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Published in:
Journal of Science and Medicine in Sport

DOI:
10.1016/j.jsams.2019.10.001

Publication date:
2020

License:
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Document Version:
Accepted author manuscript

Risk of acute and overuse injuries in youth elite soccer players: body size and growth matter

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Declaration of interest: none

Word count: 2983

Abstract word count: 248

Number of tables: 3

Number of figures: 0

Risk of ~~traumatic~~acute and overuse injuries in youth elite soccer players: body size and growth matter

Declaration of interest: none

Word count: ~~2925~~2983

Abstract word count: 248~~50~~

Number of tables: 3

Number of figures: 0

Abstract

Objectives: This study investigated anthropometric measures and growth as risk factors for overuse and ~~traumatic~~acute injuries in younger (~~i.e. 9 to 11 years~~U10-U13) and older (~~i.e. 12 to 15 years~~U13-U15) elite level soccer players.

Design: Prospective cohort study

Methods: Height, weight, and sitting height were measured at the start and the end of ~~one~~ the 2016-2017 competitive season ~~(2016-2017)~~ and growth velocities were calculated. Throughout the season, injuries were registered continuously by the (para-)medical staff of the included clubs. We analyzed the injury risk using multilevel Poisson regression models, accounting for club and team clustering.

Results: Of the included 314 players (11.~~65~~ 7 ± 1.~~69~~ 7 years of age), 160 players sustained 133 overuse and 163 ~~traumatic~~acute injuries (i.e. 106 injuries in 69 players of the younger group, 190 in 91 players of the older group). In the younger group, risk ~~for~~ of overuse injuries was associated with an increase in leg length over the season (incidence rate ratio (IRR) 1.620 [95% CI 1.230-2.117]) and risk ~~for~~ of ~~traumatic~~acute injuries with relatively younger age (IRR 1.003 [95% CI 1.000-1.006]). In the older group, a higher leg length was associated with an increased risk of overuse injuries (IRR 1.055 [95% CI 1.011-1.108]), and a higher weight and a lower growth rate with an increased risk of ~~traumatic~~acute injuries (IRR 1.043 [95% CI 1.021-1.067] and 0.903 [95% CI 0.831-0.981], respectively).

Conclusions: Injury risk factors differ by age group and type of injury. The age-~~-~~specific anthropometric and growth-~~-~~related risk factors should be monitored and these risk profiles should be considered to ~~reduce~~ manage injury risk effectively.

Key terms: football; injury risk; injury prevention; child; adolescent; youth sport

Introduction

The development of youth soccer players in the academies of professional clubs involves very specialized training with high loads at a high frequency[1] in order to prepare these elite level players for the increasing demands of contemporary professional match play.[2] These soccer-specific development programs, however, are associated with a significant injury risk. According to the literature, injury rates in boys from 9 to 18 years of age vary between 2.0 and 19.4 injuries per 1000 hours of exposure during training and match play, respectively.[3]

Identifying players and periods of increased injury risk appears to be a reasonable first step towards successfully ~~reducing~~ managing the~~is injury burden~~risk.[4] ~~Identification of a player's risk at a certain point in time could for example facilitate training load decisions and other injury risk management initiatives.~~ Nevertheless, risk profiles might vary for different injuries, due to the different injury mechanisms.[5] Therefore, it is recommended to look separately at various types of injuries, such as overuse and ~~traumatic~~acute injuries.[6]

Knowledge about anthropometric and growth-related risk factors ~~as individual player characteristics~~ is scarce in elite level youth soccer.[7] Previous research showed that the player's age is an important risk factor[7 8] and that a particular increase in injury incidence rate is seen in boys starting from 12 years of age.[9 10] This is the moment when the game evolves from small sided games to adult soccer standards, and the number, specificity and intensity of the training sessions increases, while most players also start to grow rapidly. Apart from an elevated risk ~~for~~ of injuries around the adolescent growth spurt,[8] it is not known how injury risk evolves with growth and development in children in a wider age range from pre-adolescence into adolescence. Given that previous literature has related overuse injuries[11] and some ~~traumatic~~acute injuries[12] to phases of maturation in adolescents, it is thought that the injury risk is related to youth players' body size and growth.

