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Intrinsic risk factors for acute knee injuries among male football players: a prospective cohort study

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This prospective cohort study was conducted to identify the risk factors for acute knee injuries among male football players. A total of 508 players representing 31 amateur teams were tested during the 2004 preseason for potential risk factors for knee injury through a questionnaire on previous injury, Knee Osteoarthritis Outcome Score (KOOS) and a clinical examination. Generalized estimating equations were used in univariate analyses to identify candidate risk factors, and factors with a *P*-value <0.10 were then examined in a multivariate model. During the football season, 61 acute knee injuries, affecting 57 legs (53 players), were registered. Univariate analyses revealed the KOOS subscores "Pain" and "Function in daily living" (OR for a 10-point difference in score: 1.26, 95% CI 1.03–1.55 and 1.35, 95% CI 0.98–1.85, respectively), any findings at clinical examination (OR: 2.62, 95% CI 1.03–6.68), flexion contraction in range of motion testing (OR: 0.96, 95% CI 0.93–1.00) and varus stress tests in full extension (OR: 8.50, 95% CI 1.85–39.0) and 30° flexion (OR: 5.69, 95% CI 1.73–18.8) as candidate factors. However, in a multivariate analysis, none of these factors were associated with an increased injury risk.

Knee injuries account for 14–32% of all acute injuries (Ekstrand & Gillquist, 1983; Arnason et al., 1996; Hawkins & Fuller, 1999; Junge & Dvorak, 2004; Walden et al., 2005a, 2005b) and are the most common cause of severe injuries in male football, in many cases requiring surgical treatment. (Powell & Barber-Foss, 1999; Verrall et al., 2001; Walden et al., 2005a; Agel et al., 2007) Hence, preventing knee injuries is an important goal, and to accomplish that, the specific intrinsic risk factors must be identified. (Meeuwisse, 1994) It seems that a previous knee injury places an athlete at an increased risk of suffering a new injury to the knee, especially when rehabilitation is inadequate. (Arnason et al., 2004; Hagglund et al., 2006) Also, older players are thought to be at a higher risk than younger players. (Arnason et al., 2004) Other potential risk factors have been studied in other sports, age groups and among female athletes.

Intervention studies have shown that neuromuscular training may prevent knee sprains (Caraffa et al., 1996), indicating that reduced neuromuscular control may be an important risk factor for knee injuries. However, the evidence among adult male players is limited (Caraffa et al., 1996), as most studies have been carried out in other sports or among female or younger athletes. (Myklebust et al., 2003; Mandelbaum et al., 2005; Olsen et al., 2005).

To examine the contribution of the various risk factors and explore their interrelationship, a multivariate approach is necessary. (Meeuwisse, 1994) Even though a large number of risk factor studies have been carried out, only a few have used multivariate analyses. We therefore planned the present prospective cohort study on footballers to screen for several potential risk factors for knee injuries, some of which have not been studied in depth earlier.

One goal of this study was to investigate whether simple screening tests, which are easy to perform and do not require advanced laboratory equipment, can be used to identify individuals at risk. In this way, if the questionnaire or simple strength/sprint tests in this study were to prove useful, even teams without medical staff can test themselves in the pre-season to identify players at risk of injuries.

The aim of this study was to examine potential intrinsic risk factors for injuries to the knee in a prospective cohort study among subelite male football players. We hypothesized that a history of previous acute knee injuries, reduced function scores, abnormalities on a standard clinical examination and simple performance tests could predict an increased risk of new knee injuries. In addition, we included self-reported player information such as age, height, weight, body mass index (BMI) and player position to investigate whether there were any correlations between these variables and injury risk.

Materials and methods

Design and participants

This study is based on data from a randomized trial on male amateur football players examining the effect of a training program designed to prevent injuries. The design, the intervention program and the results of the study have been described previously in detail in a separate paper. (Engebretsen et al., 2008) Because no differences were seen in injury rates between the intervention and control groups (Engebretsen et al., 2008), the entire cohort could be used to assess the effect of a number of risk factors assessed at baseline.

