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Injuries and musculoskeletal complaints in referees and assistant referees selected for the 2006 FIFA World Cup™ - Retrospective and prospective survey

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Abstract

Background: There is a considerable amount of scientific literature on football, but few studies have focused on referees, despite their key role in this sport. Existing studies focus on the physiological demands and training of referees.

Purpose: To analyse injuries and musculoskeletal complaints in referees and assistant referees selected for the 2006 FIFA World Cup™.

Study design: Retrospective survey and prospective study.

Methods: During the preparation camps for the 2006 FIFA World Cup™ in Germany, all 123 referees pre-selected for the tournament completed a questionnaire on injuries and musculoskeletal complaints. During the tournament, the characteristics and consequences of all injuries and complaints incurred by the 63 officiating referees were documented.

Results: More than 40% of the referees reported having incurred an injury and more than 60% having had musculoskeletal complaints during their career. About 20% of the group reported having suffered from musculoskeletal complaints in the last match. During the World Cup, fourteen referees (22%) incurred an injury and more than 30% had musculoskeletal complaints. This prospectively collected data showed an incidence of 20.8 injuries per 1000 match hours (95% CI: 4.17 to 37.4). The most common acute injuries were hamstring strains, calf strains, and ankle sprains, while the most frequent locations of complaints were the low back, hamstring and knee.

Conclusion: Considering the injury profile, the prevalence of associated musculoskeletal complaints, and the high physiological demands of refereeing, it appears that injury prevention programs should be developed and integrated into the fitness training routine of the referee.

Keywords: referee, soccer, injury, incidence, tournament

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Introduction

The football referee, also considered the 23rd player of a football (soccer) game,[1] is supported by two assistant referees. Together, the three have to ensure that the players follow the Laws of the Game. An official survey ("Big Count 2006")[2] by the Fédération Internationale de Football Association (FIFA) revealed that in 2006 there were, worldwide, and over all levels of football, more than 840,000 registered referees and assistant referees (about 94% male, 6% female). Compared with the first survey in 2000, there was an increase of 17% in the total number of referees.

Despite the important role of the referee in football, little scientific literature is available on refereeing. In the last 10 years, several studies have examined various physiological aspects of performance and training in connection with football refereeing.[3 4] Similar to players, referees show a mixed walking and running profile (low, medium and high intensity) during the game. The elite level referee is exposed to similar physical demands to those placed on a midfield football player. However, referees exhibit several unique characteristics: they are older than the players (by 15-20 years, on average), they are rarely full time professionals, they don't play the ball, and they normally cannot be substituted during the match. During a competitive match, a referee may cover an average distance of between 9 and 13 km, with 4-18% of this comprising high intensity activities such as sprinting.[3] Backwards and sidewards running are also typical movements made by the referee during the course of a game. Analysis of between-halves distance coverage has given some conflicting results, but research has generally shown that elite referees adopt various strategies to conserve energy during the game. It can be speculated that the most crucial moments of a game are at the end of each half (especially the second), where the likelihood of mental and physiological fatigue is higher. A referee must be prepared for performing at high intensity (when needed) throughout the match. Elite referees may perform up to 1270 activity changes and make more than 130 decisions during a game;[5] this indicates the high physiological and cognitive demands placed on the referee.

Considering the demands imposed on the cardiovascular and musculoskeletal systems, it is clear that the referee is exposed to a certain risk of injury during the game. Several epidemiological studies have focused on injuries in football players, but there is a lack of knowledge on the injury profile of the football referee.

To the best of our knowledge, only Bizzini et al[6] have investigated injuries and musculoskeletal complaints in elite referees. In this retrospective study of 71 referees in the top two divisions of the Swiss Football League the incidence of acute injuries was low, but 90% reported musculoskeletal complaints during their career.[6]

The aim of the present study was to investigate both retrospectively and prospectively the injuries and musculoskeletal complaints of all referees and assistant referees selected for the 2006 FIFA World Cup™ in Germany.

Methods

The study included a retrospective survey of injuries and musculoskeletal complaints in all referees pre-selected for the 2006 FIFA World Cup™ and a prospective

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assessment of injury in all referees officiating the final 64 matches of the tournament (9 June – 9 July 2006).

Retrospective survey

The retrospective part of the study was carried out in March and April 2006 during the two preparation camps (in Frankfurt, Germany) organized for referees and assistant referees by the FIFA Refereeing Department. On the first day of the camps, the referees were asked to complete a questionnaire on injuries and musculoskeletal complaints. Where injuries were declared, a brief personal interview was carried out to expand on the responses given in the questionnaire. Although the referees were explicitly informed that the data would be treated absolutely confidentially and only used for scientific purposes, it is possible that some referees may have thought their answers would affect their chances of selection and hence not declared or underplayed their injuries and complaints.

The specially developed, five-page questionnaire, which had proven feasible in a previous study,[6] covered the following areas: characteristics of the referee (such as socio-demographics, refereeing qualifications and experience), injuries and musculoskeletal complaints caused by training or refereeing (related to the last match, the last 12 months, and the entire career), other medical problems and time spent in training and in matches.

