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Effectiveness and implementation of the BokSmart Safe Six injury prevention programme

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CHAPTER 2:

TRENDS IN TIME-LOSS INJURIES DURING THE 2011-2016 SOUTH AFRICAN RUGBY YOUTH WEEKS.

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Abstract

Background

Youth rugby is a popular sport in South Africa (SA) with a high injury incidence. The annual SA Rugby Youth Week tournaments attract the top age group players in the country providing a sample of players for reliable injury surveillance. The aim of the study was to analyse the changes in time-loss injury rates at the SA Rugby Youth Week tournaments between 2011 and 2016, differences between age-groups, and to investigate associated injury risk factors.

Methods

All confirmed time-loss injuries at the four age group tournaments (under-13, under-16 and two under-18) from 2011–2016 were recorded. Injury incidence densities (IID) for years, tournaments and injury risk factors were calculated and Poisson regression analyses were performed to determine differences.

Results

Time-loss injuries (n=494) were reported over 24,240 exposure hours, with an overall IID of 20.4(18.6–22.2) injuries per 1000 player hours. 2013 had a significantly lower IID compared to 2011. Injury risk decreased with increasing age; under-13 and under-16 had significantly higher IID compared to under-18 Craven Week. Tackling was the phase of play at highest risk, with an IID of 7.4(6.3–8.5) injuries per 1000 player hours. Central/Peripheral Nervous System (CNS/PNS) and therefore, the Head/Neck were the most commonly occurring injuries/location injured.

Conclusion

Within the SA Rugby tournament structure, the older players had a decreased rate of injury. The tackle event was still the phase of play with the highest injury incidence regardless of age. This increase in incidence is largely due to an increase in CNS/PNS injuries.

Introduction

Rugby union (hence referred to as 'rugby') is an international sport played in over 100 countries at professional and amateur levels and is particularly popular in South Africa, with over 468,000 players (as of 2016).[1, 2] Given the contact nature of rugby, the injury incidence is high. An injury incidence density (IID) of 81 (95%CI 63–105) injuries per 1000 match hours for time-loss injuries was recorded in senior professional players[3] and 71 (95%CI 60-85) injuries per 1000 player hours specifically in South African senior professional players.[4] In youth rugby, match time-loss IID appears to be lower, with 35 injuries per 1000 match hours (95%CI 29–41) reported in English youth competitions,[5] and 22 injuries per 1000 player hours (95%CI 20–25) in South African youth tournaments.[6] This injury incidence is higher than in other sports, such as collegiate soccer which has an incidence of 19 injuries per 1000 match hours.[7] Factors associated with the higher injury rates in rugby have been investigated in both youth and senior cohorts, indicating that the tackle causes the majority of injuries and lower limb injuries are the most prevalent injuries.[3, 8] However, due to limited data, further investigation is required in youth cohorts.

This higher injury rate in rugby has resulted in many injury prevention initiatives being implemented worldwide over the years.[9-14] Specifically, the BokSmart Rugby Safety Programme was formally introduced in South Africa in 2009 in an attempt to reduce injuries, with a main focus on catastrophic concussion, head, neck and spine injuries.[15] Previously, the BokSmart programme was linked to a decrease in the number of catastrophic injuries in junior players over time in South African rugby.[16] The programme was also associated with improvements in targeted injury prevention behaviours in players.[15]

In the absence of an accessible longitudinal youth rugby cohort, the South African Rugby (SA Rugby) Youth Week tournaments, which have been the source of multiple research studies in the past,[6, 17-21] is a practical and sustainable source of information on injuries in youth rugby in South Africa. These tournaments provide a convenient and reliable sample in which the effect of time on injury rates in South African youth rugby may be evaluated. The annual SA Rugby Youth Week tournaments began in 1964, and consist of the best 22 rugby players in each of the 14 provincial rugby unions across

South Africa, per age-group division. The Youth Weeks consist of four week-long tournaments: the under-13 Craven Week (CWu13); the under-16 Grant Khomo (GKu16), and; two under-18 tournaments (Academy Week [AWu18] and Craven Week [CWu18]).[17, 19] These tournaments include invitational teams from Namibia and Zimbabwe. This large number of high quality rugby players competing in a single competition provides a relatively homogenous sample per age group per year for injury surveillance and longitudinal comparison.

