Title: Lateral ankle sprain injuries in Danish elite and sub-elite handball, badminton, and basketball

Topic: Sports Science in Society

University: Aalborg University, Aalborg, Denmark

Education: Master Sports Science 4th semester

Project period: February 1st 2018 - June 7th 2018

Group: 10101

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Number of appendices: 2

Number of pages: 11

Number of pages in worksheet: 13

Completed on: December 6th 2018

Lateral ankle sprain injuries in Danish elite and sub-elite handball, badminton, and basketball

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ABSTRACT

Ankle ligamentous sprains are extremely common in active populations, and the single most common type of acute sport injury accounting for 10-34% of all sport-related injuries. Of all ankle sprains, 80-90% are of a lateral nature caused by an inversion of the foot. Indoor/court sports account for the highest incidence rate of ankle sprains, with handball, badminton, and basketball being among the most popular worldwide. The purpose of this study was to investigate the prevalence and injury mechanism of lateral ankle sprains in Danish handball, badminton, and basketball players at elite/sub-elite level and whether these injuries relate to anthropometry, demography and injury mechanism. Furthermore, kinesiophobia caused by lateral ankle sprains was investigated. A total of 1238 respondents (925 handball players, 207 badminton players, 106 basketball players) completed a questionnaire to retrospectively determine the prevalence and nature of lateral ankle sprains, where 73.8% reported a history of lateral ankle sprains, and 28.7% had suffered a lateral ankle sprain within the preceding 12 months. The risk of suffering a lateral ankle sprain was significantly higher in handball and basketball compared to badminton, while no difference was found between handball and basketball. Badminton players were found to sustain significantly more non-contact lateral ankle sprains, while no difference was found in handball and basketball players. Demographic data showed that larger shoe size, higher level of competition, and greater amount of exposure in terms of training hours, all independently increases the risk of sustaining a lateral ankle sprain. In addition, age was found to have an inverse relationship with lateral ankle sprains, indicating that younger athletes are more prone to sustain a lateral ankle sprain. A weak correlation was found in the relationship between fear of reinjury and time elapsed since most recent lateral ankle sprain, with fear of reinjury gradually declining as time progresses. A weak correlation was found in the relationship between fear of reinjury and perceived pain in the ankle joint region, with fear gradually declining as perceived pain decreases.

Key words: Lateral ankle sprain, injury, indoor sports, kinesiophobia, injury mechanism, risk factors

INTRODUCTION

Ankle ligamentous sprains are extremely common in active populations (Gerber, et al., 1998; Ferran & Maffulli, 2006) and the single most common type of acute sport injury (Hupperets, et al., 2010; Wexel, 1998; Fong, et al., 2009; Verhagen & Bay, 2010) accounting for 10-34% of all sport-related injuries (Hupperets, et al., 2010; Fong, et al., 2007; Gribble, et al., 2016; Garrick, 1977; Verhagen, et al., 2005). Of all ankle sprains, 80-90% are of a lateral nature caused by an inversion of the foot (O'connor & Martin, 2011; Khor & Tan, 2013; Gerber, et al., 1998; Ferran & Maffulli, 2006; Luciano & Lara, 2010) resulting in injury to the lateral ligaments causing pain, swelling and limitation of movement (Clarsen, et al., 2012; Hølmer, et al., 1994).

Lateral ankle sprain injuries are associated with a big societal economic burden due to diagnostics, treatment and absence from productivity (Hupperets, et al., 2010; Doherty, et al., 2014; de Bie, et al., 1997; Fong, et al., 2008). One quarter of those who suffer an ankle sprain were absent from school or work for more than seven days (Doherty, et al., 2014). Hupperets et al. (2010) investigated the annual sports-related ankle sprain expenses in the Netherlands and estimated the costs to €187.2 million, where 80% of these expenses were due to productivity loss by absence from work. According to Nazarenko et al. (2013), an estimated two million ankle sprains occur annually in the United States, with an average cost of $318 to $914 per ankle sprain. Approximately half of the ankle sprains occur during athletic performance (Nazarenko, et al., 2013).

