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Title: Incidence and risk factors for injury in non-elite netball

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Abstract

This paper identifies the risk and protective factors for injury in non-elite netball. Three hundred and sixty eight non-elite netballers completed a baseline questionnaire at the commencement of the 1997 preseason. Participants were telephoned each month during the 1997 and 1998 playing seasons to provide details of their exposure at training and games and any injury experiences in the previous four weeks. The incidence of injury in this study was 14 injuries per 1000 player hours. The risk factors for injury were identified as: not warming up before a game (IRR 1.11, 95% CI 1.00 - 1.23) and not being open to new ideas (IRR 1.04, 95% CI 1.00 - 1.07). Training for four or more hours per week (IRR 0.66, 95% CI 0.45 - 0.98) and not sustaining an injury in the previous 12 months (IRR 0.58, 95% CI 0.43 - 0.79) were found to be protective against injury. The risk and protective factors for injury identified in this study can be used as the basis for the development of evidence-based injury prevention strategies that seek to reduce the risk of injury in sport. Injury prevention strategies should focus on the development of effective training programs that include netball-specific skills, activities and movements. Further investigation into the mechanisms associated with the risk and protective factors identified would provide further understanding of why these factors increase or decrease the risk of injury.

Introduction

Netball is the most popular team sport in Australia with an estimated one in seven adult females (455,000) playing on a regular basis[1]. The majority of netballers (81%) compete at a club or association level at least once per week and are aged between 18 and 34 years[1]. Netball is a physically demanding sport that requires a high degree of speed, strength, fitness and flexibility. With the high number of participants, together with the demands placed on players during participation, there is a risk that injury will occur.

The most common site of injury in netball is to the lower leg (including the ankle and knee)[2-3]. Ankle injuries account for 31% of injuries sustained in netball[2,4]. Injury to the knee is the second most common injury in netball, and the most serious in terms of cost and disability[3-4] It is estimated that the incidence rate of knee injuries in netball is 2.82/1000 players (including a rate for severe injuries of 1.2/1000 players)[3]. Stress fractures of the foot also occur in netball from repeated impacts with hard surfaces during landing, hopping and, to a lesser degree, when pivoting[5]. Injury to the fingers, hand or wrist are also common in netball[3-4,6].

To date, the majority of the injury research in netball has focused on elite athletes. Consequently, few studies have been able to draw inferences to the wider sporting community. Furthermore, it is likely that injuries incurred at the non-elite level of participation differ from those for elite and professional players[7]. It is important therefore, to understand the frequency and nature of sports injuries at the non-elite level to assist in the development of effective injury prevention strategies.

As injury prevention has become a major public health issue, the lack of systematic collection of sports injury-related data, particularly at a non-elite level, is of concern both nationally and internationally[8,9]. This study sought to redress the lack of reliable estimates of the incidence of injury in non-elite netball by analysing data from the first population-based sports injury study in Australia (the Western Australian Sports Injury Study)[4,10].

Methods

The Western Australian Sports Injury Cohort Study (WASIS) was a prospective cohort study of injuries to community level participants of Australian football, field hockey, netball and basketball, from the Perth metropolitan area[4,10]. This paper presents the results pertaining to the aetiology of netball injury at the community level of participation.

Players from randomly selected clubs who had not sustained a sports injury in the previous three months were invited to participate in the study. Participants agreed to complete a baseline questionnaire at the beginning of each season, and were then followed monthly, via telephone interviews, throughout the 1997 and 1998 winter playing seasons. Players who completed at least one of the monthly telephone interviews were included. During the telephone interview, participants were asked to report, how many training sessions and/ or matches were played during the preceding four weeks, and if injured, the nature of the injury, its severity and the treatment obtained. A 10% random sample of all self-reported injuries in the cohort study has been validated with medical or health professional records[11]. The full methodology is described elsewhere[4,10] and is just summarised here.

The baseline questionnaire included items about the participants' previous sports injury history, pre-season training habits, and warm-up and cool-down patterns. Specific items about the equipment used by participants (such as footwear and protective devices) were also included as were general health, lifestyle and physical activity questions. The response rate at baseline was 95% and non-respondents were not significantly different from respondents in all variables of interest. The retention rate over the two-year period of the study was 70%[10].