Therefore, the main aim of this study was to explore the changes in time-loss injury rates at the SA Rugby Youth Week tournaments between 2011 and 2016. Secondary aims were to determine whether there is any difference in overall time-loss injury incidence between the age-groups, and to investigate the associated injury risk factors.

Methods

Injury data collection was performed at four youth tournaments (CWu13, GKu16, AWu18 and CWu18) from 2011 to 2016, with each tournament varying in structure over the years (see Supplementary Table 2.1 for further details). A dedicated medical doctor was stationed at each tournament to assess any injury complaints experienced by players. The definition of an injury for the tournaments was slightly adapted from the rugby injury surveillance Consensus Statement[22] to *“any physical complaint, which was caused by a transfer of energy that exceeded the body’s ability to maintain its structural and/or functional integrity that was sustained by a player during a rugby match and required attention from the SA Rugby tournament doctor”*. The details regarding every injury seen by the doctor were recorded on an injury collection form (Appendix II), by a designated tournament researcher at the time of injury, which was designed in accordance with the injury surveillance Consensus Statement and has been used in previous studies (all studies used the same methodology).[17, 19, 22]

The SA Rugby Medical and Anti-Doping informed consent forms were signed by both the player and their guardian/parent before the tournaments. The informed consent also included a section on injury surveillance and the usage of injury data for research purposes. Players were not allowed to participate in

the tournament if this document was not signed. All data was depersonalized before it was received from SA Rugby, who own the data. Ethical clearance was granted by SA Rugby and the UCT Human Research Ethics Committee (HREC 438/2011) to access this injury database for research purposes.

“Time-loss” and “medical attention” injuries were recorded during the tournaments. “Time-loss” injuries were confirmed either at the tournament by the tournament doctor, or by telephonic follow-ups on a weekly basis after the tournament by the allocated tournament researcher. For this study, only time-loss injuries were analysed. The phase of play (tackler, ball-carrier, ruck, open play, running etc.), injury type (joint (non-bone)/ligament, central/peripheral nervous system, broken bone/fracture, muscle/tendon, bruise/contusion, laceration, other injury, unsure), game quarter (first, second, third or fourth) and injury location (head/neck, trunk, upper limb, lower limb) were analysed for longitudinal differences over the years and between the age-group tournaments (definitions as per the Consensus Statement were used).[22]

Statistical Analyses

Player exposure was calculated using the current Consensus Statement:[22]

$$Exposure = NM \times PM \times DM$$

For this equation, *NM* is the number of matches played, *PM* is the number of players per match, (always 30 players, number of players on the pitch at any given time), and *DM* is the duration of the match in hours. Exposure was used to determine the injury incidence per 1000 player match hours (injury incidence density) and the corresponding 95% Confidence Intervals (CI). Poisson regression analysis using IBM SPSS Statistics 24 (2016) was performed to determine if there was a significant change in injuries over time and if there were differences in injury incidences between years, between tournaments and between the various factors. For the factors affecting injury incidence, these were analysed as grouped variables over the four tournaments and six years because of the small numbers involved. A centred second order polynomial using GraphPad Prism version 5.0 for Windows, was used for trends over time for all injuries and injuries per tournament.

Results

Over six years (2011-2016) there were 795 matches including 7,470 players resulting in 24,240 exposure hours from the four tournaments and 494 time-loss injuries (Table 2.1).

Table 2.1: Breakdown of match exposure hours and Time-Loss injury incidence density (IID) for the six years of Youth Week tournament injury data.