To gain a more comprehensive understanding of the actual association between body size, growth and injuries around the time of (pre-)adolescence, we used a multivariate approach to identify risk profiles based on anthropometric and growth-related characteristics in elite youth soccer players from 9 to 15

years of age. Due to reported changes in injury incidence and in the type of game play, we have investigated injury risk ~~is be investigated~~ in younger (U10-U12) and older (U13-U15) players separately. Given the different mechanisms of injury that are potentially associated with different underlying risk factors, we ~~is~~ have also distinguished between overuse and ~~traumatic~~acute injuries.

Methods

The present longitudinal study monitored 314 male youth soccer players ~~by measuring them both at~~ from the start ~~and~~ to the end of the 2016-2017 competitive season ~~2016-2017~~. Players of the Under 10 (U10) up to the Under 15 (U15) age categories were recruited from the youth academies of four professional [COUNTRY ~~BLINDED~~] soccer clubs, playing in the highest division in all age categories. The elite level ~~youth soccer~~ development program of these academies consisted of at least three training sessions and one game per week, with the number of weekly training sessions increasing with age. All players who were not injured at the start of the season and who were medically cleared to play, were eligible for participation in this study. After receiving verbal and written information about the study design and the potential risks and benefits upon participation ~~was provided~~, the parents or legal caretakers and the youth players provided written informed consent and child assent ~~were received from the parents or legal caretakers and the youth players~~, respectively. The medical ethical committee ~~study protocol was approved by the medical ethical committee~~ of [BLINDED] approved the study protocol with~~and~~ all measurements ~~were~~ being performed according to the ethical standards of the Helsinki Declaration.

Anthropometric measurements were taken at the site of each included youth academy both at the start (i.e. [MONTHS ~~BLINDED~~]) and the end (i.e. [MONTHS ~~BLINDED~~]) of the competitive season. The same trained assessor [INITIALS], who was not connected to any of the youth academies and had no knowledge of the injury history of the players, took ~~A~~all measurements ~~were taken by the same trained assessor [INITIALS BLINDED], who was not connected to any of the youth academies and had no knowledge of the injury history of the players being evaluated~~.

Body height (Seca 213 Portable Stadiometer, Seca, Germany) and sitting height (Harpenden sitting height table, Holtain, UK) were measured to the nearest 0.1 cm. ~~Players' leg length was calculated as t~~The difference between their recorded body height and sitting height determined the players' leg length. Body weight was determined barefoot wearing soccer shorts and t-shirt to the nearest 0.1 kg using a digital scale (Tanita BC-420SMA, Tanita, Japan).

We calculated ~~C~~changes in body height, leg length and body weight from the start to the end of the season ~~were calculated and then~~and transformed these into growth rates per year by dividing the change (in cm or kg) by the time in between the two measurements (in years).

The relative age of the players was determined as the number of days between cut-off date January 1st and their actual date of birth within the corresponding birth year. This results in an interval scale containing 364 intervals, or 365 in 2004 as a leap year, with higher values corresponding to a relatively younger age. Using this scale (364/365 steps) to evaluate players' relative age instead of the commonly used distribution by birth quarters, we were able to analyze relative age as a continuous variable without losing valuable information due to artificial cut-off points.

