ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2017/88–95/$2.00/©JCCA 2017

Analyzing injuries among university-level athletes: prevalence, patterns and risk factors

Jean Lemoyne, PhD[1]
Caroline Poulin, DC, MSc[2]
Nadia Richer, DC[2]
André Bussières, DC, PhD[2,3]

Background: *Scientific evidence suggests many health benefits are associated with sport participation. However, high intensity participation may be related to an increased risk of musculoskeletal injuries.*

Objectives: *This study aims to: 1) describe the prevalence and patterns of sports injuries, and 2) identify its associated risk factors.*

Methods: *A cross-sectional design was used. University level athletes, involved in 7 sport disciplines reported musculoskeletal injuries sustained in the past year, as well as potential risk factors: training volume and antecedent sport participation. Group comparisons were conducted.*

Results: *82 athletes participated in the study. Respondents sustained over two injuries per year. Significant differences were found for sport category and type of injury. No differences were observed regarding antecedent sport participation.*

Discussion: *High prevalence and sport-specific*

Contexte : *Les observations scientifiques laissent entendre que de nombreux avantages pour la santé sont associés à la participation sportive. Cependant, la participation à haute intensité pourrait être associée à un risque accru de blessures musculo-squelettiques.*

Objectifs : *Cette étude vise : 1) à décrire la prévalence et les tendances en matière de blessures sportives et 2) à en déterminer les facteurs de risque connexes.*

Méthodologie : *On a utilisé une analyse transversale. Des athlètes universitaires qui participaient à sept disciplines sportives ont déclaré des blessures musculo-squelettiques au cours de la dernière année, ainsi que des facteurs de risque potentiels : le volume de l'entraînement et l'historique de participation sportive. On a réalisé des comparaisons de groupes.*

Résultats : *En tout, 82 athlètes ont participé à l'étude. Les répondants ont subi plus de deux blessures par année. On a constaté d'importantes différences sur le plan de la catégorie sportive et du type de blessure. On*

[1] Université du Québec à Trois-Rivières, Department of Human Kinetics
[2] Université du Québec à Trois-Rivières, Department of Chiropractic
[3] McGill University, School of Physical and Occupational Therapy, Faculty of Medicine

The authors declare no conflict of interest related with this project. Authors also confirmed that no funding was obtained to conduct this research.

Corresponding author:
Jean Lemoyne
Université du Québec à Trois-Rivières, Department of Human Kinetics, 3351, Boulevard des Forges, CP.500. Trois-Rivières (Québec) G9A 5H7
E-mail: jean.lemoyne@uqtr.ca
Tel: 819-376-5011 ext. 3794
Fax: 819-376-5092

injuries observed in university sport should be of concern to athletes, therapists, coaches and sport organizers.

Conclusion: *This study contributed to a better knowledge of injury patterns among university athletes, and suggests further practical and research implications.*

(JCCA. 2017;61(2):84-95)

KEY WORDS: musculoskeletal injuries, college sport, prevalence, risk factors, injury prevention, chiropractic

n'a pas observé de différence concernant l'historique de participation sportive.

Discussion : *La prévalence élevée et les blessures propres au sport observées dans le sport universitaire devraient préoccuper les athlètes, thérapeutes, entraîneurs et organisateurs d'événements sportifs.*

Conclusion : *Cette étude a contribué à une meilleure connaissance des tendances en matière de blessures chez les athlètes universitaires et laisse entendre d'autres répercussions sur le plan concret et de la recherche.*

(JCCA. 2017;61(2):84-95)

MOTS CLÉS : blessures musculo-squelettiques, sport collégial, prévalence, facteurs de risque, prévention des blessures, chiropratique

