More than 50% of players sustained a time-loss injury (> 1 day of lost training or playing time) during the 2012 Super Rugby Union Tournament – A prospective cohort study of 17 340 player-hours

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Abstract:

Background: Professional rugby union is a contact sport with a high risk of injury.
Objective: To document the incidence and nature of time-loss injuries during the 2012 Super Rugby tournament.
Design: Prospective cohort study
Setting: 2012 Super Rugby tournament (Australia, New Zealand, South Africa)
Participants: 152 players from 5 South African teams
Methods: Team physicians collected daily injury data through a secure, web-based electronic platform. Data included size of the squad, type of day, main player position, training or match injury, hours of play (training and matches), time of the match injury, mechanism of injury, main anatomical location of the injury, specific anatomical structure of the injury, the type of injury, the severity of the injury (days lost).
Results: The proportion (%) of players sustaining a time-loss injury during the tournament (IPP) was 55%, and 25% of all players sustained >1 injury. The overall incidence rate (IR per

1000 player-hours) of injuries was 9.2. The IR for matches (83.3) was significantly higher than for training (2.1) and the IR was similar for forwards and backs. Muscle/tendon (50%) and joint/ligament (32.7%) injuries accounted for >80% of injuries. Most injuries occurred in the lower (48.1%) and upper limb (25.6%). 42% of all injuries were moderate (27.5%) or severe (14.8%), and tackling (26.3%) and being tackled (23.1%) were the commonest mechanisms of injury. The IR of injuries was unrelated to playing at home compared with away (locations $\geq$ 6 hours time difference).

Conclusion: 55% of all players were injured during the 4-month Super Rugby tournament (1.67 injuries / match). Most injuries occurred in the lower (knee, thigh) or upper limb (shoulder, clavicle). 42% of injuries were severe enough for players to not play for > 1 week.

Introduction

Rugby union has one of the highest reported incidences of match injuries amongst all professional sports [1]. The Super Rugby competition is played annually between professional rugby union teams from three rugby-playing nations in the Southern hemisphere (South Africa, New Zealand and Australia). Only three studies have reported the epidemiology of injuries in the Super Rugby tournament [2] [3] [4]. The first study was a pilot study where a single team was followed during the 1997 Super 12 Rugby season [2]. In this study, the injury rate of "significant" injuries was 45 / 1000 player-hours. There was no difference in the injury rate between the forwards and the backs, and most injuries were musculo-tendinous sprains and strains. The tackle was the most common phase of play responsible for injuries [2].

The first comprehensive study was conducted during the 1999 Super 12 Rugby tournament [3]. In this study, 3 teams of 25 players were followed and both training injuries and match injuries as well as missed training/ session injuries were documented [3]. In this study, the overall match injury rate was 55 / 1000 match player-hours and the overall training injury rate was 4.3 / 1000 training player-hours. Ligamentous sprains and musculo-tendinous strains were the most common injury types, and the tackle was responsible for the majority of injuries [3]. The results of these studies were reviewed in 2001 [5].

The most recent study was conducted during the 2008 Super 14 Rugby tournament. This study was part of a comparative study to document the impact of experimental law variations on the incidence and nature of match injuries [4]. In this study, 14 teams were followed during the tournament and the incidence of time-loss match injuries was 96 / 1000 match player-hours. There was no significant difference in the incidence of match injuries in forwards and backs. The majority of injuries were joint/ligament injuries, followed by musculo-tendious injuries. The majority of injuries were associated with the tackle phase of the game [4]. In this study, training injuries were not reported. As the definition of an injury varied in these three studies, the injury rates cannot be compared. Only in the most recent study [4], was the current consensus on injury definition and data collection procedures for rugby injuries applied [6].

Currently, 15 teams from the Southern hemisphere play this tournament over a 4-month period from the late summer to the early winter period each year. The tournament is particularly demanding because: 1) the tournament is played over a much longer duration (currently 16 weeks) compared with many other international tournaments (usually $\leq$ 7 weeks duration), 2) in 2005, and more recently in 2011, there have been increases in the number of participating teams, resulting in the current long duration of the tournament, 3) matches are played weekly by each of the teams, 4) teams are awarded bonus points for tries, which encourages a more open, flowing style of play that could result in an increased tackle count during matches, and 5) unlike in other tournaments that are played in one geographical location, players in the Super Rugby tournament also have to contend with demanding travelling schedules across multiple time zones as matches are played in venues of each of the three countries.

This tournament may therefore be associated with an increased the risk of injuries. Furthermore, to our knowledge, the association between inter-continental travel and risk of injuries in rugby union has not been studied. Therefore, we studied the incidence and factors associated with injuries in five South African Super Rugby teams during the 16-week 2012 Super Rugby competition.

Methods

Type of study

This was a prospective cohort study involving 152 players from five South African Super Rugby teams over the 2012 Super Rugby tournament.

Participants

The Clinical Sport and Exercise Medicine Research Group of the UCT/MRC Research Unit for Exercise Science and Sport Medicine of the University of Cape Town conducted the study. This was a joint project with the Medical Committee of the South African Rugby Football Union (SARFU). All the players from the 5 participating teams were considered potential participants in the study. Each of the team physicians accompanying the teams was provided with detailed information about the study. The team physicians then briefed all the players about the details of the study. Written informed consent was obtained from the players. Prior to commencing the study, approval was obtained from the University of Cape Town Research Ethics Committee (REC 008/2011). The demographic data for the study population is depicted in Table 1.