All definitions used, methods applied and variables assessed were in accordance with the recent consensus statement on injury definition and data collection procedures in studies of football injuries.[7] The questionnaire comprised one section on (acute) injuries and another on musculoskeletal complaints.[6] First the referee was asked: *"Have you suffered any injury caused by refereeing a football match or the training for officiating?"*. The response options were *"yes/no"*, and if the referee answered in the affirmative, he was requested to give further details about the injury(ies) in a personal interview with the first author (MB). The next question was: *"Have you had any pain, discomfort or complaints caused by refereeing a football match or the training for officiating?"*. This question was followed by a list of the most common musculoskeletal symptoms (e.g., low back pain, pain in the Achilles tendon, etc.) with the header *"Please indicate the extent to which you suffered from any of the following symptoms"*. The possible responses for each item were graded in terms of subjective severity (*not at all, a little, moderately, severely, very severely*). It was expected that this method would help with the reporting and recording of overuse injuries expressed as musculoskeletal complaints.[6] The questionnaire was available in English, Spanish, German and French, the four official FIFA languages, since fluency in at least one of these languages is a prerequisite for selection as a FIFA referee.

Exposure time was calculated based on the information provided in the questionnaire. Match exposure in the last 12 months was calculated as the total sum of matches officiated by all referees in the last year times 1.5 hours (the minimum duration of a match). Match exposure over the career was calculated by multiplying the number of referees, the average years in refereeing, the average number of officiated games per year and 1.5 hours. Exposure in training was calculated for season and pre-season separately.

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Prospective assessment

Two weeks prior to the tournament (May 25), all selected referees and about 50 staff members were reunited at the referees' headquarters in Frankfurt. A medical team (including one medical doctor, five physiotherapists, and three massage therapists), six fitness instructors, and two sports psychologists looked after the referees until the end of the tournament. A "typical" day for the referee comprised 2 hours' training on the pitch in the morning, then one hour of individual training (optional) and one hour of theory in the afternoon, followed by regeneration/treatment sessions (individual schedules). The referees trained "normally" while they were in the headquarters, but reduced their training program a day or two before leaving to officiate matches. During the 2006 FIFA World Cup™ (9 June – 9 July 2006) the MRs and ARs (with the 4th and 5th official) travelled by air to their appointed matches at the different venues in Germany. For each match, a physiotherapist was present in the stadium. After the match, this physiotherapist phoned the head physiotherapist in Frankfurt, to inform her of any physical problems encountered by the MRs and ARs during the match.

Data on injuries and musculoskeletal complaints were collected prospectively by one physiotherapist (MB) from the medical team. Confirmation of the diagnosis was made by a medical doctor at the referees' headquarters in Frankfurt. Every acute injury incurred during match or training was recorded according to the consensus injury definition.[7] All musculoskeletal complaints that received medical attention were similarly recorded. The type and number of treatments (physiotherapy, massage, electrotherapy, taping, other) and training modifications (reduced training, such as on an exercise bike or in the pool) were recorded on a daily basis. Match exposure for the prospective survey (in hours) was calculated by multiplying the number of games (64) by the number of referees (3) and the minimum duration of the game (1.5 hours).

Population

All 123 match referees (MRs) and assistant referees (ARs) from 53 National Football Associations worldwide, pre-selected by the FIFA Refereeing Department for officiating during the 2006 FIFA World Cup™ in Germany, were included in the retrospective survey (Figure 1). All referees formed fixed trios consisting of one MR and two ARs.

Out of the initial group, 27 trios were selected to participate in the final rounds of the 2006 FIFA World Cup™. Twenty-two trios were selected to officiate the matches and five trios were appointed as a support group, acting as fourth and fifth officials during the qualification rounds. All referees, except one AR appointed to the support group, had attended the pre-tournament training camp. One of the 22 trios selected to officiate the matches was sent home before the start of the Word Cup because the MR arrived with a knee injury (meniscal lesion) that was aggravated during the first training session. The final group of 21 trios officiating the matches of the 2006 FIFA World Cup™ were included in the prospective study.

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Figure 1. Selection procedure for the match referees (MRs) and assistant referees (ARs) for the 2006 FIFA World Cup™.

The study was approved by the University of Zürich, University Human Subjects Ethics Committee. All the subjects gave their signed informed consent to participate.

Statistical analysis

The statistical analyses were carried out using SPSS (version 11; SPSS Institute, Chicago, Illinois). Results are reported as the mean and standard deviation (SD) and/or range, unless otherwise noted. Group differences between MRs and ARs were analysed by chi-square (categorical data) or unpaired t-tests (continuous variables). For incidence rates, 95% confidence intervals were calculated as the incidence ± 1.96 times the incidence divided by the square root of the number of injuries. P-values of less than 0.05 were regarded as significant.

