hip and groin areas were sites of the most severe chronic overuse injuries. Chronic overuse injuries accounted for 9.7% of injuries, of which 20% were of intermediate severity and 80% of severe nature. This represents a high percentage of injuries and has not been recorded as a separate entity in previous studies of this nature. The high percentage of recurrent injuries recorded in early season among professional players in the Border Reivers district of Scotland may reflect the same trend.[4] Long seasons, and lack of a proper end of season break for many professional players, may be partly responsible for the high occurrence of overuse injuries. Pre-season training programmes may also have had an influence, as most of the chronic overuse injuries were recorded in the first third of the season. Patterns and prevalence of recurrent and chronic overuse injuries in professional rugby must be studied further in order to make appropriate recommendations.

Only one case of concussion was recorded, confirming the previously recorded low incidence of this serious and often neglected injury.[1-3,5,6] Only one degenerative condition of the cervical spine was recorded in this study, but early degeneration of the cervical spine in rugby players has been recorded before.[15,16] A changing injury pattern from earlier studies where a higher incidence of serious, scrum-related neck injuries was reported, is noted.[12] One of the reasons for this may be the application of stricter rules in engaging, rotation and collapsing of the scrum. Although acute neck injuries have been reduced by these measures, data indicating chronic damage to the cervical spine are increasing. The reason for this type of injury may be the large forces experienced by front-row players during engagement of the scrum, which can exceed the threshold of injury to the spine.[19-21] These large forces are a consequence of the speed of engagement and the weight and number of players involved in the scrum.[19,20] A possible way of reducing these forces would be the introduction of a 'staggered scrum', where the first, second and third rows engage in succession.

A high injury rate was recorded during pre-season training and pre-season matches. Similar observations were made in previous studies, suggesting lack of match fitness, lack of general conditioning and inadequate off-season recovery time in professional rugby players.[3,4,6,10,12,15] An appropriate level of exercise tolerance, as well as reintroduction to the physical contact of the game well before the first games of the season, has been suggested.[6] In a review of anthropometric and physiological characteristics of rugby players, reduction in adiposity, improvement in flexibility, strength and aerobic capacity during the course of a season were reported.[22] This adds circumstantial evidence that lack of physical conditioning

may contribute to the high incidence of injuries early in a season.

Few injuries occurred during the first quarter of games. The finding in previous studies[7,8,11] that most injuries occurred during the final quarter of games was not shown in the current study. The evidence still suggests that injuries occur more frequently as a game progresses, suggesting that fatigue may be an important factor in injury aetiology. Attention should be given to factors contributing to fatigue during a game, such as lack of fitness, nutrition and hydration.[6] The failure to indicate higher injury rates in this study may be subsequent to the introduction of substitution of players in 1997, giving coaches the opportunity to substitute fatigued players.[5]

Conclusions

This study has confirmed the suspected high incidence of injuries in professional South African rugby players. It has also confirmed the previously recorded high incidence of musculotendinous strains and ligament sprains in rugby. The tackle has been confirmed as the most dangerous phase of play by far. Ways of reducing the high incidence of injury in the tackle phase include changing laws to prevent front-on tackling and to condition rugby players in techniques of going to ground in the tackle. Changing tackle laws may prove to be difficult without changing the nature of the game and should be approached cautiously. This study also confirmed previous findings of higher injury rates early in a season and late in games. The high incidence of injury early in a season may indicate lack of physical conditioning and lack of exposure to contact rugby. Gradual introduction to contact phases in pre-season training should be recommended to coaches. Higher injury rates later in games suggest fatigue as a cause of injury. The importance of physical fitness, proper nutrition and hydration and attention to recovery between matches, as well as the benefit of substituting fatigued players, are postulated as measures to reduce injury.

This study is the first to document injuries in professional rugby players in South Africa. Few studies providing good scientific data on injuries in professional rugby union are available. With rugby being a popular sport with a high incidence of injury, more should be done to collect epidemiological data on rugby injuries, in order to provide scientifically based information and recommendations to coaches and administrators to reduce the risk of injury. The national rugby unions, regional organising bodies and International Rugby Board are ideally situated to co-ordinate ongoing research of this kind. Research committees should also co-ordinate the study designs of future studies in order to provide more comparable data and to add to a collective data bank of injuries in professional rugby.

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