Table 1. Demographic data for the study population (all players, teams and player position) Values are mean (SD)

		N° of players	Age (years)	Body Mass (kg)	Height (m)	Body Mass Index (kg/m^2)
All players		152	25.0 (3.4)	101.5 (12.1)	1.87 (0.07)	29.1 (2.9)
Teams	**A**	18 *	22.7 (3.3)	105.6 (12.9)	1.87 (0.07)	29.9 (3.4)
	B	29	25.9 (3.6)	101.1 (11.5)	1.86 (0.07)	29.3 (2.4)
	C	33	24.8 (3.4)	99.4 (12.4)	1.86 (0.07)	28.6 (2.8)
	D	35	25.7 (3.1)	100.9 (13.0)	1.86 (0.07)	29.1 (3.3)
	E	37	25.0 (3.1)	102.3 (11.3)	1.88 (0.07)	28.9 (2.8)
Main player position	**Forwards**	85	24.9 (3.3)	110.0 (7.9)	1.89 (0.07)	30.7 (2.8)
	Backs	67	25.2 (3.6)	90.5 (6.3)	1.83 (0.06)	27.0 (1.5)

*: Only 18 of the approximately 34 players in this team gave consent to participate in the study. There were no significant differences in the age (p=0.278), height (p=0.456) and body mass (p=0.899) between the Teams.

Injury data collection

In this study, injuries were defined according to the "Consensus Statement on Injury Definitions and Data Collection Procedures for Studies of Injuries in Rugby Union" [6]. Both medical attention injuries (requiring medical intervention but not resulting in loss of training or match play > 1 day), and time loss injuries (preventing playing in matches or training for > 1 day) were recorded. However, for the purposes of comparison with other studies, only time loss injuries will be reported in this manuscript. The severity of time loss injuries was subdivided into the following categories, according to the number of days that players were unable to train or play matches: minimal (2-3 days), mild (4-7 days), moderate (8-28 days) and severe (>28 days) [6].

The team physicians of the participating teams collected injury data during the tournament. Each team physician was provided with a laptop or portable tablet to collect the data through a secure, web-based electronic platform that was specifically designed for this purpose. Data capture commenced a few days before the start of the tournament and ended after each of the teams played their last game. The team physician reported the following daily data: size of the squad (number of players), type of day (rest day, training day or match day, travel day was recorded as a rest day), team training hours, and whether or not a player was injured. If a player injury was reported, the following specific details were recorded: new or recurrent injury, playing conditions at the time of injury (surface type, condition of surface, weather conditions), main player position (forwards, backs), training or match injury, time of the match injury (which quarter of the game), and the mechanism of injury. Finally, the main anatomical location of the injury, the specific anatomical structure of the injury, the type of injury (muscle/tendon, joint/ligament, skin, bone, brain/CNS), and the severity of the injury (days lost from training or matches) was recorded. More than one injury could be recorded and two injuries in the same player were recorded as separate injuries. The electronic data collection system allowed the research team to monitor data input (logging in and entering data) on a daily basis. This allowed the research team to contact team physicians if data entry was not done regularly. There was contact between the central research office and the participating physicians via email or telephone to discuss any difficulties with the technical recording of injuries. Complete daily data entry at the end of the tournament was confirmed.

In this manner, compliance of the team physicians could be verified, and a 100% compliance for daily entry of data was achieved.

A system of coding was used to ensure player confidentiality. Teams and players were allocated random numbers, and these were kept in sealed envelopes until after completion of the tournament. All data were securely stored and accessed by the central research office only at the end the tournament.

Calculation of the player-hours (training and match)

The team physicians also recorded the number of hours of training performed by their team on training days. Daily training player-hours for each team were calculated as the number of team training hours x the number of players in the team on that day. It was assumed that all players in the team participated in the entire training sessions. The total training player-hours were calculated as the sum of all the daily training player-hours for each team over the study period.

The usual total duration of a rugby union match is 80 min (1.33 hours of play). Match player-hours for one team playing a match was calculated as 1.33 x 15 players (20 match player-hours). The total match player-hours for a team were calculated as 20 x the number of match days for a team. For team A, with only 18 players consenting, 7.9 instead of 15 players per match were counted. The 7.9 was the proportion (18/34) of the 15 players counted for a match in a team size of 34. In addition, injury data will also be expressed as the number of player-hours until an injury occurs (1 injury per number of player-hours).

The total number of player-hours (all, training, match) for all teams, individual teams, as well as main player positions (forwards and backs), is depicted in Table 2.

Table 2. Player-hours (all, training, match) for all players, individual teams and main player positions (forwards and backs)

		All player-hours	Training player-hours	Match player-hours
All players	All players	17340	15828	1512
	Forwards	9248	8442	806
	Backs	8092	7386	706
Team A	All players	1948	1763	185
	Forwards	1039	940	99
	Backs	909	823	86
Team B	All players	3363	3051	312
	Forwards	1793	1627	166
	Backs	1570	1424	146
Team C	All players	4658	4287	371
	Forwards	2484	2286	198
	Backs	2174	2001	173
Team D	All players	3469	3157	312
	Forwards	1850	1684	166
	Backs	1619	1473	146
Team E	All players	3902	3570	332
	Forwards	2081	1904	177
	Backs	1821	1666	155

Statistical analysis of data

Data were in the form of counts, i.e. the number of injuries each player sustained, and number of players injured. The proportion of injured players (injured player proportion – IPP)(also known as a period prevalence) was calculated as the % of players injured during the tournament. In addition, the IPP for different grades of injury severity are also reported. Standard descriptive statistical analyses were conducted. For injuries, these include numbers, proportions / percentages (including 95% confidence intervals) and incidences (including exact 95% confidence intervals) of injuries in the total sample as well as sub groups according to matches vs. training, main player position, main and specific anatomical location of injury, injury severity categories, period of matches and geographical location.

The incidence of injury was calculated as injuries per 1000 player-hours of training (training injuries) and match play (match injuries). This enables comparison to the incidence of injuries during matches (match player-hours) to training (training player-hours) reported in other studies and followed the international guidelines for injury reporting in rugby union [6]. The

incidence and severity of injuries was recorded for both forwards and backs and the incidence of injuries was grouped by severity and main player position. The anatomical location of injury was analysed both in training and match play, with incidence and mean severity of match injuries as a function of playing position. Injury type was documented, with incidence and mean severity of training/match injuries. The most common match/training injuries were reported, as was severity of injuries (in terms of time lost). Training activity, phase of play and time period in a match when the injury was sustained, were investigated.

