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Research article

Volume of physical activity and injury occurrence in young basketball players

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Abstract
Participation in organised, competitive physical activity by young athletes is increasing rapidly. This is concurrent with an increase in sporting injuries in the young population. This pilot study aimed to compare the weekly volume and types of physical activity in young basketball players injured and not injured during the season. Detailed physical activity and injury data were prospectively collected in 46 school-level basketball players aged 14 to 18 years. Participants completed physical activity logs which documented the type of physical activity undertaken, what the activity consisted of (i.e. training, competition) and the level at which it was played on a daily basis. Allied health staff completed a weekly injury form. Results showed that injured and uninjured athletes participated in a similar volume of total weekly physical activity over the season. However, injured athletes ($p = 0.04$) and athletes who specifically sustained overuse injuries ($p = 0.01$) participated in a greater amount of basketball refereeing than uninjured athletes. Based on these findings it was concluded that greater participation in running-type physical activity such as refereeing, as an addition to training and competition, may predispose the young basketball player to increased injury risk. Future research using larger sample sizes are required to further investigate the role of participation volume and type on injury occurrence in adolescent athletes.

Key words: Adolescent, sport injury, overuse, workload.

Introduction

Despite an increase in childhood obesity (Childhood Obesity NSW, 2002), child and adolescent participation in organised, competitive physical activity is increasing exponentially (Cook and Leit, 1995). Adolescent athletes may represent their state or national team, as well as participate in club sports, school teams and unsupervised free-play. The sum of these multiple levels of exposure and their impact on the development of injury has not been investigated comprehensively.

Young athletes may be particularly susceptible to injury sustained during sport (Cook and Leit, 1995; Stanish, 1984). An increasing number have been reported to require medical intervention for these injuries (Maffuli and Baxter-Jones, 1995), particularly overuse injuries (Patel and Nelson, 2000). There is speculation that chronic injuries in young elite athletes may negatively affect their sporting performances once competing at the senior elite level (Finch et al., 2002). Furthermore, injury in the adolescent athlete could reduce current and future participation in physical activity; negatively impacting on their health (Emery, 2003; Riddoch and Boreham, 1995).

Despite the reported increases in organised physical activity participation and the concurrent increase in injuries sustained, limited studies have investigated the association between volume of physical activity and injury in young athletes. Lyman et al. (2001) explored the number of pitches thrown by young baseball players and reported that pitching 300 to 599 had a protective effect on elbow pain, whereas throwing 600 or more pitches exacerbated the risk of pain development. Similarly, young cricket bowlers who sustained an injury had bowled significantly more frequently during the week than uninjured athletes (Dennis et al., 2005). Whilst these studies suggest a link between the volume of physical activity and injury, they only recorded one specific motion (i.e. pitching/bowling), rather than the athletes' total participation in physical activity.

Therefore this pilot study investigated the overall activity levels and injury in young athletes. The specific aims of the study were to: first, determine the difference in weekly hours of physical activity in injured and non-injured young athletes, and second, to determine the volume of different types of physical activity undertaken by injured and non-injured athletes. This study chose to investigate basketball players as it has a high risk ratio for injury in adolescent athletes (Backx et al., 1991) and has high participation rates for persons in the 15 to 24 year age group (Standing Committee on Recreation and Sport [SCORS], 2002). It was hypothesized that injured athletes would participate in a greater number of weekly hours of physical activity than non-injured athletes. As previous studies have shown that weight-bearing activity, and more specifically running, may be a risk factor for injury (Burns et al., 2003; Shaw et al., 2004), it was also hypothesized that injured athletes would have a significantly greater weekly volume of running activity than non-injured athletes.

Methods

This observational cohort study compared the weekly volume (hours) and type of physical activity in injured and uninjured young basketball players. Ethics approval was obtained from the University Human Ethics Committee.

Forty-six participants (28 boys and 18 girls) were recruited from a local school with a sporting development program. Participants were included if they were a current member of a school basketball squad and gave informed parental/guardian consent. Players who had minor injuries at the time of baseline data collection were included in the study if they were still training fully.

Baseline anthropometric data (age, sex, height and weight) and demographic information (school year level,

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main competition basketball position, and the number of years playing basketball) were collected on a standardized form. Previous injury history and the presence of current injuries were also documented.