Results

Characteristics of the referees

All 44 MRs and 79 ARs selected for the 2006 FIFA World Cup™ preparation camps participated in the retrospective part of the study. The referees had a mean age of 41 (SD 3.7, range 29-45) years, height 178 (SD 6, range 160-195) cm, weight 76 (SD 7, range 58-92) kg, and BMI 23.8 (SD 1.3, range 20.2-27.1) $kg.m^{-2}$. They had received their first official license for refereeing on average 19 (SD 5, range 8-32) years ago, and had been officiating in their top national leagues for 13 (SD 4, range 7-26) years. They had been in possession of a FIFA license for an average of 8 (SD 3.3, range 1-15) years, during which time they had also been officiating international matches. Per year, the referees officiated on average 28.9 (SD 10.3, range 10-70) national matches and 9.0 (SD 3.1, range 1-20) international matches. In the 12 months prior to the World Cup, they had officiated on average 28.2 (SD 10, range 3-60) national matches and 11.0 (SD 4.4, range 1-25) international matches. The referees trained 7.1 (SD 3.4, range 1-16) hours per week before the season and 6.1 (SD 2.44, range 1-15) hours per week during the season. More than 80% of the referees reported that they had received advice for their training from a qualified professional, and almost 60% of them declared that they did not practice any other sporting activities besides refereeing and training for refereeing. No significant differences between MRs and ARs were observed for any of these variables.

Retrospectively reported injuries

A total of 58 injuries throughout their career were reported by 50 (40.7%) referees, without difference between MR and AR. 18 MRs (40.9% of all MRs) and 32 (40.5%) ARs. Eight (6.5%) referees reported two injuries: two (4.5%) MRs and four (5.1%) ARs incurred one injury in the last 12 months and another during their career, and two (4.5%) MRs incurred both injuries during their career. In both groups, the most prevalent diagnoses were calf strains and ankle sprains. Meniscus lesions of the knee were also frequent in MRs, and strains of the hamstrings, quadriceps and adductor muscles, in ARs (for details see Table 1).

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Table 1: Injuries reported by referees during their career.

	Match referees n=44		**Assistant referees n= 79**		
	Game	**Training**	**Game**	**Training**	**Total**
Hamstring strain		2	3	9	14
Calf strain	1	5	1	5	12
Ankle sprain	1	4	1	3	9
Quadriceps strain		2		5	7
Adductor strain		1		3	4
Meniscus lesion		3	1		4
Anterior cruciate ligament rupture and meniscal tear		2			2
Knee sprain			1	1	2
Partial rupture/rupture of Achilles tendon	1			1	2
Anterior cruciate ligament rupture				1	1
Groin strain				1	1
Total	3	19	7	29	58

All reported injuries resulted in at least two weeks of absence from sport. Most injuries resulted in an absence of two to four weeks (35; 60.4%), or five to eight weeks (15; 25.7%), while eight (13.8%) injuries resulted in an absence of 12 weeks or more.

More injuries occurred during training (48; 82.8%) than matches (10; 17.2%), without difference between MRs and ARs. Information about the injury situation was provided for 32 (55.2%) injuries. Sprinting (n= 17; 53%), turning (n= 8; 25%) and changing direction without turning (n= 7; 21.8%) were the most frequent causes of injury. Sixteen injured referees (32% of all injured referees) considered that the type of shoes (n= 8) or the quality of the pitch (n=8) played a role in their injury.

Two (4.5%) MRs and three (3.8%) ARs reported a match injury in the last 12 months, resulting in an incidence of 0.7 match injuries per 1000 match hours (95% CI: 0.1 to 1.3), without difference between the groups. Concerning the entire career, the incidence was 0.1 match injuries per 1000 match hours for MRs (95% CI: 0 to 0.1), and 0.2 for ARs (95% CI: 0 to 0.3).

Retrospectively reported musculoskeletal complaints

None of the referees reported having incurred an injury during the last match, but nine (20.4%) MRs and 12 (15.2%) ARs stated that they had had at least one musculoskeletal complaint.

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In relation to the previous 12 months, 25 (56.8%) MRs and 48 (60.8%) ARs reported having had some sort of musculoskeletal complaint due to officiating; the corresponding figures in relation to the entire career were 28 (63.6%) MRs and 49 ARs (62%). In both groups, the most prevalent locations for injury were the hamstrings, knee, calf and Achilles tendon. ARs were twice as likely to report low back pain than MRs. For a detailed description of musculoskeletal complaints, see Table 2.

Table 2: Number and percentage of referees reporting musculoskeletal complaints.

