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Prevention of Injuries Among Male Soccer Players

A Prospective, Randomized Intervention Study Targeting Players With Previous Injuries or Reduced Function

Anders H. Engebretsen,[*†] Grethe Myklebust,[†] PT, PhD, Ingar Holme,[†] PhD,
Lars Engebretsen,[†‡] MD PhD, and Roald Bahr,[†] MD, PhD
From [†]Oslo Sports Trauma Research Center, Norwegian School of Sports Sciences, Oslo Norway, and the [‡]Department of Orthopaedic Surgery, Ulleval University Hospital, University of Oslo, Oslo, Norway

Background: This study was conducted to investigate whether the most common injuries in soccer could be prevented, and to determine if a simple questionnaire could identify players at increased risk.

Hypothesis: Introduction of targeted exercise programs to male soccer players with a history of previous injury or reduced function in the ankle, knee, hamstring, or groin will prevent injuries.

Study Design: Randomized controlled trial; Level of evidence, 2.

Methods: A total of 508 players representing 31 teams were included in the study. A questionnaire indicating previous injury and/or reduced function as inclusion criteria was used to divide the players into high-risk (HR) (76%) and low-risk (LR) groups. The HR players were randomized individually into an HR intervention group or HR control group.

Results: A total of 505 injuries were reported, sustained by 56% of the players. The total injury incidence was a mean of 3.2 (95% confidence interval [CI], 2.5-3.9) in the LR control group, 5.3 (95% CI, 4.6-6.0) in the HR control group (P = .0001 vs the LR control group), and 4.9 (95% CI, 4.3-5.6) in the HR intervention group (P = .50 vs the HR control group). For the main outcome measure, the sum of injuries to the ankle, knee, hamstring, and groin, there was also a significantly lower injury risk in the LR control group compared with the 2 other groups, but no difference between the HR intervention group and the HR control group. Compliance with the training programs in the HR intervention group was poor, with only 27.5% in the ankle group, 29.2% in the knee group, 21.1% in the hamstring group, and 19.4% in the groin defined as having carried out the minimum recommended training volume.

Conclusion: The players with a significantly increased risk of injury were able to be identified through the use of a questionnaire, but player compliance with the training programs prescribed was low and any effect of the intervention on injury risk could not be detected.

Keywords: football; injury prevention; ankle injuries; knee injuries; hamstring injuries; groin injuries; risk factors; randomized controlled trial

Although differences in study design and injury definitions make a direct comparison between studies difficult,[13] the incidence of injuries among adult male soccer players on the elite level has been estimated to range between 25 and 35 per 1000 game-hours.[5,14,19,34] Thus, the injury risk is considerable and high compared with most other team sports.[19] Studies from the professional leagues in Europe (Norway, Sweden, Iceland, Britain, Fédération Internationale de Football Association [FIFA], and Union of European Football Associations [UEFA]) agree that injuries to the lower extremities constitute the biggest problem.[3,5,14,18,19,33,34] The 4 dominating injury types in soccer are sprains to the ankle and knee and strains to the hamstring and groin. These account for more than 50% of all injuries, and prevention programs for soccer should therefore target these.