Year	Matches	Injuries	Exposure	Time-Loss IID (95%CI)
2011	132	92	3945	23.3 (18.6-28.1)
2012	134	79	4000	19.8 (15.4-24.1)
2013	130	52	3860	13.5 (9.8-17.1)
2014	135	79	4215	18.7 (14.6-22.9)
2015	132	78	4110	19.0 (14.8-23.2)
2016	132	114	4110	27.7 (22.6-32.8)
Total	795	494	24 240	20.4 (18.6-22.2)

Combined and Tournament Time-Loss Injury Incidence

The time-loss injury incidence for all six years was 20.4 (18.6–22.2) injuries per 1000 player hours. Injury incidence density did not change significantly over time (Figure 2.1: $p=0.53$). When comparing grouped year data, only 2013 was significantly different (lower) compared to the 2011 base data. A decrease in IID was seen up until 2013, at which point the IID then began to increase (fitted polynomial line).

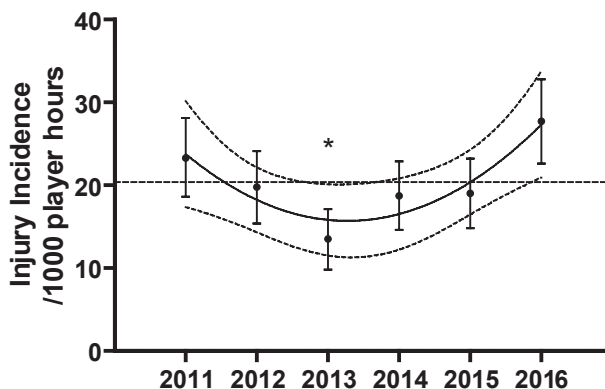


Figure 2.1: Injury incidence density, for time-loss injuries only, of the four SA Rugby Youth Week tournaments, between 2011 and 2016 (*significantly different to 2011; $P < 0.05$; horizontal dashed line represents average injury incidence over the six years; centred second order polynomial with dotted line representing 95% CI, $r^2=0.87$, $SEE=2.2$).

The average IIDs of the CWu13 (23.9 (19.5-28.2) injuries per 1000 player hours) and GKu16 (22.2 (18.2-26.2) injuries per 1000 player hours) were significantly higher compared to the CWu18 (17.2 (14.0-20.5) injuries per 1000 player hours) base variable, demonstrating a decrease in incidence as age group increased (Figure 2.2). GKu16 and AWu18 both followed a similar trend to that of the combined injury incidence, with a decrease until 2013 and then an increase again moving towards 2016, with CWu18 seeing a decrease in 2014 (Figure 2.2).

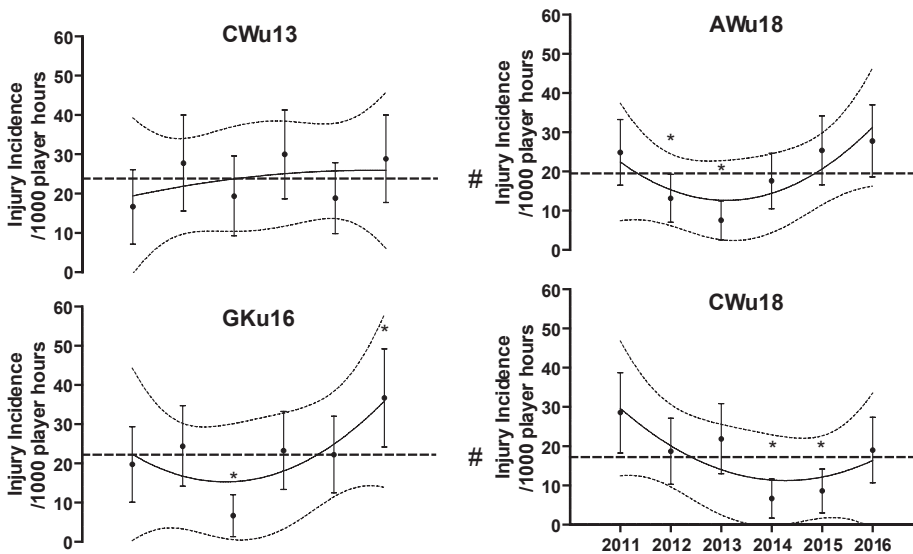


Figure 2.2: Individual SA Rugby Youth Week tournament injury incidence, for time-loss injuries only, between 2011 and 2016 (* significantly different to 2011; $p < 0.05$; # tournament average injury incidence significantly different to CWu18; dashed horizontal line represents average injury incidence over the six years for each tournament; centred second order polynomial with dotted line representing 95% CI, CWu13 $r^2=0.18$ SEE=6.9, GKu16 $r^2=0.62$ SEE=7.6, AWu18 $r^2=0.74$ SEE=5.2, CWu18 $r^2=0.69$ SEE=6.0).

