RESEARCH ARTICLE

External stressors prior to traumatic knee injury: A cohort study on youth athletes. [version 1; peer review: awaiting peer review]

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V1 First published: 25 Feb 2022, 11:236
<https://doi.org/10.12688/f1000research.109637.1>
Latest published: 25 Feb 2022, 11:236
<https://doi.org/10.12688/f1000research.109637.1>

Abstract

Background: Data on external stressors, such as social and environment variables and other "life events", and its relation to injury in youth athletic population are scarce. Investigating if external stressors is associated with injury risk may help coaches and other team staff to provide a more safe sport environment. The aim of the present study was to evaluate different aspects of external stressors and its potential association to traumatic knee injury in youth athletes.

Methods: This study comprised of youth female and male athletes from Swedish national sports high schools, aged 15–19 years, participating and competing in soccer, handball, or floorball. The athletes recorded any traumatic knee injury that had occurred during high-school in a web-based injury form. Data on external stressors and subjective perceived stress was also collected.

Results: The majority (60%) of stress factors noted was related to sport context. More athletes in the injured group of athletes reported life event stressor ($p=0.001$) and experienced stress more often ($p=0.02$) compared to the group of non-injured athletes. No differences between injured and non-injured athletes in terms of change of club, team coach, training protocol or game formation were noted ($p>0.05$). A weak correlation ($r=0.20$, $p=0.02$) was found between the number of stressors and injuries.

Conclusions: A high prevalence of external stressors are present in youth elite athletes with a majority of stress factors related to sport context. Life event stressors are present prior to injury and seem to be associated with traumatic knee injury to some degree.

Keywords

stress, risk factors, soccer, handball, floorball

Open Peer Review

Approval Status AWAITING PEER REVIEW

Any reports and responses or comments on the article can be found at the end of the article.

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Author roles: **Ryman Augustsson S:** Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Lundquist P:** Conceptualization, Formal Analysis, Resources, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: The author(s) declared that no grants were involved in supporting this work.

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How to cite this article: Ryman Augustsson S and Lundquist P. **External stressors prior to traumatic knee injury: A cohort study on youth athletes. [version 1; peer review: awaiting peer review]** F1000Research 2022, 11:236 <https://doi.org/10.12688/f1000research.109637.1>

First published: 25 Feb 2022, 11:236 <https://doi.org/10.12688/f1000research.109637.1>

Introduction

We know today that the risk of anterior cruciate ligament (ACL) injury in athletes is most likely multi-factorial and several theories for an increased risk are described in the literature. For example, weak lower extremity muscle strength^{1,2} and difference in biomechanical conditions, such as muscle activation patterns during side-cutting maneuver,³ seems to contribute to an individual being more prone to ACL injury. One would think our growing understanding of mechanism and the availability of quality prevention would have led to a distinct drop in ACL injury rates of athletes, but unfortunately, that is not the case. Paradoxically, the incidence of injury has actually increased over the years with the highest incidence reported for females 15- to 16-year-olds.⁴ The influence of psychological factors as mental stressors on sports performance and injuries has previously been demonstrated in the literature.^{5,6} Although the majority of studies have employed different methods, the results are in general agreement that “life events” can influence the risk of injury in athletes.⁷ Psychosocial stressors, such as personality, history of stressors, and life event stress, are thought to influence injury occurrence⁶ whereas social support appears to have a protecting effect.^{7,8}