	Match referees n=44			**Assistant referees n=79**		
Location of complaints	**Last match n (%)**	**Last 12 months n (%)**	**Entire career n (%)**	**Last match n (%)**	**Last 12 months n (%)**	**Entire career n (%)**
Head	1 (2.3%)	1 (2.3%)	3 (6.8%)	1 (1.3%)	5 (6.3%)	5 (6.3%)
Neck	1 (2.3%)	2 (4.5%)	2 (4.5%)	-	6 (7.6%)	6 (7.6%)
Low back	-	3 (6.8%)	4 (9.1%)	1 (1.3%)	13 (16.5%)	15 (19%)
Hip	-	2 (4.5%)	2 (4.5%)	-	1 (1.3%)	3 (3.8%)
Groin	-	2 (4.5%)	3 (6.8%)	1 (1.3%)	3 (3.8%)	4 (5.1%)
M. adductors	-	6 (13.6%)	6 (13%)	-	8 (10.1%)	8 (10.1%)
M. quadriceps	1 (2.3%)	2 (4.5%)	3 (6.8%)	1 (1.8%)	10 (12.7%)	10 (12.7%)
Hamstring	1 (2.3%)	5 (11.4%)	10 (22.9%)	1 (1.3%)	12 (15.2%)	12 (15.2%)
Knee	3 (6.8%)	7 (15.9%)	8 (18.2%)	3 (3.8%)	17 / 21.5%	17 (21.5%)
Patellar tendon	-	2 (4.5%)	4 (9.1%)	1 (1.3%)	7 (8.9%)	7 (8.9%)
Calf	2 (4.5%)	6 (15.6%)	14 (31.8%)	4 (5.1%)	14 (17.8%)	18 (22.8%)
Achilles tendon	-	1 (2.3%)	7 (15.9%)	2 (2.5%)	6 (7.6%)	9 (11.4)
Ankle	-	4 (9.1%)	3 (6.8%)	1 (1.3%)	7 (8.9%)	7 (8.9%)
Others*	2 (4.5%)	-	1 (2.3%)	-	-	1 (1.3%)

* ”others“ includes: shin splints, heel pain

Other retrospective information

Six (13.6%) MRs and six (7.6%) ARs had undergone surgery of the knee, one (2.3%) MR and three (3.8%) ARs had had an operation on the ankle, and one (2.3%) MR had received surgery on the Achilles tendon. Four (9.1%) MRs and eight (10.1%) ARs reported medical problems, mainly asthma and allergies. Six (13.6%) MRs and 12 (15.9%) ARs reported that they were taking medication regularly.

When asked whether they did anything to prevent injuries or complaints, 91 (74%) referees (33 (75.0%) MRs and 58 (73.4%) ARs) stated that they performed stretching exercises, and more than half (54.5%; 31 (70.5%) MRs and 33 (41.8%) ARs) reported regularly receiving massage, while 22.8% (14 in each group) declared that they adopted other measures (sauna, gym, etc.).

Referees officiating during the 2006 FIFA World Cup™

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All 63 referees selected for officiating as MR or AR during the World Cup were included in the prospective study (see Figure 1). No differences between this group and the remaining 60 referees were observed in their characteristics, except for their history of complaints: two of the referees in the group selected for active participation had reported complaints involving the M. quadriceps during their career, compared with eleven (18.3%) who had reported such complaints in the remaining group ($p<0.05$); twice as many in the non-selected group (21 (35%)) as in the selected group (11 (17.5%) had reported complaints involving the calf during their career ($p<.05$).

During the 2006 FIFA World Cup™, half of the referees (49.2%, 10 MRs and 21 ARs) received treatment because of a new injury and/or musculoskeletal complaints. Five referees (MR1, MR2, MR3, MR6, AR7) presented both acute injuries and musculoskeletal complaints, but in different locations, except for MR2, who had been treated for low back pain before he sustained the injury (see Tables 3 and 4). In total, 199 physiotherapy sessions, 132 massage therapy sessions, 96 electrotherapy applications, and 37 tapings were performed in treating the injuries and musculoskeletal complaints of the referees (for details see Tables 3 and 4).

Injuries during the 2006 FIFA World Cup™

During the World Cup™, fourteen (22.2%) referees incurred an injury during a match (6; 42.9%) or training (8; 57.1%) (for details, see Table 3).

Table 3: Characteristics and consequences of acute injuries during the 2006 FIFA World Cup™ and injuries and complaints reported retrospectively during the survey carried out 3 months earlier.

