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ORIGINAL ARTICLE

Evaluation of foot postures of assistant referees in the regional football league

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Purpose: The aim of this study was to investigate the physical activity status, foot postures and plantar pressure distributions of football assistant referees in the Istanbul Regional League, who presented with the complaint of calf pain.
Methods: A total of fifteen assistant referees (mean age: 21.00±1.9 years) and 15 healthy subjects (mean age: 21.53±0.8 years) were included the study. The participants' physical activity levels were evaluated with the Short Form of the International Physical Activity Questionnaire (IPAQ-SF), foot posture was examined with the Foot Posture Index-6 (FPI-6) and pedobarographic examinations were performed with the Novel EMED-xR.
Results: There was a statistically significant difference between the referee group and the control group in two sub parameters of the IPAQ-SF which were total physical activity MET- min/wk, vigorous MET- min/wk (p=0.044, p=0.002, respectively). In pedobarographic evaluation, there was not a statistically significant difference between the referee and control groups in maximum force and peak pressure of any area of the foot. Also, there was not a statistically significant difference in FPI-6 test.
Conclusion: The present study results showed that side running did not change the foot posture in assistant referees. It was determined that calf pain, which could not be affected due to a physical cause, was not associated with foot posture. We suggest that future studies should examine sports field, the sports equipment and other factors related pain to determine the cause of pain.
Keywords: Foot, Football referee, Pedobarography, Posture, Physical activity.

Bölgesel futbol ligindeki yardımcı hakemlerin ayak postürlerinin değerlendirilmesi

Amaç: Bu çalışmanın amacı, baldır ağrısı şikayeti ile kliniğe başvuran İstanbul Bölge Ligi futbol yan hakemlerinin ayak postürlerinin, fiziksel aktivite durumlarının ve ayak taban basınç dağılımlarının incelenmesi idi.
Yöntem: Çalışmaya toplam 15 yan hakem (ortalama yaş: 21,00±1,9 yıl) ve 15 sağlıklı birey (ortalama yaş: 21,53±0,8 yıl) dâhil edildi. Katılımcıların fiziksel aktivite düzeyleri Uluslararası Fiziksel Aktivite Anketi'nin (IPAQ-SF) kısa formu ile, ayak postürleri Ayak Postür İndeksi-6 (FPI-6) ile değerlendirildi. Pedobarografik incelemeler Novel EMED-x Rile ile yapıldı.
Bulgular: Hakem grubu ile kontrol grubu arasında IPAQ-SF'nin fiziksel aktivite metabolik eşdeğer dakika/hafta (MET-dk/hf), kuvvetli MET-dk/hf alt parametrelerinde iki grup arasında istatistiksel olarak anlamlı farklılık vardı (sırasıyla; p=0,044, p=0,002). Pedobarografik değerlendirmede, hakem ve kontrol grupları arasında, ayağın herhangi bir bölgesinin maksimum kuvvet ve pik basınç değerlerinde istatistiksel olarak anlamlı bir fark yok idi. Ayrıca, FPI-6 testinde istatistiksel olarak anlamlı bir fark yok idi.
Sonuç: Bu çalışma, yardımcı hakemler tarafından yapılan yan koşuların ayak postürünü değiştirmediğini göstermiştir. Fiziksel bir nedeni saptanamayan baldır ağrısının ayak postürü ile ilişkili olmadığı belirlendi. Gelecekte yapılacak çalışmalarda ağrının nedeniyle ilgili olarak spor alanının, kullanılan spor malzemelerinin ve ağrıya yol açabilecek diğer faktörlerin ayrıntılı incelenmesini önermekteyiz.
Anahtar kelimeler: Ayak, Futbol hakemi, Pedabarografi, Postür, Fiziksel aktivite.