Introduction

A large body of evidence supports the health benefits of participation in sport.[1] However, research also reveals that the excessive practice of sport, especially in the competitive context, is associated with an increased risk of musculoskeletal injuries.[2,3] Sport injuries are associated with high direct and indirect costs, and can lead to early sport retirement for up to 24% of athletes.[4] Sport injury may also lead to decreased sport participation and associated all-cause morbidity, overweight/obesity and post-traumatic osteoarthritis.[5] A cross-sectional study of 236 young elite athletes suggested an injury prevalence rate three to five times higher than the general population.[6] Multiple mechanisms contribute to explaining the high prevalence of musculoskeletal injuries among competitive level athletes.[7] According to Almeida[8], training volume is an important risk factor that was associated with sport injuries. Specifically, the number of hours of vigorous training was significantly correlated with the presence of musculoskeletal overuse injuries. Furthermore, high training regimes also appear to increase the risk of sustaining acute injuries in high contact team sports such as rugby.[9]

Not surprisingly perhaps, antecedent competitive level sport participation may be associated with an increased prevalence of musculoskeletal injuries. According to Malina[10], antecedent sport participation is defined as being involved in systematic training in a single sport at a relatively young age. Moderate to high levels of sport participation usually occurs at puberty, in particular within North American sport systems. Caine *et al*.[11] demonstrated that during adolescence, taking part in elite sports and specializing in a single sport were both associated with a higher prevalence of injuries during those years. For instance, Hall and colleagues showed that the risk of developing anterior knee pain was four times higher among "early specialized" female basketball, soccer and volleyball players.[12] However, despite the Hall study, little is known about the long-term effects of antecedent sport participation from an epidemiological perspective. In this regard, prior research suggests there is a need to improve our understanding of acute and overuse injury patterns among high performing athletes. Investigating the relationship between sport injuries and its potential risk factors is relevant from a health promotion perspective.[5] Collecting data about injury patterns and related risk factors can inform the design of novel strategies to prevent injuries among athletes.

The purpose of the current study was to analyze the injury profile of university-level athletes involved in multiple sport disciplines. This study aimed to 1) describe and compare the injury profiles (e.g. prevalence and distribution) of seven sport disciplines, and 2) determine if reported injuries (acute or overuse) were associated with two risk factors: training volume and early sport specialization (i.e., antecedent sport participation).

Methods

A cross-sectional study was administered between November 2014 and January 2015 among university level athletes (50% males (M), 50% females (F), aged between 21 and 29 years old). All athletes (N=120) involved in the university's sport programs were invited to participate in the study. Participants came from seven university-level sports: cross-country running (M and F), cheerleading, golf (M), ice hockey (M), soccer (M and F), swimming (M and F), and volleyball (F). We decided to regroup athletes who were involved in the same sports, resulting in six groups. The institution's research ethical board (CER-14-204-07-25) approved this project. The athletes who agreed to take part in the data collection received an information letter and completed a consent form.

Participants completed an online questionnaire (appendix 1). Questions were developed based on prior studies and antecedent recommendations.[13,14] Three experts assessed the survey questionnaire for face and content validity and a pilot version was tested on five users. The first part of the questionnaire consisted of three questions covering demographic information (age, gender, hand dominance). Secondly, participants were asked to self-report any prior injuries (over lifetime) at the onset of their competition season. Injury was defined in the questionnaire as "a physical complaint or observable damage to body tissue produced by the transfer of energy experienced or sustained by an athlete during participation on athletic training or competition regardless of whether it received medical attention or its consequence with respect to impairments in connection with competition or training".[13] For each reported injury; participants were asked to specify the date, specific site, tissue involved, type of injury, possible cause, associated factors, type and duration of invalidity and time to recovery. A maximum of ten "past injuries" could be reported. Preliminary data analyses revealed that none of the participants reported over six "lifetime" injuries. Data collection was facilitated by the presence of a chiropractic intern paired with each team. The last section of the questionnaire measured potential risk factors including training volume and antecedent sport participation.

Training volume was measured using two indicators: duration and frequency of training sessions. For duration of training, participants had to report the total number of hours per week they invested in training (sport-specific, physical preparation, competition) since the beginning of the season. For the frequency of training, participants had to report the number of weekly sessions they were involved in their sport (training, competition, etc.).