Referee	Type of injury during 2006 World Cup™	Match or training injury	Type and frequency of treatment	Days of reduced training	Injuries reported retrospectively in March/ April 2006	Complaints reported retrospectively in March/ April 2006
MR1	Heel open wound	M	Taping (8)	6	None	None
MR2	Low back muscle strain	M	Physiotherapy (8) Massage (6) Electrotherapy (4)	5	None	M. quadriceps (lm) Low back (lm, 12, ca) Adductors (lm, 12, ca)
MR3	Elbow contusion	M	Physiotherapy (4) Taping (4) Electrotherapy (4)	0	Calf strain (ca) Hamstring strain (ca)	Head, neck (lm, 12, ca) Calf (lm, 12, ca) Hamstring (lm, 12, ca) Low back (lm, 12, ca)
MR4	Rib contusion	T	Taping (5)	2	None	None
MR5	Ankle ligament sprain	T	Physiotherapy (10) Taping (10) Electrotherapy (5)	7	None	None
MR6	Hamstring muscle strain	T	Physiotherapy (7) Massage (8) Electrotherapy (6)	5	Ankle sprain (12)	Ankle (12)
MR7	Heel contusion, Plantar fascia	T	Massage (6) Electrotherapy (5)	4	Meniscus lesion (ca) Achilles rupture (ca)	Knee (ca) Achilles (ca)
AR1	Rectus <u>femoris</u> muscle strain	M	Physiotherapy (10) Massage (8) Electrotherapy (7)	6	Ankle sprain (prior to 2006 FIFA World Cup™) Adductor strain (ca)	Low back (12, ca) Adductors (12, ca)
AR2	Hamstring muscle strain	M	Physiotherapy (15) Massage (12) Electrotherapy (10)	10	Calf strain (12) Hamstring strain (ca)	Calf (12, ca) Hamstring (12, ca)
AR3	Knee ligament	M	Physiotherapy (8)	4	Meniscus lesion (ca)	Head, neck (ca)

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	sprain (MCL)		Electrotherapy (6)			
AR4	Hamstring muscle strain	T	Physiotherapy (5) Massage (6)	3	None	None
AR5	Calf muscle strain	T	Physiotherapy (6) Massage (5) Electrotherapy (5)	3	None	Calf (lm, 12, ca) Hamstring (12, ca)
AR6	Ankle sprain	T	Physiotherapy (5) Taping (5)	5	Calf strain (12) Hamstring strain (ca)	Ankle (ca)
AR7	Thoracic muscle strain	T	Physiotherapy (5) Electrotherapy (4)	1	Ankle sprain (ca)	Achilles tendon (12, ca) Ankle (12, ca)

MR= match referee; AR= assistant referee; M= match; T= training; lm= last match; 12= last 12 months; ca= career

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In each group (MRs and ARs) there were three injuries during matches and four during training. However, this equated to a two-fold greater frequency of injuries in MRs (7; 33.3%) than ARs (7; 16.7%). The match injuries resulted in an incidence of 20.8 per 1000 match hours for all referees (95% CI: 4.2 to 37.4); for the MRs, the incidence was 31.3 injuries per 1000 match hours (95% CI: 0 to 66.8) and for the ARs, 15.6 injuries per 1000 match hours (95% CI: 0 to 33.2). None of the injuries caused any absence from officiating. However, 13 of the 14 injured referees had to reduce or modify their normal team training on the pitch for an average of 4.4 days (range 0 – 10). The treatment of these injuries required a total of 83 physiotherapy sessions, 56 electrotherapy applications, 51 massage therapy sessions, and 31 tapings.

While in MRs the most frequent diagnosis was contusion, in ARs five out of seven injuries were strains. Only one MR (MR2) incurred an injury in the same location as that where he had previously reported having complaints (low back), but the injury was a newly incurred muscle strain and not an aggravation of his pre-existing low back pain. In contrast, four ARs incurred an injury in the same location as that where they had previously suffered injuries and/or complaints. AR3, who suffered a knee collateral ligament strain during the 2006 FIFA World Cup™, had already undergone surgery on the same knee due to a meniscus lesion more than a year ago.

Musculoskeletal complaints during the 2006 FIFA World Cup™

During the World Cup™, 22 (34.9%) referees were treated in connection with 30 musculoskeletal complaints (Table 4), without difference between ARs and MRs. The treatment of these musculoskeletal complaints required a total of 116 physiotherapy sessions, 81 massage therapy sessions, 40 electrotherapy applications, and 6 tapings.

The most frequent complaint was low back pain (33.3%), followed by complaints involving the calf (16.7%) and Achilles tendon (10.0%). The majority of referees suffering from low back pain during the World Cup™ (60%) had reported this symptom previously. Two referees (MR10 and AR24) treated because of knee pain had already undergone surgery on the same knee. Also, two of the three referees suffering from Achilles tendon pain (AR18, AR19) had had the same complaint during the previous 12 months. In total, 60% of the complaints treated during the World Cup™ were not related to any injury or complaint reported in the retrospective questionnaire.

Table 4: Musculoskeletal complaints during the 2006 FIFA World Cup™ and reported retrospectively during the survey carried out 3 months earlier.