A total of 35 teams ($n = 769$ players) from the Norwegian first, second or third division of football for men, geographically located in the proximity of Oslo invited to participate in the study. The third division teams either won their league or finished as first runners up the previous season, resulting in a relatively homogenous group of teams, even if they competed in three different divisions. Three of the teams ($n = 60$ players) declined the invitation to participate, 177 players did not report for testing, three players did not speak Norwegian and could therefore not complete the questionnaire and four players were excluded for other reasons (Fig. 1). Hence, 244 of the players invited could not be included. In addition, one team ($n = 17$ players) was later excluded because the physiotherapist did not record injuries, resulting in a final sample of 508 players representing 31 teams from three divisions (first division, $n = 7$, 122 players; second division, $n = 16$, 260 players; and third division, $n = 8$, 126 players). The study was approved by the Regional Committee for Medical Research Ethics, Helse Øst, and written consent was obtained.

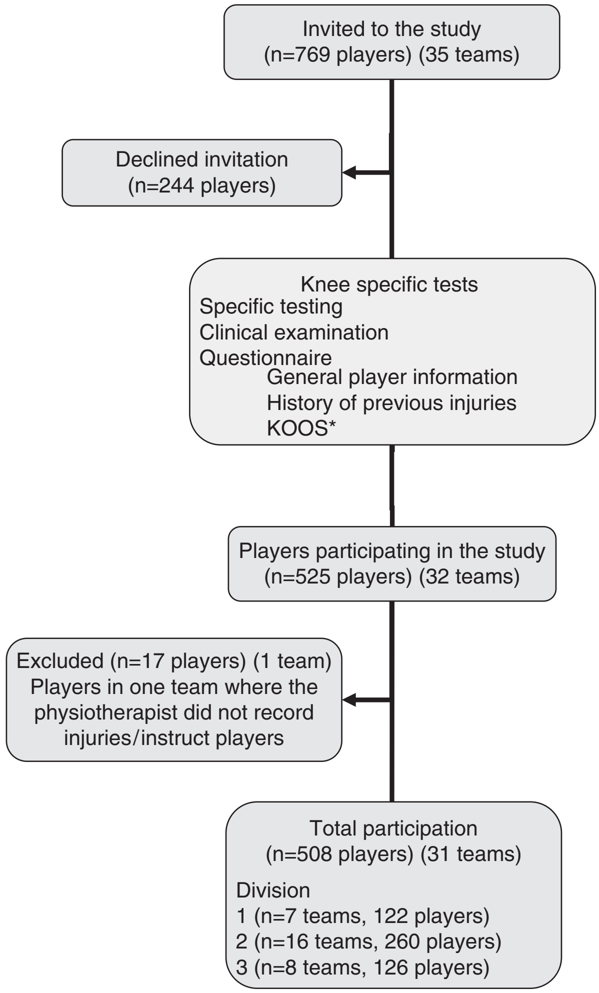

Fig. 1. Flow chart showing movement of numbers of players participating. KOOS, Knee Osteoarthritis Outcome Score.

Risk factor screening

The teams were tested for potential risk factors for knee injuries during the 2004 pre-season, January through March, at the Norwegian School of Sport Sciences. Every player capable (not injured at the time) completed three counter-movement jumps, two 40 m sprint tests, a clinical examination and a questionnaire.

The counter-movement jump test was performed on a force plate (AMTI LG6-4-1, Advanced Mechanical Technology Inc., Watertown, Massachusetts, USA), with arms held at the waist, and the player from a standing position flexed in his knees to at least 90° before he jumped as high as he could. All three tests were scored as the maximal height of rise of the center of gravity in centimeters, calculated based on data on body weight and ground reaction forces during the jump.

The 40 m sprint test was performed with a contact mat and double beam timing gates at the Norwegian School of Sport Sciences, measuring the time from when the front foot left the floor to the time sensor at 40 m.

The clinical testing of the players was performed by a group of ten sports physical therapists and sports physicians who were blinded for injury history (scars were not concealed). Both legs were examined for knee axis (normal, genu varum, genu valgum), range of motion for flexion and extension (measured in degrees), Lachman test (positive, negative), anterior drawer (positive, negative), posterior drawer (positive, negative) and valgus and varus stress tests in extension and 30° of flexion (positive, negative).

The players also completed a questionnaire in two parts, where the first part covered general player information (age, height, BMI, position on the field, number of junior or senior national team matches played, level of play this season) and history of previous injuries (number, severity, nature and number of months since the most recent knee injury, use of protective gear such as tape or brace and whether the most recent injury had caused the player to miss matches). The second part was a function score for the knee [Knee Osteoarthritis Outcome Score (KOOS)] (Roos et al., 1998) translated into Norwegian. This form consists of five major parts (symptoms, pain, function in daily living, function in sport and recreation, quality of life) and is scored by calculating the mean value of the five parts in percent of the total possible score, where 100% is the maximal and 0% is the lowest score. The KOOS form has never been used before as a screening tool as it was done in the present study.