*Address correspondence to Anders H. Engebretsen, Oslo Sports Trauma Research Center, Norwegian School of Sports Science, PO Box 4014 Ullevål Stadion, N-0806 Oslo, Norway (e-mail: Anders.Engebretsen@nih.no).
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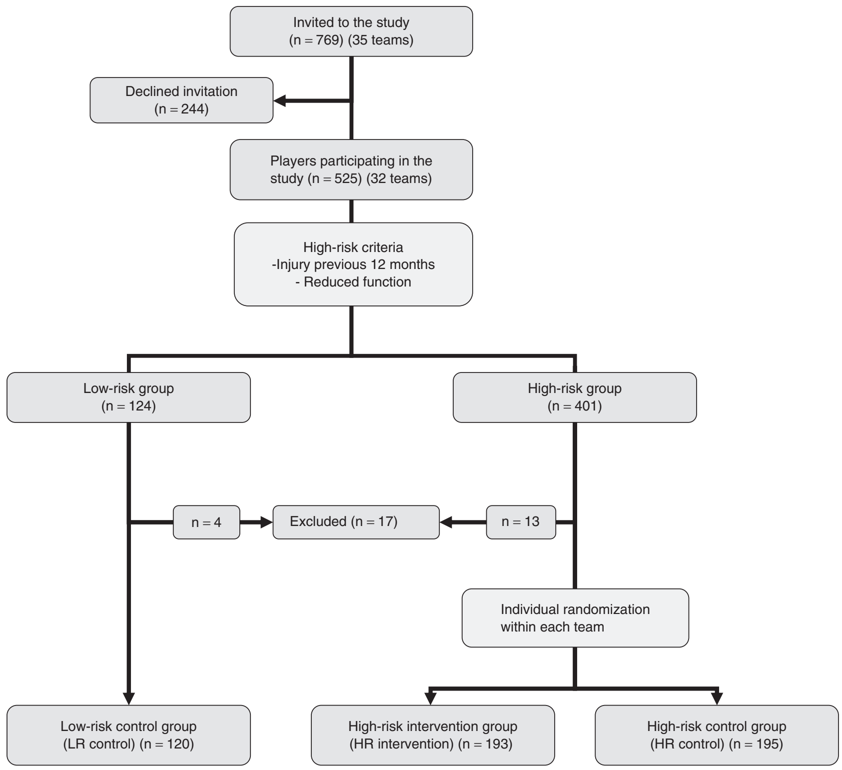

Figure 1. Flow chart showing movement of patients through the study.

As early as 1983, Ekstrand et al[10] showed a significant reduction in the overall number of soccer injuries through a 7-part prevention program. The rate of the most common types of soccer injuries, sprains and strains to ankles and knees, was reduced significantly. However, in more than 20 years, only 9 more injury prevention studies have been published in soccer, and only 5 of them among men at the senior level.[4,7,8,31,32] Tropp et al[32] showed that a balance training program or the use of orthoses resulted in significantly fewer ankle sprains than for a control group. Later, orthoses and proprioceptive training were proven useful to prevent ankle and knee injuries, respectively.[8,31] Finally, Askling et al[7] and Arnason et al[4] have recently observed a reduction in hamstring strains among male players through eccentric strength-training programs.

Although the incidence and pattern (injury type, localization, and severity) of injuries in soccer have been described in detail,[9,12,24,29] much less is known about their risk factors. Therefore, we do not know which players should be targeted, for instance through specific training programs. The risk of injury seems to be influenced by age,[11,17,24,29] sex,[17,25] and level of play.[12,24] In addition, a history of previous injury was shown to be a significant risk factor for ankle sprains in soccer as early as 1985.[32] This was recently confirmed by Arnason et al[6] in the largest cohort study from elite soccer to date, in which the main risk factors for the 4 main injury types were previous injury and age. We therefore hypothesized that players with a history of previous injury or symptoms indicating reduced function would represent a group with an increased injury risk, who should be targeted with specific prevention programs addressing their reported deficits. A previous injury could compromise joint function through reduced mechanical instability or neuromuscular control, or muscle function through scar tissue formation, reduced strength, or more subtle changes in the length-tension relationship.

One aim of this study was therefore to examine whether we could identify players with an increased risk of injury using a questionnaire focusing on history of previous injury and joint/muscle function. We also wanted to examine if exercise programs targeting players with an increased risk of injury could prevent the 4 most common injury types in soccer, ankle and knee sprains and hamstring and groin strains.

METHODS

Teams playing in the Norwegian 1st, 2nd, or the top of the 3rd division that were geographically located in the proximity of Oslo (n = 35 teams, 769 players) were invited to participate in the study. The 8 3rd division teams included either won their league or finished as first runners-up the previous season, resulting in a relatively homogeneous group of teams, even if they competed in 3 different divisions.

Three of the teams (n = 60 players) declined the invitation to participate, 177 players did not show up for testing, 3 players did not speak Norwegian and could therefore not complete the questionnaire, and 4 players were excluded for other reasons (Figure 1). Hence, 244 of the players invited could not be included. In addition, 1 team (n = 17 players) was later excluded because the physiotherapist did not instruct the intervention group players nor record

Figure 2. Example of an ankle exercise. The exercise was prescribed to be performed with a straight leg and with a gradual progression in difficulty (see Table 1).