~~Injuries were registered by t~~The (para)medical staff of each participating youth academy registered all injuries using a prespecified injury registration form (Appendix A). On this form, they registered information about the injury diagnosis (i.e. anatomical location and type of injury) as well as the mechanism (i.e. overuse or acute injury). None of the medical staff members registering the injuries was involved in research and all were equally supervised by the research team in order to avoid a bias in data collection due to research involvement of the clinician.[13] ~~On this form, information about the injury diagnosis (i.e. anatomical location and type of injury) as well as the mechanism (i.e. overuse or traumatic injury) was registered.~~ An injury was defined as a medical attention injury. That is, any injury that required an assessment of medical or paramedical staff.[5] In the participating youth academies, all players ~~unable to participate~~experiencing any complaint ~~in~~ during a training or match, regardless of soccer time loss, were required to see the academy's (para)medical staff who then assessed the injury. This thus concerned all types of complaints, ranging from large wounds to musculoskeletal injuries and concussions. An overuse injury was defined as an injury caused by repeated microtrauma without a single identifiable event responsible for the injury, whereas an ~~traumatic~~acute injury resulted from a specific, identifiable event.[5] For each injury, the date of occurrence and the date of return to full participation were registered. The number of days in between these defined the time lost due to that particular injury. The number of overuse or acute injuries per player season was defined as the injury incidence, and the number of days lost per player season was defined as the injury burden. The number

of overuse and acute injuries ~~(i.e. all, traumatic and overuse)~~per player season (i.e. incidence of overuse and traumatic injuries separately) ~~registered for each participating player across the season~~ wereas used as the outcome variable in our analyses.

Based on the training calendar and the number of competition matches played by each of the participating teams, we calculated team-based exposure ~~was calculated~~ over the entire season for each team. By dividing t~~T~~his total exposure time~~, was then divided~~ by the number of weeks in the competitive season, we ~~to~~ calculated the average weekly exposure time of the players in their respective teams. Given the high training fidelity and the structured weekly training program, this weekly average is considered relatively accurate for weeks that a player~~s~~ was not injured.

All analyses were performed in R (version 3.5.4), for the younger (U10-U12) and the older (U13-U15) group separately, with the alpha level of significance set at 0.05. Descriptive statistics of individual player characteristics are presented as means ± standard deviations. We modelled ~~C~~count variables of injuries per player season ~~were modelled~~ using Poisson regression models, negative binomial regression models, zero-inflated Poisson regression models or zero-inflated negative binomial regression models according to the best fit using the R-package "glmmTMB" (version 0.2.1.0). To acknowledge the clustered data structure with players being clustered within teams (N=6) and teams being clustered within clubs (N=4), we added a random effect for these variables to each model. Analyses were checked for model fit using the likelihood ratio test statistics with the Akaike's information criterion.[14] As exposure to soccer is a determinant for the risk of soccer injuries, we corrected all models ~~were corrected~~ for the average weekly exposure time. Multivariate regression models were fit including those ~~predictors~~ variables that displayed a p-value < 0.1 at the univariate level. Multicollinearity between predictors was examined using a correlation matrix and diagnostic statistics.[15] When multicollinearity was present between predictors (i.e. an intercorrelation with r > 0.6), we only considered the predictor with the strongest association to the outcome variable ~~was considered~~ in the multivariate model. Exponentiated c~~C~~oefficients of these final models were interpreted as incidence rate ratios (IRRs), displaying the relative risk by a change of one unit in the predictor variable.

Results

In total, 314 players (mean age: 11.~~65~~ 7 ± 1.~~69~~7) were monitored during one competitive season. Anthropometric and growth-related characteristics of the entire sample as well as the younger (U10-U12) and older group (U13-U15) separately, are displayed in Table 1. A total of 296 injuries (i.e. 133 overuse injuries and 163 ~~traumatic~~acute injuries) were registered in 160 players~~, of which~~In the younger group, 69 players sustained a total of 106 ~~occurred in 69 players of the younger group~~injuries and in the older group, 91 players sustained a total of 190 injuries (Table 1). ~~190 in 91 players of the older group (Table 1), in 69 and 91 players respectively.~~ The time lost due to injury ranged from 0 to 79 days per injury for overuse injuries and from 0 to 69 days per injury for ~~traumatic~~acute injuries. The mean time loss per type of injury for each group ~~can be found~~is displayed in Table 1. The injury incidence and injury burden were more than twice as high in the older group than in the younger group, with 1.33 versus 0.62 injuries per player season and 26.1 versus 11.0 days ~~lay-off time~~ lost per player season, respectively (Table 1). A detailed overview of the injuries per subgroup according to ~~their type and~~ location is provided in Appendix ~~A~~B. Table 2 displays ~~D~~differences between injured and non-injured players ~~can be found in Table 2~~. The IRRs of the multivariate models with 95% confidence intervals and p-values are presented in Table 3, and the raw data for the variables showing significant associations are visualized in Appendix C. Average weekly soccer exposure did not show a significant association with the number of injuries per player season in any of the models described.