In addition, a similar screening was performed for risk factors for ankle, hamstring and groin injuries. The data from these tests are/will be reported separately (Engebretsen et al., 2009).

Injury reporting

An injury was defined as any physical complaint sustained by a player that resulted from a football match or football training, forcing the player to miss or being unable to take full part in future football training or match play ("time-loss" injury). Acute injuries were defined as injuries with a sudden onset associated with a known trauma, whereas overuse injuries were those with a gradual onset without any known trauma. Two of the authors were blinded to all other information regarding risk factors and categorized all injuries based on the injury reports from the physiotherapist. For the purpose of the present paper, an injury was classified as a knee injury if it was recorded as an acute injury of the knee ligaments, menisci, bone or joint cartilage, or if hemarthros had occurred as a result of knee sprain. Injuries were classified into three severity categories according to the time it took until the player was fully fit to take part in all types of organized football play: minor (1–7 days), moderate (8–28 days) and major (>28 days).

The team physiotherapist was responsible for reporting injuries for all the players on the team throughout the preseason and the season. Most of the teams from the first and second division already had a physical therapist working with the team. In cases where there was no physical therapist attached to the team, we provided them with one. However, the physiotherapist was not required to be present at every training session and match; the degree of follow-up therefore varied from team to team participating in the study. The head coach for every team registered each player's participation in training and the number of minutes played in matches.

Reliability testing

Intertest reliability tests were carried out by different test personnel for the clinical examination by having the same player repeat the same test with different personnel after he had completed the first test. Each examiner was blinded to the results of the others. The same scoring system/clinical forms were used at both stations. The intertest reliability for the categorical variables in the interpretation was computed using kappa statistics and for continuous variables as the coefficient of variation.

The intertest reliability for the clinical examination computed using κ statistics was 1.00 for all tests examined: Lachman, posterior drawer, varus stress test in extension, varus stress test in 30° of flexion, valgus stress test in extension) and valgus stress test in 30° of flexion.

Statistical methods

Exposure to matches and training was calculated by adding the individual duration of all training and match play during the season.

For the continuous dependent variable risk factor analyses, where each leg was the unit of analysis, generalized estimating equations (STATA, version 8; STATA, College station, Texas, USA) were used, accounting for total individual exposure during the football season, any within-team correlations and the fact that the left and right foot belonged to the same player. Knee injury during the season was set as the dependent variable, while total hours of football play during match and training was set as the total exposure. To account for the dependency within persons due to analyses by each leg as a unit, the correlation pattern was chosen as unstructured, i.e. without any presumption about its structure. Logistic regression analyses were used to examine the relationships between per subject calculated dichotomous injury variables and their risk factors.

All risk factor variables were examined in univariate analyses, and those with a P-value <0.10 were investigated further in a multivariate model. P-values of <0.05 were considered as statistically significant.

Results

The total incidence of injuries during the season was 4.7 injuries per 1000 playing hours (95% CI 4.3–5.1), 12.1 (95% CI 10.5–13.7) for match injuries and 2.7 (95% CI 2.4–3.1) for training injuries. The exposure to match play and training was 108 111 player hours. A total of 61 acute knee injuries were reported, affecting 57 legs and 53 (10.4%) of the 508 players in the study (Table 1). The overall incidence of acute knee injuries was 0.6 injuries per 1000 playing hours (95% CI 0.4–0.7), 0.3 injuries per 1000 training hours (95% CI 0.2–0.4) and 1.8 injuries per 1000 match hours (95% CI 1.2–2.5). A total of 46 players sustained one knee injury, six sustained two injuries and one player sustained three injuries. Of the 61 injuries, 30 occurred on the right and 31 were on the left side. There were 10 minor injuries (time loss 1–7 days), 26 moderate injuries (8–28 days) and 23 severe injuries (>28 days). In two cases, information on the duration of time loss was missing.