Antecedent sport participation was measured using two items. Participants were asked, "Between age 13 and 18, did you take part in other elite-competitive sports other than the one you are involved in your university team?" We also asked the age at which they started their university team sport.

For descriptive purposes, we calculated the frequency and proportional distribution of injuries by participant characteristics and training volume. Training volume was subdivided into the number of weekly training sessions (≤ 3, between 4 and 7, and more than 7 sessions per week) and the number of hours of training per week (between 5-10, between 10-15, and > 15 hours). Antecedent sport participation was sub-divided into two categories: participants who took part in sports other than their current discipline between the age of 13 and 18 versus those who did not, meaning no antecedent competitive sports.

First, we verified for distribution normality concerning training volume (duration and frequency), and self-reported injuries. Normal probability plots and verification for excessive skewness / kurtosis were conducted to verify for normality assumptions. In the present case, no excessive values were observed (skewness values between -0.07-0.93, and kurtosis values between -0.11-0.91), but significant values for Wilk-Shapiro normality test, suggest a slight violation of normality assumptions. We conducted ANOVAs with Monte Carlo randomization[15] to verify if training volume and number of injuries differ regarding each team. Then, we compared the injury profile by verifying if the injury profile differed for three risk factors: weekly training sessions, hours of training per week (or training volume) and antecedent sport participation. In cases with a significant F value, we conducted post hoc tests to identify specific group level differences, by using Tukey's HSD test. The mean number of injuries per athlete and prevalence rate (with 95% confidence intervals) was calculated for each sport discipline. We calculated the lifetime injury incidence rate (injury rate per athlete-lifetime). The injury incidence rate was calculated with 95%

Table 1.
Participants' training volume and injury profile
(total injuries, mean, lifetime prevalence and lifetime injuries per athlete)

Teams	Total (N=81)	Cross country (n=15)	Cheerleading (n= 11)	Ice Hockey (n=22)	Soccer (n=20)	Swimming (n=5)	Volleyball (n=8)	Test statistic (df)	P value
Gender, males (%)	40 (49)	5 (33)	2 (18)	22 (100)	9 (45)	2 (40)	0 (0)	Descriptive only	
Age (M±SD)	24.0 ± 1.9	24.6 ± 2.4	23.7 ± 2.3	24.1 ± 0.8	23.1 ± 1.4	25.2 ± 2.4	24.9 ± 2.6	$F\ (_{5,75}) = 2.0$	0.08
Duration (Hours / week)	12.3 ± 5.4*	11.5 ± 4.1	9.1 ± 3.1	16.9 ± 5.4	10.5 ± 2.8	15.8 ± 8.7	7.7. ± 2.2	$F_{(5,73)} = 9.1$	< .001
Frequency (Sessions / week)	4.9 ± 2.9**	7.1 ± 2.9	2.9 ± 1.4	6.7 ± 2.8	3.0 ± 0.9	6.8 ± 3.7	2.7 ± 1.2	$F_{(5,73)} = 13.1$	< .001
Sessions (Hours / session)	3.2 ± 1.9	1.9 ± 1.4	4.5 ± 3.3	2.9 ± 1.4	3.7 ± 1.0	2.2 ± 0.8	3.5 ± 2.7	$F_{(5,73)} = 5.9$	.002
Injuries (% of total)	185 (100) §	21 (11)	28 (16)	47 (25)	58 (31)	12 (6)	19 (11)	$\chi^2_{(5)} = 53.4$	< .001
Lifetime injury rate per athlete (95% CI)	2.26 (1.9-2.6)	1.47 (0.9-2.2)	2.55 (1.7-3.7)	2.01 (1.5-2.7)	2.9 (1.5-3.8)	2.20 (1.2-3.9)	2.38 (1.5-3.7)	$F_{(5,73)} = 1.2$	0.27
Lifetime prevalence (%)	55 (67.1)	6 (22.2)	8 (29.6)	15 (55.5)	17 (63.2)	4 (14.8)	4 (15.4)	$\chi^2_{(5)} = 17.8$	0.01