Referee	Complaint during 2006 World Cup™	Days of reduced training	Type and frequency of treatments	Complaints reported retrospectively in March / April 2006
MR1	Low back	0	Physiotherapy (11) Massage (9)	None
MR2	Low back, Calf	0	Physiotherapy (7) Massage (9)	M. quadriceps (lm) Low back (lm, 12, ca)

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				Adductors (lm, 12, ca))
MR3	Knee	2	Physiotherapy (6) Electrotherapy (5)	Head, neck (lm, 12, ca) Calf (lm, 12, ca) Hamstring (lm, 12, ca) Low back (lm, 12, ca)
MR6	Achilles tendon	0	Physiotherapy (5) Electrotherapy (5)	Ankle (12)
MR8	Low back	0	Physiotherapy (3) Massage (5)	Ankle (12) Knee (ca) Knee surgery
MR9	Calf	1	Physiotherapy (4) Massage (4)	Neck (12) Knee (12) Calf (Ca)
MR10	Knee	0	Physiotherapy (3) Electrotherapy (3)	Hip (12, ca) Hamstring (12, ca) Knee (12, ca) Calf (ca) Knee surgery
AR7	Low back, Calf	0	Physiotherapy (7) Massage (6)	Achilles tendon (12, ca) Ankle (12, ca)
AR8	Low back, Shoulder	0	Physiotherapy (5) Electrotherapy (4)	None
AR9	Low back	0	Physiotherapy (2) Massage (7)	Low back (ca)
AR10	Low back	0	Massage (5)	Low back (12, ca) Knee (12)
AR11	Low back, Hamstring, M. adductor	2	Physiotherapy (8) Massage (8)	Low back (12, ca)
AR12	Low back	3	Physiotherapy (12) Massage (13)	Low back (ca) M. quadriceps (12) Hamstring (12, ca) Knee (12) Hip (ca)
AR13	Low back	0	Massage (6)	Low back (ca)
AR14	Calf	0	Massage (5)	Adductors (12, ca)
AR15	Calf, Achilles tendon	0	Physiotherapy (10) Electrotherapy (7)	Achilles tendon (12)
AR16	Achilles tendon	0	Physiotherapy (5) Electrotherapy (10)	Achilles tendon (12, ca)
AR17	Thoraco-cervical spine	0	Physiotherapy (7)	Head (lm, ca) Calf (lm, 12, ca) Achilles tendon (lm, 12, ca) Low back (12, ca)
AR18	Thoracic spine, Ribs	0	Physiotherapy (3)	Knee (12, ca) Achilles tendon (ca)
AR19	Ankle	3	Physiotherapy (5)	Head (12)

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			Electrotherapy (4) Taping (6)	Neck (12) Low back (12) Calf (ca)
AR20	Shoulder	0	Physiotherapy (7)	Knee (12)
AR21	Knee	2	Physiotherapy (6) Electrotherapy (6)	Knee (ca) Knee surgery

MR= match referee, AR= assistant referee;

lm= last match, 12= last 12 months, ca= career

Discussion

In the present study, injuries and musculoskeletal complaints of all referees pre-selected for the 2006 FIFA World Cup™ were investigated both retrospectively and prospectively. In effect, this was a study of 63 of the world's best referees. The personal characteristics (age, BMI, experience of refereeing) of this group were almost identical to those reported in other studies dealing with elite referees officiating in international football tournaments.[8 9] However, the mean age of this referee group was higher than that of referees performing at national level only; [6 10-13] since elite football referees often only reach the top of their career (which may mean selection for the FIFA World Cup) at ages greater than 40 years.[3]

The retrospective part of the study followed the methodology of a previous study on Swiss elite referees.[6] Similar to the latter study, 41% of the referees in the present study reported an injury during their career, and also only injuries resulting in at least 2 weeks absence were reported. The problems associated with retrospective surveys (i.e. memory effects) have been previously described.[14 15] Since only moderate to severe injuries were reported, the true incidence of injuries may have been underestimated. The locations and types of injuries reported by the FIFA referees were also similar to those reported by the Swiss referees.[6] Hamstring strains, calf strains, and ankle sprains accounted for more than 60% of all reported injuries throughout the referees' careers. Muscle strains and ligament sprains are also the injuries most commonly documented for football players.[16 17] However, football players are on average 15 years younger than international referees;[3 4] Arnason et al[18] found that increased age and previous hamstring strains were the main risk factors for hamstring strains in footballers. The FIFA referees reported more injuries during training (82.8 %) than during the match (17.2%). This finding is in accordance with the study of Bizzini et al on Swiss elite referees,[6] and might be explained by the greater exposure time in training than in matches.

In the present study, the incidence of match injuries in the last 12 months was considerably lower (tenfold) than that reported for elite Swiss referees.[6] Since memory effects (a limitation within any retrospective study design) can be considered to be equal for both studies, a possible "answer bias" due to the selection procedure for the 2006 FIFA World Cup™ might be an explanation for this finding. For an international FIFA referee, officiating in the World Cup (the most important football event in the world) represents the pinnacle of the refereeing career. In view of this, we

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cannot rule out the possibility that certain individuals may not have answered the questionnaire entirely honestly.