Indoor/court sports account for the highest incidence rate of ankle sprains (Doherty, et al., 2014; Fong, et al., 2007). Handball, badminton and basketball are among the most popular indoor sports with millions of participants worldwide (Pasanen, et al., 2017; Fu, et al., 2017; Moller, et al., 2012). In Denmark, badminton and handball are two of the most popular sports (Fester & Gottlieb, 2016) while basketball is growing

and registering an increasing number of participants (Fester & Gottlieb, 2016). These sports are associated with an extremely high risk of suffering lateral ankle sprains (Fong, et al., 2007; Doherty, et al., 2014; Gribble, et al., 2016). Fong et al. (2007) reviewed ankle injury occurrence in sports and found that, of all injuries, ankle sprains accounted for 20.3% in badminton, 14.5% in basketball, and 13.5% in handball. The incidence rate though was highest for handball followed by basketball and badminton.

Looking at the sports individually, Seil et al. (1998) investigated sports injuries in senior men's handball teams in a one-year prospective study and found ankle sprains to be the most common injury, accounting for 33.3% of all injuries. Additionally, Moller et al. (2012) investigated injury risk in Danish youth and senior elite handball and found that 29% of reported traumatic injuries were ankle injuries. In badminton, Fahlström et al. (1998) investigated acute injuries in recreational players and found that ankle sprains and fractures accounted for 27.2% of all injuries being the most frequent injury. These findings are consistent with Kroner et al. (1990) who found the ankle joint to be the most frequently injured site among badminton players, accounting for 67% of all ligament and joint injuries. In basketball, Pasanen et al. (2017) followed athletes in a 3-year period and found that 48% of all injuries affected the ankle. Additionally, Leanderson et al. (1993) investigated ankle injuries in sub-elite basketball retrospectively and found that 78% of all players reported an ankle injury within the preceding two seasons.

A previous ankle sprain has been shown to be the main predictor for suffering an ankle sprain (Pefanis, et al., 2009; Fulton, et al., 2014; McKay, et al., 2001; Martin, et al., 2013), increasing the risk by up to five times (McKay, et al., 2001). Following acute injuries, such as lateral ankle sprains, athletes may experience pain-related fear and fear of reinjury, termed kinesiophobia (Verwoerd, et al., 2015; Verbunt, et al., 2003; Kvist, et al., 2005; Flanigan, et al., 2013). The level of fear experienced by an athlete can impair performance, or even totally prevent returning to sports, as some athletes avoid certain activities and movements associated with repeated injury (Vlaeyen, et al., 1995). Furthermore, this phenomenon is associated with negative psychological responses (Kvist, et al., 2005), which can ultimately lead to longstanding avoidance and physical inactivity eventually leading to a lower quality of life (Vlaeyen & Linton, 2000; Kvist, et al., 2005).

The notably high lateral ankle sprain injury rate in indoor sports has led to numerous different prevention strategies in handball, badminton, and basketball (Fong, et al., 2007; Doherty, et al., 2014). Additional studies are beneficial in investigating whether athlete characteristics (anthropometry and demography: Gender, age, height, body mass, sports, exposure, shoe size, level of competition) play a role in the occurrence of lateral ankle sprains. Such information might be helpful to the users in selecting the most beneficial prevention strategies. The present study aimed to investigate the prevalence and nature of lateral ankle sprains in Danish handball, badminton, and basketball players at elite/sub-elite level and whether these injuries relate to athlete characteristics (anthropometry, demography). Furthermore, kinesiophobia caused by lateral ankle sprains was investigated.

METHODS

Participants

All included athletes participated in either handball, badminton or basketball on elite or sub-elite level (league, 1st, 2nd, and 3rd division) in Denmark. The inclusion criteria for the study were: (i) registered in a Danish club on divisional level or higher; (ii) training and/or playing on divisional level or higher; (iii) able to understand and read Danish. A total of 1271 respondents commenced a survey regarding lateral ankle sprains, where 33 responses were excluded due to missing content, meaning 1238 athletes completed the survey (Table 1). Eight did not state level of competition and nine participants were excluded from injury mechanism analyses due to missing content. The sample of the present study corresponded to 18.0% of the population in handball, 26.5% of the population in badminton and 12.2% of the population in basketball.

Table 1: Demography and anthropometry presented as mean and standard deviation for handball players, badminton players, basketball players, and in total.