In ~~younger players~~the younger group, the multivariate model indicated a higher risk of~~for~~ overuse injuries related to a change in leg length (IRR = 1.620, $p < 0.001$). Per centimeter growth of the legs, the injury risk was 62% higher. In older players, having longer legs at the start of the season was associated with a higher injury risk of 5.5% per centimeter (IRR = 1.055, $p = 0.006$).

In the younger group, the model revealed that a lower relative age ~~(i.e. born later after the cut-off date)~~ was associated with the risk of~~for~~ ~~traumatic~~acute injuries. For every additional day a player was born after the cut-off date, the injury risk was 0.3% higher (IRR = 1.003, $p = 0.020$). In older players, a higher weight at the start of the season ~~the risk for traumatic injuries was associated with a higher weight at the start of the season~~ (IRR = 1.043, $p < 0.001$) and a lower growth rate over the season (IRR = 0.903, p =

0.015) were associated with risk of acute injuries. The risk was 4% higher per kg and 10% lower for every cm increase in height, respectively.

Discussion

The results of this longitudinal study showed that risk factors ~~for of traumatic~~overuse and ~~overus~~acute injuries vary between different age groups of pre-adolescent and adolescent elite level soccer players. In younger players (~~i.e. 9 to 11 years~~U10-U12), a higher increase in leg length was associated with more overuse injuries, whereas having longer legs at the start of the season was associated with a higher risk ~~for of~~ overuse injuries in older players (~~i.e. 12 to 15 years~~U13-U15). In the younger group, we ~~also~~ found an association between relative age and ~~traumatic~~acute injuries, with relatively younger players being at increased risk. In the older group, the risk ~~for of traumatic~~acute injuries was higher in players being heavier at the start of the season and those with a lower growth rate over the season.

A greater increase in leg length was identified as a risk factor for overuse injuries. It should be noted that the peak growth of the legs sets in during preadolescence, before the actual peak height velocity or the adolescent growth spurt is reached.[16] This increase in leg length during its peak in preadolescence (i.e. from the age of 11 years onwards) is relatively larger than the increase in total body height (in cm/y) during the actual growth spurt.[16] It is supposed that muscles, tendons and apophyses adapt slowly to changes in extremity length, mass, and moment of inertia.[17] Consequently, this slow adaptation might increase the stress on muscle-tendon junctions and apophyses, possibly resulting in overuse injuries.[17] [18] The structural changes in combination with an underdeveloped muscle coordination of the dynamic stabilizers might increase injury risk. Our findings suggest that it is of importance to closely monitor growth of the lower extremities in young soccer players~~,~~ in order to identify periods of growth, during~~in~~ which the player is significantly more susceptible for overuse injuries. This can be done by measuring the players on a ~~monthly~~ regular basis (e.g. every three months).[19]

A relatively younger age (i.e. born later after the cut-off date) was associated with the risk of~~The risk for traumatic~~acute injuries~~was associated with a relatively younger age (i.e. when a player is born later after the cut-off date)~~. ~~Existing~~ Previous studies investigating the association between relative age and injury risk, show contradicting results in athletes aged between 10 and 15 years from different sports and levels of play.[20] [21] It is assumed that, due to the physical contact in sports such as soccer, the relatively younger players, who are likely to be smaller, lighter, and weaker, would sustain more injuries

in contact situations.[20 21] Nevertheless, a study comparing age-only competition categories and age-weight categories, found no difference in injury incidence.[22] This previously made assumption~~, however, cannot~~is also not ~~be~~ supported by our data, showing that the non-injured players were significantly shorter and lighter than the players who suffered ~~traumatic~~acute injuries. More ~~research~~ large prospective studies ~~is~~are needed to further assess the risk of injury in relation to relative age and, in particular, to unravel the mechanisms behind this association.