Figure 3. Example of a knee exercise. The exercise was prescribed to be performed in the knee-over-toe position and a flexed knee, with gradual progression in difficulty (see Table 2).

injuries, resulting in a final sample of 508 players representing 31 teams.

The teams were tested during the preseason (January through March 2004) at the Norwegian School of Sports Sciences. The players were asked to fill out a questionnaire in 5 parts. The first section consisted of general information (date of birth, team, field position, and player experience). The second through fifth sections included information on the ankle, knee, hamstring, and groin, respectively. Each of these sections covered the history of previous injuries (severity, nature, and number of months since the most recent injury, use of protective gear such as tape or brace, and if the injury had caused the player to miss matches), and a function score for each region. The questionnaires used to assess function were the Foot and Ankle Outcome Score (FAOS) and Knee Osteoarthritis Outcome Score (KOOS) score, which were translated to Norwegian.[27,28] For the hamstring and groin, we developed similar function scores, Hamstring Outcome Score (HaOS) and Groin Outcome Score (GrOS), based on the same principles as FAOS and KOOS, only specific to these regions and their typical symptoms (see Appendix, available in the online version of this article at http://ajsm.sagepub.com/cgi/ content/full/X/X/X/DC1/).

Based on the questionnaire, the 508 players were divided into 2 groups (Figure 1), a high-risk (HR) and a low-risk (LR) group. The criteria for classifying a player as having an assumed increased risk of injury were a history of an acute injury to the ankle, knee, hamstring or groin during the previous 12 months or a reduced function with

Figure 4. Groin exercise. A variety of different exercises were prescribed for strengthening of the groin muscles. In this example, the player is pushing the legs together for 15 seconds while keeping a ball between the knees (see Table 3).

an average score of less than 80% for any of the body parts mentioned. A player fulfilling any of the inclusion criteria for any of the 4 body parts was assigned to the HR group. The players in the HR group were randomized individually, but stratified within each team, into 2 groups, the HR intervention group and the HR control group (Figure 1). In this way, each team would normally have players from all 3 groups (HR intervention, HR control, and LR control).

The players in the HR intervention group were only included on the basis of the inclusion criteria they fulfilled, meaning that they only received a training program for the body part(s) to which they were assumed to have an increased risk of injury. In a situation in which a player

TABLE 1
The Ankle Exercise Program[32,a]

Weeks 1-2	
Balance board	Both legs on the board, with arms crossed. Attempt to stand still and maintain the balance.
	Similar exercise, but now performed on 1 leg.
	Both legs on the board, bouncing a ball alternately with both hands, standing as still as possible during the exercise.
	Both legs on the board, throwing the ball and catching it.
Balance pad	One leg on the pad, maintaining balance for 30 seconds on alternating legs.
	Jumping exercise—from outside the pad, landing on alternating legs.
Weeks 3-5	
Balance board	Ball juggling performed while standing on 1 leg.
Balance pad	Bouncing the ball around the pad while standing on 1 leg.
	Calf raise while standing on both legs on the pad.
Weeks 6-10	
Balance board	Soccer-specific exercises, juggling the ball while standing on 1 leg, also combining both the balance board and balance pad, placing the pad on top of the board.
Balance pad	Closing the eyes while standing on 1 leg, and other exercises including landing on 1 or 2 legs while jumping from a box/stairs.

[a]All exercises were prescribed to be performed with a straight leg (no knee flexion) (Figure 2) and with a gradual progression in difficulty. The players were instructed to switch between the balance board and pad, and, as they became more proficient, to include ball-based exercises while keeping their balance.