Demography	Handball (925)	Badminton (207)	Basketball (106)	Total (1238)
Male [n]	458	127	73	658
Female [n]	467	80	33	580
League [n]	17	4	23	44
1. Division [n]	190	11	32	233
2. Division [n]	246	35	18	299
3. Division [n]	469	152	33	654
Age [years]	23.5 ± 4.3	22.8 ± 7.2	23.7 ± 6.8	23.4 ± 5.2
Height [cm]	179.9 ± 10.1	178.4 ± 9.7	185.1 ± 11.0	180.1 ± 10.3
Body mass [kg]	79.4 ± 14.3	72.0 ± 11.6	80.6 ± 14.8	78.2 ± 14.2
Training hours [hours/week]	5.3 ± 2.3	6.8 ± 3.6	7.4 ± 4.6	5.8 ± 2.9
Shoe size [EU]	41.9 ± 3.1	41.8 ± 3.0	43.6 ± 3.2	42.0 ± 3.1

Survey

All participants completed a modified Danish version of the previously validated NCAA Injury Surveillance System questionnaire (Dick, et al., 2007). This was used to retrospectively obtain information on anthropometry and demography (gender, age, height, body mass, sports, shoe size, exposure, level of competition) and lateral ankle sprain occurrence (most recent lateral ankle sprain, fear of reinjury, perceived pain in the ankle region, injury mechanism). Exposure was defined as number of weekly training hours. Lateral ankle sprains were divided into two main injury mechanisms: (i) contact; the sprain occurred by stepping onto an object, e.g. foot, ball, opponent etc. and (ii) non-contact; the sprain occurred by stepping/landing awkwardly directly onto the floor. The questionnaire was distributed on paper on site of the training residence before, or immediately after a training session, and collected once filled. A lateral ankle sprain was further explained and defined verbally to the athletes as a lateral distortion of the ankle/foot resulting in pain, stiffness and/or swelling of the ankle (Clarsen, et al., 2012; Hølmer, et al., 1994) causing absence from training.

Data and statistical analysis

Descriptive statistics was used to investigate anthropometric and demographic data (gender, sport, age, height, body mass, shoe size, exposure). Values are expressed as mean and standard deviation.

Prevalence of lateral ankle sprains was calculated with 95% confidence interval (CI) for each sport individually and in total.

Univariate logistic regressions were used to determine whether lateral ankle sprain prevalence within the preceding 12 months could be predicted by the type of sport (handball, badminton or basketball). Furthermore, univariate logistic regressions were used to determine whether lateral ankle sprain prevalence within the preceding 12 months could be predicted by athlete characteristics (gender, age, height, body mass, sports, exposure, shoe size, level of competition). Odds ratios (OR) with 95% CI were reported for univariate logistic regressions.

A One-way ANOVA with Bonferroni-correction was used to investigate any possible difference in exposure for 3rd division compared to 2nd division, 1st division, and league.

A Spearman correlation test was used to investigate whether fear of reinjury and time elapsed since most recent lateral ankle sprain expressed a monotonic relationship.

A Spearman correlation test was used to investigate whether fear of reinjury and perceived pain expressed a monotonic relationship.

A Chi-squared test was used to investigate any differences in proportions of lateral ankle sprains suffered by contact and non-contact in handball, badminton and basketball players, respectively.

A critical probability level of 0.05 was used throughout all tests. All statistical analyses were done using SPSS version 25.0 (IBM SPSS Statistics Inc., Chicago, IL, USA).

Table 2: Prevalence of lateral ankle sprains all-time, within 24 months, within 12 months, and contact and non-contact lateral ankle sprains relative to the total number of lateral ankle sprains all-time with 95% CI.

Factor	Badminton	Handball	Basketball	Total
LAS (all-time)	51.2% (44.4;58.0)	78.2% (75.5;80.8)	78.3% (70.5;86.1)	73.7% (71.2;76.1)
LAS (< 24 months)	24.6% (18.8;30.5)	46.5% (43.3;49.7)	56.6% (47.2;66.0)	43.7% (40.9;46.5)
LAS (< 12 months)	11.6% (7.2;16.0)	31.4% (28.4;34.3)	38.7% (29.4;48.0)	28.7% (26.2;31.2)
Contact	14.2% (07.5;20.8)	46.6% (42.9;50.2)	56.1% (45.4;66.8)	43.7% (40.4;46.9)
Non-contact	85.8% (79.2;92.5)	53.4% (38.4;44.8)	43.9% (33.1;54.6)	55.9% (52.7;59.1)

