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# INCIDENCE OF MATCH INJURIES OF SOUTH AFRICAN JUNIOR NETBALL PLAYERS

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## *ABSTRACT*

*The aim of this study was to assess the incidence of injuries during match play in a cohort of junior (u/15, u/16 and u/19) South African netball players. A total of 560 female players (u/15=220, u/16=220, u/19=120) who participated in 2015 All Ages South African Tournament and the Wildeklawer Schools Tournament in 2017, were included in the study. A questionnaire was used to collect data on all the injuries during the two tournaments. The overall incidence of injuries was 22.5 per 1000 playing hours. The anatomical site with the most injuries was the knee (30%), followed by the ankle joint (28%) and lower leg (9%). The most commonly injured structures were the ligaments and muscles associated with the injured sites. To reduce the risk and incidence of injuries among netball players, the implementation of structured, evidence-based injury prevention programmes based on the theory of specific adaptation to the imposed demands of the game, should be considered. These programmes should focus on improving core stability, neuromuscular control and balance or proprioception, and correction of biomechanics during the execution of the functional activities of netball.*

***Keywords*:** Incidence; Injuries; Injury prevention; Junior; Netball.

## INTRODUCTION

Netball is associated with high physical demands and movements that require agility, which includes a sudden change of speed and direction, thereby increasing the risk of injury (Coetzee *et al*., 2014). To prepare physically for these demands, players often engage in training programmes with high intensity and frequency (Chandler *et al*., 2014). Young netball players often become involved in adult training programmes to improve physical fitness and expose themselves to higher training loads and intensities. Players may experience pressure from coaches and parents to perform at their maximum, sometimes increasing their risk of sustaining injuries (Netball SA, 2011). According to the American Academy of Orthopedic Surgeons (AAOS, 2012), a significant increase in overuse injuries among children has been noted, mostly due to sport-related activities. The AAOS expressed concern about injuries in young athletes, as it may have tremendous long-term effects on their wellbeing.

Although movement and sports participation are critical for children's physical and psychological development, positive rewards should outweigh the risks and dangers. Adolescents are particularly vulnerable because of the specific growth and developmental

phase they experience. Injuries can result in serious long-term effects on their growth and developing patterns. Therefore, this study focused on the incidence of match injuries among adolescents.

Van Mechelen *et al.* (1992) proposed a four-step model for the management of sport injuries. The first step is to determine the extent of the injury. In the second step, the aetiology and mechanisms of the sports injury are examined. The third step involves the introduction of preventative and therapeutic measures, which will then be assessed with regard to their efficiency by repeating step 1. Therefore, by monitoring the incidence of injuries, preventative and therapeutic measures can be implemented by Netball South Africa. The study collected data on the incidence of match injuries in junior netball players and provided information relating to the first two steps of the model.

## AIM OF STUDY

The aim of this study was to determine the incidence of injuries among South African junior netball players (school level), aged between 15 and 19 years, during match-play. To achieve this the following objectives were set:

- To record the incidence and types of injuries in junior netball players in competitive tournaments;
- To assess the participation of injured players in preventative training modalities to reduce injuries; and
- To assess the incidence of injuries for the different player positions, namely goal attack (GA), wing attack (WA), goal defence (GD), goal shooter (GS), centre (C), wing defence (WD) and goal keeper (GK).

## METHODOLOGY

### Study design

This cross-sectional study was conducted to determine the incidence of injuries among u/15 to u/19 netball players in South Africa during match-play. A total of 560 players – 220 u/15, 220 u/16 and 120 u/19 players – who participated in the 2015 All Ages South African Tournament and the Wildeklawer Schools Tournament in 2017, were included in the study. The u/15 and u/16 players played 71 games per age group, and the u/19 players 36 games, giving a total of 178 games for the three age groups.

### Data collection tools

A questionnaire was used to collect data on all the injuries and training modalities at the two tournaments. Coaches and medical staff received instructions on how to complete the questionnaire. The questionnaire of the Rugby Injury Consensus Group for monitoring the epidemiology of rugby injuries (Orchard *et al*., 2005; Fuller *et al*., 2006; Fuller *et al*., 2007; Pluim *et al*., 2009) was adapted by the researchers to address the aims of the present study and to standardise definitions of injury (Langeveld *et al*., 2012). A section on training history was added to examine the use of evidence-based preventative training modalities. Completed questionnaires were collected at the end of each day of the tournament (Langeveld *et al*., 2012).