About two thirds of the referees reported having had some sort of musculoskeletal complaint during their career. Similar numbers of referees reporting musculoskeletal complaints with respect to the last 12 months and the entire career indicate the problems of recall bias. Thus, the prevalence of complaints during the career clearly represents a minimum estimate and should be interpreted with caution. In the study of Bizzini et al[6] on elite Swiss referees, 86% reported having had some sort of complaint in the last 12 months caused by refereeing. An alternative explanation to the deliberate underreporting of previous injuries and complaints by the FIFA referees in the retrospective part of the study may be a better physical fitness in this elite group.
In the present study, the main areas affected by musculoskeletal complaints were the hamstrings, knee, calf, Achilles tendon and low back, confirming the findings of Bizzini et al[6]. In a study dealing with shock absorbing soles, Fauno et al[19] also found that the calf, thigh, low back, Achilles tendon and knee were the most common locations for overuse symptoms in a group of 91 referees officiating in a five-day football tournament.

During the 2006 FIFA World Cup™, all acute injuries and musculoskeletal complaints of referees were documented prospectively. Six match injuries and eight training injuries were recorded. Though none of these resulted in absence from officiating, all except one injured referee had to reduce or modify their training regimen. The incidence of 20.8 match injuries per 1000 match hours was substantially lower than that reported for the football players involved in the same tournament (68.7 injuries per 1000 match hours).[20] The incidence of non-contact injuries in players (18 injuries per 1000 match hours) seems similar to that of referees, but some of the non-contact injuries in players resulted in absence from training or match.

During the 2006 FIFA World Cup™ tournament, one third of the 63 officiating referees presented musculoskeletal complaints. The relative distribution of the complaints was similar to that reported retrospectively, except that low back pain was reported more frequently in the tournament. 60% of the referees presenting with low back problems had already reported this complaint in the retrospective questionnaire, confirming the well-known recurrent nature of low back pain.[21 22] Nonetheless, the prevalence was lower than in cross-country skiers and rowers, and similar to orienteerers and non-athletic controls.[23]

Even though all the referees who suffered an injury during the 2006 FIFA World Cup™ were — after optimal medical and therapeutic care — still able to perform in the tournament, these data clearly show that the referee and his assistants are also exposed to a relatively high risk of injury during the match. The physiological and psychological demands on elite referees are high, and this group of athletes deserves more attention in relation to technical and physical preparation for the game. Futures studies should investigate the possibility of developing specific injury prevention programs for the referee and assistant referee.

What is already known on the topic?

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Football referees play an important role in a football match, however little is known about their injury profile.

What this study adds?

The incidence of injuries reported retrospectively was low, but half of the referees received treatment during the World Cup because of a new injury and/or musculoskeletal complaints.

The most common acute injuries were hamstring strains, calf strains, and ankle sprains, while the most frequent locations of complaints were the low back, hamstring and knee.

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References

1. Eissmann HJ. The 23rd Man: sport medical advice for football referees. Leipzig: Gersöne-Druck, 1996.
2. The FIFA Big Count 2006: 230 million active in football.: FIFA Communications Division., 2007:PDF Download (http://www.fifa.com/search/index.htmx?q=big+count).
3. Castagna C, Abt G, D'Ottavio S. Physiological aspects of soccer refereeing performance and training. *Sports Med* 2007;37(7):625-46.
4. Stolen T, Chamari K, Castagna C, Wisloff U. Physiology of soccer: an update. *Sports Med* 2005;35(6):501-36.
5. Krustrup P, Bangsbo J. Physiological demands of top-class soccer refereeing in relation to physical capacity: effect of intense intermittent exercise training. *J Sports Sci* 2001;19(11):881-91.
6. Bizzini M, Junge A, Bahr R, Dvorak J. Injuries and musculoskeletal complaints of referees - A complete survey in the top divisions of the Swiss Football League. Submitted.
7. Fuller CW, Ekstrand J, Junge A, Andersen TE, Bahr R, Dvorak J, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Br J Sports Med* 2006;40(3):193-201.
8. Castagna C, Abt G, D'Ottavio S. Activity profile of international-level soccer referees during competitive matches. *J Strength Cond Res* 2004;18(3):486-90.
9. Helsen W, Bultynck JB. Physical and perceptual-cognitive demands of top-class refereeing in association football. *J Sports Sci* 2004;22(2):179-89.
10. Reilly T, Gregson W. Special populations: the referee and assistant referee. *J Sports Sci* 2006;24(7):795-801.
11. Dottavio S, Castagna C. Analysis of match activities in elite soccer referees during actual match play. *J Strength Cond Res* 2001;15(2):167-71.
12. Rontoyannis GP, Stalikas A, Sarros G, Vlastaris A. Medical, morphological and functional aspects of Greek football referees. *J Sports Med Phys Fitness* 1998;38(3):208-14.
13. Weston M, Helsen W, MacMahon C, Kirkendall D. The impact of specific high-intensity training sessions on football referees' fitness levels. *Am J Sports Med* 2004;32(1 Suppl):54S-61S.
14. Twellaar M, Verstappen FT, Huson A. Is prevention of sports injuries a realistic goal? A four-year prospective investigation of sports injuries among physical education students. *Am J Sports Med* 1996;24(4):528-34.
15. Junge A, Dvorak J. Influence of definition and data collection on the incidence of injuries in football. *Am J Sports Med* 2000;28(5 Suppl):S40-6.
16. Junge A, Dvorak J. Soccer injuries: a review on incidence and prevention. *Sports Med* 2004;34(13):929-38.
17. Tucker AM. Common soccer injuries. Diagnosis, treatment and rehabilitation. *Sports Med* 1997;23(1):21-32.
18. Arnason A, Sigurdsson SB, Gudmundsson A, Holme I, Engebretsen L, Bahr R. Risk factors for injuries in football. *Am J Sports Med* 2004;32(1 Suppl):5S-16S.
19. Fauno P, Kalund S, Andreasen I, Jorgensen U. Soreness in lower extremities and back is reduced by use of shock absorbing heel inserts. *Int J Sports Med* 1993;14(5):288-90.