*Table 3: Odds ratio (95% CI) and p-values for demographic and anthropometric factors predicting injury prevalence within 12 months. *denotes statistical significance ($p < 0.05$). In comparison of sports, first mentioned sport is the reference.*

Factor	p-value	Odds ratio with 95% CI
Age	$p = 0.000071$*	0.948 (0.923;0.973)
Height	$p = 0.305$	1.001 (0.999;1.002)
Body mass	$p = 0.676$	1.000 (0.999;1.002)
Shoe size	$p = 0.002$*	1.065 (1.024;1.109)
Exposure	$p = 0.001$*	1.074 (1.031;1.119)
Gender (all-time)	*$p = 0.581$*	1.074 (0.834;1.383)
Sport		
Handball vs badminton	$p = 1.897 \times 10^{-14}$*	0.293 (0.214;0,401)
Handball vs basketball	$p = 0.974$	1.008 (0.619;1.642)
Basketball vs badminton	$p = 0.000006$*	0.291 (0.170;0.497)
Level of competition (3 div. ref)		
Liga	$p = 0.266$	1.509 (0.731;3.113)
1. div	$p = 0.001$*	1.854 (1.287;2.671)
2. div	$p = 0.004$*	1.597 (1.159;2.202)

RESULTS

In badminton, 106 of 207 of all players had a history of lateral ankle sprains (all-time), 24 of 207 had suffered a lateral ankle sprain within the preceding 12 months (<12 months) and 51 of 207 had suffered a lateral ankle sprain within the preceding 24 months (<24 months) (Table 2). Of all lateral ankle sprains, 15 of 106 were classified as a contact injury and 91 of 106 were classified as a non-contact injury (Figure 2).

In handball, 723 of 925 of all players had a history of lateral ankle sprains (all-time), 290 of 925 had suffered a lateral ankle sprain within the preceding 12 months (<12 months) and 430 of 925 had suffered a lateral ankle sprain within the preceding 24 months (<24 months) (Table 2). Of all lateral ankle sprains, 335 of 719 were classified as a contact injury and 384 of 719 were classified as a non-contact injury (Figure 2).

In basketball, 83 of 106 of all players had a history of lateral ankle sprains (all-time), 41 of 106 had suffered a lateral ankle sprain within the preceding 12 months (<12 months) and 60 of 106 had suffered a lateral ankle sprain within the preceding 24 months (<24 months) (Table 2). Of all lateral ankle sprains, 46 of 82 were classified as a contact injury and 36 of 82 were classified as a non-contact injury (Figure 2).

In total, 912 of 1238 of all players had a history of lateral ankle sprains (all-time), 355 of 1238 had suffered a lateral ankle sprain within the preceding 12 months (<12 months) and 541 of 1238 had suffered a lateral ankle sprain within the preceding 24 months (<24 months) (Figure 1). Of all lateral ankle sprains, 396 of 907 were classified as a contact injury and 55.9% (507 of 907) were classified as a non-contact injury (five were excluded due to missing content).

Univariate logistic regressions on athlete characteristics and lateral ankle sprain revealed age (OR: 0.948; 95% CI: 0.923;0.973), shoe size (OR: 1.064; 95% CI: 1.024;1.109) and training hours (OR: 1.074; 95% CI: 1.031;1.119) to be predictive measures on the risk of suffering a lateral ankle sprain. The risk of suffering a lateral ankle sprain was reduced with an increase in age, while an increase in shoe size and training hours increased the risk of suffering a lateral ankle sprain (Table 2).

Univariate logistic regressions on sports and lateral ankle sprain revealed badminton players to have a significantly lower risk of suffering a lateral ankle sprain compared to handball players (OR: 0.293; 95% CI: 0.214, 0.401), and basketball players (OR: 0.291; 95% CI: 0.170, 0.471). No difference was found between handball and basketball (Table 2).

Univariate logistic regressions on level of competition and lateral ankle sprains revealed 1st division players to have significantly higher risk of suffering a lateral ankle sprain compared to 3rd division players (OR: 1.854; 95% CI: 1.287, 2.671). Second division players also had a significantly higher risk of suffering a lateral ankle sprain compared to 3rd division players (OR: 1.597; 95% CI: 1.159, 2.202). No further analysis from the univariate logistic regressions showed any significance on risk of suffering a lateral ankle sprain. Spearman correlation tests revealed significant correlations between fear of reinjury and time elapsed since most recent lateral ankle sprain ($r = 0.344$; $p < 0.05$) and between fear of reinjury and perceived pain in the ankle joint ($r = -0.351$; $p < 0.05$).