§ 2 injuries were reported by the golf player (not included for the analyses).

confidence intervals for Poisson rates, as the number of injuries is typically not normally distributed. The lifetime prevalence (overall prevalence) was defined as the total number of athletes injured divided by the total size of each subgroup. Secondly, we compared injury prevalence, to see if acute injuries were more prevalent than overuse injuries. Self-reported injuries were categorized in two subgroups: acute and chronic (or overuse) based on Fuller *et al*.[16] who define acute injuries as traumas resulting from a single, identifiable event, and chronic-overuse injuries, which correspond to gradual-onset injuries caused by repeated trauma. We then calculated chi-square (χ^2) statistic on a 2x2 crosstab: injury type x sport type.

Finally, we computed the mean injuries (with 95% confidence intervals) per athlete for four risk factors: 1) weekly hours (treated as continuous variable), 2) weekly sessions (treated as continuous variable), and 3) antecedent sport participation (2 levels). Due to the distribution of self-reported injuries, a Poisson regression model analysis was performed to identify significant predictors and to estimate their associated incidence risk ratio. Training volume in terms of hours and weekly sessions were included as predictors for the incidence rate ratios (IRRs) which were obtained by exponentiation of the regression coefficients. Due to the potential biased estimates which can be obtained due to unequal sample sizes on sport type ($n_{individual} = 21$, $n_{team} = 61$), we accounted for the sport type effect by adding this variable as a clustering variable.

Results

Table 1 presents the characteristics of the sample population and training volume for each sport discipline. Eighty-two university-level athletes, (50% male (n=41)) returned a completed survey questionnaire, corresponding to a response rate of 68%. Non-response (N= 38, 32% of total population) may be explained by multiple factors, such as refusal to take part to the study, or simply athletes not opening the invitation message sent by the research staff. Respondents had a mean age of 24.0 ± 1.9 (range: 21-29 years) and were involved in seven sport disciplines: cross-country running (n=15), cheerleading (n=11), golf (n=1), ice hockey (n=22), soccer (n=20), swimming (n=5), and volleyball (n=8). Due to a low response rate (n=1) from the men's golf team, this sport category was excluded from the analyses. Moreover, 41% of participants reported not having taking part in other activities than their specific sport disciplines between the age of 13 and 18.

On average, across the six sport disciplines, athletes trained 12.3 (± 5.4) hours per week, and performed an average of 4.95 (± 2.9) sessions per week. Sessions lasted on average 3.2 (± 1.9) hours. In summary, post-hoc an-

Table 2.
Types of injuries by sport category (for descriptive purposes)

	Total (%)	Individual sports (% of total)	Team sports (% of total)
Concussion	24 (12)	4 (2)	20 (11)
Sprain	67 (39)	10 (6)	57 (33)
Muscle tear	30 (17)	13 (7)	17 (10)
Fracture	27 (16)	9 (6)	18 (10)
Dislocation / luxation	5 (3)	1 (1)	4 (2)
Acute injuries (total)	153 (87)	37 (76)	**116 (92)** §§
Overuse injuries (total) (Tendonitis, Bursitis, Shinsplints)	22 (13)	**12 (24)** §	10 (8)

$^{**}p < 0.01$
2 injuries were reported by the golf player (not included for the analyses).
A total of 175 injuries (out of 185) are reported (10 missing data for injury type).