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Football is one of the most popular sports in the world, with more than 270 million players.[1,2] While football players and coaches are the main factor in the popularity of football, referees have a not inconsiderable impact with the decisions taken and game management. There are more than 800 referees and assistant referees registered with the Federation Internationale de Football Association (FIFA)[3] and 412 referees and 722 assistant referees registered with the Turkish Football Federation.[4]

With the application of the rules of the game, the assistant referees help the referee to control the match. They also assist the referee in all other matters involving the running of the match at the request and direction of the referee. As a general rule, the assistant referee should face the pitch whilst running. Side-to-side movement should be used by the assistant referee for judging offside.[5]

Although referee performances are low compared to that of the football players, the referees must be very active to be able to be close to the positions in the game and make the right decisions. The referees generally use straight running, but if necessary, side and back running styles are preferred especially by the assistant referees.[6] A referee runs 9-13 km during the match and 4-18% of the run is in sprint mode.[7] The mean total distance covered by top-class assistant referees has been reported as 7.28 km (range 5.78-8.16 km), of which 1.15 (0.86-1.44) km was high-intensity running and 1.16 (0.12-2.34) km was sideways running.[8] As running is associated with greater velocity, the forces that go through the foot when it lands can be substantially greater than during walking.[9]

The high tempo performance of referees during matches and trainings brings to mind that referees may frequently experience pain and musculoskeletal injuries. From a review of literature on this topic, it was understood that referees have not been researched as much as football players and generally, studies have been in the form of retrospective surveys.[10] Bizzini et al. stated that 40% of the referees who participated in the 2006 FIFA World Cup were injured at least once during their professional life and 60% had a musculoskeletal problem. An average of 20.8 injuries were determined to have occurred in the 1000-hour match period.[11] In studies conducted in Sweden, the injury rate of referees has been reported as between 22.5% and 44%.[12,13] Silva et al. emphasized the frequency of strains, especially in the lower extremity, and while similar rates of calf and thigh muscle strain were found in referees, posterior thigh and calf muscle strains were more frequently seen in assistant referees.[14]

One of the risk factor of foot and calf pain is foot posture and function. The contour of the medial longitudinal arch is a characterization of foot posture, and it is typically divided into normal, planus or cavus. Altered walking pattern and excessive improper loading of osseous and soft tissue can cause to change foot structure.[15]

In general, the referees have been determined with more pain and musculoskeletal problems after the match than the assistant referees, and complaints of the calf and groin area were more frequent in the referees.[13] There has been no study to date in literature that has examined the effect on foot posture and plantar pressure distribution of the side running performed by assistant referees during the match.

The aim of this study was to investigate the physical activity status, foot postures and pressure distributions of referees in the Istanbul Region League, who presented with the complaint of calf pain. Our hypothesis, based on our clinical experience, has been that side running for long periods can change foot posture and plantar pressure distribution and cause calf pain.

METHODS

The study included Istanbul regional assistant referees who presented at the Physiotherapy and Rehabilitation Department, Faculty of Health Sciences, Marmara University, between January 2017-June 2017 and a healthy control group. Physical and radiological examinations were made by specialist physician and findings did not reveal any cause of calf pain. In their anamnesis, they have reported that they were routinely doing warming up exercises before the matches, and cooling down and stretching exercises after the matches. Approval for the study was obtained

from the Marmara University Faculty of Health Sciences Ethics Committee. Each participant signed an informed consent form.

The inclusion criteria were as follows for the referees; age range of 18-30 years, having a Turkish football federation license and calf muscle region pain at least once in the past year. The exclusion criteria were as follows: having treatment for pain, having a spine or lower extremity surgery. Age-matched healthy volunteers coming forward from our university student population were evaluated as control group.

Physical activity levels, foot posture and pedobarographic analysis were evaluated.