Results

Injured player proportion (IPP)(Period prevalence) of time-loss injuries in all players

During the tournament, 160 time-loss injuries were recorded in 83 players. The proportion of players sustaining a time-loss injury (IPP) during the tournament was therefore 54.6%. The IPP during the tournament for injuries, by injury severity, was as follows: 19.7% for minimal and mild injuries (2-7 days missed), 20.4% for moderate injuries (8-28 days missed), and 14.5% for severe injuries (> 28 days missed). Therefore, 34.9% of players sustained an injury during the tournament that was severe enough to prevent training or playing in a match for 8 days or more. Furthermore, 38 of all players (25% of all players) sustained more than one time-loss injury during the tournament. Most of the injuries (126/160; 78.8%) occurred during matches, compared with training (34/160; 21.2%).

Incidence of all time loss injuries (all, match and training injuries)

A total of 17 340 player-hours were monitored during the tournament, of which 1 512 were match player-hours, and 15 828 were training player-hours. The overall incidence of time-loss injuries was 9.2 per 1000 player-hours (95% CI: 7.9 – 10.8). The incidence of match injuries (per 1000 player-hours) was significantly greater (83.3; 95% CI: 69.4-99.2) compared with training injuries (2.1; 95% CI: 1.5-3.0). Injury rates (per 1000 player-hours) were not significantly different between individual teams.

Main player position (forwards and backs)

In forwards, a total of 95 injuries were recorded, while 65 injuries occurred in back players. The number of injuries, playing hours (match and training) and the incidence of all injuries (per 1000 player-hours) and injuries during matches and training in forwards and backs is depicted in Table 3.

Table 3. The incidence of injuries (injuries per 1000 player-hours) (95%CI) in all players, forwards, and backs during matches and training

		Number of time loss injuries	Player-hours	Incidence of injuries / 1000 player-hours	95% CI	
All injuries	Forwards	95	9248	10.3	8.3	12.6
	Backs	65	8092	8.0	6.2	10.2
Match injuries	Forwards	75	806	93.0	73.2	116.6
	Backs	51	706	72.3	53.8	95.0
Training injuries	Forwards	20	8442	2.4	1.4	3.7
	Backs	14	7386	1.9	1.0	3.2

The incidence of injuries in forwards was not significantly higher compared with injuries in backs for all injuries (forwards 10.3; 95% CI: 8.3-12.6; backs 8.0; 95% CI: 6.2-10.2)(p=0.125), match injuries (forwards 93.0; 95% CI: 73.2-116.6; backs 72.3; 95% CI: 53.8-95.0) and training injuries (forwards 2.4; 95% CI: 1.4-3.7; backs 1.9; 95% CI: 1.0-3.2).

Main anatomical location (all players, forwards and backs)

The incidence of all injuries (per 1000 player-hours) by main anatomical location for all players, forwards and backs is depicted in Table 4.

Table 4. Frequency (% of injuries) and incidence (per 1000 player-hours) of all injuries and match injuries in all players, main player positions (forwards and backs), and by main anatomical location of injury

		Main anatomical location	n	%	Player-hours	IR	95% CI	
All injuries	**All players**	**Head/neck**	21	13.1	17340	1.2	0.7	1.9
		Upper limb	41	25.6	17340	2.4	1.7	3.2
		Trunk	21	13.1	17340	1.2	0.7	1.9
		Lower limb	77	48.1	17340	4.4	3.5	5.6
	Forwards	**Head/neck**	14	14.7	9248	1.5	0.8	2.5
		Upper limb	26	27.3	9248	2.8	1.8	4.1
		Trunk	11	11.6	9248	1.2	0.6	2.1
		Lower limb	44	46.3	9248	4.8	3.5	6.4
	Backs	**Head/neck**	7	10.8	8092	0.9	0.3	1.8
		Upper limb	15	23.1	8092	1.9	1.0	3.1
		Trunk	10	15.4	8092	1.2	0.6	2.3
		Lower limb	33	50.8	8092	4.1	2.8	5.7
Match injuries	**All players**	**Head/neck**	19	15.1	1512	12.6	7.6	19.6
		Upper limb	38	30.2	1512	25.1	17.8	34.5
		Trunk	17	13.5	1512	11.2	6.6	18.0
		Lower limb	52	41.3	1512	34.4	25.7	45.1
	Forwards	**Head/neck**	12	16.0	806	14.9	7.7	26.0
		Upper limb	23	30.7	806	28.5	18.1	42.8
		Trunk	9	12.0	806	11.2	5.1	21.2
		Lower limb	31	41.3	806	38.4	26.1	54.6
	Backs	**Head/neck**	7	13.7	706	9.9	4.0	20.4
		Upper limb	15	29.4	706	21.3	11.9	35.1
		Trunk	8	15.7	706	11.3	4.9	22.3
		Lower limb	21	41.2	706	29.8	18.4	45.5

n=Number of time-loss injuries
%: % Of injuries in all players, forwards and backs-the % are out of the total number of injuries, not the total number of players
IR: Incidence rate per 1000 player-hours

All injuries

The majority of injuries in all players occurred in the lower limb (48.1%), followed by the upper limb (25.6%). Less commonly the trunk (13.1%) and the head/neck region (13.1%) were affected. The majority of the injuries in the forwards occurred in the lower limb (46.3%), followed by the upper limb (27.4%). Less commonly the head/neck region (14.7%) and the trunk (11.6%) were affected. The majority of the injuries in the backs occurred in the lower limb (50.8%), followed by the upper limb (23.1%). Less commonly the trunk (15.4%) and the head/neck region (10.8%) were affected.

Match injuries

The majority of the match injuries in all players occurred in the lower limb (41.3%), followed by the upper limb (30.2%). Less commonly the head/neck region (15.1%) and the trunk (13.5%) were affected. The majority of match injuries in the forwards occurred in the lower limb (41.3%), followed by the upper limb (30.7%). Less commonly the head/neck region (16.0%) and the trunk (12.0%) were affected. The majority of match injuries in the backs occurred in the lower limb (41.2%), followed by the upper limb (29.4%). Less commonly the trunk (15.7%) and the head/neck region (13.7%) were affected.