A sports injury was defined as one that occurred whilst participating in sport and which lead to one of the following consequences: a reduction in the amount or level of sports activity; need for medical advice or treatment and/or; adverse economic or social effects for the person[4]. For the purposes of this study, recurrent injuries were counted as one injury if the original injury was not deemed to have resolved. Conversely, multiple injuries to an individual were counted as separate injuries if a new site of injury was given (all other injuries were considered recurrent, thus were counted only once).

Frequencies of count variables and crude odds ratios were calculated using SPSS software[12]. All other analysis was conducted using Stata[13]. The distribution of sports injuries highlighted a predominance of athletes who had not been injured during the 1997 and 1998 sports seasons. To take account of this, zero inflated poisson regression (ZIP) was used to account for the potential over dispersion when multiple zeros (no injuries) were present [14-16]. All baseline variables were initially included in the ZIP model. A backward stepwise approach was adopted to identify the significant risk and protective factors for injury using the standard probability value of 0.05**.** After each computation, the variable with the highest non-significant value was deleted prior to any further computation.

Incidence rates were calculated using the total number of injuries sustained by cohort members as the numerator and the number of hours cohort members spent at training and games (combined) during the 1997 and 1998 winter playing seasons as the denominator. Incidence rates were calculated for each month and over the total study period. Incidence rate ratios (IRR) were used to quantify the increased or decreased risk of injury associated with each significant risk and protective factor identified. The standard errors of the rates $\sqrt{((\text{number of injuries})/(\text{total hours exposure}))}$ were used to calculate the 95% confidence intervals of the incidence rates for each month of the study period.

Results

Description of cohort

Of the 368 netballers included in the study, 66% were aged between 16 and 30 years. Most had completed secondary schooling (64%) and almost a third had attained an additional qualification (29%). The majority of the participants were in full-time employment (25%) or were students (40%).

Baseline characteristics

Seventy three percent (n=269) of the participants had at least six years netball experience and 70% (n=257) had undertaken training for netball in the previous year. Fifty four percent (n=109) trained for at least four hours per week and 17% (n=61) trained between two and four hours each week. Fewer than two thirds of participants reported always warming up before training (61%, n=225) and before playing a game (60%, n=220). In contrast, only 19% (n=70) cooled down after training and 17%

(n=62) after playing a game. The majority of participants trained and/or played netball up to eight hours (79%, n=291) or at least 12 hours (16%, n=59) each month.

In relation to general health issues reported at baseline, 19% (n=71) of participants reported that they had a long term or recurrent back problem and one third (35%, n=128) reported being previously diagnosed with a lower limb pathology including 28% (n=104) with a foot or ankle abnormality. Eighty one percent (n=298) had engaged in vigorous exercise other than netball in the past month and almost half (47%, n=170) had exercised up to six additional hours in the past month.

History of sports injury

Thirty percent of the participants (n=112) were injured during at least one month of the 1997 playing season. Of these, 74% (n=83) sustained one injury, 21% (n=24) two injuries, and the remaining 5% (n=5) sustained three or more injuries. In 1998, 44% (n=160) were injured during at least one month of the season. Of these, 56% (n=90) sustained one injury, 26% (n=42) two injuries and the remaining 18% (n=28) sustained three or more injuries.

Injury to the lower limb was the most common injury (66%, n=166). These included injury to the ankle (32%, n=81) and knee (17%, n=43). Other common injuries were to the hand or wrist (15%, n=39) and to the back (9%, n=23). The most common nature of injury was ligamentous sprains (34%, n=86), followed by muscular strains (22%, n=57) and bruising (15%, n=38). The total number of injuries sustained by participants over the observational period equated to an injury incidence rate of 14/1000 player hours (see Figure 1). There was an elevated incidence of injury at the beginning of the first season ($z=2.69$, $p=0.02$). The incidence of injury then reduced significantly and remained at or around that level for the remainder of the study period (see Figure 1).