TABLE 2
The Knee Exercise Program[8,23,a]

Weeks 1-2	
Balance board	Both legs on the board, with arms crossed, always keeping the knee-over-toe position.
	Similar exercise, but now performed on 1 leg.
	Both legs on the board, bouncing a ball alternately with both hands, standing as still as possible during the exercise.
	Both legs on the board, throwing the ball and catching it.
Balance pad	One leg on the pad, maintaining balance for 30 seconds on alternating legs.
	Walk onto the pad, stopping and keeping the balance.
	Jumping exercise—from outside the pad, landing on alternating legs.
Weeks 3-5	
Balance board	Ball juggling performed while standing on 1 leg.
	Two-legged squats, with knee-over-toe position.
Balance pad	Bouncing the ball around the pad while standing on 1 leg.
Weeks 6-10	
Balance board	Soccer-specific exercises, juggling the ball while standing on 1 leg, also combining both the balance board and balance pad, placing the pad on top of the board.
Balance pad	Closing the eyes while standing on 1 leg, and other exercises including landing on 1 or 2 legs while jumping from a box/stairs.
	One-legged squats, and balance exercises while closing the eyes.
Floor exercise	One-legged jumping on 1 foot in an imaginary zig-zag course.

[a]All exercises were prescribed to be performed with the knee-over-toe position and a flexed knee (Figure 3) with gradual progression in difficulty. As with the ankle program, the players were instructed to switch between the balance board and pad, and include ball-based exercises as they progressed.

ended up with 4 programs, the team physical therapist was asked to merge the programs into 1 continuous program. However, even if a player fulfilled the inclusion criteria for 1 body part on only 1 side, he was asked to perform the prevention exercises for both legs.

The players were asked to complete the ankle, knee, and groin training programs (Tables 1 through 3, Figures 2 through 4) 3 times a week for 10 weeks during the preseason, in separate training sessions done in addition to the regular team training. For the hamstring program (Table 4, Figure 5), a 10-week progression was prescribed.[22] The intervention players were also asked to perform the exercises once per week for the rest of the season as maintenance. The programs were meant to progress in difficulty, to challenge the players as their performance improved. The players were also asked to report all exercises they performed on a form, checking a box if they had carried out the preventive training that day. The form covered all 10 weeks for compliance assessment.

Most of the teams from the 1st and 2nd divisions already had a physical therapist working with the team. When there was no physical therapist attached to the team, we provided them with one. Each physical therapist was rewarded with a stipend (10 000 NOK, or approximately 1900 USD). In addition to reporting injuries throughout the preseason and season, the physical therapist was

TABLE 3
The Groin Exercises[16,a]

Warm-up	Keeping a ball between the extended legs, pushing the legs together for 15 s, while lying on the ground. Repeated 10×. Similar exercise, only difference having the knees flexed and the ball between the knees.
Transverse abdominal muscles	Lie facing the ground, only resting on the forearms and toes in a straight position, contracting the abdominal muscles, "forcing the umbilicus inwards." Performed in 20 s, repeated 5×.
Sideways jumping	Knee-over-toe position while jumping sideways with arms resting on the hips.
Sliding	Wearing only socks, slide a leg alternately away and towards the other that is bearing the weight. The exercise can be performed both sideways and diagonally for 30-60 s before switching legs.
Diagonal walking	Exercise described by Holmich et al[16] performed 5 × 15 s on each leg.

[a]The players were instructed to perform the exercise 3 times a week for approximately 15 minutes. A ball was needed for some of the exercises (Figure 4), and the exercises could be performed without warming up.

TABLE 4
The Hamstring Exercise Program[a]

Week	No. of Training Sessions Per Week	No. of Repetitions
1	1	5 + 5
2	2	6 + 6
3	3	3 × 6-8
4	3	3 × 8-10
5-10	3	12 + 10 + 8

[a]The Nordic hamstring exercise is performed standing on the knees on a soft foundation, slowly lowering the body toward the ground using the hamstrings while the feet are held by a partner (Figure 5). Progression is achieved by increasing the initial speed, and eventually having a partner push forward.

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responsible for instructing all the players who were randomized into the HR intervention group in their training programs. Each player was given a folder describing the exercises he was asked to do, as well as any necessary equipment such as balance mats and balance boards.

An injury was defined as any physical complaint sustained by a player that resulted from a soccer match or soccer training, resulting in a player being unable to take a full part in future soccer 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. Injuries were classified into 3 severity categories according to the time it took until the player was fully fit to take part in all types of organized soccer play: minor (1-7 days), moderate (8-28 days), and major (>28 days).