Specific anatomical structure

The incidence of time-loss injuries (per 1000 player-hours)(all, match, training) by specific anatomical structure for all players is depicted in Table 5.

Table 5. The incidence of time-loss injuries (per 1000 player-hours) (all, match, training) by specific anatomical structure of injury

			n	IR	95% CI	
All injuries	**Head/neck**	**All head/neck injuries**	**21**	**1.2**	**0.7**	**1.9**
		Head / Face	18	1.0	0.6	1.6
		Neck / Cervical spine	3	-	-	-
	Upper limb	**All upper limb injuries**	**41**	**2.4**	**1.7**	**3.2**
		Shoulder / Clavicle	27	1.6	1.0	2.3
		Upper arm / forearm / elbow	5	0.3	0.1	0.7
		Hand / Fingers / Wrist	9	0.5	0.2	1.0
	Trunk	**All trunk injuries**	**21**	**1.2**	**0.7**	**1.9**
		Upper trunk / Chest / Thorax / Rib	9	0.5	0.2	1.0
		Lower back / Lumbar	7	0.4	0.2	0.8
		Pelvis / Sacrum / Abdomen	5	0.3	0.1	0.7
	Lower limb	**All lower limb injuries**	**77**	**4.4**	**3.5**	**5.6**
		Hip / Groin	11	0.6	0.3	1.1
		Thigh	19	1.1	0.7	1.7
		Knee	25	1.4	0.9	2.1
		Ankle	8	0.5	0.2	0.9
		Foot/ Toe	6	0.3	0.1	0.8
		Lower leg	8	0.5	0.2	0.9
Match injuries	**Head/neck**	**All head/neck injuries**	**19**	**12.6**	**7.6**	**19.6**
		Head / Face	17	11.2	6.6	18.0
		Neck / Cervical spine	2	-	-	-
	Upper limb	**All upper limb injuries**	**38**	**25.1**	**17.8**	**34.5**
		Shoulder / Clavicle	25	16.5	10.7	24.4
		Upper arm / forearm / elbow	4	-	-	-
		Hand / Fingers / Wrist	9	6.0	2.7	11.3
	Trunk	**All trunk injuries**	**17**	**11.2**	**6.6**	**18.0**
		Upper trunk / Chest / Thorax / Rib	9	6.0	2.7	11.3

		Lower back / Lumbar	4	-	-	-
		Pelvis / Sacrum / Abdomen	4	-	-	-
	Lower limb	**All lower limb injuries**	**52**	**34.4**	**25.7**	**45.1**
		Hip / Groin	7	4.6	1.9	9.5
		Thigh	10	6.6	3.2	12.2
		Knee	22	14.6	9.1	22.0
		Ankle	5	3.3	1.1	7.7
		Foot/ Toe	3	-	-	-
		Lower leg	5	3.3	1.1	7.7
Training injuries	**Head/neck**	**All head/neck injuries**	**2**	**0.1**	**0.0**	**0.5**
		Head / Face	1	-	-	-
		Neck / Cervical spine	1	-	-	-
	Upper limb	**All upper limb injuries**	**3**	**0.2**	**0.0**	**0.6**
		Shoulder / Clavicle	2	-	-	-
		Upper arm / forearm / elbow	1	-	-	-
		Hand / Fingers / Wrist	-	-	-	-
	Trunk	**All trunk injuries**	**4**	**0.3**	**0.1**	**0.6**
		Upper trunk / Chest / Thorax / Rib	-	-	-	-
		Lower back / Lumbar	3	-	-	-
		Pelvis / Sacrum / Abdomen	1	-	-	-
	Lower limb	**All lower limb injuries**	**25**	**1.6**	**1.0**	**2.3**
		Hip / Groin	4	-	-	-
		Thigh	9	0.6	0.3	1.1
		Knee	3	-	-	-
		Ankle	3	-	-	-
		Foot/ Toe	3	-	-	-
		Lower leg	3	-	-	-

n=Number of injuries
IR: Incidence rate per 1000 player-hours
Incidence rate and 95%CI are only reported for n $\geq$ 5

All injuries

The specific anatomical structure with the highest incidence of all injuries (per 1000 player-hours) was the shoulder / clavicle (1.6), followed by the knee (1.4), thigh (1.1) and the head / face (1.0).

Match injuries

The specific anatomical structure with the highest incidence of all match injuries (per 1000 match player-hours) was the shoulder / clavicle (16.5), followed by the knee (14.6), and the head / face (11.2).

Training injuries

The specific anatomical structure with the highest incidence of all training injuries (per 1000 training player-hours) was the thigh (0.6).

Type of injuries

The frequency and incidence of injuries by type of injury for all injuries, match injuries, and training injuries is depicted in Table 6. For all injuries, the detail about the type of injury was available in 150/160 (93.8%) injuries, 119 match and 31 training injuries (Table 6.).