Insert Figure 1

Risk and protective factors for injury

Although all baseline variables were included in the ZIP model**,** Table 1 only shows the independent predictors that were significantly associated with injury (adjusting for age). Not warming up before a game was associated with an increased risk of injury (IRR 1.11, 95% CI = 1.00-1.23) as was not being open to new ideas (IRR 1.04, 95% CI 1.00 - 1.07). Participants who reported training for at least 4 hours per week had significantly fewer injures than those who trained for <4 hours per week (IRR 0.55, 95% CI = 0.45-0.98). Not being injured in the last 12 months also reduced the risk of injury to participants in this study (IRR 0.58, 95% CI = 0.43-0.79) (see Table 1).

Insert Table 1

Discussion

The majority of participants in this study fitted the Australian profile of non-elite competitors, playing once per week and being aged between 18 and 34 years[1]. These findings are particularly important as this research is the first population-based study to be conducted in Australia at the non-elite level[4]. The study sought to determine the incidence, and risk and protective factors associated with injury in community level netball in Australia.

Netball is a fast, skilful game requiring a high level of anaerobic and aerobic fitness[17-18]. Research has shown that training can significantly impact upon anaerobic and aerobic fitness; joint stability; neuromuscular adaptation; proprioception, agility, power, strength, speed and specific skill[17-18]. This study found that those participants who trained for four or more hours each week had a 39% reduced risk of injury compared with participants who trained less than four hours per week. It may be that the increased exposure improved skills and techniques thereby reducing the injury risk in these players. Prevention strategies should therefore be developed to test the most effective training programs for netball and the optimum training periods required to provide some protection against injury in this sport[18-19].

Being injury free in the 12 months preceding the observational period was protective against injury for players. Study participants who had not sustained an injury in the previous 12 months had a 42%

reduced risk of injury when compared with players who had sustained an injury in the previous year. Previous injury has been cited as a risk factor for injury in many international and national studies, across various sports, however there is no evidence supporting the reason why this is so[20]. It has been suggested that previous injury may compromise structural integrity leading to muscle imbalance, impaired proprioception or altered joint/muscle function[21-22]. There are no published scientifically validated tests or set criteria for return to play following injury in any non-elite sport[23]. Furthermore, little is known about the factors that impact upon the mechanisms of common injuries in non-elite sport[24]. Understanding the mechanisms of common injuries in non-elite sport has the potential to inform effective injury prevention strategies. This information could also be used to develop rehabilitation programs and guidelines for return to play following injury.

This study found that only 60% of netballers reported warming up before training and the game. Not warming up before a game increased the risk of injury in netball by 48%. The effectiveness of warming up in sport is controversial. Studies that have investigated combinations of generic and sports-specific movements have had varied success[25]. Regardless of the movements completed, there is evidence to support warm-up as a means of preparing the body for action. Warming up increases the vascularity of muscles, reduces the load on the musculotendinous junctions, improves proprioception around joints, and increases vascularity and extensibility of ligaments[22,25-26]. All of these physiological factors impact upon the bodies readiness to perform[25]. Studies have found that warming up assists in the mental preparation of sport participants. It also helps participants to focus on the sports-specific tasks ahead. Further research is required to determine the most appropriate warm up technique in netball and why it is protective.

Various psychological measures were computed for each athlete. Different personalities can affect individual or team performances[27]. One personality trait that proved a significant risk factor for injury in this study was lack openness to new ideas. Openness equates to broad-mindedness, tolerance and open-mindedness. Conversely, lack of openness encompasses narrow-mindedness, strict routines and conservative thinking[27].

Several measures were initiated to minimise bias associated with the collection of data via self-report [10]. Firstly, recall bias was minimised by using trained researchers to collect the baseline data at each team's home clubrooms. Secondly, injury and exposure experiences at both games and training were collected via monthly telephone interviews. Regular, personal contact with participants was a major strength of the research provided a more accurate picture of the exposure and injury experiences of the study participants.

The incidence of injury over the study period was 14/1000 player hours. With almost half a million netballers regularly completing in Australia[1], the development of effective injury prevention strategies has the potential to impact significantly in the number of injuries sustained. Furthermore, many injuries in netball are costly (especially those to the ankle and knee)[4]. With the annual direct cost of sport injury in Australia estimated at $1.65 billion, a small reduction in the incidence of injury in netball could extrapolate to significant savings to the health care system[4,7].