When it comes to traumatic knee injury, such as the ACL injury, the impact of psychological factors on return to sport after injury has recently gained increased attention.^{9–12} For example, fear of re-injury seem to influence returning to preinjury levels of activity after injury negatively.¹³ In addition, other factors such as social and contextual also seem to influence recovery following a traumatic knee injury in sport.⁹ Social support, engagement in care together with environmental influences and sport culture appears to be of importance during rehabilitation.⁹ In addition, sources of social support from physical therapists, coaches, family, friends and teammates seem to be important in different stages of rehabilitation.^{9,10} Thus, both internal (fear) and external (environment and social support) factors are important when it comes to return to sport after injury. External stressors are events and situations that occur in contrast to internal that are self-induced.¹⁴ While there has been increased attention to the role of psychological factors and other stressors on return to sport after injury, some data is also available on these factors association to the risk of injury.^{15,16} It has been reported that changes in stress seem to predict injury in sport and psycho-physiological as well as sociocultural factors can influence the risk of injury.¹⁶ In summary, many risk factors for traumatic knee injury in sport are presented in the literature, including psychological, social and contextual variables. However, the majority is associated with adult athletes and knowledge of the impact of these kind of stress factors and its relation to traumatic knee injury in youth sports are still limited.

A considerable number of youth athletes are recruited to the Swedish national sports high schools each year aiming for an elite career. Previous studies have reported a relatively high prevalence of injury among these athletes.^{17–19} Both physical¹⁹ as well as biopsychosocial²⁰ aspects has been addressed as risk factors for injuries in this population. An increased training load, together with low subjective well-being, insufficient sleep and nutrition have also been proposed as risk factors.^{21,22} Low subjective well-being can be considered as an internal stressor while insufficient sleep and nutrition are external stressors. However, data on other external stressors, such as social and environment variables and other “life events”, and its relation to injury in this youth population are scarce. Two previous studies^{23,24} has been investigating the relationship between life events stressors and injury among high school athletes. In both these studies, high school football players who experience high levels of negative life stress were at greater risk of becoming injured.^{23,24} In another study, performed on youth female football players, high level of life stress were significant predictors for new injuries.²⁵ As far as we know, research on external stressors prior to traumatic knee injury in high school elite athletes are lacking. Investigating life events, environment and social circumstances in this upcoming elite population may increase our understanding of being a young athlete. In addition, exploring if these external stressors is associated with injury risk may help coaches, physical therapists and other team staff to provide a more safe sport environment.

Therefore, the aim of the present study was to evaluate different aspects of external stressors and its potential association to traumatic knee injury in youth team athletes.

Methods

Study design and procedure

Data for this cohort study, adhering to the STROBE statement,²⁶ was collected during 2020. Invitation and information about the study was sent by email to coaches of 70 sport high school programs in Sweden. The team coach at each school distributed a web-based form to the athletes during their first, second or third year of the high-school period by email or through the school's intra-net system. A reminder email was sent out if the school team coach received no response within one month. The survey platform SurveyMonkey[®] was used for data collection and the form was filled out once. Once the form was completed, the athlete could not re-enter.

Subjects

This study comprised of youth athletes from Swedish national sports high schools. Inclusion criteria were male and female athletes, aged 15–19 years, participating and competing in soccer, handball, or floorball. Athletes with traumatic

knee injury prior to high school were excluded. To investigate the impact of stressors, only athletes with traumatic knee injury during the last eight months was included in the final analysis.

Ethics and consent

All athletes achieved written information and signed informed consent online prior to data collection. An introduction page consisting of information on the study was provided at the first page of the form together with an informed consent page. All respondents provided consent by ticking a box before the form opened. Ethical approval was received from the Swedish Ethical Review Authority (EPN no 2019-02609) and the study is consistent with World Medical Association Declaration of Helsinki article 23.²⁷

Outcome measures

The primary outcome was external stressors regarding life event issues and secondary outcome was traumatic knee injury which both were assessed by a web-based form. The web-based form was designed by the authors (SRA and PL) and pilot-tested on youth athletes not included in the study, to obtain views about the design and to achieve face validity. The life event questions were partly retrieved from the Life Event Survey for Collegiate Athletes (LESCA),²⁸ but only dichotomized to gain data on whether the event had taken place or not ("yes" or "no"). In addition, questions were also excluded and/or modified to better adapt to Swedish high school athletes. A final version of the form was constructed and used in the present study and consisted of two parts. In the first part of the form the athletes also recorded his/hers traumatic knee injury together with information about training regimes (hours of practice). A traumatic knee injury was defined as an injury to the ACL, other ligaments, menisci, cartilage damage or fracture. This definition was provided in the form. The second part included questions about external stressor; change of club, team coach, training protocol and game formation, conflict within the family, death or serious illness of family member, conflict with friend or partner, breakup from relationship and school exams, during the last six months for those athletes without injury and six months prior to injury for injured athletes. The athletes were also asked about subjective perceived stress using a 5-point Likert scale; 1=never, 2=rarely, 3=occasionally, 4=often, 5=very often.