Univariate analyses (Table 2) revealed that the KOOS subscores "Pain" and "Function in daily living" were potential leg-dependent risk factors for acute knee injuries. Also, the clinical examination was a potential means of identifying players at risk;

Table 1. Classification of the acute knee injuries reported in the study

Classification	Number of injuries	%
Injury type		
Dislocation	2	3
Patella dislocation (MPFL tear)	2	
Meniscus tear	7	11
Medial meniscus tear	2	
Lateral meniscus tear	3	
Unspecified meniscus tear	2	
Cartilage lesion	1	2
Lateral femoral condyle	1	
Sprain	51	84
MCL	23	
LCL	4	
ACL	7	
PCL	1	
Hemarthosis	4	
Unspecified	12	
Injury severity (based on time loss)		
1–7 days	10	16
1–4 weeks	26	43
>4 weeks	23	38
Missing	2	3
Match or training injury		
Training	26	43
Match	35	57
Injured side		
Left	31	51
Right	30	49

MPFL, medial patellofemoral ligament; MCL, medial collateral ligament; LCL, lateral collateral ligament; ACL, anterior cruciate ligament; PCL, posterior cruciate ligament.

Table 2. Odds ratios for the risk of knee injury, calculated from generalized estimating equations taking into account the individual exposure and the fact that the left and the right leg belonged to the same player

	n	Current injury			OR	95% CI	*P*-value
		Uninjured (*n* = 959)	Injured (*n* = 57)				
		n/mean ± SD	*n*/mean ± SD	% injured			
Information on injury history							
Previous knee injury	1016						
Yes	352	332	20	5.7%	1.00		
No	664	627	37	5.6%	0.97	[0.55–1.71]	0.91
Number of previous injuries	1016						
No previous injury	664				1.00		
1 injury	230	220	10	4.3%	0.64	[0.31–1.30]	0.22
2 injuries	79	74	5	6.3%	1.29	[0.51–3.27]	0.60
3 injuries	25	23	2	8.0%	1.24	[0.26–5.87]	0.79
4 injuries	7	6	1	14.3%	2.75	[0.34–22.0]	0.34
5 injuries	4	4	0	0%	5.28	[1.13–24.7]	0.03
> 5 injuries	7	5	2	28.6%	9.43	[1.78–49.8]	< 0.01
Time since previous injury	1013						0.41
Never	664	627	37	5.6%	1.00		
0–6 months	86	80	6	7.0%	1.42	[0.52–3.86]	0.49
6–12 months	51	48	3	5.9%	0.99	[0.28–3.58]	0.99
1–2 years	61	57	4	6.6%	1.25	[0.40–3.87]	0.70
> 2 years	151	144	7	4.6%	0.66	[0.25–1.70]	0.39
KOOS function score*	962	95 ± 9.5	94 ± 15.1		1.14	[0.89–1.46]	0.29
Symptoms	994	93 ± 10.9	92 ± 14.3		1.12	[0.89–1.39]	0.34
Pain	1002	97 ± 8.6	94 ± 16.9		1.26	[1.03–1.55]	0.03
Function in daily living	1001	98 ± 6.4	97 ± 10.0		1.35	[0.98–1.85]	0.06
Function in sport and recreation	1004	94 ± 14.1	92 ± 20.6		1.12	[0.95–1.32]	0.16
Quality of life	1007	92 ± 14.6	90 ± 21.3		1.13	[0.96–1.32]	0.14
Clinical examination	845	795	50	5.9%			
Any pathological findings	51	45	6	11.8%	2.62	[1.03–6.68]	0.04
No pathological findings	794	750	44	5.5%	1.00		
Knee axis	877	824	53	6.0%			0.10
Normal	621	590	31	5.0%	1.00		
Genu varum	226	206	20	8.8%	1.88	[1.01–3.48]	0.05
Genu valgum	30	28	2	6.7%	1.04	[0.22–4.95]	0.96
Range of motion							
Flexion (degrees)	883	139° ± 5.9° (830)	137° ± 9.7° (53)		0.96	[0.93–1.00]	0.05
Extension (degrees)	883	0.5° ± 5.9° (830)	0.6° ± 6.4° (53)		1.03	[0.98–1.08]	0.27
Laxity tests							
Lachman test	848	798	50	5.9%			
Positive	14	13	1	7.1%	1.50	[0.17–13.0]	0.72
Negative	834	785	49	5.9%	1.00		
Anterior drawer	884	831	53	6.0%			
Positive	10	9	1	10%	2.13	[0.22–20.2]	0.51
Negative	874	52	1	0.1%	1.00		
Posterior drawer	887	834	53	6.0%			
Positive	4	4	0	0%	0.21	[0.00–775]	0.71
Negative	883	830	53	6.0%	1.00		
Valgus stress test (in extension)	885	832	53	6.0%			
Positive	9	8	1	11.1%	2.48	[0.26–23.5]	0.43
Negative	876	824	52	5.9%	1.00		
Valgus stress test (in 30° of flexion)	887	834	53	6.0%			
Positive	20	19	1	5.0%	1.00		
Negative	867	815	52	6.0%	1.13	[0.14–9.02]	0.91
Varus stress test (in extension)	887	834	50	5.6%			
Positive	9	6	3	33.3%	8.50	[1.85–39.0]	0.01
Negative	878	828	53	6.0%	1.00		
Varus stress test (in 30° of flexion)	887	834	53	6.0%			
Positive	17	13	4	23.5%	5.69	[1.73–18.8]	< 0.01
Negative	870	821	49	5.6%	1.00		