An injury was defined as any physical complaint from the player during a netball match or practice session that forced the player to receive medical attention (Fuller *et al.*, 2007). The injury incidence rate for each age group was calculated as the ratio of the number of injuries observed in the age group to the total number of playing hours. The total number of playing hours for the age group was calculated as the number of games played multiplied by the length of the game (in hours), multiplied by 14 (the number of players active in each game).

### Analysis of data

All data were captured electronically in a Microsoft Excel 2007 spreadsheet. SAS version 13.1 statistical software was used for further analysis of the data. Means and standard deviations or medians and percentiles were calculated for numeric data. Frequencies and percentages were determined for categorical data.

### Ethical clearance

The study was approved by the Health Sciences Research Ethics Committee of the Faculty of Health Sciences, University of the Free State (HSREC 115/2016). Permission was obtained from South African Schools Netball, the Department of Basic Education, and the tournament organisers.

## RESULTS

### Incidence of injury

A total of 46 injuries were reported at the two tournaments, of which 17 injuries were reported by the u/15 group, 20 by the u/16 group and 9 by the u/19 group. Of the 46 injuries, 42 (91.3%) occurred during match-play and 4 (8.7%) during practice or warm-up sessions. A total of 26 (56.5%) of the injuries were acute injuries, while 20 (43.5%) were re-injuries. Twenty-seven (58.7%) injuries resulted from contact with another player, while the remainder were non-contact injuries.

Based on the 42 injuries recorded during match-play, the injury incidence rates were 22.8, 22.8 and 21.2 per 1000 playing hours for the u/15, u/16 and u/19 players, respectively, and thus very similar across the three age groups. The overall injury incidence rate was 22.5 per 1000 playing hours.

### Anatomical site of injuries

Table 1 shows the number and percentage of injuries per anatomical site, by age group and overall. In the total group of players, the majority of injuries were knee injuries, followed by ankle and lower leg injuries. Injuries to the elbow, hand, fingers, groin, feet, and ribs were observed only once each.

For the u/15 players, the most injured site was the ankle, followed by the knee, wrist and lower leg. In contrast, the u/16 players had a higher incidence of injuries of the knee, followed by the ankle, lower back, posterior thigh and lower leg. Similar to the u/16 players, in the u/19 players the knee was the most injured anatomical site, again followed by the ankle and posterior thigh.

***Table 1.*** **ANATOMICAL SITE AND INCIDENCE OF INJURIES PER 1000 HOURS OF MATCH PLAY**

| Site | Age group u/15 n (%) | u/16 n (%) | u/19 n (%) | Total n (%) |
|---|---|---|---|---|
| Knee | 3 (17.7) | 7 (35.0) | 4 (44.4) | 14 (30.4) |
| Ankle | 6 (35.3) | 4 (20.0) | 3 (33.3) | 13 (28.3) |
| Lower leg | 2 (11.8) | 2 (10.0) | – | 4 (8.7) |
| Wrist | 2 (11.8) | 1 (5.0) | – | 3 (6.5) |
| Lower back | 1 (5.9) | 2 (10.0) | – | 3 (6.5) |
| Posterior thigh | – | 2 (10.0) | 1 (11.1) | 3 (6.5) |
| Elbow | – | 1 (5.0) | – | 1 (2.2) |
| Hand | 1 (5.9) | – | – | 1 (2.2) |
| Finger | 1 (5.9) | – | – | 1 (2.2) |
| Groin | – | 1 (5.0) | – | 1 (2.2) |
| Feet | 1 (5.9) | – | – | 1 (2.2) |
| Rib | – | – | 1 (11.1) | 1 (2.2) |
| Total injuries | 17 (100) | 20 (100) | 9 (100) | 46 (100) |
| Total injuries sustained during match play | 17 | 17 | 8 | 42 |
| Playing hours (h) | 745.5 | 745.5 | 378.0 | 1869.0 |
| Incidence rate per 1000h | 22.8 | 22.8 | 21.2 | 22.5 |

