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TRAINING HABITS, TRAINING SURFACE AND INJURIES AMONG SOUTH AFRICAN NETBALL PLAYERS

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ABSTRACT

Netball involves rapid acceleration, deceleration and directional changes exerting considerable force on articular and peri-articular structures, resulting in a high risk of injuries. Preventing injuries to the ankle and knee joints of netball players is of particular concern. Improvement in core stability, neuromuscular control (NMC) and biomechanics have been proven to reduce knee injuries within the sporting population. Improvement in proprioception is effective in reducing ankle injuries. Playing surfaces with higher friction values seem to elevate the rate of injuries. The aim of this study was to assess participation in preventative training modalities to reduce joint injuries that occur most frequently in a cohort of elite South African netball players (N=1280). The effect of the playing surface on injury rates was also assessed. Subjects participated in three elite netball tournaments in South Africa. By means of a questionnaire it was found that between 51.7% and 59% of injured netball players did no exercises to improve their core stability, NMC or proprioception. The cement playing surface delivered a 1.9 times higher injury rate than the synthetic surface. Netball coaches should be educated on the value and implementation of exercise modalities that could limit injuries to the ankle and knee joints of netball players.

Key words: Netball injuries; Injury prevention; Playing surface.

INTRODUCTION

Coaches throughout the world are increasingly pushing the limits of human adaptation and training loads with the aim of achieving top performances. Despite the benefits of scientific conditioning programmes, each sporting code has an inherent risk of injury (Smith *et al*., 2005). It is, therefore, important to understand the frequency and nature of sport injuries to assist in the development of effective injury prevention strategies. The role of any strength and conditioning/sport development coach is not only to get the sportsperson fit and ready to take the field of play, but also to prevent injuries. Proactive prevention of injuries is often neglected. Even elite netball coaches and teams with a scientific approach to the game have confessed to being reactive rather than proactive with regard to scientific strength and conditioning programmes and injury prevention (Elphinston & Hardman, 2006). Therefore, governing bodies should be aware of the epidemiological evidence of injury risk in sport and that effective preventative measures are available (Fuller & Drawer, 2004).

The majority of injuries sustained by netball players are to the lower limbs, specifically the ankle and knee joints (Hopper & Elliott, 1993; Hopper *et al*., 1995a; Hopper *et al*., 1995b;

Smith *et al*., 2005; Ferreira & Spamer, 2010). Ligaments are the most commonly injured structures (Hume & Steele, 2000; Finch *et al*., 2002; McManus *et al*., 2006). Recurrent injuries to the ankle are common in this sporting population and it seems that knee injuries are quite severe. It is suspected that some netball players retire early from the sport because of serious knee injuries (Hopper *et al*., 1995a; Otago & Peake, 2007). In this regard, injuries to the anterior cruciate ligament (ACL) are of particular concern for netball players (Hopper *et al*., 1995b).

Injury prevention

Decreases in injury rates can be established through pro-active initiatives (Elphinston & Hardman, 2006). Even though improved techniques to rehabilitate sport injuries are constantly being developed, it may be of greater importance to prevent injuries (Bahr & Holme, 2003). In an attempt to limit the amount of ACL injuries that are sustained by sportswomen, controllable contributing factors must be addressed (Ireland, 1999; Herrington, 2011). Researchers have investigated rule changes that could reduce ground reaction forces that would lead to a decrease in moment angles in the knee, which in turn lowers the risk of ACL injuries (Otago, 2004; Herrington, 2011). According to Yu and Garrett (2007), ACL injuries occur when excessive shear forces are applied to the ACL. A non-contact ACL injury occurs when poor movement patterns cause a sportsperson to place high enough forces or moments on the ligament that exceed the amount of tension it can sustain (Boden *et al*., 2010). Therefore, it is of crucial importance to understand how the ACL is loaded through movement and what the mechanisms and risks are for injury. Improvement of neuro-muscular control can limit the risk of knee injuries (Hewett *et al*., 1999; Myer *et al*., 2008). This is of particular importance due to high-risk manoeuvres, such as jumps and landings, quick acceleration and deceleration, and rotational movements that occur in netball (Ferreira & Spamer, 2010; Herrington, 2011).

Various authors place emphasis on the value of proprioceptive exercise as part of training programmes, as it has been shown to be valuable in limiting injuries of the lower extremities, especially in preventing injuries to the ankle joint (Bahr *et al*., 1997; Wedderkopp *et al*., 1999; Stasinopoulos, 2004; Verhagen *et al*., 2004; Emery *et al*., 2005). There is also evidence of the beneficial effects of improved core stability in the prevention of knee injuries (Kibler *et al*., 2006; Zazulak *et al*., 2007a).