*All results (OR and 95% CI) are presented for a reduction of 10 in KOOS.

The number of legs shown for the uninjured and injured groups reflects the number for which each of the tests was completed.

Range (mean, minimum–maximum) and standard deviation (SD) of continuous variables: KOOS total score: 95.0, 17.8–100.0 (SD: 9.9); symptoms: 93.0, 10.7–100.0 (SD: 11.1); pain: 96.4, 2.8–100.0 (SD: 9.3); functions in daily living: 98.0, 36.8–100.0 (SD: 6.6); function in sport and recreation: 93.9, 0.0–100.0 (SD: 14.6); quality of Life: 92.1, 0.0–100.0 (SD: 15.1); flexion: 138.4, 105–155 (SD: 6.2); extension: -4.7, -20 -20 (SD: 5.9).

Each leg was the unit of analysis, including both continuous (mean ± SD) and categorical (yes/no) independent variables.

KOOS, Knee Osteoarthritis Outcome Score.

any positive finding at clinical examination, deviations from the normal knee axis and flexion contraction in the range of motion testing were candidate factors. As for the specific knee testing, a positive varus stress test in full extension and in 30° of flexion were potential predictors of an increased risk. However, none of the player-dependent factors tested were significantly associated with a risk of knee injury (Table 3). Because this study is based on data from a randomized trial, separate analyses controlling for group assignment (intervention or control group) were performed, but with no change in the results. Also, a Poisson model approximating multinomial logistic regression analyses was used, in order to compare players who sustained no injuries vs those who sustained one injury vs those who sustained more than one injury. Again, the results did not differ from the original analyses.

Out of a total of 1016 cases, the final multivariate analysis was based on 812 cases after cases with missing data were excluded. No significant risk factors for new acute knee injuries were identified in the final multivariate analysis (Table 4).

Discussion

The main finding of this cohort study investigating the potential risk factors for knee injuries in football was that none of the potential leg- or player-dependent risk factors studied could be used to predict increased risk of injury.

Table 4. Multivariate analysis of the potential risk factors with $P<0.10$ in univariate analyses

Risk factors	OR	95% CI	*P*-value
KOOS			
Pain	1.15	[0.69–1.90]	0.59
Function in daily living	1.11	[0.52–2.38]	0.79
Clinical examination	2.34	[0.89–6.16]	0.09

Adjusted odds ratio (OR) and 95% confidence interval (CI) of number of previous knee injuries as continuous variable, any positive finding on clinical examination and per difference of 10 in KOOS sub scores "Pain" and "Function in daily living."

P-values are the results from analysis in STATA using generalized estimating equations.

KOOS, Knee Osteoarthritis Outcome Score.

Table 3. Odds ratios for the risk of knee injury, calculated by logistic regression analyses