Grouped Data

Even though there was a difference in the point estimates, the data could not be analysed with confidence because of the small numbers involved. Therefore, the factors affecting injury incidence were analysed as grouped variables over the four tournaments and six years.

Injury Event

Tacklers were injured at an incidence of 7.4(6.3–8.5) injuries per 1000 player hours which was significantly greater when compared to all other phases of play (Figure 2.3).

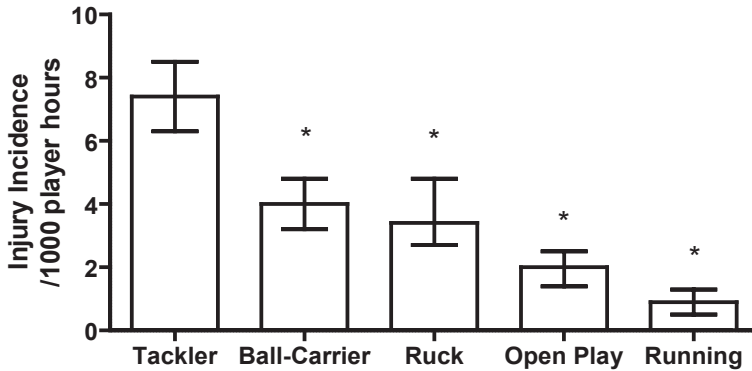


Figure 2.3: Injury incidence for the grouped SA Rugby Youth Week tournament 'phase of play' data, averaged over the period 2011 to 2016. (*significantly different to the Tackler; $p < 0.05$).

Injury Location

When looking at the specific locations, 34% of injuries over the six years were sustained to the head/face area, and 16% to the shoulder/collarbone (Table 2.2). The knee and ankle were the most commonly injured lower extremity sites, each with 12% of total injuries. When these specific injury locations were grouped into the four general injury locations (i.e. head/neck, upper limb, trunk, lower limb), the head/neck region was the most injured location over the six years with an injury incidence of 8.3 (7.1–9.4) injuries per 1000 player hours (Figure 2.4). The lower limb was the second most injured location with an incidence of 6.6 (5.6–7.6) injuries per 1000 player hours, but this incidence was still significantly lower than the head/neck region.

Table 2.2: Specific injury locations of all injuries over the period 2011 to 2016 (presented as a percentage of all injuries; $n=494$)

Injury Location	Injuries (%)
Head/Face	34
Shoulder/Collarbone	16
Knee	12
Ankle	12
Neck/Cervical	7
Wrist	2
Hand/Finger/Thumb	2
Hip/Groin	2
Back of Thigh	2
Lower Leg	2
Upper Arm	1
Elbow	1
Forearm	1
Sternum/Ribs	1
Low Back	1
Front of Thigh	1
Foot/Toe	1

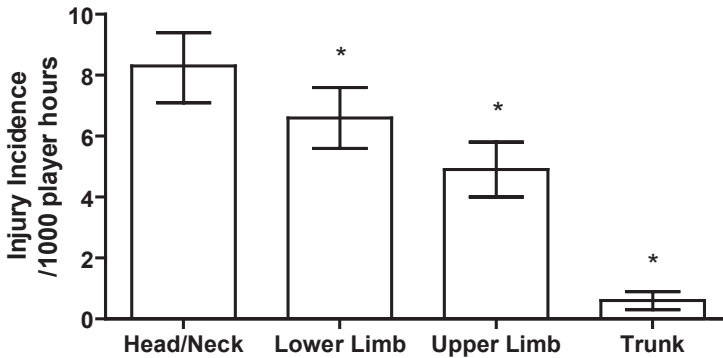


Figure 2.4: Injury incidence data per injury location for the grouped SA Rugby Youth Week tournaments averaged over the period 2011 to 2016 (* significantly different to Head/Neck as the base variable)