The playing surface is an extrinsic factor that can play a major role in injury rates (Pasanen *et al*., 2008). The hardness and the surface-to-shoe interface resistance seem to be two factors that need to be considered in sport injuries. An increase in resistance of the interface seems to be a risk factor for traumatic injuries in sports that require rotational movements (Pasanen *et al*., 2008). Murphy *et al*. (2003) are of the opinion that the hardness of the surface can influence the ground reaction forces and can contribute to overloading of tissues, for example, bone, ligaments, muscle and tendons.

There is significant and consistent evidence in the literature to support the use of injury-prevention strategies in adolescents. These include pre-season conditioning, functional training and education, as well as strength and balance programmes that are continued throughout the playing season (Abernethy & Bleakley, 2007). It is, therefore, important to

identify the causes and nature of sport injuries in netball and accordingly to introduce a proactive injury prevention programme in South African netball.

Epidemiology of netball injuries

The research reported in this article is part of a larger study. The purpose of the first study (Langeveld *et al*., 2012) was to determine the epidemiology of injuries at the national u/19 and u/21 tournaments of University Sport of South Africa (USSA) and the national senior championships in 2009. The results of that particular study showed a high incidence of 500.7 injuries per 1000 playing hours. Most injuries occurred to the ankle joint (34%), followed by the knee (18%), fingers, hand and wrist (15% each). Ligaments were the most commonly injured structures. However, the majority of injuries were minor in terms of game time lost in the tournament (Langeveld *et al*., 2012).

RESEARCH PROBLEM

The purpose of this part of the study was to identify injury trends and possible associated factors at these tournaments, to compare it with available literature and finally to make suggestions for interventions to limit the amount of injuries sustained by netball players. Firstly, the goal of this study was to assess the amount of time that South African netball players spend on modalities, such as core training, neuromuscular control (NMC) and biomechanics, proprioception and flexibility as part of their conditioning. Secondly, the goal was to assess the influence of the playing surface on the injuries sustained by netball players.

METHODOLOGY

Sample

The study population included all the participants (N=1280) in the 2009 USSA national u/19 and u/21 tournaments and the 2009 national senior championships. A total of 205 injuries were sustained by 192 players. At each tournament, teams competed in a Round-Robin format over 4 to 6 days. The top 4 teams in each section played semi-final and final knockout matches to determine the winner of each tournament. Each team played 1 or 2 games per day.

Questionnaire

A questionnaire was used to collect data on all injuries and training modalities. After scrutiny of various injury surveillance questionnaires and definitions of injuries, the questionnaire was based on one that was drafted by the Rugby Injury Consensus Group to monitor the epidemiology of rugby injuries (Orchard *et al*., 2005; Fuller *et al*., 2006; Fuller *et al*., 2007; Pluim *et al*., 2009). It was adapted by the researchers to address the aims of this study and to standardise definitions of injury. A section on training history was added to examine the use of evidence-based preventative training modalities. This section consist of 5 training modalities, namely: core stability; flexibility; proprioceptive exercises; neuro-muscular control; and biomechanics (improved landing technique). The player had to indicate the amount and duration of sessions per week spent on these training modalities.

Informed consent was obtained from Netball South Africa, the event organisers and players. Ethical clearance was also acquired from the Ethics Committee of the University of the Free State to undertake this study (UFS-HUM-2014-35).

Questions were only posed to injured players. Team managers, coaches and medical staff were instructed on how to complete the questionnaire. Team managers and medical staff were responsible to ensure that each injured player completed a questionnaire, assisted by the primary researcher. The primary questionnaire supervisor of each team was trained by the primary researcher to ensure that they and the injured players understood the meaning of each question. In the event of uncertainty, the primary researcher could be called for assistance. Completed questionnaires were collected daily at a scheduled meeting for managers at the adjournment of each day's play. With this procedure, reasonable measures were put in place to ensure that all data on injuries sustained at these tournaments were collected in keeping with the accepted method of data collection of Hopper and Elliot (1993) and Hopper *et al*. (1995a).

Statistical analysis and interpretation of data

All data was electronically captured in Microsoft Excel 2007. The SAS version 9.1.3 statistical software was used for the further analysis of data. Means and standard deviations or medians and percentiles were calculated for numeric data. Frequencies and percentages were calculated for categorical data.