***Table 2.*** **TYPE OF INJURY SUSTAINED**

| Type | Age group u/15 n (%) | u/16 n (%) | u/19 n (%) | Total n (%) |
|---|---|---|---|---|
| Ligament injury | 9 (56.3) | 7 (36.8) | 5 (55.6) | 21 (47.3) |
| Muscle tear/strain/cramp | 2 (12.5) | 8 (42.1) | 1 (11.1) | 11 (25.0) |
| Laceration | 2 (12.5) | 2 (10.5) | 1 (11.1) | 5 (11.4) |
| Tendon injury | – | – | 1 (11.1) | 1 (2.3) |
| Meniscus/cartilage | – | – | 1 (11.1) | 1 (2.3) |
| Dislocation | 1 (6.3) | – | – | 1 (2.3) |
| Other[b] | 2 (12.5) | 2 (10.5) | – | 4 (9.1) |
| **Total[a]** | 16 (100) | 19 (100) | 9 (100) | 44 (100) |

[a] For one injury in each of the u/15 and u/16 age groups, the injury type was not recorded;
[b] Other injuries involved the elbow, hand, fingers, groin, feet and ribs.

The types of injuries, by age group and overall, are presented in Table 2. For both the u/15 and u/19 groups the most prevalent type of injury were ligamentous injuries, whereas the u/16 group reported a higher incidence of injuries to muscular structures, followed by ligamentous injuries.

### Injuries by player position

Table 3 presents the injuries that occurred for each player position, by age group and overall. In the total group, the goal attack (GA) sustained most injuries, followed by the wing attack (WA) and goal defence (GD), with the goal keeper (GK) having the lowest injury incidence.

***Table 3.*** **INJURIES BY PLAYER POSITION**

| Player position | Age group u/15 n (%) | u/16 n (%) | u/19 n (%) | Total n (%) |
|---|---|---|---|---|
| Goal attack (GA) | 7 (43.8) | | 4 (44.4) | 11 (25.0) |
| Wing attack (WA) | 2 (12.5) | 5 (26.3) | 1 (11.1) | 8 (18.2) |
| Goal defence (GD) | 2 (12.5) | 4 (21.1) | 2 (22.2) | 8 (18.2) |
| Goal shooter (GS) | 2 (12.5) | 3 (15.8) | – | 5 (11.4) |
| Centre (C) | – | 3 (15.8) | 2 (22.2) | 5 (11.4) |
| Wing defence (WD) | 3 (18.8) | 2 (10.5) | – | 5 (11.4) |
| Goal keeper (GK) | – | 2 (10.5) | – | 2 (4.6) |
| **Total**[a] | 16 (100) | 19 (100) | 9 (100) | 44 (100) |

[a] For one injury in each of the u/15 and u/16 age groups, the player position was not recorded.

### Time of injury

To evaluate whether fatigue (either cardiovascular or muscular) during a match could be a possible mechanism of injury, the number and percentage of injuries for each quarter of the match are presented in Table 4.

***Table 4.*** **TIME OF INJURY DURING MATCH**

| Time | Age group u/15 n (%) | u/16 n (%) | u/19 n (%) | Total n (%) |
|---|---|---|---|---|
| Practice/warm-up | – | 3 (15.8) | 1 (11.1) | 4 (9.3) |
| 1st quarter | 7 (46.7) | 8 (42.1) | 1 (11.1) | 16 (37.2) |
| 2nd quarter | – | – | 1 (11.1) | 1 (2.3) |
| 3rd quarter | 8 (53.3) | 8 (42.1) | – | 16 (37.2) |
| 4th quarter | – | – | 6 (66.6) | 6 (14.0) |
| **Total**[a] | 15 (100) | 19 (100) | 9 (100) | 43 (100) |

[a] For two injuries in u/15 and one injury in u/16 age group, the time of injury was not recorded.

The majority of injuries among the u/15 and u/16 players occurred in the first and third quarters. In the u/19 group the majority of injuries were reported in the last quarter of the game. Overall, there was no evidence that injuries occurred more frequently in the later parts of the match.