Factor	*n*	Current injury			OR	95% CI	*P*-value
		Uninjured ($n=465$)	Injured ($n=43$)				
		n/mean ± SD	*n*/mean ± SD	% injured			
Age (years)	500	24.0 ± 4.1 (449)	24.3 ± 4.4 (51)		1.05*	[0.79–1.40]	0.75
Height (cm)	497	181.5 ± 6.1 (446)	180.4 ± 8.0 (51)		0.82*	[0.62–1.09]	0.19
Weight (kg)	493	78.1 ± 7.9 (442)	76.5 ± 8.7 (51)		0.81*	[0.60–1.09]	0.16
BMI (kg/m^2)	486	23.7 ± 1.7 (437)	23.6 ± 1.4 (49)		0.94*	[0.69–1.27]	0.42
Player position	485	435	50	10.3%			0.63
Forward	84	77	7	8.3%	1.00		
Winger	70	62	8	11.4%	1.45	[0.50–4.23]	0.50
Attacking midfielder	62	58	4	6.5%	0.79	[0.22–2.82]	0.71
Central midfielder	66	58	8	12.1%	1.54	[0.53–4.50]	0.43
Wingback	87	73	14	16.1%	2.18	[0.83–5.73]	0.11
Center back	71	68	3	4.2%	1.70	[0.54–5.42]	0.31
Goalkeeper	45	39	6	13.3%	1.70	[0.54–5.42]	0.37
Level of play	508	455	53	10.4%			0.14
1st division	119	102	17	14.3%	1.00		
2nd division	256	229	27	10.5%	0.76	[0.36–1.59]	0.46
3rd division	133	124	9	6.8%	0.48	[0.18–1.28]	0.14
Junior or senior national team matches	508	455	53	10.4%			
Yes	92	85	7	7.6%	0.68	[0.30–1.56]	0.36
No	416	370	46	11.1%	1.00		
Knee function testing (best results)							
Counter movement jump test	423	38.6 ± 4.7 (381)	38.2 ± 4.6 (42)		1.13*	[0.83–1.55]	0.44
40-m sprint test	398	5.20 ± 0.2 (363)	5.18 ± 0.2 (35)		0.94*	[0.64–1.38]	0.74

*Per increase of one standard deviation.

The number of players in the uninjured and injured groups reflects the number of players who completed each of the tests.

Range (mean, minimum–maximum) and standard deviation (SD) of continuous variables: age: 24.0, 16.2–37.7 (SD: 4.2); height: 181.4, 153–198 (SD: 6.3); weight: 77.9, 56–105 (SD: 8.0); BMI: 23.7, 19.4–29.8 (SD: 1.7); counter movement jump test: 37.7, 25.9–56.8 (SD: 4.7), 40 m sprint test: 5.20, 4.71–5.81 (SD: 0.2).

Each player was the unit of analysis, including both continuous (mean ± SD) and categorical (yes/no) independent variables.

BMI, body mass index.

The literature on risk factors for acute knee injuries among male football players is limited. Previous knee injuries seem to be the most important risk factor for new injuries, both in male football (Ekstrand & Gillquist, 1983; Arnason et al., 2004; Hagglund et al., 2006) and among male athletes in other sports. (Meeuwisse et al., 2003; Taunton et al., 2003; Yung et al., 2007) Arnason et al. (2004) found previous knee injury to be the only significant risk factor for a new injury to the same knee in a large cohort study investigating risk factors for football injuries. In the same study, increased valgus laxity was associated with a history of previous injury. In a recent study among female youth football players, previous injury was the only risk factor identified. (Steffen et al., 2008a) These results are in contrast to the present study, where no association was seen between previous injury and new injuries in the categorical analysis. However, there is a trend suggesting an association between injury risk and the number of self-reported previous knee injuries. Also, as we observed a highly significant correlation between any pathological finding on the clinical knee examination and increased injury risk, this represents indirect evidence of the same association. It could be that the most serious injuries, causing abnormalities that could be detected through the clinical exam, do predispose a player toward new injuries. In this study, the sensitivity and specificity were 36% and 99% for the Lachman test with respect to identifying players with self-reported previous ACL injuries. Still, the overall findings in this study indicate that the strength of the candidate risk factor of previous injury is low and alone it cannot be used to identify and target high risk players with preventive measures, at least not in this player population.

Although one should think that significant injuries should be easily remembered, there are indications in the literature that the number of previous injuries or even injury location may be difficult to report correctly. (Gabbe et al., 2003) Therefore, recall bias may be a significant factor. (Arnason et al., 2004; Steffen et al., 2008a) Nevertheless, a recent study from Swedish elite football bypassed this problem by including prospective data collected over two consecutive seasons. They showed that an injury in the first season increased injury risk during the subsequent season. (Hagglund et al., 2006).