RESULTS AND DISCUSSION

Injury profile

A total of 1280 players who participated in 447 games at 3 netball tournaments were included in the study. A total of 192 players sustained 205 injuries, representing 15% of players who sustained 1 or more injuries. Acute injuries represented 91% of the injuries, while 8.8% of the injuries were recurrent or chronic in nature. Ninety-five per cent (95%) of the injuries were sustained during matches played at these tournaments, while 3% were sustained during warm-up and 2% during practice sessions. In 60.8% of the cases, physical contact with another player led to the injury (Langeveld *et al*., 2012). Factors associated with injuries included tournament play and previous injury, as well as lack of core stability and lack of neuro-muscular and proprioceptive training (Langeveld *et al*., 2012).

Participating in core stability training sessions

Table 1 specifies the participation in core stability training sessions. There is evidence in the literature that suggests that improvement in core stability has the advantage of limiting sport injuries, specifically regarding knee injuries (Kibler *et al*., 2006; Zazulak *et al*., 2007a; Zazulak *et al*., 2007b). With this in mind it is disturbing to note that more than half (51.7%) of injured players made no attempt to improve their core stability.

TABLE 1. **CORE STABILITY: PARTICIPATION IN TRAINING SESSIONS**

Sessions per week	Frequency	Percentage	Cumulative frequency	Cumulative percentage
0	104	51.74	102	51.74
1	21	10.45	125	62.19
2	26	17.91	161	80.10
3	18	8.96	179	89.05
4	11	5.47	190	94.53
5	11	5.47	201	100.00

Participation in neuromuscular control (NMC) and biomechanical training sessions

Table 2 summarises the participation in NMC and biomechanical training sessions by the injured netball players. It is clear from epidemiological studies that an incorrect landing technique was one of the main contributing factors in ankle and knee injuries (Hopper & Elliot, 1993; Hopper *et al*., 1995a; Hopper *et al*., 1995b; Hume & Steele, 2000; Walker, 2010; Herrington, 2011). There is also increasing evidence in the literature indicating that improvement in NMC and biomechanics contribute to injury prevention (McLean *et al*., 2004; McLean *et al*., 2005; Yu *et al*., 2006; Powers, 2007; Walker, 2010; Herrington, 2011). Despite the high rate of injuries in netball (Hopper & Elliot, 1993; Hume & Steele, 2000; Otago & Peake, 2007), alarmingly more than half (57.7%) of the injured players in the current study indicated that they do not participate in exercise sessions to improve NMC and biomechanics (improved landing technique).

TABLE 2. **NMC AND BIOMECHANICAL: PARTICIPATION IN TRAINING SESSIONS**

Sessions per week	Frequency	Percentage	Cumulative frequency	Cumulative percentage
0	116	57.71	116	57.71
1	13	6.47	129	64.18
2	30	14.93	159	79.10
3	22	10.95	181	90.05
4	12	5.97	193	96.02
5	8	3.98	201	100.00

According to Chaudhari and Andriacchi (2006), the high incidence of non-contact ACL injuries is undoubtedly a problem along with many contributing factors, including biomechanical factors. Therefore, it is presumed that mechanical aspects, such as dynamic alignment and joint stability of a weight-bearing limb, play a crucial role in the prediction of injuries. Faulty biomechanics in the sagittal plane was suspected to be the main contributing factor to non-contact ACL injuries (Yu & Garrett, 2007). This is in conflict with other evidence that suggests that loading in the sagittal plane places a ceiling on the forces contributing to ACL loading and that valgus forces are more likely to be a causative factor of ACL injuries in sportswomen (McLean *et al*., 2004). According to McLean *et al*. (2005), it is important to limit knee valgus moments in sporting activities to reduce ACL injuries. These authors also advise improved NMC at the hip to limit knee valgus angles during a cutting movement. This is of particular importance for sportswomen (McLean *et al*., 2005).

According to Powers (2003), knee valgus occurs because of femoral adduction (relative to the pelvis), tibial abduction (relative to the femur), or a combination of both. Excessive femoral adduction during dynamic activities can occur because of weak hip abductors, particularly the gluteus medius. Yu *et al*. (2006) also indicated how hip movement can contribute to ACL loading. Electromyography studies show that during a squat performed in a hip dominant position (knees behind the toes), muscle activity in the knee extensors decrease as compared

to a quad dominant position (knees over the toes), which decreases the load on the ACL (Powers, 2007). It is, therefore, of utmost importance to ensure that sportspersons competing in events where jumps and landing are part of the game are trained to optimise their NMC and biomechanics.

Participation in proprioceptive training sessions

There are again various authors who place emphasis on the value of proprioceptive exercise as part of the training programme, seeing that it has been shown to be valuable in limiting injuries to the lower extremities, especially to the ankle joint (Bahr *et al*., 1997; Wedderkopp *et al*., 1999; Stasinopoulos, 2004; Verhagen *et al*., 2004; Emery *et al*., 2005). Again, despite overwhelming evidence of the value of proprioceptive training, 59% of the injured players in this study made no attempt to improve this component during their physical preparation (Table 3). It is important to note that these underutilised modalities are preventative and remedial for the injuries (ankle and knee joint) that occur most frequently in netball players (Hume & Steele, 2000).