alyses revealed that volleyball players and cheerleading participants were involved in fewer training hours than the other groups ($F_{(5,73)} = 9.12$, $p < .001$). Group comparisons also revealed significant group differences regarding weekly sessions ($F_{(5,73)} = 8.01$, $p < .001$), in favor of ice hockey, swimming and cross-country participants. Number of hours per session were significantly lower among cheerleading participants ($F_{(5,73)} = 5.92$, $p = .002$). Despite a significantly higher number of injuries reported by soccer and hockey players ($\chi^2 = 53.4$, $p < .001$) and on lifetime prevalence ($\chi^2 = 17.8$, $p = .01$), no significant differences were observed regarding the average number of lifetime injury rate per athlete ($F_{(5,73)} = 1.23$, $p = .27$). In summary, participants reported an average of 2.28 injuries per athlete; with a prevalence of 91% (only 7 athletes reported having no injuries). The overall "lifetime" prevalence of injuries (one injury or more) was 67.1%.

As shown on Table 2, 185 musculoskeletal injuries were reported, suggesting an average of more than two injuries per athlete (mean= 2.3; 95% CI 2.14-2.36). The distribution of injuries was as follows: ankle (20%), knee (15%), shoulder (13%), head (11%) and back (7%). Specific patterns of injury type and sport disciplines were also observed. Acute injuries were predominant, representing 87% of all reported injuries. Sixty-six percent of acute or traumatic injuries (sprain, facture, etc.) occurred during team sports, whereas overuse injuries (tendonitis, etc.) were slightly more common in individual sports (54% versus 46%). Participants involved in team sports were more affected by acute injuries (92% versus 76%). Conversely, those in individual sports reported a significantly higher level of overuse injuries (24% versus 8%). These results will be addressed in more detail in the discussion section.

For the second objective of the study, results from the

Table 3.
Multivariate estimates of IRR and 95% CI adjusted for injuries per athlete.

Risk factors	Reported injuries	Mean (95% CI) injuries per athlete	Pseudo R^2	IRR [a] (95% CI) injuries	Wald $\chi 2$ (df)	p
[b]**Training sessions (n)**				0.96 (0.92 - 1.02)	13.33 (10)	0.21
≤ 3 (n=36)	89	2.44 (1.97 - 2.92)				
4 - 7 (n=26)	60	2.35 (1.79 - 2.90)				
≥ 8 (n==18)	36	2.00 (1.33 - 2.67)				
[b]**Training (hours)**				1.00 (0.96 - 1.05)	22.72 (19)	0.25
≤ 10 (n= 36)	79	2.19 (1.69 - 2.64)				
10-15 (n= 37)	95	2.51 (2.05 - 2.98)				
> 15 (n= 7)	16	2.00 (0.93 - 3.07)				
Antecedent sport participation				1.06 (0.92 - 1.13)	3.57 (1)	0.06
Yes (n = 33)	92	2.36 (1.75 - 2.74)				
No (n = 49)	95	2.24 (1.95 - 2.78)				
Sport type						
Team (n=61)	133	2.46 (2.07 - 2.84)				
Individual (n=20)	52	1.67 (1.16 - 2.17)				

CI = Confidence interval; IRR = Incidence rate ratio; df = degrees of freedom
[a] Coefficients are on an exponential scale (exp[β] = IRR); 95% Bootstrap Confidence Interval.
[b] Training volume (sessions and hours) was treated as a continuous variable

Poisson regression analysis suggested that when sport type was controlled as a clustering effect, the occurrence of injury was not associated with either the number of weekly training sessions (Wald χ^2 (df) = 13.33 (1), p = .21), training volume in terms of weekly hours (Wald χ^2 (df) = 22.72 (19), p = .25), and antecedent sport participation (Wald χ^2 (df) = 3.58 (1), p = .06). Table 3 presents the incidence rate ratios (IRRs) and associated 95% confidence intervals (CIs) for each variable.