Injury risk was associated with higher baseline values of weight regarding~~for~~ ~~traumatic~~acute injuries, and leg length regarding~~for~~ overuse injuries. This finding is in line with the suggestion that taller and heavier players have to absorb greater reaction forces through their soft tissue and joints.[23] As none of the elite youth soccer players in our study was overweight and would benefit from weight loss, this finding suggests that training programs should focus more on increasing the general load tolerance in players of the U13 to U15 age categories, next to soccer specific technical and tactical training per se.

The risk of~~for~~ ~~traumatic~~acute injuries was related to a lower growth rate. Players in this age group demonstrating a lower growth rate compared to their peers, are more likely to have passed the adolescent growth spurt already. These players are generally the strongest and tallest of the group, who tend to play more and are thus more exposed to injury risk.[24] The physically stronger players during puberty are also more likely to show an increased risk-taking behavior, which potentially leads to (more) ~~traumatic~~acute injuries in talented adolescent athletes.[25]

Different anthropometric and growth~~-~~-related injury risk factors were identified for the younger and the older group in the present study. This result is in line with previous findings of Read et al.,[26] who reported different risk factors for lower extremity injuries in different age groups of English elite level youth soccer players. It has also been shown that injury patterns in youth players differ from those in adult players,[27] which is mainly attributed to the different responses of the immature skeleton to high training loads.[28] The results of ~~the present~~our study also point towards that same assumption. Therefore, it is advised that the stage of growth and development of the player ~~should~~ is~~be~~ taken into account to assess and manage injury risk, for example by incorporating initiatives such as bio-banded training to tailor especially physical training programs to the player's stage of growth and maturation.[29]

The main limitation of the present study is the lack of data on players' individual soccer exposure and training load, both within as well as outside the youth academy. However, we corrected the analyses for team based average weekly exposure time. Given the structured training and competition schedule with the same number of training sessions per week, and the main reason for absence being an injury, the team-based average reflects the players' exposure during the non-injured time relatively well. Another limitation is the lack of data on previous injuries (i.e. before the start of the study), which is considered a risk factor for sustaining future injuries in youth athletes.[23] However, previous research has shown that retrospective data on injuries are not reliable,[30] which shows that it is hard to get a clear picture of any previously sustained injuries. Nevertheless, at the start of the study all players were medically cleared to play and were fully participating in the team's training and match schedule. A last limitation is the follow-up duration of one competitive season, including only two measurement points for the anthropometric parameters. To get a broader insight in the association between growth and injuries, future research could prospectively follow players with more frequent anthropometric measurements to capture smaller changes in growth and development.

Conclusion

Based on our results, we can conclude that relative age, body weight, leg length, as well as total growth and leg growth are associated with an increased injury risk in both younger and older adolescent male elite level youth soccer players. Although the risk factors studied cannot be modified, it should be noted that every player will go through a period of varying growth velocity during which the risk of injury also changes. Identifying these periods of increased injury risk could help to sensitize coaches and allow youth academies to actively manage the injury risk by reducing the training load of players being currently at increased risk. In practice, this means that youth academies should continuously monitor the height, weight, and leg length of their soccer players. Future screening tools should also be designed specifically for either~~distinguish between~~ overuse ~~and~~or ~~traumatic~~acute injuries.

Practical implications

- Anthropometric parameters and growth velocity are associated with injuries in youth elite level soccer players.
- Injury risk factors are different ~~between 9 to 11~~for U10-U12 than~~and~~ ~~12 to 15 year old~~U13-U15 elite level soccer players, for both overuse and ~~traumatic~~acute injuries. These age-related differences should be taken into account when assessing and managing injury risk.
- Monitoring growth in young players is important to identify periods of increased injury risk.

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345 **Table 1.** Players' anthropometric characteristics (mean ± SD) for the total sample and both subgroups.