Injury Type

The central and peripheral nervous system (CNS/PNS) with an incidence of 6.3 (5.3–7.3) injuries per 1000 player hours and the joint (non-bone)/ligament category at 6.2 (5.2–7.2) injuries per 1000 player hours, were the most commonly occurring injury types across all years and tournaments (Figure 2.5). Concussions contributed to the majority of CNS/PNS injuries. For concussions only, the incidence was 5.9 (5.0–6.9) concussions per 1000 player hours. The trend in concussions decreased until 2013, and increased in 2014–2016, which followed a similar pattern to the overall injury rate trend over time (Figure 2.1). Ankle ligament injuries and shoulder/collarbone joint injuries made up the majority of the joint (non-bone)/ligament injuries.

Match Period

The third quarter with 21.1(17.5–24.8) injuries per 1000 player hours and fourth quarter with 22.6(18.8–26.4) injuries per 1000 player hours had significantly higher injury incidences compared to the first quarter, at 15.7(12.5–18.8) injuries per 1000 player hours.

Discussion

The aims of the study were to determine if there was change in time-loss injury incidences over the six years of the study, and also to examine differences between the age groups and factors associated with injury incidences in youth

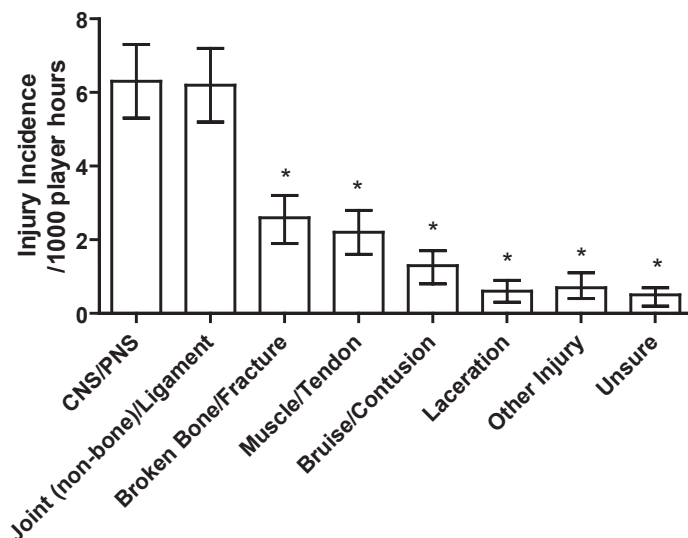


Figure 2.5: Injury incidence of the various injury types for the grouped SA Rugby Youth Week tournaments averaged over the period 2011 to 2016 (*significantly different to CNS/PNS - Central Nervous System/Peripheral Nervous System).

rugby in South Africa. The injury rates remained stable, however there were significant differences between age groups and injury rates. There were also significant differences between the factors associated with injury.

Combined and Tournament Time-Loss Injury Incidence

The average injury incidence from 2011 to 2016 for the SA Rugby Youth Week tournaments was 20.4 (18.6–22.2) injuries per 1000 player hours. Injury incidence has remained relatively stable over the six years, except for 2013 where there was a significant decrease in injury rates. The year 2013 had the lowest number of injuries and lowest exposure hours. The overall incidence reported in this study is less than most other studies who have reported on time-loss injuries in youth cohorts. Palmer-Green *et al.* [5] reported an injury incidence of 35 injuries per 1000 player hours in school players. Studies by Hislop *et al.* [10] and Archbold *et al.* [23] had incidences of 30 injuries per 1000 player hours (control group), and 29 injuries per 1000 player hours, respectively. It must, however, be noted that all of the above studies were performed over a rugby season(s), whereas this study was performed over high-intensity week-long tournaments, with the country's best players in each respective age

group, playing approximately three matches during each week. However, as these tournaments feature selected players of a high-calibre, there might be less of a mismatch in skill and size compared to that of a regular school playing in a typical rugby season in South Africa.