Table 6. Incidence (per 1000 player-hours) and frequency (% of all injuries) of all injuries, match injuries and training injuries by tissue type

	Anatomical type	n	%	IR	95% CI	
All injuries	Muscle/tendon	75	50.0	4.3	3.4	5.4
	Joint/ligament	49	32.7	2.8	2.1	3.7
	Skin	6	4.0	0.3	0.1	0.8
	Bone	10	6.7	0.6	0.3	1.1
	Brain/CNS	10	6.7	0.6	0.3	1.1
Match injuries	Muscle/tendon	55	46.2	36.4	27.4	47.4
	Joint/ligament	40	33.6	26.5	18.9	36.0
	Skin	6	5.0	4.0	1.5	8.6
	Bone	9	7.6	6.0	2.7	11.3
	Brain/CNS	9	7.6	6.0	2.7	11.3
Training injuries	Muscle/tendon	20	64.5	1.3	0.8	2.0
	Joint/ligament	9	29.0	0.6	0.3	1.1
	Skin	0	-	-		
	Bone	1	3.2	-		
	Brain/CNS	1	3.2	-		

n=Number of injuries (n=150)
%: % of injuries
IR: Incidence rate per 1000 player-hours

The majority (> 90%) of injuries (all, match, and training) occurred in the soft tissues (muscle, tendon, ligament, skin, brain or CNS). Of the soft tissues, muscle / tendon injuries accounted for the majority of all injuries (50.0%), match injuries (46.2%) and training injuries (64.5%). This was followed by joint / ligament injuries (all injuries=32.7%, match injuries=33.6%, and training=29.0%). During matches, the incidence of musculo-tendinous injuries (IR=36.4 / 1000 player-hours; 1 in 27.5 player-hours) and joint / ligament injuries

(IR=26.5 / 1000 player-hours; 1 in 37.7 player-hours) is notably higher than the incidence of injuries in all other tissue types.

Injury severity

The severity of injuries was classified according to number of days lost. These data were available for 149 of the 160 time loss injuries (93.1% of all injuries), 122 match and 27 training injuries. The frequency (% of injuries) and incidence (per 1000 player-hours) for all injuries, match injuries and training injuries by grades of severity is depicted in Table 7.

Table 7. The frequency (% injuries) and incidence (per 1000 player-hours) of injuries by grades of severity of injuries (all, match and training)

	Injury severity	**n**	**%**	**IR**	**95% CI**	
All injuries	Minimal (2-3 days)	49	32.9	2.8	2.1	3.7
	Mild (4-7 days)	37	24.9	2.1	1.5	2.9
	Moderate (8-28 days)	41	27.5	2.4	1.7	3.2
	Severe (> 28 days)	22	14.8	1.3	0.8	1.9
Match injuries	Minimal (2-3 days)	43	35.2	28.4	20.6	38.3
	Mild (4-7 days)	32	26.2	21.2	14.5	29.9
	Moderate (8-28 days)	30	24.6	19.8	13.4	28.3
	Severe (> 28 days)	17	13.9	11.2	6.6	18.0
Training injuries	Minimal (2-3 days)	6	22.2	0.4	0.1	0.8
	Mild (4-7 days)	5	18.5	0.3	0.1	0.7
	Moderate (8-28 days)	11	40.7	0.7	0.3	1.2
	Severe (> 28 days)	5	18.5	0.3	0.1	0.7

n=Number of injuries (missing data in 11 injuries)
%: % of injuries
IR: Incidence rate per 1000 player-hours

All injuries

The majority of injuries were of minimal or mild severity (> 57%). Moderate and severe injuries accounted for 27.5 % and 14.8% of all injuries respectively.

Match injuries

The majority of match injuries were also of minimal or mild severity (> 60%) and moderate or severe match injuries accounted for 24.6 and 13.9% of all match injuries respectively. The incidence of moderate and severe match injuries was 19.8/1000 player-hours (95% CI 13.4-28.3; 1 in 51 match player-hours) and 11.2/1000 player-hours (95% CI 6.6-18.0; 1 in 89 match player-hours) respectively.

Training injuries

Although the overall incidence of training injuries was low (2.1; 95% CI: 1.5-3.0), the majority of all training injuries, in contrast to match injuries, were of moderate or severe nature (> 59.2%). Moderate and severe training injuries accounted for 40,7 % and 18,5% of all training injuries respectively.

The frequency (% of injuries) and incidence (per 1000 player-hours) for all injuries and match injuries by severity in the main anatomical locations are depicted in Table 8.

Table 8. The incidence (per 1000 player-hours) and frequency (% injuries) of grades of severity of injuries (all, match) by main anatomical location

		Injury severity	n	%	IR	95% CI	
All injuries	**Head / neck**	Minimal (2-3 days)	9	42.9	0.5	0.2	1.0
		Mild (4-7 days)	6	28.6	0.3	0.1	0.8
		Moderate (8-28 days)	5	23.8	0.3	0.1	0.7
		Severe (> 28 days)	1	4.8	-	-	-
	Upper limb	Minimal (2-3 days)	9	24.3	0.5	0.2	1.0
		Mild (4-7 days)	14	37.8	0.8	0.4	1.4
		Moderate (8-28 days)	3	8.1	0.2	0.0	0.5
		Severe (> 28 days)	11	29.7	0.6	0.3	1.1
	Trunk	Minimal (2-3 days)	12	60.0	0.7	0.4	1.2
		Mild (4-7 days)	4	20.0	-	-	-
		Moderate (8-28 days)	3	15.0	-	-	-
		Severe (> 28 days)	1	5.0	-	-	-
	Lower limb	Minimal (2-3 days)	19	26.8	1.1	0.7	1.7
		Mild (4-7 days)	13	18.3	0.7	0.4	1.3
		Moderate (8-28 days)	30	42.3	1.7	1.2	2.5
		Severe (> 28 days)	9	12.7	0.5	0.2	1.0
Match injuries	**Head / neck**	Minimal (2-3 days)	8	42.1	5.3	2.3	10.4
		Mild (4-7 days)	6	31.6	4.0	1.5	8.6
		Moderate (8-28 days)	5	26.3	3.3	1.1	7.7
		Severe (> 28 days)	0	-	-	-	-
	Upper limb	Minimal (2-3 days)	9	25.7	6.0	2.7	11.3
		Mild (4-7 days)	13	37.1	8.6	4.6	14.7
		Moderate (8-28 days)	3	8.6	-	-	-
		Severe (> 28 days)	10	28.6	6.6	3.2	12.2
	Trunk	Minimal (2-3 days)	10	58.8	6.6	3.2	12.2
		Mild (4-7 days)	4	23.5	-	-	-
		Moderate (8-28 days)	2	11.8	-	-	-
		Severe (> 28 days)	1	5.9	-	-	-
	Lower limb	Minimal (2-3 days)	16	31.4	10.6	6.0	17.2
		Mild (4-7 days)	9	17.6	6.0	2.7	11.3
		Moderate (8-28 days)	20	39.2	13.2	8.1	20.4
		Severe (> 28 days)	6	11.8	4.0	1.5	8.6

n=Number of injuries
%: % of injuries
IR: Incidence rate per 1000 player-hours
Incidence rates and 95%CI are only reported for $n \geq 5$

All injuries

The majority of all injuries to the head and neck, upper limb, and trunk were of minimal or mild severity (> 57%). However, 55% of all lower limb injuries were graded as moderate (42.3%) or severe (12.7%).