Physical activity was defined as any sport or fitness related activity including training, competition or recreational participation. Walking was not included due to the difficulties associated with monitoring and measuring this activity. Physical activity data was recorded daily using a participation log that recorded the (a) physical activity/sport undertaken; (b) type of activity (training, competition, recreational participation); (c) standard of the participation (school, representative, social); and (d) duration in hours and minutes. Each day of the week was divided into 'morning', 'afternoon', 'evening' and 'other' to work as context cues (Sallis et al., 1993). The completed forms were collected at the next training session and checked for accurate content by a single researcher.

An injury was defined as an incident related to physical activity, that resulted in either time lost from athletic participation, medical diagnosis and treatment (Noyes et al., 1988) or the presence of pain or discomfort. Pain was included within the injury definition in this pilot study to ensure all minor conditions were reported. Non sports-related injuries were excluded from analyses. All injuries were recorded by a single researcher at each training session (sustained in the previous week) on a standardised injury report form (Sports Medicine Australia, 2007) that recorded the injury date, site, mechanism, nature, severity and diagnosis (if known). Whether the injury caused subsequent physical activity volume restriction, and the duration of this restriction, was also recorded.

The mechanism of injury was based on the athlete's report of how the injury occurred and researcher clinical reasoning. Injuries were classed as overuse if they were due to overload/ repeated load and/or a specific injury incident was not reported. Acute injuries consisted of contact injuries (where athletes were struck by/collided with another player, struck by the ball, or collided with a fixed object), and non-contact injuries (the result of a fall/stumble, landing from a jump, overextension, or twisting to pass/accelerate). Injury severity was measured on two separate scales. The first scale categorised injuries into those causing (limiting injury) and not causing a modification of volume of the physical activity undertaken (non-limiting injury). The second scale classified an injury into three categories; one to seven days of modified activity was classed as 'mild', eight to twenty-one days as 'moderate' and injuries causing greater than 21 days of modified activity were classed as 'severe'.

Demographic, physical activity participation and injury data were entered into SPSS (version 11.5) for analysis. Participation data was divided into activity categories including basketball, weight training, physical education class, running, and all other physical activities/ sports. Basketball participation was categorised as training, competition, refereeing, shooting practice and recreational participation. Injury diagnosis, if available, was entered descriptively.

All continuous data (anthropometric/demographic and participation) were checked for normality. Skewed data were analysed with a non-parametric test. Independent t-tests or the Mann-Whitney U test were used for the analysis of two independent groups. Three independent group means (participation hours of athletes sustaining acute, overuse and no injuries) were analysed with a one-way ANOVA test or Kruskal-Wallis test. The chi-square test or Fisher exact test was used to analyse categorical data. Significance was set at $p < 0.05$ for all statistical tests.

Results

Fifty-seven athletes were recruited for the study. Eleven of these athletes were excluded as less than three weeks of data were collected over the 15 week period of data collection, due to either absence from training (n = 10) or dropping out of the basketball program (n = 1). If an athlete sustained a limiting injury, their data was only included for analysis if at least three weeks of participation data were collected prior to the injury. Forty-six participants (28 boys and 18 girls, mean age 16.0 years, range 14.7 to 18.1 years) completed the study. No differences in age, years playing basketball or injury rate or type were found between male and female athletes, therefore all athletes were considered as one data group for analysis.

Seven athletes were injured at baseline, however none of these injuries were causing modified participation in physical activity. No significant differences were found in the weekly participation hours undertaken during the season by players injured and not injured at baseline ($t(39) = 0.896$, $p = 0.38$).

Physical activity data

The mean (*SD*) hours of physical activity undertaken by participants was 10.1 (3.3) per week. Basketball was the single activity with the highest weekly participation volume (mean 7.7 hours per week). The mean (*SD*) hours of weekly participation in all other organised sports (including cricket, Australian Rules football, kickboxing, karate, soccer, netball, softball, tennis and squash) was 0.5 (1.0) hours combined. Other common activities included weight training, physical education class and running (Table 1).