Statistical analysis

Statistics were calculated using IBM SPSS (IBM SPSS Statistics for Windows, Version 27.0. IBM, Armonk, NY). Descriptive data are presented with frequency for the different variables of stressors. Prevalence (expressed as a percentage) was calculated as the proportion of the number of factors relative to the total number of athletes. The Spearman's rank-order correlation was used to assess the association between traumatic knee injury and external stressors as well as for perceived stress (internal stressor) and external stressor. For comparison of external stressor between injured and non-injured athletes, the Fisher's exact test was used. Sex difference, in the number of stressors, was analyzed using the Mann-Whitney U test. The level of significance was set at $p < 0.05$.

Results

Participants – dropout analysis

A total of 329 athletes (mean age 17 years (± 0.9)) responded to the questionnaire. Of these, 66% ($n=215$) consisted of soccer players, 14% ($n=46$) handball players and 20% ($n=63$) floor ball players. A total of 84 athletes sustained 122 traumatic knee injuries, during their sport high school period, given an overall injury prevalence of 37%. Of these, 38 athletes were excluded from further analysis due to previous traumatic knee injury earlier than 8 months from registration. Thus, 291 athletes (132 female) were included for injury registration. For comparison of stressors, 167 non-injured athletes were further excluded due to incomplete response of the questionnaire and, consequently, 125 athletes were included in the final sample (Figure 1). Table 1 gives the values for age, training and match hours for dropout ($n=167$) and non-dropout participants ($n=125$).

Injury and exposure data

In the 291 athletes, 65 traumatic knee injuries (19 ACL injuries) were registered in 48 athletes during the last 8 months. The injury prevalence was higher in female athletes (30%) compared to male athletes (16%) ($p=0.001$). The estimated mean number of training hours (h) was 8h/week and of match play 2 h/week, whereas estimated mean number of training hours for other training regimes (e.g. strength and conditioning) was 3.5 h/week.

Occurrence of external stressors

Seventy-two percent ($n=34$) of the injured athletes reported some kind of stressor within six months prior to injury (Table 2). The majority (60%) of stress factors was related to the sport context. For the non-injured athletes, 74% ($n=57$) reported some kind of stressor during the last six months. More athletes (58%) in the injured group of athletes reported life event stressor compared to the group of non-injured athletes (31%) ($p=0.001$). The athletes did not report any death or serious illness of family member. More athletes (40%) in the injured group of athletes experienced stress more often

Figure 1. Flow chart of study participants.

Table 1. Age, training and match hours are presented with mean (SD) for dropouts and non-dropout participants (FUP).

	Dropouts (n=167)	Non-dropouts (n=125)
Age	17 (0.9)	17 (0.9)
Training hours	7.8 (2.6)	7.9 (2.5)
Match hours	2.2 (1.3)	2.1 (2.0)

Table 2. Frequency and percentage of external stressors and perceived stress in injured (n=48) and non-injured (n=77) athletes.