Discussion

The objective of this study was to determine the injury profile in a population of university-level competitive athletes. Awareness of the injury profile and of risk factors among university level athletes may help develop strategies to reduce the risk of injuries. Our results indicated that injuries appear to be common among university-level athletes, with an average of over two injuries per athlete per year. Such high prevalence should be of concern to athletes, coaches and sport organizers. Ankle, knee and shoulder injuries were the most frequently affected areas, similar to what has been reported elsewhere.[8]

This study also suggested that the injury profile differs according to type of sport, with acute injuries being more common in team sports. However, the present investigation cannot specifically establish cause and effect relationships to explain the athletes' injuries. Such preoccupation was beyond the scope of this investigation, and large samples, systematic follow-ups, and multiple sport samples would have been necessary to establish causal relationships of injury patterns. Several factors may explain our findings. First, contacts with opponents and/or teammates are common in team sports such as ice hockey and soccer.[17] Collisions with teammates are also frequently reported in volleyball, especially when players fall near the net following an attack.[18] Acute injuries may also be caused by ball contact (e.g. serve and smash reception, blocks). In cheerleading, acute injuries can result from falling on the floor after being thrown by teammates. In this regard, it is plausible to suggest that the nature of sport, by its exposure to contact may be a factor that could explain differences between athletes' injury patterns. For example, athletes involved in individual sports (and low risk of contact) undergo a highly repetitive training regime, which is a factor that could possibly explain the higher level of overuse injury.[19] However, it is important to specify that the small sample size for individual sports and the limited number of individual contact sports (e.g. boxing, taekwondo, etc.) are a limitation of this study. Furthermore, the relatively small sample size prevents us from drawing conclusive interpretations about sport type differences. Future research designs should try to recruit among a larger pool of athletes, who participate in a wider range of Canadian, university-level sport disciplines. In summary, further research should increase sample size and therefore expand the number of sports to draw conclusions that are more generalizable.

Together, these findings suggest stakeholders (therapists, trainers, coaches, etc.) should consider tailoring injury prevention plans. Reviews and meta-analyses of effective interventions to reduce the risk of sports-related injuries suggest prevention plans may include insoles (Odd Ratio [OR]: 0.51, 95% CI 0.32–0.81), external joint supports (OR: 0.40, 95% CI 0.30–0.53), and specific training programs (OR: 0.55, 95% CI 0.46–0.66) [20]. Further, the pooled estimate of randomized controlled trials examining a preventative effect of neuromuscular training in the reduction of lower extremity injuries in youth team sport (soccer, European handball, basketball) demonstrates a significant overall protective effect injury (incidence rate ratio: IRR=0.64 (95% CI 0.49-0.84) or a 36% reduction in lower extremity injury risk.[21] Clearly, much can be done to reduce injury risks in young athletes.

The present study also tried to shed some light on the possible associations between training volume (number of sessions and hours trained per week), antecedent sport participation and the participants' injuries. While our findings failed to reveal significant associations, possibly because of the low sample size, other studies suggest that athletes exposed to a higher training load, including high intensity, and high number of hours of training, are facing a higher risk of injury.[22,23] Little is known about the long-term consequences of antecedent sport participation and the development of overuse injuries.[12] Use of more specific measures of early specialization, instead of antecedent sport participation (as a potential risk factor) may contribute to delineating possible risks. For instance, number of antecedent sport disciplines, amount of training per age group, and competitive level and number of years in the specialized and non-specialized sport disciplines may be factors to consider.

This study contributed to enhancing knowledge on multiple facets related to the field of sport traumatology. Our results suggest further investigation about the potential confounding effect of contact, and propose investigating among a larger pool of athletes. From this perspective, it would be relevant in future research designs to identify individual sport disciplines, which could be categorized as contact sports and therefore explain more precisely injury patterns. To our knowledge, this is the first study to provide a detailed portrait of the athletes within their teaching institution. From this perspective, our study suggests the need for coaches to consider recommending regular medical follow-ups of athlete's and injury prevention programs. Further research should focus on a larger scale data collection to have a more detailed picture of university athletes' injury profile.

The data collection procedures used for this investigation contributed to gathering relevant information related to athletes' injuries, and contributed to helping health care team in their interventions (e.g. prevention, follow-ups). The questionnaire was adapted to the needs of our stakeholders (coaches, athletes, medical staff and researchers) wishing to more effectively monitor athlete's progress.