The short form of the International Physical Activity Questionnaire, which includes activity in the last seven days, was used for physical activity assessment. This short form consists of seven questions and provides information about sitting, walking, moderate intensity activities and time spent in intense activities. Calculation of the total score of the short form includes walking, moderate intensity activity, and time (minutes) and frequency (days) of intense activity. The sitting score (sedentary behavior level) was calculated separately. In the evaluation of all activities, each activity was performed for at least 10 minutes at a time. A score of "MET-minutes / week" was obtained by multiplying the minutes, days, and MET values (times of resting oxygen consumption). The walking time (minutes) was multiplied by 3.3 MET to calculate the walking score. The calculation included 4 MET for moderate intensity activity and 8 MET for high-intensity activity. The score obtained was classified as having no physical activity (MET = <600 energy level), an insufficient activity level (MET = 600-3000 energy level) and a sufficient activity level (MET=3000 energy level).[16] When determining how much energy was spent on each physical activity, the weekly duration (min) of each activity and the MET values for IPAQ were multiplied. The validity and reliability study of the survey for Turkey was made by Sağlam et al.[17]

Foot posture observational analysis was performed using (FPI-6). During the evaluation, the participant was asked to stand in the neutral position. The six clinical criteria employed in the FPI-6 are talar head palpation, supra and intra lateral malleolar curvature, calcaneal frontal plane position, prominence in the region of the talonavicular joint, congruence of the medial longitudinal arch and abduction/adduction of the forefoot on the rear foot. Each of the component tests or observations are scored as 0 for neutral, with a minimum score of -2 for clear signs of supination, and +2 for positive signs of pronation. The total score obtained was recorded. The score range 0 - +4 was interpreted as a neutral position of the foot,> +4 as pronounced, and negative as supine.[18,19]

Pedobarographic evaluation of foot pressure was applied using the Novel EMED-xR (Emed, Germany) which consists of a 380 mm - 240 mm pressure platform with 2 sensors/cm^2, a pressure range of 10 to 950 kPa, and sampling frequency of 50/60 Hz. We measured the peak pressure (kPa), maximum force (N), and contact area cm^2; (Automask; Novel GmbH) in the forefoot, midfoot, hindfoot, and toes. The arch index was calculated by dividing the pressure area of the midfoot by the total pressure areas of the forefoot, midfoot, and midfoot. During the evaluation, the height of the platform was removed by placing meds in front of and behind the platform. Participants were asked to walk at normal walking speed in bare feet. A total of 5 measurements were taken of the right and left foot, then the averages of these measurements were calculated and recorded.[20]

Statistical analysis

Statistical analyses were performed using Statistical Package for Social Sciences version 16 software (SPSS Inc., Chicago, IL, USA). Conformity of the data to normal distribution was tested using the Shapiro Wilks test. The results of the evaluations were compared using the Mann Whitney U test. Correlation analysis of the results was applied using the Spearman correlation test. A value of $p<0.05$ was accepted as statistically significant.

RESULTS

Evaluation was made of a total of 30 males, as the referee group of 15 assistant referees (mean age: 21.00±1.9 years) and the control group of 15 healthy participants (mean age: 21.53±0.8 years). The average duration of

functioning as a referee was 20.9±8.6 months (range: 13-39 months).

Pedobarographic analysis showed a difference between the referee and control groups in respect of maximum force and peak pressure values but not at statistically significant level ($p>0.05$) (Table 1).

There was a statistically significant difference between the referee group and the control group in two sub parameters of the International Physical Activity Questionnaire Short Form (total physical activity MET-min/wk, vigorous MET - min/wk; $p=0.044$, $p=0.002$, respectively) (Table 2). Level of physical activity in the referee group was higher than that of the control group. No members of the referee group had a low physical activity level, 33% were evaluated as at a moderate physical activity level and 67% at a high physical activity level. In the control group, the distribution of physical activity level from low to high was 13%, 47% and 40%, respectively.

Although there was not a statistically significant difference between the referee group and the control group according to the results of the Foot Posture Index results ($p>0.05$) (Table 2), 60% of the referee group had a pronated foot, on both the right and left side (Table 3).

DISCUSSION

In this study, evaluation was made of the effects of side running, which is the most common assistant referees running style during matches and training, on the plantar pressure distribution and foot posture of assistant referees who performed in the Regional Football League. Assistant referees run on toes and forefoot with flexion of ankle, knee and hip to be fast during the match. Our hypothesis has been that side running on their toes and forefoot for long periods can change foot posture and plantar pressure distribution and cause calf pain. However no significant changes were determined in foot posture and plantar pressure distribution when compared with healthy individuals.