### Training habits of netball players

For the group of players with injuries, Table 5 indicates the mean number of training sessions per week and the mean duration of sessions, by age group and overall, spent on the different training modalities considered relevant for injury prevention (Coetzee *et al*., 2014). Overall, injured players had a mean of approximately two sessions per week of biomechanics, core and proprioception training, with a mean duration of approximately 24 and 19 minutes for biomechanics and proprioception, respectively, and approximately 32 minutes for core training. The mean number of flexibility sessions per week was notably higher, namely 3.6, with a mean duration of approximately 23 minutes.

***Table 5*. TRAINING MODALITIES USED BY INJURED PLAYERS RELEVANT FOR INJURY PREVENTION**

| Modality | Variable | Age group u/15 | u/16 | u/19 | Total |
|---|---|---|---|---|---|
| Biomechanics | Number | 2.4 | 1.6 | 1.8 | 1.9 |
| | Duration | 31.0 | 15.0 | 28.3 | 23.6 |
| Core | Number | 2.3 | 2.2 | 1.7 | 2.1 |
| | Duration | 33.4 | 25.3 | 42.8 | 31.8 |
| Flexibility | Number | 3.5 | 3.6 | 4.0 | 3.6 |
| | Duration | 20.7 | 20.3 | 31.1 | 22.7 |
| Proprioception | Number | 2.1 | 1.8 | 2.9 | 2.1 |
| | Duration | 22.3 | 13.9 | 23.3 | 18.9 |

Mean number of training sessions per week; Mean duration of session (minutes)

## DISCUSSION

### Incidence of injuries

To compare the findings with relevant literature (McMillan, 2004; Langeveld *et al*., 2012; Pillay & Frantz, 2012; Partner *et al*., 2018), it is important to be aware of the methodology for determining the incidence of injuries. The majority of research on the epidemiology of injuries has focused on elite and senior participants (McMillan, 2004; Langeveld *et al*., 2012; Pillay & Frantz, 2012) or evaluated injury incidence for an entire netball season (Hopper, 1986; Hopper *et al*., 1995; Hume & Steele, 2000; McManus *et al*., 2006; Partner *et al*., 2018). However, the incidence of injuries among the junior players during match-play in only two tournaments were recorded.

In this study, the injury incidence rate of the u/15, u/16, and u/19 players was very similar across the three age groups, but notably higher than in the study of McMillan (2004), who reported 11.3 injuries per 1000 playing hours. Comparable to our results, Hume and Steele (2000) reported an incidence rate of 23.8 injuries per 1000 playing hours in a population with a mean age of 18.4±4.4 years, for a three-day competitive tournament. The latter study is thus

more relevant to the findings of the present study, while McMillan (2004) focused on an entire competitive season that included injury occurring during practice and not only during match-play in tournaments.

On an amateur level of play in the UK, a total of 5.7 injuries per 1000 hours was reported (Partner *et al.*, 2018), which was lower than in the current study. Again, the deviation could have resulted from the different study populations, since the present study focused on junior, yet competitive players. Increased levels of competitiveness can increase physical demands and load on the body, in particular on an immature skeletal structure. This factor could also explain the higher incidence of injuries reported by another South African study with elite netball players that reported an incidence rate of 32.8 injuries per 1000 playing hours (Langeveld *et al.*, 2012). Australian investigators reported only 14 injuries per 1000 playing hours (McManus *et al*., 2006) and in a recent study of Attenborough *et al.* (2016) only 6.75 injuries per 1000 playing hours during match-play for participants at the University of Sydney were reported.

The variation in injuries per playing hours could be attributed to the different methodological approaches in the various studies. However, it could also reflect the level of competitiveness and differences in training programmes. Australia, for example, invests heavily in evidence-based prevention and rehabilitation programmes in netball (Hopper, 1986; Hopper *et al*., 1995).

The difference in socio-economic status of the countries that had been compared could also have an impact on the availability of such programmes. Limited financial resources in developing countries, such as South Africa, are available for employing qualified and experienced coaching staff and for players to seek medical treatment for injuries in order to prevent re-injuries.

**Anatomical site and type of injuries**

The percentage of contact injuries was 59% versus 41% for non-contact injuries. Although this difference may not seem substantial, the proportion of contact injuries is unexpectedly high when the rules of netball are considered, specifically the rule that states that contact with another player is prohibited. According to the rule pertaining to contact, "[n]o player may accidentally or deliberately physically contact an opponent if it hinders that person's play. Like the obstruction call, if a player is called for contact, they must stand down while the penalty pass (or shot) is taken" (Willcox, 2011).