Match injuries

Similarly, the majority of match injuries to the head and neck, upper limb, and trunk were of minimal or mild severity (> 50%). However, 51% of all lower limb injuries were graded as moderate (39.2%) or severe (11.8%).

Training injuries

The number of training injuries in each sub-category of severity was too small for meaningful statistical analysis.

Match injuries at different periods in the match

The frequency (%) of match injuries during different periods in the match, and by severity of the injury, is depicted in Table 9. The period was reported for 125 of the 126 match injuries.

Table 9. The frequency (% match injuries) during different quarters of matches and for different severity of injury

Period in match	All match injuries	%	Minimal	%	Mild	%	Moderate	%	Severe	%
1st quarter	22	17.6	3	7.0	7	22.6	7	23.3	4	23.5
2nd quarter	33	26.4	8	18.6	11	35.5	10	33.3	4	23.5
3rd quarter	29	23.2	13	30.2	6	19.4	6	20.0	4	23.5
4th quarter	39	31.2	18	41.9	7	22.6	6	20.0	5	29.4
Cool-down	2	1.6	1	2.3	0	0.0	1	3.3	0	0.0

%: % of injuries

The majority of match injuries (> 50%) occurred in the third and fourth quarter of the match. In general, this trend holds for all degrees of severity of injuries, with the exception of match injuries classified as mild and moderate severity. Very few injuries (< 2%) occurred during the cool down phase after a match.

Mechanism of injuries

The mechanism associated with all injuries, match injuries and training injuries (%) is depicted in Table 10.

Table 10. Main mechanisms of all injuries, match injuries and training injuries (training activity at the time of a training injury) in all players

	Main mechanisms	n	%
All injuries (n=160)	Kicking	3	1.9
	Collision	9	5.6
	Ruck	13	8.1
	Running	18	11.3
	Scrum	6	3.8
	Tackled	32	20.0
	Tackling	37	23.1
	Other *	42	26.3
Match injuries (n=126)	Kicking	2	1.6
	Collision	6	4.8
	Ruck	11	8.7
	Running	9	7.1
	Scrum	5	4.0
	Tackled	31	24.6
	Tackling	36	28.6
	Other *	26	20.6
Training injuries (n=34)	Kicking	1	2.9
	Collision	3	8.8
	Ruck	2	5.9
	Running	9	26.5
	Scrum	1	2.9
	Tackled	1	2.9
	Tackling	1	2.9
	Other *	16	47.1

n=Number of injuries
%: % of injuries
*: Includes “Other non-contact”, “Other contact”, “Not known” or “Not identified”

The most common specified mechanism for all injuries and match injuries was tackling (all=23.1%; match=28.6%) or being tackled (all=20.0%; match=24.6%). Other mechanisms, not listed, were associated with the majority of training injuries (47.1%) and also accounted for a significant proportion of all injuries (26.3%) and match injuries (20.6%).

Intercontinental travel and playing in locations ≥ 6 hours time difference

In this study, a crude analysis of the effects of travelling across ≥ 6 time zone differences on the incidence of all time-loss injuries, match injuries and training injuries could be explored (Table 11).

Table 11: The incidence of injuries (per 1000 player-hours) for all injuries, match injuries and training injuries at a home location (matches and training in the home country) or an away location (matches and training in a location ≥ 6 time zone differences; Australia or New Zealand)

	Home location					Away location				
	Player-hours	**n**	**IR**	**95% CI**		**Player-hours**	**n**	**IR**	**95% CI**	
All	13967	126	9.0	7.5	10.7	3373	34	10.1	7.0	14.1
Matches	1100	100	90.9	74.0	110.6	412	26	63.1	41.2	92.5
Training	12867	26	2.0	1.3	3.0	2961	8	2.7	1.2	5.3

n: number of injuries
IR: Incidence rate per 1000 player-hours

There were more home location vs. away location player-hours because the South African teams played all matches (matches in their own city and the opponents' city) against each other in the home country (South Africa). All matches against New Zealand or Australian teams consisted of at least one match in the home country and one match in the away (foreign) location. There was no significant difference in the incidence of all injuries (expressed as per 1000 player-hours), match injuries or training injuries when play took place in the home country compared with a foreign location (≥ 6 time zone differences).

The incidence of injury (expressed as injuries per 1000 player days) when playing at the home locations (9.0; 95% CI: 7.5 to 10.7) was not significantly different to playing at the away locations (10.1; 95% CI: 7.0 to 14.1).

Discussion

The main findings of this study in the 2012 Super Rugby tournament over ≈ 16 weeks were as follows: a) almost 55% of all players sustained a time-loss injury during the tournament, and 25% of players sustained more than one time-loss injury, b) the overall incidence of time-loss

injuries was 9.2 per 1000 player-hours, and the incidence of match injuries (83.3) was significantly higher compared with training injuries (2.1), c) the incidence of injuries in forwards and backs was not significantly different, d) the main anatomical location of injuries was the lower limb (48.1%) followed by the upper limb (25.6%), e) the specific anatomical location with the highest incidence of injury was the shoulder/clavicle followed by the knee and thigh, f) soft tissue injuries to the muscle/tendon (50% of injuries) or joints/ligaments (32.7%) accounted for >80% of all injuries, g) injuries were classified as moderate (27.5%) or severe (14.8%) in 42% of all injuries, and these were mainly in the lower limb (62%), h) most match injuries occurred in the latter stages of a game, and i) tackling (26.3%) and being tackled (23.1%) were the most common mechanisms of injury. Finally, preliminary data show that the incidence of time-loss injuries (all, match injuries and training) was not related to playing and training at the home country location compared with an away location (following intercontinental travel to play in different locations $\geq$ 6 hours time difference).