Match exposure was defined as play between teams from different clubs, while training exposure was defined as team-based and individual physical activities under the control or guidance of the team coaching or fitness staff aimed at maintaining or improving soccer skills or physical condition. All injuries were categorized by the authors based on the injury reports from each physiotherapist.

The main outcome measure was the sum of the risk for an ankle sprain, knee sprain, groin strain, or hamstring strain.

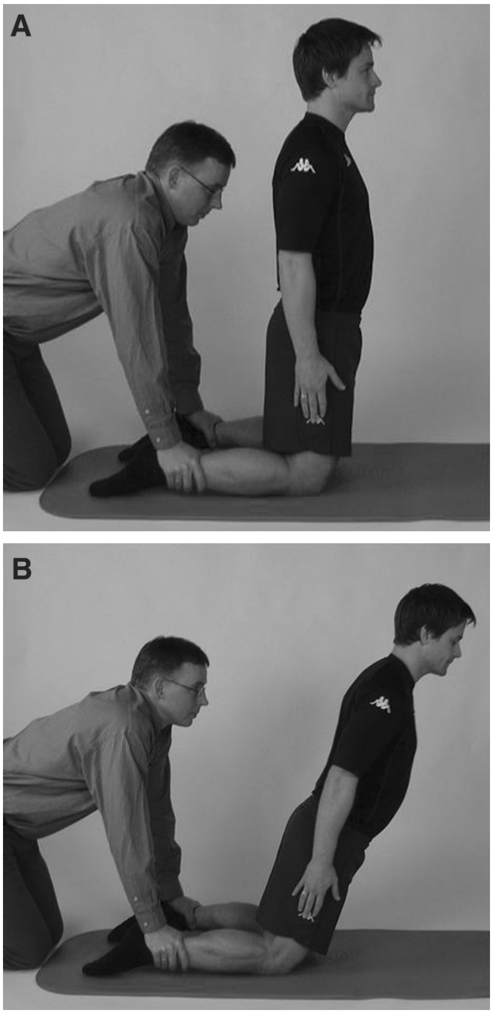

Figure 5. The hamstring exercise program. (A) start position. The player stands on his knees on a soft foundation with the feet being held by a partner. (B) slowly lowering the body toward the ground using the hamstrings while focusing on keeping the body straight (see Table 4).

Statistical Methods

Exposure was calculated in hours as the sum of all individual exposures recorded during training and match play

TABLE 5
Match, Training, and Total Exposure, Number of Injuries, and Injury Incidence (With 95% Confidence Intervals) for the 3 Groups Throughout the Season[a]

	Training			Match			Total		
	Exposure (h)	Injuries	Incidence (per 1000 h)	Exposure (h)	Injuries	Incidence (per 1000 h)	Exposure (hours)	Injuries	Incidence (per 1000 h)
HR intervention (n = 193)	34 422	100	2.9 (2.3-3.5)	7434	93	12.5 (10.0-15.1)	41 856	207	4.9 (4.3-5.6)
HR control (n = 195)	33 757	103	3.1 (2.5-3.6)	7156	100	14.0 (11.2-16.7)	40 913	216	5.3 (4.6-6.0)
LR control (n = 120)	20 925	40	1.9 (1.3-2.5)	4417	34	7.7 (5.1-10.3)	25 342	82	3.2 (2.5-3.9)
Total	89 103	243	2.7 (2.4-3.1)	19 008	227	11.9 (10.4-13.5)	108 111	505	4.7 (4.3-5.1)

[a]HR, high risk; LR, low risk.

during the season. The injury rate was compared between the HR control group and the HR intervention group, and the HR control group and the LR control group, respectively, using a *z* test, reporting 95% confidence intervals (CIs) based on the Poisson model. Chi-square tests were used to compare the proportion of injured players between the HR intervention group and the HR control group, and between the HR control group and the LR control group, respectively. Otherwise, results are presented as the means with standard deviations.