Of the other potential risk factors suggested from studies in different sports, age groups or among female athletes in the literature (gender, (Lindenfeld et al., 1994; Ahmad et al., 2006; McLean et al., 2007) age, (Backous et al., 1988; Lindenfeld et al., 1994; Ostenberg & Roos, 2000) slow reaction time, (Taimela et al., 1990) personality factors, (Taerk, 1977; Lysens et al., 1989; Taimela et al., 1990; Junge et al., 2000) disobeying fair play, (Roberts et al., 1996; Peterson et al., 2000) playing position, (Lindenfeld et al., 1994) quadriceps-to-hamstring strength ratio, (Ahmad et al., 2006) landing technique, (Hass et al., 2005; McLean et al., 2007) fatigue, (McLean et al., 2007) neuromuscular control of the knee (Hewett et al., 2005) or trunk (Zazulak et al., 2007), a history of low back pain (Zazulak et al., 2007) and general joint laxity (Baumhauer et al., 1995; Ostenberg & Roos, 2000; Beynnon et al., 2001; Myer et al., 2008), only age was tested in this study and this did not prove useful. It should be noted that knee joint laxity was tested through static stress tests; this should not be confused with the dynamic valgus pattern associated with non-contact ACL injuries among female athletes.(Hewett et al., 2005) We also included maximal jump and sprint test in this study because we hypothesized that players generating the largest forces when running and cutting and in landings could be at a greater risk of knee injury. Moreover, in the present study, different self-reported measures of body size (height, weight, BMI) were not associated with an increased injury risk, which is in accordance with previous risk factor studies. (Arnason et al., 2004; Steffen et al., 2008b).

Elite players only constitute a small portion of all football players, and advanced resources for screening tests are not available for the majority of players. Therefore, the main purpose of the current study was to see whether simple tests could be used to screen for injury risk. More advanced tests requiring advanced laboratory equipment have been used in studies on risk factors for ACL injuries among female athletes, (Hewett et al., 2005; Ahmad et al., 2006; Zazulak et al., 2007) and an association has been demonstrated with deficits in neuromuscular control of the trunk, biomechanical measures of neuromuscular control and valgus loading of the knee, and a high quadriceps-to-hamstring ratio.

Limitations

While most of the teams in the first and second division already had a physical therapist working with the team, we had to provide the remaining teams with one to be responsible for the injury reporting. They were rewarded with a stipend, but the resources were not sufficient to allow for daily follow-up of the teams by the physical therapist. Thus, there is a potential bias in injury reporting depending on the availability of the physical therapist, at least for minor injuries. This could also partly explain the low injury rate in this study compared with other studies in football, even though most of these studies are from the elite level, where the injury rate is expected to be higher. (Ekstrand & Gillquist, 1983; Arnason et al., 1996; Hawkins & Fuller, 1999; Junge & Dvorak, 2004; Walden et al., 2005a, 2005b).

Also, in the current study, we had to rely on the coaches for the exposure registration. We had no way to check their figures, but there should be no reason to misreport. If a game or a practice session was missed, it would affect all players on the team, which is unlikely to influence the analysis regarding any specific risk factor. The same should be the case for the physiotherapists registering injuries.

This study is one of the largest cohort studies on risk factors for injuries to date, with as many as 61 acute knee injuries. Nevertheless, the statistical power is limited for multivariate tests. Still, the strength of the candidate risk factors studied does not indicate that any of these would be helpful as screening tools. As pointed out by Bahr and Holme (2003) in their review, to detect moderate to strong associations, 20–50 injury cases are needed, whereas small to moderate associations would need about 200 injured subjects. However, for a risk factor to be clinically relevant with sufficient sensitivity and specificity, strong associations are needed. The objective of risk factor research is to identify clinically relevant, not just statistically significant factors. In this context, several of the factors that were found to be statistically significant in the univariate analysis are unlikely to be clinically relevant. Our conclusions are therefore based solely on the results of the final multivariate analysis.

This study was carried out among subelite male football players, and should not be extrapolated to other sports, females, youth players or other levels of play.

Perspectives

Because elite players only constitute a small portion of all football players, and advanced resources for screening tests are not available for the majority of players, the main goal of this study was to see whether players at a high risk of sustaining acute knee injuries could be identified through simple screening tests such as questionnaires or through a pre-participation physical examination by a physician or a physical therapist. We therefore did not include tests requiring advanced laboratory equipment in the study. Based on the present results, it does not seem possible to screen players in the preseason with the tools used in this study, at least not in this player population. Whether more advanced testing would make it possible to identify players at a risk of acute knee injuries in male football is not known.

Key words: knee injuries, football, risk factors, prospective cohort study, previous injuries.

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