A Chi-squared test on injury mechanism revealed a significant difference in badminton ($p < 0.05$) between contact and non-contact injuries. In handball and basketball, no significant differences were found between contact and non-contact injuries ($p > 0.05$) (Figure 2).

A One-way ANOVA on exposure in each level of competition revealed that league, 1st division, and 2nd division had significantly ($p < 0.05$) more training hours compared to 3rd division.

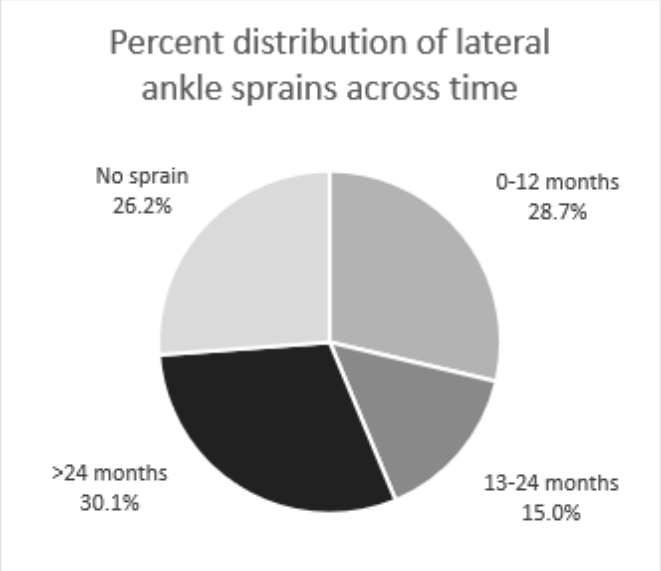

Figure 1: Percental distribution of lateral ankle sprain prevalence across time relative to the total amount of respondents.

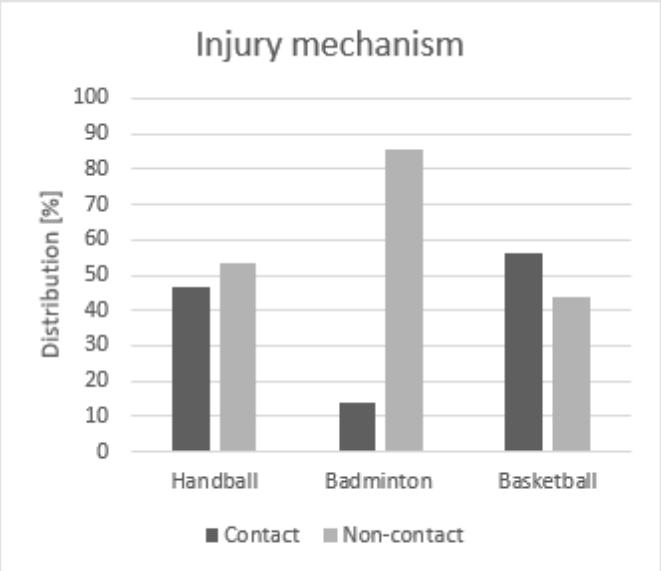

Figure 2: Percental distribution of injury mechanism in each sport.

DISCUSSION

Lateral ankle sprain prevalence

The present study aimed to investigate the prevalence and nature of lateral ankle sprains in Danish handball, badminton, and basketball players at elite/sub-elite level and whether these injuries relate to anthropometry, demography and injury mechanism. The main findings of the present study were, that among 1238 responses, 73.8% reported a history of lateral ankle sprains, and 28.7% had suffered a lateral ankle sprain within the preceding 12 months. The prevalence of lateral ankle sprains found in the present study adds to a growing body of evidence reporting that lateral ankle sprain injuries are extremely common in sports, and a serious cause of extensive absence from sports among athletes (Fong, et al., 2007; Gribble, et al., 2016).