TABLE 3. **PROPRIOCEPTIVE: PARTICIPATION IN TRAINING SESSIONS**

Sessions per week	Frequency	Percentage	Cumulative frequency	Cumulative percentage
0	119	59.00	119	59.20
1	16	7.96	135	67.16
2	27	13.43	162	80.60
3	20	9.95	182	90.55
4	8	3.98	190	94.53
5	11	5.47	201	100.00

Participation in flexibility training sessions

Table 4 summarises the participation of netball players in flexibility training sessions. Flexibility is the one component which the majority of netball players worked at diligently, with 64.2% of all injured players participating in between 3 and 5 sessions per week. This is the case despite the fact that flexibility is the one component where there is no clear evidence to suggest that it has a positive role to play in the prevention of injuries (Thacker *et al*., 1999; De Noronha *et al*., 2006).

TABLE 4. **FLEXIBILITY: PARTICIPATION IN TRAINING SESSIONS**

Sessions per week	Frequency	Percentage	Cumulative frequency	Cumulative percentage
0	9	4.48	9	4.48
1	7	3.48	16	7.96
2	56	27.86	72	35.82
3	46	22.89	118	58.71
4	42	20.90	160	79.60
5	41	20.40	201	100.00

It is the responsibility of the coach to ensure that time is set aside to incorporate exercises in the training programme that improve not only flexibility, but also core stability, NMC and biomechanics (improved landing technique), as well as proprioception. Enlightening coaches about the value of these components by means of coaching courses could be of great value and a positive step towards injury prevention (Gianotti *et al*., 2010; Saunders *et al*., 2010).

Playing surface

At the South African senior championships the games were played on cement courts (54 hours), as well as on a synthetic indoor surface (77 hours). Even though the majority of games were not played on cement surfaces, 500 injuries per 1000 playing hours occurred on cement surfaces, while only 260 injuries per 1000 playing hours occurred on synthetic surfaces. This represents a 1.9 times higher injury rate on cement surfaces than on synthetic surfaces. The current results also indicate that 148 knee injuries per 1000 playing hours (80%) occurred on the cement surface compared to only 26 knee injuries per 1000 playing hours (20%) on the synthetic surface. Furthermore, the majority (88.9%) of serious injuries resulting in players being out of action for more than 7 days, occurred on the cement surface.

One study to compare injury rates on different surfaces in a similar sport is that of Pasanen *et al*. (2008), who found the incidence of injury on artificial surfaces in Finnish floorball to be 2.2 times higher than on wooden flooring that causes less friction. This highlights the importance of the playing surface in injury prevention. The main contributing factors that influence the risk of injury on different playing surfaces seem to be the hardness of the surface and the amount of friction of the footwear-surface interface. Increased hardness of the surface caused increased ground reaction forces, which could contribute to increased loading and fatigue of bone and soft tissues (Murphy *et al*., 2003; Otago, 2004; Herrington, 2011). A higher injury risk is associated with high amounts of friction between footwear and playing surface in sport where weight-bearing rotational movements are common (Pasanen *et al*., 2008). The increased friction may contribute to increased shearing forces around the knee, which puts the ACL at risk (Yu & Garrett, 2007).

CONCLUSION AND RECOMMENDATIONS

Out of a total of 1280 players participating in 447 games at the three netball tournaments, 192 players sustained 205 injuries. This is equal to 15% of the players sustaining one or more injuries.

This injury surveillance study reported a high incidence of injuries among elite netball players in South Africa and revealed factors possibly associated with injuries. A surprising underutilisation of evidence-based preventative strategies has been identified. Based on the results of this study, the following conclusions and recommendations seem warranted:

- Netball coaches must be educated on the value of improved core stability, neuro-muscular control (NMC), biomechanics and proprioception. Coaches are strategically placed to have an impact on injury rates and to prevent the trends of recurring ankle injuries.

- The majority of netball games in South Africa are played on cement surfaces. Because of the high injury rate on these surfaces, creative ways need to be found to reduce ground reaction forces and resistance of footwear-surface interface. Further research in this regard may contribute greatly to the reduction of injury rates in netball and should be actively promoted.
- Future epidemiological studies will have to assess the efficacy of intervention programmes.

If these factors are addressed and their effects monitored, a positive contribution could be made to the prevention of netball injuries.

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