Basketball activity included training (58.5 %), competition (16 %), refereeing (11.6 %), shooting practice (10.1 %) and recreational basketball (3.9 %).

Injury data

Twenty-six athletes (56.5%) sustained 35 injuries. The incidence rate of injuries per athlete over the season was 0.76. Twenty-one athletes suffered a single injury, five athletes suffered two injuries and two athletes sustained three injuries over the season. The season injuries comprised of 62.9% acute and 37.1% overuse injuries. Of the acute injuries, 59.1 % were contact injuries and 40.9% non-contact.

The majority of injuries involved the lower limb (n = 22, 62.9%). Ten were injuries to the hip and thigh, eight involved the knee/shin/calf and four involved the ankle or foot. Injuries to the upper limb accounted for 20% of injuries (n = 7). Of the upper limb injuries, the majority involved the hand or wrist (n = 4), two were to the

Table 1. Mean (SD) of hours of weekly participation in common physical activities.

Activity	Average hours of participation across all athletes	Number of athletes participating
Basketball	7.73 (3.29)	46
Weight training	.73 (.7)	36
Physical Education class	.31 (.48)	21
Other organised sports	.54 (.99)	15
Running	.33 (.72)	11
Cycling	.14 (.56)	10
Swimming	.07 (.26)	7
Other	.29 (.98)	7

shoulder or upper arm and one involved the elbow/forearm. The remaining injuries involved the trunk (n = 4, 11.4%) and the head and neck (n = 2, 5.7%).

The nature of injury most commonly reported by the athletes was pain (n = 9, 25.7 %), followed by overuse injury to the muscle or tendon (n = 7, 20%) and muscle strain (n = 7, 20 %). Five of the injuries were characterized as a bruise/contusion (14.3%), four as a ligament sprain (11.4 %), and three as inflammation or swelling (8.6 %).

The majority of injuries suffered during the season were non-limiting injuries (n = 26, 74.3%). Limiting injuries comprised 25.7% of injuries (n = 9). Participation modification ranged from one day to just under a month, and no athletes sustained a season-ending injury. According to the Sports Medicine Australia severity assessment tool, the large majority of injuries sustained during the season were minor injuries (66.7%).

Injured versus uninjured athletes

Athletes were separated into those injured and not injured during the season, and their demographic data were compared. There were no significant differences in age ($z = -.598$, $p = 0.55$), sex (χ^2 (1, N = 46) = 0.51, $p > 0.05$), height ($z = -.611$, $p = 0.54$), weight ($t(44) = -.651$, $p = 0.52$), or years playing basketball ($t(44) = -.312$, $p = 0.76$) between injured and uninjured groups.

No significant differences were found in the total amount of physical activity undertaken weekly by injured and uninjured athletes ($t(41) = 0.434$, $p = 0.67$, Table 2). The two groups differed significantly in the hours of refereeing performed each week, with the injured group performing 1.21 hours and the uninjured 0.54 hours ($z = -2.096$, $p = 0.04$). Other additional forms of basketball participation including shooting practice ($z = -1.711$, $p = 0.09$) and recreational basketball ($z = -1.86$, $p = 0.06$) were also somewhat greater in the injured group.

Uninjured athletes, athletes suffering only acute injuries, and athletes suffering only overuse injuries were compared with respect to weekly participation hours. Athletes who suffered only overuse injuries participated in a greater amount of refereeing than uninjured athletes ($z = -2.802$, $p = 0.01$, Table 3). This was not the case in acutely injured athletes ($z = -1.6$, $p = 0.53$). Athletes who suffered only acute injuries participated in a larger weekly volume of shooting practice than uninjured athletes ($z = -2.263$, $p = 0.02$) and athletes suffering overuse injuries ($z = -2.309$, $p = 0.02$).

Discussion

This pilot study examined the association between volume and type of physical activity, and injury occurrence in a group of young basketball players. It was found that athletes who sustained an injury over the data collection period did not participate in a significantly different volume of total weekly physical activity when compared to athletes that remained uninjured. Injured athletes however, participated in significantly more basketball refereeing each week than uninjured athletes. There was also a trend for weekly hours of shooting practice and recreational basketball participation to be higher in injured athletes.