	Total sample	**Younger group (U10-U12)**	**Older group (U13-15)**
	(N = 314)	(n = 171)	(n = 143)
Player characteristics			
Age (y)	11.7 ± 1.7	10.3 ± 0.9	13.3 ± 0.8
Height (cm)	149.6 ± 12.1	141.7 ± 6.9	159.0 ± 10.3
Weight (kg)	39.3 ± 10.0	33.4 ± 4.5	46.5 ± 10.2
Leg length (cm)	72.4 ± 6.6	68.1 ± 4.2	77.0 ± 5.6
Growth (cm/y)	5.5 ± 2.1	5.0 ± 1.4	6.2 ± 2.6
Weight change (kg/y)	4.8 ± 3.1	3.4 ± 1.9	6.4 ± 3.5
Change in leg length (cm/y)	2.8 ± 1.6	2.6 ± 1.4	3.2 ± 1.8
Relative age[1]	126.0 ± 94.3	125.1 ± 94.4	127.1 ± 94.5
Soccer exposure (min/week)	309.2 ± 46.9	293.1 ± 36.1	328.4 ± 51.1
Injury characteristics			
All injuries			
N (%)	296 (100)	106 (100)	190 (100)
Lay-off (days)	12.2 ± 14.0	12.7 ± 14.6	12.0 ± 13.8
Incidence (#/player season)	0.94	0.62	1.33
Injury burden (days/player season)	17.8	11.0	26.1
Overuse injuries			
N (%)	133 (45)	40 (38)	93 (49)
Lay-off (days)	14.0 ± 15.1	14.6 ± 17.2	13.8 ± 14.3
Incidence (#/player season)	0.42	0.23	0.65
Injury burden (days/player season)	9.2	4.7	14.6
~~Traumatic~~Acute injuries			
N (%)	163 (55)	66 (62)	97 (51)

Lay-off (days)	10.8 ± 13.0	11.6 ± 12.7	10.3 ± 13.1
Incidence (#/player season)	0.52	0.39	0.68
Injury burden (days/player season)	8.7	6.3	11.5

y: year, cm: centimeter, kg: kilogram, [1]: number of days a player is born after January first, min: minutes, SD: standard deviation, lay-off: number of days of missed training and/or match play due to injury, #: number of injuries

347 **Table 2**. Anthropometric characteristics (mean ± SD) of non-injured and injured players per subgroup.

	Overuse injuries		**~~Traumatic~~Acute injuries**	
	Non-injured	Injured	Non-injured	Injured
Younger group	*(n = 136)*	*(n = 35)*	*(n = 126)*	*(n = 45)*
Age (y)	10.3 ± 0.8	10.5 ± 0.9	10.3 ± 0.9	10.5 ± 0.8
Height (cm)	141.5 ± 7.1	142.6 ± 5.7	141.3 ± 7.4	143.1 ± 4.8
Weight (kg)	33.1 ± 4.5	34.2 ± 4.6	33.2 ± 4.9	33.7 ± 3.1
Leg length (cm)	68.0 ± 4.5	68.6 ± 3.1	67.8 ± 4.6	69.1 ± 3.0
Growth (cm/y)	4.8 ± 1.3	5.5 ± 1.5*	4.9 ± 1.4	5.2 ± 1.3
Weight change (kg/y)	3.3 ± 1.8	3.9 ± 2.3	3.3 ± 2.0	3.7 ± 1.5
Change in leg length (cm/y)	2.4 ± 1.4	3.3 ± 1.4*	2.6 ± 1.5	2.5 ± 1.4
Relative age[1]	129.2 ± 96.1	109.4 ± 87.3	119.7 ± 94.1	140.5 ± 94.6*
Older group	*(n = 76)*	*(n = 67)*	*(n = 82)*	*(n = 61)*
Age (y)	13.1 ± 0.8	13.4 ± 0.8	13.1 ± 0.8	13.5 ± 0.8*
Height (cm)	156.8 ± 9.7	161.5 ± 10.5*	156.5 ± 9.8	162.3 ± 10.1*
Weight (kg)	44.3 ± 8.9	48.9 ± 11.0*	43.7 ± 8.5	50.2 ± 11.0*
Leg length (cm)	75.8 ± 5.1	78.32 ± 5.8*	75.9 ± 5.4	78.5 ± 5.6*
Growth (cm/y)	6.0 ± 2.3	6.3 ± 2.9	6.7 ± 2.5	5.5 ± 2.6*
Weight change (kg/y)	6.0 ± 3.4	6.8 ± 0.5	6.5 ± 3.6	6.3 ± 3.3
Change in leg length (cm/y)	3.0 ± 1.6	3.4 ± 2.0	3.5 ± 1.9	2.7 ± 1.6*
Relative age[1]	155.8 ± 91.9	139.8 ± 96.4	136.5 ± 97.8	144.4 ± 89.0