	Injured athletes	Non-injured athletes
External stressors		
Change of club	17 (35%)	27 (35%)
Change of team coach	24 (50%)	51 (66%)
Training protocol and/or game formation	22 (46%)	46 (60%)
Other life event stressors;	27 (56%)	24 (31%)
Conflict within family	4 (9%)	4 (5%)
Conflict with friend or partner	19 (40%)	17 (22%)
Breakup	2 (4%)	0 (0%)
Several school exams	2 (4%)	3 (4%)
Perceived stress		
Never	1 (2%)	8 (10%)
Rarely	5 (11%)	22 (29%)
Occasionally	23 (48%)	31 (40%)
Often	17 (35%)	14 (18%)
Very often	2 (4%)	2 (3%)

compared to the non-injured group (21%) ($p=0.02$). There were no differences between injured and non-injured athletes in terms of change of club, team coach, training protocol or game formation ($p>0.05$). There were no differences in the number of stress factors between injured female (mean 2.4) and male (mean 2.5) athletes ($p=0.83$) as well as between uninjured female (mean 2.4) and male (mean 2.6) athletes ($p=0.61$). A weak correlation ($r=0.20$, $p=0.02$) was found between the number of stressors and injuries. In addition, a moderate significant relationship ($r=0.45$, $p<0.001$) was found between life event stressors and perceived stress. No other external stressors were related to perceived stress ($p>0.05$).

Discussion

The main results of the current study were that a high prevalence of external stressors were present in both injured (72%) and non-injured athletes (74%) with a majority (60%) of stress factors related to sport context. In addition, the rate of life event stressors were higher in the injured group of athletes compared to the group of non-injured athletes ($p=0.001$).

From the total cohort, 65 traumatic knee injuries (19 ACL injuries) were registered in among 291 athletes during the last 8 months. The injury prevalence was higher in female athletes (30%) compared to male athletes (16%) ($p=0.001$). The injury data is similar to a previous study¹⁹ reporting traumatic knee injury prevalence for these sport high school athletes. The relatively high rate of traumatic knee injury is concerning and predictive factors still needs to be investigated.

In the present study, seventy-two percent ($n=34$) of the injured athletes reported some kind of stressor within six months prior to injury. However, for the non-injured athletes the number of athletes reporting stressor during the last six months was approximately the same (74%). The majority (60%) of stress factors was related to the sport context in both injured and non-injured athletes. This is not surprisingly, as the athletes have been starting a new school and, thus, many of the athletes have been changing the sport environment including coach and training regimes. The relationships within the sporting context has previous been noted to play an important role for perceived stress and risk of injury.^{24,29} When the coach is perceived as source of stress, athletes seem to have a greater risk for overuse injuries.²⁹ In addition, athletes in conflict with teammates seem to have a greater risk of sustaining an acute injury.²⁹ However, in the present study, no differences between injured and non-injured athletes were found in terms of change of club, team coach, training protocol or game formation ($p>0.05$). Also, we did not ask about conflict with teammates and, thus, no such data are available from our cohort. In the particular population of the present study, all the athletes are exposed to perceived strain associated with the stressor of starting a new school. Ergo, the stressors related to the new environment (change of club, coach etc.) would probably effect the risk of injury, compared to other youth athletes, but no differences could be expected in the same group of these specific athletes. Yet, more athletes (40%) in the injured group of athletes experienced stress more often compared to the non-injured group (21%) ($p=0.02$) and a weak correlation ($r=0.20$, $p=0.02$) was found between the number of stressors and rate of injury.

In the present study, more athletes (58%) in the injured group of athletes reported life event stressor compared to the group of non-injured athletes (31%) ($p=0.001$). In addition, a moderate significant relationship ($r=0.45$, $p<0.001$) was found between life event stressors and perceived stress. One of the most persistent findings in the sport injury literature is research examining life-related stress. Previous research has shown that negative life stress seems highly predictive of injury occurrence.^{25,28} In the present study, questions related to life event stressors included; conflict within the family, death or serious illness of family member, conflict with friend or partner, breakup from relationship and school exams. Nor death or serious illness of family member were found among the athletes. In addition, conflict within the family and breakup were not that common. However, *conflict with friend or partner* was almost twice as frequent in injured (40%) as in non-injured athletes (22%). Thus, we believe that it is utterly important for the coach, and team staff, to be aware of athlete's distress and observant of conflicts to which the athlete is exposed. Bonding and communication between coach and athletes has previous been discussed as important factors when it comes to athletes' training compliance and participation.^{30,31} This might also be of significance when it comes to recognize life event stressors in athletes. From the coach's perspective, having a good relationship with the athletes might help distinguish athletes' mental condition and life event stressors and, thus, facilitate injury preventive actions.