Injured player proportion (IPP)

In this study, we have shown an IPP of almost 55%. This means that 55% of all the players starting the tournament sustained a time-loss injury during this tournament, This finding is of concern, particularly as 20.4% of players will sustain a moderate injury (8-28 days lost) (6-7 players in a squad of 3-34 players) and 14.5% of players will sustain a severe injury (> 28 days lost) (4-5 players in a squad of 3-34 players). Furthermore, 25% of players sustained more than one injury (about 8 players in a squad of 30-34 players). The injured player proportion (IPP) has not been reported in previous studies during tournaments. However, IPP can be estimated from raw data presented in these studies. In the two previous Super Rugby studies, the estimated IPP varies between 64% of the 75 players in the 1999 Super Rugby tournament (14 weeks) [3] to 82% of the 441 players in the 2008 Super Rugby tournament (16 weeks) [4]. In the 7-week Rugby World Cup tournaments, only 2% of 416 players were injured in the 1995 Rugby World Cup, while the IPP is estimated as 26-34% of the approximately 615 players in the 2003 [7], 2007 [8], and 2011 [9] Rugby World Cup competitions (7 weeks). These estimates are likely to overestimate the IPP as the number of players with more than one injury were not reported in these studies. Even if there is an overestimation of the IPP in these studies, our data indicate that there is at least a 2 times higher proportion of players who will sustain an injury in the Super Rugby tournament compared with a player in the Rugby World Cup.

The reason for this is largely related to the duration of the tournament, but there is not necessirily a linear relationship between the number of exposure weeks, and the proportion of injured players. Other factors such as progressive player fatigue, repeated injuries in the same player (25% in our study) and other factors may contribute to the increased proportion of players that are injured in more prolonged tournaments. Indeed, evidence for this comes from one of the earliest study in the Super Rugby tournament, where it was reported that injuries that caused a player to miss a game occurred almost exclusively in the pre-season program or the final third of the season [2]. Therefore, we believe that to report the IPP (for all injuries and for different grades of injury severity) in tournaments of different durations, is of value and needs to be explored in future studies. More specifically, we believe the IPP has important practical clinical value to the team physician who is responsible for planning how many players are likely to be injured during a tournament so that injury prevention and management strategies for rehabilitation and return to play can be instituted. Finally, team coaches and team managers will benefit from knowing the IPP for tournaments of different durations so that the squad size and logistical arrangements for rehabilitation or transport of injured players can be planned.

Incidence of match injuries

In the recently published meta-analysis, the overall incidence of match injuries in senior men's professional Rugby union was reported as 81 per 1000 player-hours [1]. Our data are consistent with this reported overall incidence of match injuries in senior men’s professional rugby union. However, our data can only be compared to the data from two of the three studies during the Super Rugby tournament [3] [4]. In the one study, the definition of injury is substantially different from the definition that we used, and a true comparison is not strictly valid [2]. Therefore, our data can only be compared to the incidence of match injuries reported in two Super Rugby studies. The incidence of match injuries in our study (83.3) was considerably higher than that reported by Holzhausen et al. (2006) (55) [3], but lower then that reported by Fuller et al. (2009) (96) [4]. The precise reasons for this wide discrepancy are not clear. However, there have been changes to rules and their application, number of teams competing in the tournament, scheduling of the tournament, and individual team strategies for injury prevention during the last 5 to 6 years. Therefore, it is not possible to accurately interpret the differences in the incidences of injury in these three studies.

Incidence of training injuries

In our study, we also documented the incidence of training injuries. The incidence of training injuries in our study (2.1 per 1000 player-hours) is very consistent with the incidence of training injuries that was reported in the meta-analysis of injuries in men's professional Rugby union (2-4 per 1000 player-hours). We could only compare the incidence of training injuries in our study to one other study in Super Rugby (4 per 1000 player-hours) [3]. Finally, our data are consistent with all the published data showing a considerably higher incidence of injuries in matches compared with training [1]. We suggest that an on-going surveillance program to document injuries (mainly match injuries) during this tournament be instituted so that risk factors for injury can be identified, injury prevention strategies can be planned, and outcomes of implementation strategies be measured.

Injuries by player position, anatomical region and type of injury

Our data showed that more injuries occurred in the lower limb region (48.1%), than in the upper limb region (25.6%). These data are similar for match injuries alone, and when forwards are compared with backs. This observation is also very consistent with the data reported in the meta-analysis on injuries in men's professional rugby union [1]. Knee and thigh injuries were the most common lower limb injuries, and this is also consistent with most previous studies of injuries in men's professional rugby union [1].

The majority (>80%) of all injuries in our study affected soft tissue structures, particularly the muscles/tendons (50% of injuries) and joints/ligaments (32.7%). These data are similar if match, and training injuries are analysed separately. Once again, these data are consistent with the majority of studies published on injuries in men's professional rugby union [1].