348 SD: standard deviation, y: year, cm: centimeter, kg: kilogram, [1]: number of days a player is born after

349 January first, *: $p < 0.05$ in univariate Poisson regression

Table 3. Outcomes of the multivariate Poisson regressions models investigating risk factors for the different types of injuries.

	Overuse injuries		**~~Traumatic~~Acute injuries**	
	IRR (95%-CI)	p	IRR (95%-CI)	p
Younger group				
Weight (kg)			0.929 (0.856-1.000)	0.057
Relative age[1]			1.003 (1.000-1.006)	0.020
Change in leg length (cm/y)	1.620 (1.230-2.117)	<0.001		
Older group				
Weight (kg)			1.043 (1.021-1.067)	<0.001
Leg length (cm)	1.055 (1.011-1.108)	0.006		
Growth (cm/y)			0.903 (0.831-0.981)	0.015

kg: kilogram, [1]: number of days a players is born after January 1st, cm: centimeter, y: year, IRR: incidence rate ratio, 95%-CI: 95% confidence interval

Acknowledgements: The authors would like to thank the participating youth academies, coaches, and players for their collaboration. The Research Foundation – Flanders kindly supported this study through a PhD research grant awarded to Nikki Rommers. The funding source had no involvement in the conduct and reporting of the study.

Appendix A. Injury report form

Please fill in the information below as accurate as possible for every injury of physical complaint.

- **Date:** ……/……/……
- **Name player**: ……
- **Team**: U10 - U11 - U12 - U13 - U14 - U15
- **Training/match:** Training - Match
- **Surface:** Natural grass - Artificial turf - Unknown - Other :……
- **Contact injury:** No - Contact player - Contact ball - Contact object
- **Diagnosis: body side, body part, type of injury**

  Left - Right

  ……

  ……
- **Recurrent injury:** No - Yes
- **Type of injury:** Acute/trauma - Overuse
- **Date return to play:** ……

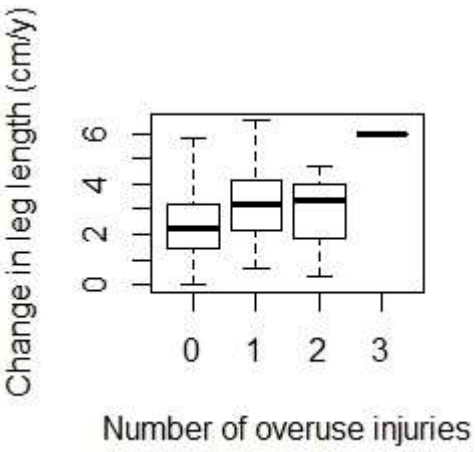
Appendix B. Description of injuries by location