Prevalence reflects the number of subjects with an attribute at any given time point or period, which help decision makers determine where to target health care (Noordzij, et al., 2010; Ward, 2013). For example, large numbers of athletes suffering a lateral ankle sprain will necessitate staffing and training compared to a lower number of athletes suffering an ankle sprain (Ward, 2013). Factors that influence prevalence are the number of incident cases, recoveries, and recovery time. The authors of the present study argue that using incidence rate to compare the extent of a problem may cause a minority of athletes to distort the overall picture. A small proportion of a sample suffering a high number of ankle sprains might give the impression that the number of athletes suffering a lateral ankle sprain is higher than the actual number. The optimal solution would be to include both incidence and prevalence, but due to the retrospective nature of the study and recall bias, the calculation of incidence was assessed to not be sufficiently accurate to include. Abdalla et al. (2015) reported limitations to retrospective practices, such as recall bias, and more specific under-reporting.

All data collected in the present study is retrospective and obtained on site of the training residence. Therefore, athletes who had not returned to sports due to a lateral ankle sprain, might have been absent from the training session when data was collected, meaning these subjects were not included in the survey. This might reduce the prevalence of lateral ankle sprains found in the present study.

Sports related ankle sprains

The present study found that Danish divisional handball and basketball players had a significantly higher risk of suffering lateral ankle sprains than their badminton counterparts. Roughly 78% of both handball and basketball players had a history of lateral ankle sprains, while this was the case for 51.2% of the badminton players. Additionally, 31.4% of the handball players and 38.7% of the basketball players had suffered a lateral ankle sprain within the preceding 12 months, while this was only the case for 11.6% of the badminton players. The present study found that a contact injury mechanism accounted for 46.6% of all lateral ankle sprains in handball, 56.1% in basketball, and 18.5% in badminton. Significantly more lateral ankle sprains sustained in badminton were caused by a non-contact injury mechanism than contact injury mechanism, whereas no difference was found in handball and basketball. The discrepancy in lateral ankle sprain prevalence and mechanism might be related to the diverse nature of the three sports. Handball is considered a full-contact sport with less restrictive rules and an element of physical player contact, which might cause a higher injury risk (Petersen, et al., 2005). Similarly, basketball can be considered a contact sport in which athletes are susceptible to acute injuries (Dick, et al., 2007), whereas badminton is a non-contact sport (Dhillon, et al., 2014). Furthermore, handball and basketball players could be at increased risk of suffering injuries as they might land awkwardly in an attempt to avoid contact, or as a result of being pushed out of balance. These aspects should be considered when preventing lateral ankle sprains in indoor sports.

In contrast to most previous studies examining the number of ankle sprains/injuries relative to the total number sustained and incidence (Beynnon, et al., 2005; Cumps, et al., 2007; Wedderkopp, et al., 1999; Yde & Nielsen, 1990; Yung, et al., 2007; Fong, et al., 2007; Tyler, et al., 2006), the present study aimed to investigate both prevalence of lateral ankle sprains and the cause of injury, in handball, badminton, and basketball. Similar studies do exist, though methodological limitations often apply, which complicates a direct comparison. This problem will be elaborated further in the following section.

Hupperets et al. (2010) investigated ankle sprains among athletes and found that 33% suffered an ankle sprain during a one-year follow-up. No detailed information about the participating athletes was included, which complicates a comparison of studies. Additionally, several studies have reported that 10-34% of all injuries affects the ankle (Fong, et al., 2007; Gribble, et al., 2016; Garrick, 1977; Verhagen, et al., 2005). However, these studies only report lateral ankle sprains relative to the total number of injuries suffered, whereas the present study reports the player prevalence. Therefore, the findings of previous studies are not directly comparable with the findings of the present study.

Giroto et al. (2017) investigated injuries and risk factors in Brazilian elite handball players in a 6 month-period and found that 19.4% had incurred an ankle injury. Taking the different duration of data collection into account, this seems consistent with the prevalence of 31.4% within 12 months found in the present study.

Kofotolis & Kellis (2007) investigated ankle sprain injuries in female Greek professional basketball players prospectively for two years and found that 15.7% had sustained an ankle sprain, whereas the present study found a prevalence of 56.6% within the preceding 24 months among basketball players. All athletes included by Kofotolis & Kellis (2007) played on professional teams with full-time medical staff at disposal, which was not the case for the basketball players included in the present study. Supervised physical therapy can help prevent injuries (Tyler, et al., 2006), which might explain the discrepancy between ankle sprain prevalence. This might also explain the discrepancy between previous studies and the present study regarding the influence of level of competition on injury occurrence.