RESULTS

Screening and Randomization

Of the 508 players included in the study, 388 (76%) were assumed to have an increased risk for 1 or more injury types based on their history of previous injury and/or function scores. Of these, 195 players were randomized to the HR control group and 193 players to the HR intervention group (Figure 1). In the intervention group, 2 players were asked to perform all of the 4 training programs; 22 players, 3 programs; 62 players, 2 programs; and 107 players, 1 program. Of the 305 training programs prescribed, 102 were for the ankle, 65 for the knee, 76 for the hamstring, and 62 for the groin.

Player Exposure

The total exposure to match play and training was 108 111 player hours (Table 5), and there was no difference in mean player exposure between the HR intervention group (217 ± 94 hours), the HR control group (210 ± 103 hours), and the LR control group (211 ± 88 hours).

Injuries

A total of 505 injuries were reported (Table 5), sustained by 283 (56%) of the 508 players included in the study. In the LR control group, there were 82 injuries, while there were 216 injuries in the HR control group and 207 injuries in the HR intervention group. There was no difference in the incidence of injuries between the HR intervention group and the HR control group (relative risk [RR], 0.94; 95% CI, 0.77-1.13), while the incidence was lower in the LR control group than both other groups (RR, 0.65 vs the HR intervention group; 95% CI, 0.51-0.85; RR, 0.61 vs the HR control group; 95% CI, 0.48-0.79).

TABLE 6
Injury Type and Injury Severity (Based on Time Loss) in the 3 Groups[a]

	HR Intervention Group (n = 193)	HR Control Group (n = 195)	LR Control Group (n = 120)
Injury type			
Acute (%)	143 (41)	153 (43)	57 (16)
Overuse (%)	62 (42)	61 (41)	25 (17)
Other (%)	2 (50)	2 (50)	0 (0)
Time loss			
1-3 days (%)	37 (7)	54 (11)	24 (5)
4-7 days (%)	47 (9)	42 (8)	13 (3)
1-4 weeks (%)	81 (16)	66 (13)	27 (5)
>4 weeks (%)	30 (6)	40 (8)	12 (2)
Not specified (%)	12 (2)	14 (3)	6 (1)

[a]Percentages are shown within each group. HR, high risk; LR, low risk.

During the season, 45.8% of the players in the LR control group (55 of 120 players) sustained 1 or more injuries, compared with 58.5% in the HR control group (114 of 195 players; $P = .029$ vs the LR control group; χ^2 test) and 59.1% in the HR intervention group (114 of 193 players; $P = .90$ vs the HR control group).

There was no difference in injury severity among the 3 groups (Table 6).

Intervention Outcome: Intention-to-Treat Analysis

For the main outcome measure, the sum of injuries to the ankle, knee, hamstrings, and groin, the total incidence was 2.3 injuries per 1000 playing hours (95% CI, 2.1-2.6). The corresponding figures were 1.3 (95% CI, 0.9-1.8) for the LR control group, 2.8 (95% CI, 2.3-3.3) in the HR control group, and 2.6 (95% CI, 2.1-3.0) in the HR intervention group. There was a significantly lower injury risk in the LR

TABLE 7
Intention-to-Treat Analysis for Ankle, Knee, Hamstring, and Groin Injuries[a]

	HR Intervention Group				HR Control Group				
	Players at Increased Risk	Injuries	Injured Players	Injury Incidence (95% CI)	Players at Increased Risk	Injuries	Injured Players	Injury Incidence (95% CI)	*P* Value (Control vs Intervention)
Ankle	102	13	10 (10%)	0.6 (0.3-0.9)	107	20	14 (13%)	0.9 (0.5-1.3)	.21
Knee	65	7	6 (9%)	0.5 (0.1-0.9)	66	8	7 (11%)	0.5 (0.2-0.9)	.93
Hamstring	85	23	17 (20%)	1.5 (0.9-2.0)	76	17	14 (18%)	0.9 (0.5-1.4)	.17
Groin	62	11	10 (16%)	0.9 (0.4-1.4)	98	16	13 (13%)	0.7 (0.4-1.1)	.67

[a]The number of players with an increased risk of injury to the different body parts (ankle, knee, hamstring and groin) within the two high risk groups and the number of injuries that occurred to the same body part among these players. HR, high risk; LR, low risk; CI, confidence interval.

control group compared with the 2 other groups (RR, 0.49; 95% CI, 0.33-0.71 vs the HR control group; RR, 0.53; 95% CI, 0.36-0.77 vs the HR intervention group). However, no difference was seen between the HR intervention group and the HR control group (RR, 0.93; 95% CI, 0.71-1.21).