	ALL INJURIES						OVERUSE INJURIES						ACUTE INJURIES					
	Total		Younger (U10-U12)		Older (U13-U15)		Total		Younger (U10-U12)		Older (U13-U15)		Total		Younger (U10-U12)		Older (U13-U15)	
Injury location	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Head/face	5	1.69	4	3.77	1	0.53							5	3.07	4	6.06	1	1.03
Shoulder/clavicular	3	1.01	1	0.94	2	1.05	1	0.75	1	2.50			2	1.23			2	2.06
Upper arm																		
Elbow	2	0.68	1	0.94	1	0.53							2	1.23	1	1.52	1	1.03
Forearm	1	0.34	1	0.94									1	0.61	1	1.52		
Wrist	3	1.01	3	2.83									3	1.84	3	4.55		
Hand/finger/thumb	13	4.39	7	6.60	6	3.16							13	7.98	7	10.61	6	6.19
Sternum/ribs/upper back	3	1.01			3	1.58	1	0.75			1	1.08	2	1.23			2	2.06
Lower back/pelvis/sacrum	11	3.72	1	0.94	10	5.26	8	6.02	1	2.50	7	7.53	3	1.84			3	3.09
Hip/groin	48	16.22	16	15.09	32	16.84	31	23.31	10	25.00	21	22.58	17	10.43	6	9.09	11	11.34
Thigh	67	22.64	20	18.87	47	24.74	37	27.82	11	27.50	26	27.96	30	18.40	9	13.64	21	21.65
Knee	48	16.22	18	16.98	30	15.79	32	24.06	9	22.50	23	24.73	16	9.82	9	13.64	7	7.22
Lower leg/Achilles tendon	23	7.77	7	6.60	16	8.42	13	9.77	4	10.00	9	9.68	11	6.75	3	4.55	8	8.25
Ankle	46	15.54	18	16.98	28	14.74	5	3.76	2	5.00	3	3.23	40	24.54	16	24.24	24	24.74
Foot/toe	23	7.77	9	8.49	14	7.37	5	3.76	2	5.00	3	3.23	18	11.04	7	10.61	11	11.34
TOTAL	296		106		190		133		40		93		163		66		97	

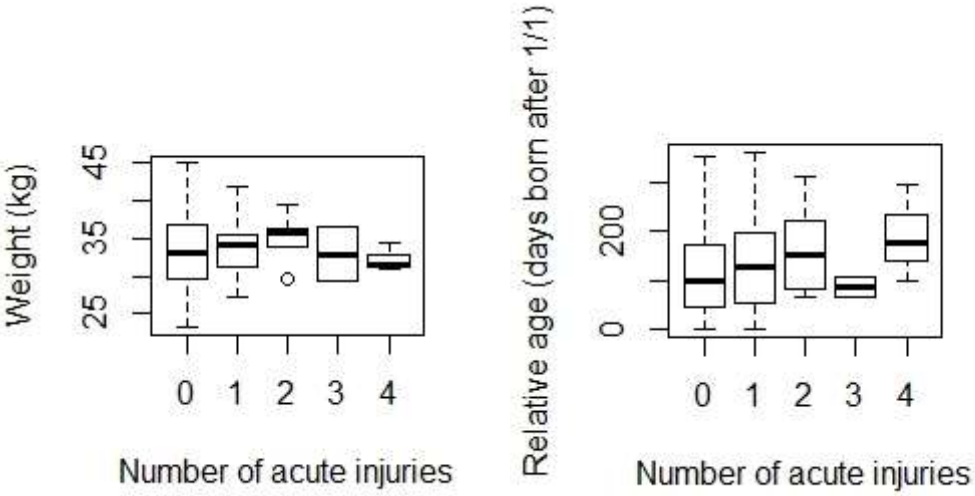
n: number of

Appendix C. Visual presentation of the raw data for the most important risk factors

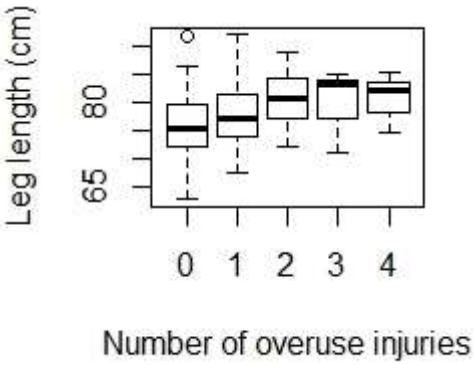
C.1. Risk factors for overuse injuries in the younger group (U10-U12)



C.2. Risk factors for acute injuries in the younger group (U10-U12)



C.3. Risk factors for overuse injuries in the older group (U13-U15)



C.4. Risk factors for acute injuries in the older group (U13-U15)