Cumps et al. (2007) compared injury incidence across different levels of competition in male basketball and concluded that the risk of incurring injuries is highest at the lower levels of competition and lowest in professional teams. D'Souza (1994) found that higher level track and field athletes suffered fewer injuries than lower level athletes. Furthermore, Nielsen and Yde (1989) found that injury incidence varied across all levels of competition, and no level showed any significant difference in European football teams. The present study found 3rd division athletes to have a significantly lower risk of suffering a lateral ankle sprain compared to 2nd and 1st division. No difference was found between 3. division and league, which might be due to the low sample size obtained from league level. Though inconsistent with some previously mentioned studies, other studies have found similar results (Beynnon, et al., 2005; Keightley, et al., 2012; Emery & Meeuwisse, 2006).

Beynnon et al. (2014) found higher level athletes (defined as high school and college) to have an increased chance of incurring a first-time, non-contact anterior cruciate ligament (ACL) injury in several different sports (lacrosse, basketball, football, field hockey, rugby, American football, volleyball). Furhermore, Keightley et al. (2012) and Emery et al. (2006) who investigated female ice hockey and minor ice hockey, respectively, both found a greater risk of injury in higher level competitions. It is evident that conflicting research exists on this area. Additional research is beneficial to examine the relationship between lateral ankle sprains, and other injuries, and level of competition.

Training exposure may play a role in ankle sprain occurrence. The present study found 1st and 2nd division athletes to have significantly more training hours than their 3rd division counterparts. Furthermore, weekly exposure was found to be a significant risk factor for predicting lateral ankle sprains. Common sense deducts that higher amount of exposure results in higher risk of incurring a lateral ankle sprain, which might explain the relationship between exposure and ankle sprain occurrence, but previous studies have found contradicting results. McKay et al. (2001), found that the amount of training does not significantly affect the occurrence of ankle injuries in basketball players. However, the amount of training was defined as number of participations, whereas the present study defined the amount of training as a number of hours. The discrepancy in findings of the present study and McKay et al. (2001) might be due to methodical differences. Furthermore, Yeung et al. (1994) investigated recreational and elite Hong Kong athletes and found no relationship between exposure and ankle sprain incidence. They hypothesized that even though elite athletes performed a larger amount of training, they might be better equipped to reduce ankle injuries due to their higher skill level and awareness of the importance of proper warm-up and stretching prior to activity. All athletes included in the present study played on either elite or sub-elite level, which could mean that technical skill level and awareness is somewhat similar across league and divisions, leaving the amount of exposure as the predictive measure for lateral ankle sprain risk. According to Kentta et al. (2001), increased amount of training can lead to overtraining, which might result in an increased risk of injury. Overtraining can lead to mental burn-out and reduce concentration, which deteriorates movement coordination and therefore causes a greater risk of injury (Kibler, et al., 1992).

Risk factors for suffering a lateral ankle sprain

The results of the present study showed that age, exposure and shoe size were predictive measures with a significant correlation to lateral ankle sprains suffered within the preceding 12 months. An inverse relationship was found between lateral ankle sprain occurrence and age, indicating that younger athletes are more prone to sustaining a lateral ankle sprain. This is consistent with Doherty et al. (2014) who reviewed incidence and prevalence of ankle sprain injuries and concluded that adolescents are more prone to injury, implying that this may be linked to the development of the motor control system. These results though are not consistent with the finding of McKay et al. (2001) and Kofotolis & Kellis (2007), who both investigated ankle sprains in basketball players. McKay et al. (2001) found no relationship between athlete characteristics (gender, height, body mass, shoe size, exposure) and the risk of suffering a lateral ankle sprain, while Kofotolis & Kellis (2007) found this to be the case for age, body mass and height. The discrepancy between these studies and the present study may be due to different methods applied. McKay et al. (2001) and Kofotolis & Kellis (2007) acquired data prospectively on a smaller sample size in contrast to the present study which retrospectively investigated a much larger sample size. Furthermore, a larger proportion of female athletes was included in McKay et al. (2001) and Kofotolis & Kellis (2007) compared to the present study, which included a large proportion of male athletes.