From an overall perspective, knee injuries were the most prevalent, followed by the ankle joint. Previous research also reported a high incidence of knee and ankle injuries (McMillan, 2004; Langeveld *et al*., 2012; Pillay & Frantz, 2012). Furthermore, Mitani (2017) reported that reduced lower limb alignment and increased range of joint motion in females may be risk factors for injury because they lead to increased physical stress being exerted on the lower legs during sporting activities.

Since ankle and knee joints are the most common injury sites, preventative modalities should target these anatomical sites. Overall across the three age groups, the most prevalent injuries were ligamentous injuries and injuries to muscular structures (Table 2). Published investigations do not always report on the type of injury, only the anatomical structures (McManus *et al*., 2006; Langeveld *et al*., 2012; Partner *et al*., 2018).

**Injuries by player position**

According to the present data, the GA, WA and GD had the highest risk of injury, while the GK had the lowest. The GA is reported to have the highest cardiovascular demands when characterised by the time spent in the maximum heart rate ($HR_{max}$) zone (Shaw, 2018). Furthermore, Fox *et al.* (2013) concluded that midcourt positions that include the GA, WA and GD, mostly engage in jogging, running and sprinting, which further increase their work-to-rest ratio. An increase in both physical demands and active rest could further escalate the risk of injury.

It has been found that the amount of jumping was more or less consistent throughout the team (Fox *et al*., 2013). If this were the case, players who invest more time on jogging, running and sprinting, also engage in jumping while executing dynamic patterns. This may increase their injury risk in attempted jumps, seeing that this is the most frequently reported mechanism of injury, compared to players that jump from a static position (Attenborough *et al.* (2016).

However, when comparing the incidence of injuries per player position with the demands of the different positions, it seems that the risk of injury increases with higher physical requirements. Therefore, it can be confirmed that training programmes should focus on the individualised demands of the different playing positions.

**Time of play when the injury occurred**

A limited number of studies reported in the literature indicated the time of injury during play. Analyses of when injuries occurred and what the reason could be, have not been provided, with the exception of the study by Langeveld *et al.* (2012).

The majority of injuries among the u/15 and u/16 players occurred in the first and third quarters of the match, which was similar to the findings reported by Langeveld *et al.* (2012). Conversely, the majority of injuries in the u/19 group were reported in the last 10 minutes of the game. No any evidence was found that injuries occurred more frequently in the later parts of the match.

**Training habits of netball players**

Since injuries among young athletes may have long-term effects on growth (Caine *et al*., 2006; Shanmugam & Maffulli, 2008), training programmes should focus on injury prevention and include age-appropriate exercises. Shanmugam and Maffulli (2008) recommended that coaches should consider the players' physical maturity and not only their chronological age.

Frisch *et al.* (2009) concluded that certain factors and modalities should be considered in the training programmes of junior players, such as the duration of sessions, training programme content, frequency and player compliance. It has been proposed that improvements in proprioceptive training (Verhagen *et al*., 2004; Hiller & Grayson, 2017; Hopper *et al*., 2017), core stability (Verhagen *et al*., 2004; Emery *et al*., 2005; Kibler *et al*., 2006), neuromuscular control (NMC) and biomechanics (improved landing technique), could contribute to injury prevention (Zazulak *et al*., 2007a; Frisch *et al*., 2009).

**Neuromuscular training**

Several studies investigated the effect of neuromuscular training on physical performance and employing it as an injury prevention modality. Hopper *et al.* (2017) described neuromuscular training as a holistic approach that addresses different training modalities, such as resistance and plyometric training, to improve dynamic joint stability in athletes. Hopper *et al.* (2017)

further argued that neuromuscular training should be an integral part of the training programme of female adolescent athletes, due to the fact that these athletes show continuous decreases in their strength and power performance indices and increases in injury risk, in comparison with their male counterparts. However, in the present study, the mean amount of time spent on neuromuscular training or proprioception was 19 minutes, during a mean of two sessions per week. Nevertheless, it is critical to establish if this amount of time spent on neuromuscular training was sufficient.