When the injury data are broken down into the age groups, our findings show that the injury rate decreased with increasing age (averaged over the six years), which is contradictory to Haseler *et al.* (2010) who showed that the U18 age category had significantly higher injury rates to that of the U13 age group, with players followed over a single season.[8] The combined tournament and injury incidence data showed a trend, which saw an initial drop in rates until 2013, and then an upward shift in injury incidence from 2014 to 2016. This pattern was largely due to the individual GKU16 and AWU18 tournaments. This change from 2013, can partly be attributed to the similar trend in the concussion injury incidence, which had the same turning point in 2013. In the second cycle of national BokSmart training (beginning late in 2011)[13] emphasis was placed on concussion identification, its treatment and management, which led to tighter and stricter protocols applied at the SA Rugby tournaments. This increase in concussions, and therefore in total injuries reported, might simply be a reflection of this increased awareness, identification and reporting of suspected and confirmed concussions.

This increase in injury incidence could also be an effect of players at the tournaments continually increasing in mass and stature.[24] However, there is currently no evidence to support this assumption. The trend towards an increase in incidence needs to be monitored and the format of the tournaments should be restructured if necessary, based on the injury data presented at the time.

Injury Event

It is well documented that the tackle event in rugby is the phase of play with the highest associated injury risk.[3, 5, 8, 25-29] This was confirmed in our study, where the tackler had a significantly higher injury incidence compared to all other phases of play. Ball carried into contact was the phase of play with the next highest injury incidence. In other youth cohorts, the tackle event was analysed as a whole and not divided into separate tackler and ball-carrier

roles, and therefore could not be compared.[5, 8] The ruck was the next largest contributor to injuries in other youth cohorts; similar to our Youth Week cohort where the ruck had the highest injury incidence after the tackler and ball-carrier.[5, 8] Injury rates in the tackle have been shown to decrease with better technique, illustrating that coaching is an effective intervention,[20] in contrast to exercise interventions in collision sports.[30] However, it must be noted that a recent exercise intervention did show a reduction in concussion rates in youth rugby players.[10] This previous ineffectiveness in exercise interventions could be due to fewer injuries occurring in open play/running, and most injuries being contact related. Therefore, regardless of age group or level of play, the tackle event, including both tackler and ball-carrier roles, has the highest injury risk of all phases of play and needs continued attention in education and injury prevention programmes.[10-13, 31]

Injury Type and Location

In this study, the central and peripheral nervous system (CNS/PNS) was the most commonly recorded injury type, with joint (non-bone)/ligament injuries having a slightly lower injury incidence (but not significant). Similarly, in youth cohorts, Palmer-Green *et al.* showed that joint (non-bone)/ligament injuries occurred more often than muscle/tendon injuries, but CNS/PNS injuries were one of the lowest reported injury types (this was before raised concussion awareness).[5] The rise in concussion rates have been seen in previous studies in the English Premiership[32] and the Australian sporting population,[33] where increased awareness has been acknowledged as factor. This injury profile is different to the professional game, where muscle/tendon injuries are the most common. [3] However, in the professional game, even though joint (non-bone)/ligament injuries are still prominent, the CNS/PNS injury rates are lower than both joint (non-bone)/ligament and muscle/tendon injuries.[3]

The overall incidence of concussions in this study was 5.9 injuries per 1000 player hours, which is in contrast to Haseler *et al.* who reported an incidence of only 1.8 injuries per 1000 player hours over a season.[8] However, in a more recent cluster-randomized controlled trial, the control group had similar rates to the SA Rugby Youth Week tournaments, with an incidence of 8 injuries per 1000 player hours for concussions over a season.[10] This difference between Haseler *et al.* and the recent data could be due to the rise in awareness and recognition,

the more conservative inclusion of both suspected and confirmed concussions, and the presence of a dedicated medical doctor at every tournament.[17, 34] The large number of suspected and confirmed concussions is a concern, especially as this is within the youth population. The trend for concussions to increase from 2014, should be monitored over time to determine if this is a consequence of increased awareness and better reporting or a real effect. The current increasing pattern also provides an opportunity for the development of preventative measures, such as a recent study of English schoolboy players which showed reductions in concussions in youth.[10] Furthermore, another study has also shown the potential for contact technique effecting concussion risk.[21]