When the players in the HR intervention and HR control groups with increased risk of injury were compared, we found no significant differences in the risk of injury to the body part in question between the 2 groups for any category (ankle: RR, 0.64; 95% CI, 0.32-1.29; knee: RR, 0.96; 95% CI, 0.35-2.64; hamstrings: RR, 1.55; 95% CI, 0.83-2.90; and groin: RR, 1.18; 95% CI, 0.55-2.54) (Table 7).

Compliance With the Training Program and Per-Protocol Analysis

Compliance with the training programs in the HR intervention group was poor, with only 27.5% (28 players) in the ankle group and 29.2% (19 players) in the knee group having completed 30 or more training sessions. For the hamstring and groin exercises, compliance was even less, with only 21.1% (12 players) and 19.4% (16 players) completing 20 or more training sessions, respectively. Hence, the compliant (more than 30 exercises for ankle and knee, and more than 20 training sessions for hamstring and groin) groups are small. As many as 15.7% (16 players) reported not having done any ankle exercises; 11.8% (12 players), 1 to 9 exercise sessions; and 24.5% (25 players), 10 to 19 sessions; while 20.6% (21 players) reported having carried out 20 or more sessions, but less than the target number of 30. The corresponding figures for knee exercises were 23.1% (0 exercise sessions reported), 9.2% (1-9 sessions), 13.8% (10-19 sessions), and 24.6% (20-29 sessions). For hamstring exercises, the figures were 63.2% (0 exercise sessions reported), 7.9% (1-9 sessions), and 7.9% (10-19 sessions); and for groin exercises, 67.7% (0 exercise sessions reported), 4.8% (1-9 sessions), and 8.1% (10-19 sessions).

In a per-protocol analysis on ankle injuries, the incidence of ankle injuries in the compliant group, who sustained 3 injuries (2 of 28 injured players), was 0.5 (95% CI, –0.1 to 1.0) injuries per 1000 hours, compared with 0.9 (95% CI, 0.5-1.3) injuries per 1000 hours among players with an increased risk of ankle injuries in the HR control group (RR = 0.51; 95% CI, 0.2-1.7). Similarly, we could not detect any difference in the risk of knee injury between players in the HR intervention group who were compliant with the knee program (0.2 [95% CI, –0.2 to 0.7] injuries per 1000 hours) and the HR players in the HR control group (0.5 [95% CI, 0.2-0.9] injuries per 1000 hours; RR = 0.46; 95% CI, 0.1-3.7). In the same way, no difference was observed in the incidence of hamstring (RR = 0.94; 95% CI, 0.3-3.2) and groin injuries (RR = 1.6; 95% CI, 0.5-5.6) between players in the HR intervention group who were compliant with the respective training programs and the HR control group.

DISCUSSION

The main finding of this study was that, although we were able to identify players with an increased injury risk through a comprehensive questionnaire, there was no effect of the targeted intervention on injury risk. The most likely explanation for this is the low compliance with the exercise programs. With such low compliance in the intervention group (ranging from 20% to 30% for the different exercise programs), no effect could be expected on injury rate.

In contrast to most previous intervention studies, we chose to randomize players individually to the intervention or control group. We relied on the team physical therapists to instruct the players in the intervention program. However, to avoid contamination, the players were asked to do the exercises outside the regular team training sessions—before or after training or at home. The low overall compliance in the intervention group indicates that significant contamination between groups is unlikely to have occurred. As seen in previous studies, the main challenge is getting players in the intervention group to follow preventive training programs, not keeping other players from training.[23] However, a potentially bigger risk of contamination is the fact that 19 of the 31 teams did team-based preventive exercises similar to ours regularly throughout the preseason, and 16 of these reported good training regimens. We could not, of course, keep the teams from carrying out their normal preventive exercises. Although these team-based exercises were done by players in both groups, the fact that players from the control group trained with exercises similar to our intervention exercises does, of course, reduce the potential of showing a positive preventive effect of our intervention and represents a limitation in this study. Moreover, exercises carried out by each player on his own are probably not as effective as when they are carried out under qualified supervision,[30] not just because of a lower compliance, but also because the quality of the exercises performed can not be ensured in the same way. Potentially negative factors such as initial muscle soreness or eventual boredom could possibly be overcome more effectively in a group training session with a qualified instructor.