Injury prevention strategies should seek to reduce the incidence of common injuries in netball by gaining and understanding of the mechanisms associated with each of these injuries[20,28]. Training program should be specific to netball and focus on demands of the games[29]. Skills and movement patterns of individual positions during game play should form the basis of these programs. All injury prevention programs, resources and strategies should be produced in formats that encourage coaches and players from all levels of competition to uptake them It may also be appropriate to investigate if injury prevention models that have proven effective in other sports could be extrapolated to netball[23,25,29-30].

Conclusions

Participation in sport need not be inexplicitly linked with injury. The risk and protective factors for injury identified in this study can be used as the basis for the development of evidence-based injury prevention strategies that seek to reduce the risk of injury in sport. However, further investigation into the mechanisms associated with the risk and protective factors identified would provide further understanding of why these factors increase or decrease the risk of injury. This would assist the development of appropriate and effective interventions to prevention injury in netball.

Injury prevention strategies should focus on the development of effective training programs that include netball-specific skills, activities and movements. These training programs should mirror the positional demands of games. Injury prevention strategies should also be developed that target common injuries with the view to reducing their incidence and severity. Educational resources for coaches and players that address the importance of rehabilitation prior to returning to play after injury should also be a priority.

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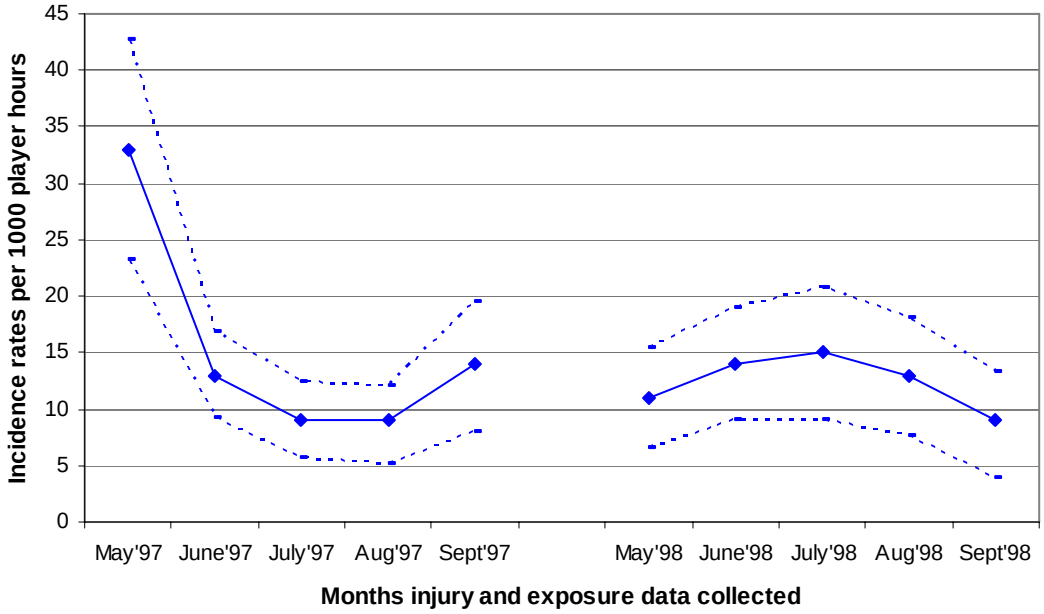
Figure 1 Incidence of injury in community level netball during training and games combined



Key: The dotted lines represent the 95% confidence limits around the incidence rates

Table 1. Significant risk and protective factors for injury in netball

Factor	R/P*	p > |z| value**	Incidence rate ratio (95% Confidence interval)+
Trained 4 or more hours per week	P	0.039	0.66 (0.45 to 0.98)
Was not injured playing sport in the last 12 months	P	0.001	0.58 (0.43 to 0.79)
Not warming up before a game	R	0.048	1.11 (1.00 to 1.23)
Not open to new ideas etc	R	0.010	1.04 (1.00 to 1.07)

Key: * Risk (R) or protective (P) against injury
** An alpha level of $p < 0.05$ was set as the criterion for statistical significance for all analyses
+ IRR after adjusting for age

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Practical applications:

- Risk and protective factors identified in this study should be considered when developing interventions.
- Interventions should be developed that seek to lower limb injury in netball.
- Training programs should include components that address the differing needs of positions.