This study indicates that additional repetitive and running-type activities may increase the young basketball player's risk of injury. These findings support previous studies which link increased risk of injury to greater running duration (Burns et al., 2003; Vleck and Garbutt, 1998). Refereeing and recreational basketball activities involve large amounts of running as well as changes of direction, which could explain the reason behind their association with injury. Although the actual difference in hours of refereeing was small between the two groups (1.21 hours per week in injured athletes and 0.54 hours in uninjured athletes), the findings highlight the potential impact of supplementary forms of basketball participation (i.e. not training or competition) on injury risk.

Table 2. Average weekly participation hours of injured and uninjured athletes. Data are means (SD).

Physical activity	Injured	Uninjured
Total participation	10.31 (3.33)	9.87 (3.37)
Basketball (Total)	8.11 (3.59)	7.29 (2.93)
Basketball (Training)	4.31 (1.43)	4.76 (2.22)
Basketball (Competition)	1.16 (.78)	1.33 (.71)
Basketball (Shooting Practice)	.97 (1.17)	.56 (1.06) ††
Basketball (Refereeing)	1.21 (1.96)	.54 (2.27) *
Basketball (Recreational)	.46 (.85)	.12 (.29) †
Running	.34 (.80)	.31 (.62)
Weight training	.78 (.62)	.68 (.80)

* $p = 0.04$. † $p = 0.06$. †† $p = 0.09$.

Table 3. Average weekly hours of basketball participation in uninjured athletes and athletes suffering overuse and acute injuries. Data are means (SD).

Physical activity	Overuse injuries	Acute injuries	Uninjured
Training	4.25 (1.3)	4.24 (1.62)	4.76 (2.22)
Competition	1.08 (.76)	1.3 (.88)	1.33 (.71)
Shooting	.26 (.45)	1.43 (1.43) *[a]	.56 (1.06)
Refereeing	2.28 (2.5)	1.12 (1.87)	.54 (2.27) *[b]
Recreational	.36 (.49)	.47 (.88)	.12 (.29)

* Significant Kruskal-Wallis score ($p < 0$ .05).
[a] acute vs. uninjured; acute vs. overuse
[b] overuse vs. uninjured

Only overuse injuries were significantly related to amount of weekly refereeing. Past studies which have demonstrated a greater incidence of overall injury with increased participation, have attributed this purely to the increased time available for an injury to occur (Egermann et al., 2003). This study, that found only overuse injury associated with weekly refereeing, negates this suggestion.

Acute injury was significantly associated with volume of shooting practice. As the majority of acute injuries were contact injuries (59.1%), it does not appear that the repetitious shooting action itself was the main cause of injury. Rather, shooting practice provided increased exposure time for acute injuries to occur (e.g. finger hit by the ball or a rolled ankle as running forward for the rebound).

Limitations of the study

The accuracy of documented physical activity duration was maximised with prospective data collection and a maximum of one week recall, though self report has inherent error. Self reporting is however an extremely cost efficient, and practical method of collecting large amounts of data (Sallis et al., 1993).

As this study focused on participation duration and type, intensity was not measured directly. However the categorisation of basketball participation into training, competition, and additional basketball activities did measure the intensity of participation somewhat. As intensity may plausibly impact on injury risk, significant relationships may not have been detected due to that missing parameter of participation. Only a small number of past studies have measured the intensity of participation in addition to duration, and compared this data to injury occurrence (Anderson et al., 2003; Gabbett, 2004; Quarrie et al., 2001). This is most likely due to difficulties in gathering accurate and consistent estimations of intensity (Dennis et al. 2003).

Conclusion

This study showed that greater participation in running-type physical activity (e.g. refereeing) as an addition to training and competition, may predispose the young basketball player to increased injury risk; and in particular overuse injury risk. Future studies should investigate the precise volumes of physical activity predisposing to injury, so that solid participation guidelines can be implemented with the aim of decreasing current injury rates in the young athletic population.

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Key points

- Basketball players participating in larger amounts of running-type physical activity, in addition to regular training and competition, may be predisposed to overuse injury
- Future studies using larger sample sizes are required to investigate the precise volumes of physical activity that increase injury risk
- This would assist in the development of participation guidelines to decrease the current injury rates observed in the young athletic population.

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