Because the compliance was low, the statistical power is also too low to assess the effect of the training programs in the subgroups that did follow the training protocol (ie, through the per-protocol analyses). The 4 programs used were selected either because there was evidence from previous prevention studies to indicate that they are effective or because they have been shown to be effective as rehabilitation exercises after injury. To prevent ankle and knee injuries, various forms of balance-training exercises have been shown to be effective in other study populations.[8,10,15,20,21,26,31,32] Strain injuries to the hamstrings have been effectively prevented through eccentric strength training, such as that used in the present study.[4,7,16,22] A program of strength training and core stability exercises has been shown to be highly effective in the treatment of long-standing groin pain in a population consisting mainly of soccer players.[16] This program formed the basis for the present program, but because we thought it would be unrealistic to implement the entire groin program, we prescribed an abbreviated 10- to 15-minute session to increase compliance. In other words, each of the program components were based on studies indicating their effect in prevention or rehabilitation of the 4 main injury types. However, previous injury as a risk factor is not fully understood; it may be that ankles and knees are not fully restored structurally or functionally. Although the injury prevention literature supports several different exercises, there is limited evidence that reinjuries can be prevented through the same exercises. We do not know which exercises should be chosen to prevent reinjuries and which have potential for primary prevention of the same injury types.

It is possible that the compliant players may have benefited from the programs if they had carried out more sessions. We know that a certain minimum of exercise must be performed before an effect may be expected.[23] For the purposes of data analysis, we suggested that at least 30 exercises (20 for hamstring and groin) needed to be carried out. However, this number is arbitrary, as there is no evidence on the dose-effect relationship for any exercise program to prevent injuries.

Although the intervention was ineffective, this study demonstrates that the players who had the most to gain from preventive exercises could be identified. The risk of injury was approximately twice as high among athletes with a history of previous injury and/or reported reduced function. This identification was achieved through the use of a simple questionnaire only, and the addition of more elaborate functional tests did not increase the predictive value of the screening (data not shown). The rationale for the approach used, employing a self-completed questionnaire, provided the potential for expanding the range of application of the athlete screening process. The questionnaire represents a cost-effective means of player screening, which could also be done using Web-based solutions. In this way, teams and players with no medical staff could do a self-test in the preseason to find out whether they have an increased risk of injuries.

The increased risk associated with a history of previous injury and reduced function also has other implications. One is that preventing the first injury should be a high priority, to keep players from entering the vicious cycle of repeated injuries to the same body part. This cannot be achieved only at the team level; more research is needed and effective injury prevention may also involve changes to the rules of the game and more specific training of referees.[1,2] The most likely explanation for previous injury being such a consistent risk factor for reinjuries is that the joints or muscles in question are not fully restored structurally and/or functionally. Based on this, it seems reasonable to suggest that one thing teams can do, even at lower levels of play, is to focus on improving rehabilitation after injury and implementing adequate return-to-play guidelines. Players with reduced function after previous injury should undergo a structured rehabilitation program until full function is established. However, it remains to be proven whether this would reduce injury risk significantly. The present study also shows that this cannot be left to the players themselves; adequate supervision is necessary.

One limitation of this study is the difference in physical therapist contact between the HR intervention players and the other groups. To instruct in the intervention exercises, the physical therapist became well acquainted with each of the intervention players, and not always to the same extent with the other players on the team. Thus, there was a potential for a bias in injury reporting, as the same physical therapist also was responsible for reporting injuries.

CONCLUSION

We were able to identify the players with an increased risk of injury through a questionnaire on previous injuries and joint and muscle function only. However, the introduction of individual specific preventive training programs did not affect the injury risk in this intervention, most likely due to a low compliance with the training programs prescribed.

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