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20. Dvorak J, Junge A, Grimm K, Kirkendall D. Medical report from the 2006 FIFA World Cup Germany. *Br J Sports Med* 2007;41(9):578-81; discussion 581.
21. Adams MA, Mannion AF, Dolan P. Personal risk factors for first-time low back pain. *Spine* 1999;24(23):2497-505.
22. Pengel LH, Herbert RD, Maher CG, Refshauge KM. Acute low back pain: systematic review of its prognosis. *BMJ* 2003;327(7410):323.
23. Bahr R, Andersen SO, Loken S, Fossan B, Hansen T, Holme I. Low back pain among endurance athletes with and without specific back loading--a cross-sectional survey of cross-country skiers, rowers, orienteerers, and nonathletic controls. *Spine* 2004;29(4):449-54.

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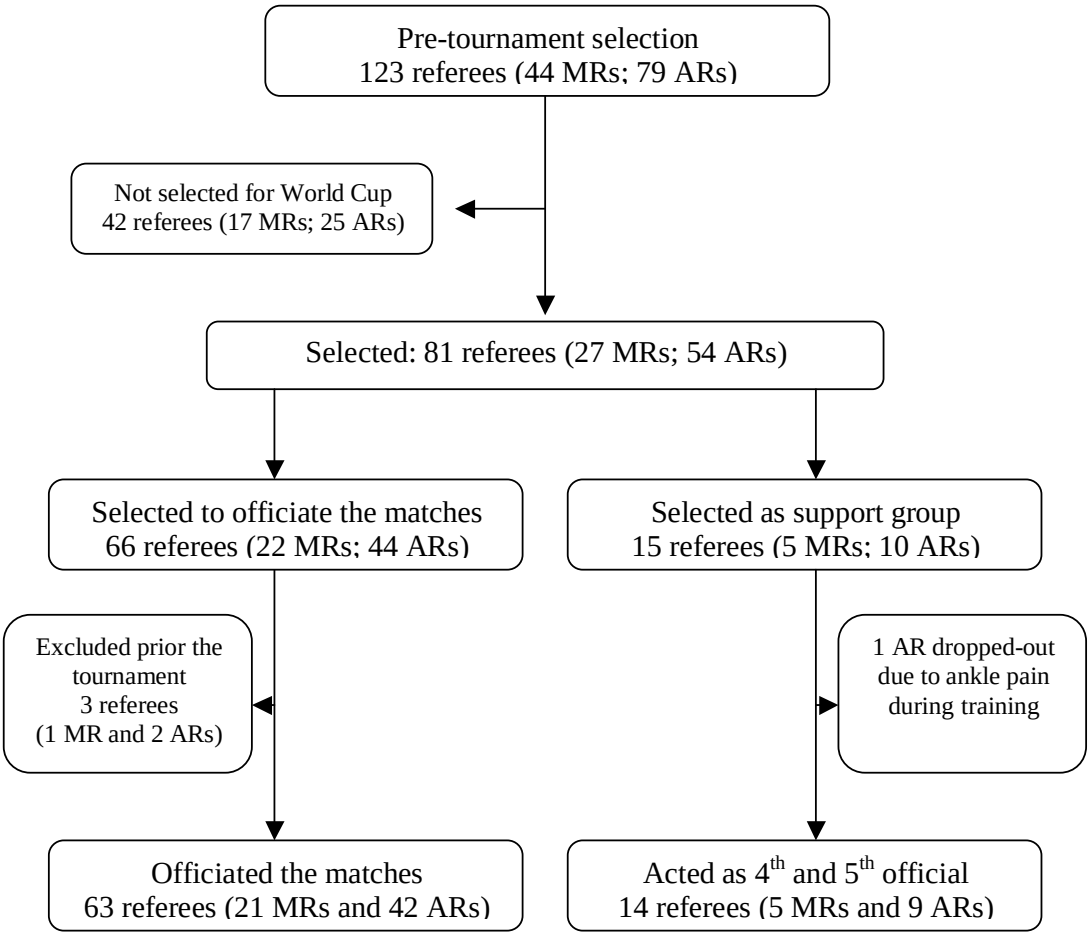
Figure 1. Selection procedure for the match referees (MRs) and assistant referees (ARs) for the 2006 FIFA World Cup™.