CNS/PNS injuries were the most common recorded injury type, which was also reflected in the head/neck location being the most injured body location. This rate was significantly higher than injuries to the lower and upper limbs. In previous research at senior professional rugby, the lower limb is usually the most commonly injured body part, and in youth rugby data the lower limb and upper limbs are usually injured more frequently than the head/neck.[3, 5, 8, 25] Hislop *et al.* showed, in both control and intervention groups, similar findings to the SA Rugby Youth Week tournaments, with the head/neck being the most commonly injured body location.[10]

The injury types and body location profiles at the SA Rugby Youth Week tournaments are different to some of the older studies performed in both youth cohorts and professional rugby, but are similar to more recent studies performed in youth rugby, even over season long interventions.

Match Period

The third and fourth quarters in this study had significantly higher injury incidence rates compared to the first quarter of matches played, indicating an increased injury risk as match time progressed. In professional rugby a similar pattern was evident, however, even the second quarter was shown to have an increased risk compared to the first quarter.[3, 25] This could be an effect of fatigue, as tackle technique has been shown to worsen with increasing levels of fatigue.[3] The third quarter is often an increased risk period in a match due to the preceding half-time break, and players not warming-up sufficiently

before the second-half kicks off, and/or a lack of concentration following the break.[35] The possible effects of player substitutions, and changes in on-field playing combinations might also require further exploration. These results of increasing injury incidence per match quarter supports the current literature and indicates that regardless of the age of the players involved, injury risk increases, as the match time progresses. Coaches need to consider this when making substitutions and formulating strength and conditioning plans. Also, SA Rugby and the tournament medical staff need to be sufficiently prepared for an influx of injuries towards the end of matches by having sufficient medical personnel and supplies.

Perspective

The SA Rugby Youth Week tournaments provide a unique cohort of youth rugby players participating in high intensity week-long tournaments every year and cover different age groups. The injury data collected over the six years (2011-2016) has a lower time-loss injury incidence compared to the older studies on youth cohorts over a rugby season(s), but in line with more recent studies. This increase in incidence is largely due to an increase in CNS/PNS injuries. This finding might solely be due to a prominent focus shift on concussions, more sensitive criteria in place for its identification, treatment and management, more education and greater awareness on the topic. To explore this concept further, these findings and conclusions should be compared to new tournament data from future studies. Within the SA Rugby tournament structure, as the players increase with age, the injury rates decreased, with the tackle event still being the phase of play with the highest injury incidence regardless of age. In these tournaments, the role of tackler, as opposed to the ball-carrier, leads to significantly more injuries. These findings will assist SA Rugby to enhance their injury prevention programmes and help tailor them to the various age groups and injury concerns prevalent within the South African context.

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Chapter 2

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Supplementary Table 2.1: Tournament format over the years. (M = Match day where some teams play, TM = Tournament Match day where every team at the tournament plays, R = Rest day where no team plays)

	Craven Week U13				Grant Khomo U16				Academy Week U18				Craven Week U18			
	2011-2013	2014-2015	2016	2016	2011	2012-2015	2016	2016	2011 - 2012	2013	2014	2015	2016	2011	2012	2013 - 2016
Teams (n)	18	18	18	24	26	24	24	20	26	26	26	24	24	24	20	20
Matches (n)	36	36	36	36	39	36	30	30	39	34	39	36	36	30	29	30
Duration (min)	40	50	50	70	70	70	60	60	70	70	70	70	70	70	70	70
Structure	M,M,R,M,M	M,M,R,M	M,M,R,M	M,M,R,M	M,M,R,M	M,M,R,M	M,R,M,R,M	M,R,M,R,M	M,M,R,M	M,M,R,M	M,M,R,M	M,M,R,M	TM, TM, TM, TM, TM, TM, TM, TM	TM, TM, TM, TM, TM, TM	TM, TM, TM, TM, TM, TM	TM, TM, TM, TM, TM, TM
Exposure (hours)	720	900	900	900	810	900	900	900	1365	1190	1365	1260	1260	1050	1015	1050