The present study found that athletes with a larger shoe size were more prone to suffer lateral ankle sprains (OR: 1.065; 95% CI: 1.024;1.109). This is consistent with Milgrom et al. (1991) who investigated risk factors of lateral ankle sprains on military recruits and found that those who suffered a lateral ankle sprain had significantly greater foot width and length. This might suggest that increased foot size causes an increased risk of suffering a lateral ankle sprain. Increased width and length of the foot is associated with an increased moment arm and corresponding inversion moment compared with a foot that is significantly shorter and narrower (Milgrom, et al., 1991). The findings of the present study support the notion that larger foot size increases the risk of suffering an ankle sprain, though conflicting evidence do exist (McKay, et al., 2001). Additional research may be beneficial in understanding whether a correlation between foot size and lateral ankle sprains exists.

Kinesiophobia

Previous studies have investigated kinesiophobia in relation to other conditions such as ACL reconstruction and chronic lower back pain (Flanigan, et al., 2013; Chmielewski, et al., 2008; Vlaeyen & Linton, 2000), but to the authors' knowledge, no study has previously investigated fear of reinjury and pain in relation to lateral ankle sprains, even though this injury is

considered the most prevalent among professional and recreational athletes and elicits a great risk of reinjury (Fong, et al., 2007; Doherty, et al., 2014; Fu, et al., 2017; Gribble, et al., 2016).

The present study found a weak correlation between time since most recent injury and fear of reinjury, meaning that as time progresses, the level of fear decreases gradually. Similarly, Chmielewski et al. (2008) found the level of fear after ACL reconstruction to be associated with the timeframe of returning to sports. According to Vlaeyen & Linton (2000), an athlete's fear will decrease, and the impairment gradually decline as time progresses. The results from the present study support this notion to some degree as a significant, but weak, monotonic relationship between most recent lateral ankle sprain and fear of reinjury was found.

The present study found a weak correlation between fear of reinjury and perceived pain, meaning that higher states of fear are related to a higher rating of pain. Flanigan et al. (2013) investigated fear of reinjury and pain after ACL reconstruction and found that pain was the main factor in hindering returning to sports. Furthermore, fear of reinjury was cited in half of the subjects who did not return to sport.

A probable reason for the weak relationships, found in the present study, might be the diverse nature of lateral ankle sprains. In contrast to ACL reconstruction injuries, usually causing 6-9 months of absence, big differences exist in the severity of time-loss after suffering a lateral ankle sprain. A severe ankle sprain might result in absence from sports for up to six months, while a mild ankle sprain might only cause a few days of absence (van den Bekerom, et al., 2012; Miller, et al., 2012). Athletes suffering a mild ankle sprain recently might rate fear of reinjury and perceived pain lower than athletes suffering a severe ankle sprain a long time ago. This notion is supported by Kvist et al. (2005) who reported that the success of returning to a pre-injury state depends on the recovery of the injury. In this regard, those who were less fearful of reinjury and those who confront their fear of reinjury, will return to their pre-injury state at a greater extent (Kvist, et al., 2005). Therefore, athletes with a long history of ankle sprains might also feel impaired for a longer duration than athletes who has suffered few or no previous lateral ankle sprains, even though time elapsed since most recent ankle sprain is similar. Vlaeyen & Linton (2000) proposed behavioural treatment methods designed to modify learned restricting behaviour in patients suffering from chronic musculoskeletal pain. With the findings of the present study in mind, this approach might be applicable to athletes suffering a lateral ankle sprain.

SUMMARY

The findings of this retrospective study showed that 73.7% of Danish elite/sub-elite badminton, handball, and basketball players had suffered a sports-related lateral ankle sprain, while 28.7% of all players sustained a lateral ankle sprain within the preceding 12 months. The risk of suffering a lateral ankle sprain was significantly higher in handball and basketball compared to badminton, while no difference was found between handball and basketball. Badminton players were found to sustain significantly more non-contact lateral ankle sprains, while no difference was found in handball and basketball players. Larger shoe size, higher level of competition, and greater amount of exposure in terms of training hours, were all independently found to increase the risk of sustaining a lateral ankle sprain. In addition, age was found to have an inverse relationship with lateral ankle sprains, indicating that younger athletes are more prone to sustain a lateral ankle sprain. A weak correlation was found in the relationship between fear of reinjury and time elapsed since most recent lateral ankle sprain, with fear of reinjury gradually declining as time progresses. A weak correlation was found in the relationship between fear of reinjury and perceived pain in the ankle joint region, with fear gradually declining as perceived pain decreases.

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