Despite its strengths, this study has several limitations. First, our sample was relatively small. This constraint limits generalization of the results to other athletic populations, and to other universities' sports programs. A larger scale study, involving other provincial varsity sport programs would allow for a more complete description of Quebec's university athletes' profile. Second, self-report measures have the potential of recall bias, which can influence the results. Antecedent research showed that recall was associated with multiple challenges in a 12-month recall period among Australian football players.[24] In study recall bias was very likely, and participants may have reported only what they perceived as their most important injuries, resulting in a biased estimation of their lifetime injuries. To reduce such potential limitations, further studies should consider the feasibility of prospective study designs, an approach that would provide more valid estimates of antecedent injuries. Third, our categorization of sport injuries lacked specificity. More detailed injury records about each athlete would have contributed to estimating their injury patterns more precisely, which could have provided a better explanation of their mechanisms. Moreover, using a standardized injury classification tool (e.g. the Orchard Sport Injury Classification[25], the Sport Medicine Coding System[26]) would also have provided a more detailed profile for each athlete. Fourth, measuring antecedent sport participation using a single item may not properly capture the essence of the domain. Last, as with any cross-sectional design, the causative aspects remain untested. We cannot rule out the possibility that reported injuries caused risk factors (e.g., reduced number of training sessions or hours per week and antecedent sport participation) or that another unmeasured variable is the potential cause of both risk factors and injuries. Future studies should prospectively explore the incidence rate and injury risk factors among competitive sport athletes across several universities and other competitive sports outside of the collegiate system.

Conclusion

Injuries are common among university-level athletes. This study revealed that competitive athletes sustained on average more than two injuries each year, with ankle, knee and shoulder injuries being most frequently reported. Further, the injury profile appears to differ according to type of sport, with acute injuries being more common in team sports and overuse injuries in individual sports. The high prevalence of injuries among university-based athletes should be of concern to athletes, coaches and sport administrators as all have an important role to play in designing tailored injury prevention programs. Nonetheless, further studies should aim to include athletes from multiple varsity sport university programs, and consider prospective research designs to provide a fuller picture of the injury profile among these athletes.

Practical Implications

- This study suggests that the high prevalence of injuries is a major issue among university level athletes, especially acute injuries.
- Stakeholders should consider that sport injury mechanisms (and injury profile) differ between sport disciplines. Further analyses are needed among other sport disciplines.
- A greater understanding of sport-specific injury mechanisms may help reduce the risk of injuries among university athletes.

Acknowledgements

The authors gratefully acknowledge Ms. Laura Mendoza, for her assistance with recruiting participants, data collection and descriptive analysis and Ms. Heather Owens for her assistance with the manuscript. Authors also wish to acknowledge each UQTR's athletic team medical staff for encouraging athletes to take part to the study.