Hopper *et al*. (2017) used an intervention of neuromuscular training that lasted six weeks, with three sessions of 60 minutes each on non-consecutive days, which showed a significant improvement in performance and subsequently reduced the risk of injuries among these players. Balance training (neuromuscular control) proved to reduce the number of ankle injuries, especially in players with a history of ankle injuries (McLean *et al.*, 2004). Deficits should be addressed individually for an optimal effect on players (Verhagen *et al.*, 2004).

**Biomechanical training**

Hopper (1986) found that improper landing techniques were a notable factor contributing to the risk of ankle and knee injuries. In the present study, injured players were asked about the frequency and duration of biomechanical training and technique, specifically the preparation and correction of landing patterns. It was found that the mean amount of time spent on this modality was 24 minutes per session, with a mean of two sessions per week. If this were compared to the mean amount of time spent during a game, the question arises whether this training is sufficient to prepare the athlete for the demands during the game. Since the focus of this research was to determine the incidence of injuries, the answer to this question can only be found with further analysis of whether existing training programmes are focusing on sufficient preparation to meet the demands of the sport. A gap in this regard in the literature was identified that should be addressed in future research.

**Core training**

Previous investigators (Kibler *et al.*, 2006; Zazulak *et al*., 2007a; Zazulak *et al*., 2007b) found that improvements in core stability could reduce sports injuries, specifically knee injuries. As shown in Table 5, the injured netball players on average only engaged in two core training sessions of 32 minutes each per week. This might be one of the reasons why knee injuries, in particular, are so prevalent among netball players. It could be asked whether more core sessions would successfully contribute to injury prevention in netball. Further research in this regard is recommended.

**Flexibility training**

Attenborough *et al.* (2016) found that a predictor of an ankle injury is a posterior-medial reach of less than 77% of the player's leg length, subsequently referring to a better degree of ankle mobility. Hiller and Grayson (2017) confirmed this finding and stated that a decrease in the ankle dorsiflexion range of motion is correlated with ankle injuries in netball players. If this were true, it would be critical to implement programmes that address the mobility of the ankle. In the present study, flexibility training was the modality on which notably the most time was spent by junior netball players.

As proposed by the Canadian Fitness Professionals (CanFitPro, 2016), complex movements that challenge balance, stability and coordination and involve multiple muscle groups, require

four to six workouts per week for athletes. However, the guidelines of the American College of Sports Medicine (ACSM) for exercise testing and prescription (ACSM, 2018) recommended only two to three workouts per week for the general population. The training frequency of the junior netball players in the current study was below the recommended guidelines for athletes.

## CONCLUSIONS

In this study, the incidence of injuries in junior netball players in competitive tournaments was determined. The overall incidence rate was found to be 22.5 injuries per 1000 playing hours. These findings were consistent with previous findings that the greatest proportion of injuries in netball players occurs in the knee and ankle joints.

## RECOMMENDATIONS

In this injury surveillance study, the incidence of injuries among junior netball players in South Africa was reported and factors were proposed that might be associated with these injuries. Surprisingly, however, evidence-based preventative strategies have been found to be underutilised. The following conclusions and recommendations are based on the results of this study:

- The majority of netball games in South Africa are played on cement surfaces, which was the case in this study. Given the high injury rate on these surfaces, creative ways are needed to reduce ground reaction forces and the resistance of footwear-surface interface. Further research in this domain may contribute greatly to the reduction of injury rates in junior netball and should be actively promoted.
- Based on the literature and the incidence of match playing injuries, training programmes focusing on injury prevention strategies that include age- and maturity-appropriate exercises, could possibly benefit junior netball players. In addition, it is emphasised that coaches should consider junior netball players' physical maturity rather than only their chronological age.
- Based on the high incidence of injuries among junior netball players reported in this study, future epidemiological studies should assess the efficacy of injury prevention programmes and the need for intervention with existing injury rehabilitation programmes.
- The re-injury rate observed in our study (43.5%) was concerning and should be addressed by health professionals and appropriate return-to-play and return-to-performance protocols.
- The proportion of contact injuries (58.7%) was another concern. Thus, it can be recommended that referees strictly and consistently implement the rule regarding contact in netball.

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