In the current study, there were no sex differences in the number of stress factors for the injured as well as for uninjured athletes ($p<0.05$). Thus, external stressors seem to be as common in both male and female athletes and do not seem to influence injury risk differently.

This is in contrast with previous studies that have demonstrating sex-based differences in elite athletes^{32,33} where female athletes seem to have higher rates of mental health symptoms.³³ Female athletes have previously been reported to have a higher prevalence of anxiety and eating disorders, depression, sleep problems and self-harming behaviors compared to male athletes.³² However, symptoms of anxiety disorder, depression and eating disorders were lower in team ball sports compared to aesthetic sports.³² The participants in the current study consisted of only of team ball sports and no aesthetic

athletes are represented. Thus, one plausible explanation for the results of non-existing sex differences, in the present study, might be that differences may not be that obvious in team ball sports.

Strengths and limitations

This study is one of the first to investigate external stressors in youth soccer, floorball and handball athletes of Swedish national sports high schools. The study provides new insights valuable for the medical team, teachers and coaches working in the field of Special sports and high schools athletes. Still, there are some limitation in the present study. First, the findings presented in the present study can only be applied to youth athletes in soccer, handball and floor ball and cannot be generalized to other sports. In addition, only 125 athletes, of the 329, were evaluated regarding stressors. We cannot exclude that the dropouts could have affected the result, although we did not observed any differences between dropout and non-dropout participants. However, this observational study is of exploratory character and all pupils, that met the inclusion criteria were invited to participate the study.

Another limitation is the form used in the present study. The form was designed by the authors and the life event questions were partly retrieved from the Life Event Survey for Collegiate Athletes (LESCA),²⁸ but only dichotomized to gain data on whether the event had taken place or not (“yes” or “no”). It would have been easier to compare results if a common, and valid, instrument would have been used. However, by modification of the instrument, we could better adapt the questionnaire to Swedish high school athletes. In addition, a pilot testing was performed on youth athletes to obtain views about the design and to achieve face validity.

Conclusions

A high prevalence of external stressors are present in youth elite athletes with a majority of stress factors related to sport context. These stressors appear to be as prevalent in female as in male athletes. Life event stressors are present prior to traumatic knee injury and seem to be associated injury to some degree. As a coach, medical or other related staff to youth athletes, it is important to be aware of changes in the training environment, but primarily in the home environment of the athlete.

Data availability

Mendeley Data: External stressors prior to traumatic knee injury: A cohort study on youth athletes.³⁴ DOI:[10.17632/g553zhdswp.1](https://doi.org/10.17632/g553zhdswp.1)

The project contains the following underlying data: Raw dataset final sample.csv.

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver](#) (CC BY 4.0 Public domain dedication).

Reporting guidelines

Data for this cohort study was following the STROBE statement.²⁶ Registration: Registered on [ClinicalTrials.gov](https://www.clinicaltrials.gov), 04/28/2021. NCT04869566. Registration page link: [External Stressors Prior to Traumatic Knee Injury in Youth Athletes. - Full Text View - ClinicalTrials.gov](#)

Authors’ contributions

SRA was responsible for data collection, analysis and interpretation of data, and drafting the manuscript. PL contributed in the analysis and interpretation of data, and provided feedback on drafts of the manuscript. All authors read and approved the final version of the manuscript.

Consent

Written informed consent for publication of the participants’ details was obtained from the participants.

Funding

No sources of funding to declare.

Competing interests

No competing interests were disclosed

Grant information

No sources of funding to declare.

Ethical approval

The study was approved by the Swedish Ethical Review Authority (EPN no 2019-02609).

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