References

1. Haskell WL, Lee IM, Pate RR, *et al*. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sport Exer. 2007; 39(8):1423-1434.
2. Alonsa J, Junge A, Renstrom P, *et al*. Sports injuries surveillance during the 2007 IAAF world athletics championships, Clin J Sport Med. 2009; 19(1): 26-31.
3. Hamel D, Tremblay B, Nolin B, *et al*. (2012). Étude des blessures subies au cours de la pratique d'activités récréatives et sportives au Québec en 2009-2010 [Analysis of Quebec's sport and leisure injuries : 2009-2010]. Retrieved online: http://rseq.ca/media/844914/etudeblessuresrecreasportqc2009-2010.pdf
4. Steffen K, Engebretsen L. More data needed on injury risk among young elite athletes. Br J Sport Med. 2010; 44(7): 485-489.
5. Richmond S, Fukuchi R, Ezzat A, *et al*. Are joint injury, sport activity, physical activity, obesity, or occupational activities predictors for osteoarthritis? A systematic review. J Ortho Sport Phys Ther. 2013; 43(8):515–524.
6. Van Hilst J, Hilgersom NF, Kuilman MC, *et al*. Low back pain in young elite field hockey players, football players and speed skaters: Prevalence and risk factors. J Back Musculoskelet Rehabil. 2015; 28(1): 67-73.
7. Yang J, Tibbetts A, Covassin T, *et al*. Epidemiology of overuse and acute injuries among competitive collegiate athletes. J Athl Training. 2012; 47(2): 198-204.
8. Almeida SA, Williams KM, Shaffe, RA, *et al*. Epidemiological patterns of musculoskeletal injuries and physical training. Med Sci Sport Exer. 1999; 31(8): 1176-1182.
9. Brooks JH, Fuller CW, Kemp SP, *et al*. An assessment of training volume in professional rugby union and its impact on the incidence, severity, and nature of match and training injuries. J Sport Sci. 2008; 26(8): 863-873.
10. Malina RM. Early sport specialization: roots, effectiveness, risks. Curr Sport Med Rep. 2010; 9(6): 364-371.
11. Caine D, Maffulli N, Caine C. Epidemiology of injury in child and adolescent sports: injury rates, risk factors, and prevention. Clin J Sport Med. 2008; 27(1): 19-50.
12. Hall R, Foss KB, Hewett TE, *et al*. Sports specialization is associated with an increased risk of developing anterior knee pain in adolescent female athletes. J Sport Rehabil. 2015; 24(1): 31-35.
13. Timpka T, Alonso JM, Jacobsson J, *et al*. Injury and illness definitions and data collection procedures for use in epidemiological studies in Athletics (track and field): Consensus statement. Br J Sport Med. 2014; 48: 484-490.
14. Kerr Z, Dompier R, Snook E, *et al*. National collegiate athletic association injury surveillance system: review of methods for 2004-2005 through 2013-2014 data collection. J Athl Training. 2014; 49(3): 552-560.
15. Edgington, ES. Randomizatrion tests. 1980; New York : M Dekker.
16. Fuller CW, Ekstrand J., Junge A, *et al*. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. Scand J Med Sci. Sports 2006; 16(2): 83-92.
17. Emery CA, Meeuwisse WH, McAllister JR. Survey of sport participation and sport injury in Calgary and area high schools. Clin J Sport Med 2006; 16(1): 20-26.
18. Verhagen EALM, Van der Beek AJ, Bouter LM, *et al*. A one season prospective cohort study of volleyball injuries. Br J Sports Med. 2004; 38: 477-481.
19. Renström P, Johnson RJ. Oversuse injuries in sports. Sports Med. 1985; 2(5): 316-333.
20. Leppänen M, Aaltonen S, Parkkari J, *et al*. Interventions to prevent sports related injuries: a systematic review and meta-analysis of randomised controlled trials. Sports Med. 2014; 44(4):473-486.
21. Emery CA, Roy TO, Whittaker JL, *et al*. Neuromuscular training injury prevention strategies in youth sport: a systematic review and meta-analysis. Br J Sport Med. 2015; 49(13):865-870.
22. Whittaker JL, Small C, Maffey L, *et al*. Risk factors for groin injury in sport: an updated systematic review. Br J Sport Med. 2015; 49(12):803-809.
23. Jacobsson J, Timpka T, Kowalski J, *et al*. Injury patterns in Swedish elite athletics: annual incidence, injury types and risk factors. Br J Sport Med. 2013; 47(15):941-952.
24. Gabbe BJ, Finch CF, Bennell KL, Wajswelner H. How valid is a self-reported 12-month sports injury history? Br J Sport Med. 2003; 37(6): 545-547.
25. Rae K, Orchard J. The orchard sports injury classification system (OSICS) version 10. Clin J Sport Med. 2007; 17(3): 201-204.
26. Meeuwisse WH, Preston Wiley J. The sport medicine diagnostic coding system. Clin J Sport Med. 2007; 17(3): 205-207.