Injury severity

Our incidence (per 1000 match player-hours) of injuries classified as of minimal severity (28.4) appears to be slightly higher that that reported for minimal injuries in the meta-analysis (17; 95% CI: 15-19). Our incidence of mild (21.2) match injuries is similar to that reported in the meta-analysis of injuries in men's professional rugby union (23; 95% CI: 20-26), while the incidence of moderate (19.8), and severe (11.2) injuries in our study is lower than that reported in the meta-analysis for moderate (28; 05% CI: 25-31), and severe (15; 95% CI: 13-

17) injuries [1]. Therefore, the overall profile of the severity of injuries in our study indicated a spectrum of less severe injury compared with that reported in the meta-analysis. The severity of training injuries has never been reported in the Super Rugby tournament. Although the overall number of training injuries (and the incidence) in our study was low, we do note that 59.2% of the training injuries resulted in more than 8 days lost to training or competition. Therefore, in our study, training injuries, when they occur, tended to be more severe, and this has been reported in some [10] but not other studies [9]. In a recently published meta-analysis, it was concluded that differences in injury severity between match and training injuries were trivial [1] and we suggest that this requires further study. The majority of upper limb injuries were minimal to moderate (62.2%), and the majority of lower limb injuries were moderate (42.3%) or severe (12.7%). In our study we note that a higher proportion of upper limb injuries were more severe (29.7% of upper limb injuries). The lower and upper limb areas constitute most of the injuries (73%), and also constitute most of the moderate/severe injuries (84%) and these data are consistent with reports from other studies in rugby union on anatomical location [4, 9][8] and severity of injuries [8-10][1]. Strategies to reduce the incidence and severity of injuries in these two main anatomical areas require further study.

Timing and mechanism of injuries

As has previously been reported, most match injuries in our study also took place in the third and fourth quarters of matches. The lowest percentage of injuries occurs in the first quarter of a match. Furthermore, as has been documented in most studies in rugby union, we also showed that tackling, and being tackled, were the two most frequent mechanisms responsible for match injuries [1]. As most training sessions do not involve contact, it is not surprising that in our study, mechanisms such as running, and other mechanisms were responsible for the occurrence of training injuries. We do note that in 47.1% of training injuries and a 20.6% of match injuries the mechanism of injury was classified as “Other”. This finding of a high proportion of a “non-specific” category is not unique to our study. In many other studies, categories with no known specific mechanisms were often also classified as “Other”, or reported separately as “Other non-contact”, “Other contact”, “Not known” or “Not identified” [11] [10] [8] [9] [12]. When these “non-specific” categories are combined into one, as we did, they also consistently represent a relatively high proportion (or in some cases incidence, when these data were reported as such) of injuries that is similar to our data. We therefore regard this as a limitation of current methodology in epidemiology of rugby injury studies in general, and this requires investigation.

Injuries and intercontinental travel

Finally, to our knowledge, for the first time, we were able to explore whether travelling across multiple time zones, and playing in a foreign location away from home is associated with an increased risk for injury. Our preliminary data show that there was no significant difference in the incidence of time-loss injuries, match injuries, or training injuries whilst playing at home, or at a location away from home ($\geq$ 6 time zones difference). This is of particular clinical relevance to team physician travelling with the team, as we have previously shown that the effects of travelling away from home can affect illness rate [13].

Strengths and limitations of the study

The main strengths of this study are that a) it represents a large prospective cohort study in rugby union that was conducted in a tournament of a long duration played at a very high level, b) team physicians recorded daily data with a very high compliance rate, c) incidence rates were accurately documented for matches and training, and d) injury definitions, data collection and reporting was consistent with the consensus statement on rugby injury epidemiology research. A limitation of the study was that a further detailed exploration of subgroups was not possible due to small sample sizes, particularly for training injuries, and that even for this large cohort some of the reported statistics are based on small numbers. We also acknowledge that in one team (Team A) only 18/34 (53%) players gave consent to participate in the study. However, this was taken into account in all calculations of the incidence rates (per 1000 player-hours). Finally, the location specific incidence rates can at most be considered as preliminary and this would require further investigation.

Summary and clinical implications

In summary, the main clinical implications of the data presented in this study are:

- A team physician can also expect 1.67 injuries per match played during the Super Rugby tournament, and most of these injuries will occur in the latter stages of a game
- 25% of injuries will be of sufficient severity that players will not be able to play for 1-4 weeks, while 11% of match injuries will be of sufficient severity that players will not be able to play for $\geq$ 4 weeks

- As matches are played every week, it means that a) after every 3 games, at least one player in the squad will be unfit to play for 1-4 weeks, and b) after every 6 games, at least one player in the squad will be unfit to play for ≥ 4
- The majority of injuries occur in the lower limb (mainly the knee and thigh), and the upper limb (shoulder and clavicle), and these are mostly musculo-tendinous injuries followed by joint or ligament injuries
- In contrast to illness, preliminary data indicate that intercontinental travel and playing in a foreign destination is not associated wit an increased risk of injury

In conclusion, epidemiological studies of this nature are very important to a) identify factors associated with injury, b) design intervention strategies for the reduction of injury risk, and c) measure the outcome of any intervention strategies. Therefore, a program of on-going surveillance of injuries in the Super Rugby tournament is necessary and steps to implement this have been initiated.

What are the new findings?

- Almost 55% of all players in the Super Rugby tournament sustained a time-loss injury and 25% of players sustained more than one injury and we suggest that the reporting of the IPP is important in future rugby-related injury epidemiological studies
- There is a high incidence of match injuries during the Super Rugby tournament (83 per 1000 match hours or 1.67 injuries per game), that is similar to that reported for men's professional rugby
- Moderate or severe injuries account for a significant proportion (42%) of injuries
- Therefore, after every 3 games in the tournament, at least one player in a team will be unfit to play for 1-4 weeks, and after every 6 games at least one player in the squad will be unfit to play for ≥ 4 weeks
- Most injuries occur in the lower limb (knee and thigh) followed by the upper limb (shoulder and clavicle)
- Most injuries occur during the tackling phase of the game (tackling and being tackled)
- Injury risk is similar in forwards and backs
- Injury rates are not related to playing away from the home country

How might it impact on clinical practice in the near future?

- Team physicians serving the Super Rugby teams can anticipate the injury risk, nature and type of injuries in their teams during a prolonged tournament such as the Super Rugby tournament and therefore plan appropriate medical care
- Prevention strategies to reduce injury risk in this tournament are urgently required and should be targeted towards certain areas e.g. lower limb soft tissue (muscle/tendon) injuries
- Team management and coaches can now anticipate how the effects of injuries are likely to alter squad composition during the 4-month tournament and allow for advanced planning of medical and rehabilitative support staff.

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