Referees have to be in the right place to observe and interpret the game, thus their performance during a game increases in conjunction with the importance of competitions. Top-class assistant referees generally run more than 6 km during a match, of which 1.15 (0.86-1.44) km is high-intensity running and 1.16 (0.12-2.34) km is sideways running.[8] During Champions League matches in the 2004/2005 season, the mean distance covered by assistant referees was 6.61 km.[21] In the Americas Cup, assistant referees covered a total mean distance during matches of 5.8 km.[22] For high performance during the game, assistant referees should train regularly. Thus, according to the results of the present study, the total physical activity level and vigorous physical activity level were significantly higher in the referee group. The reason for not obtaining a difference between the two groups in respect of the moderate physical activity and walking level may have been the subjective evaluation with a questionnaire, and that the control group comprised students who used public transport and walked long distances in a day. Of the referee group, 67% were in the high physical activity category according to the exercises performed in the previous week. The majority of the control group were in the moderate physical activity category. None of the referee group was in the low physical activity category, whereas 13% of the control group were evaluated at a low physical activity level. For the objective performance evaluation of assistant referees, previous studies in literature have generally used an appropriate device.[21,23] Thus, the lack of an objective assessment of physical performance can be considered a limitation of this study.

When the referees were questioned about warm-up and stretching exercises before and after matches or training, all were determined as performing these exercises adequately. Nevertheless, even though the referees had no pathological diagnosis, they were feeling moderate pain in their calf muscles. It was hypothesized that sideways running for a long time during the game and the training program may have changed the foot posture structure in assistant referees with pain in the calf muscles. However, no statistically significant difference was found in the plantar pressure characteristics and the FPI 6 test between the assistant referees and the control group. As there have been no previous studies in literature investigating the effect of side

Table 1. Comparing the foot pressure values of the groups.

	Right Side			Left Side		
	Referees Group Mean±SD	Control Group Mean±SD		Referees Group Mean±SD	Control Group Mean±SD	
Max force (% BW)						
Forefoot	84.96±5.99	85.2±9	*	86.07±8.65	89.1±7.56	*
Midfoot	22.16±7.15	19.5±11.5	*	21.24±5.83	17.8±11.1	*
Hindfoot	67.03±9.70	70.70±7.26	*	66.34±10.07	71.1±6.42	*
Peak pressure (kPa)						
Forefoot	371.33±113.75	385±120.81	*	373.33±135.72	375±121.47	*
Midfoot	142.62±28.96	140±40.19	*	138±30.51	145±42.06	*
Hindfoot	306.67±102.82	305±53.6	*	322±109.83	310±74.73	*

* p>0.05. BW: Body weight. kPa: Kilo Pascal.

Table 2. Comparison of physical activity level and the Foot Posture Index-6 of the groups.

	Referees Group Mean±SD	Control Group Mean±SD	
Total physical activity MET-min/wk	4530±2431.5	2709±1746,6	**
Vigorous MET-min/wk	3200±2168.8	960±1092,3	**
Moderate MET-min/wk	252±311.1	296±365,2	*
Walking MET-min/wk	1076±178.5	1453±1019,3	*
Sitting time (min)	1680±761.3	1750±1149,3	*
FPI-6 Score			
FPI-6 Right Side	4.47±3.27	3.87±2.588	*
FPI-6 Left Side	4.20±3.406	3.87±2.56	*

* p>0.05. ** p<0.05. MET: Metabolic Equivalent. FPI-6: Foot Posture Index.

Table 3. Level of the Foot Posture Index-6.

	Ride Side			Left Side		
	Referees Group (N=15)	Control Group (N=15)	Total	Referees Group (N=15)	Control Group (N=15)	Total (N=30)
Highly pronated (%)	0	0	0	0	0	0
Pronated (%)	60	47	53	60	40	60
Normal (%)	33	53	43	33	60	46
Supinated (%)	0	0	0	0	0	0
Highly supinated (%)	7	0	4	7	0	4

running on foot posture, it was not possible to discuss the findings. Miles and Clarkson stated that delayed onset muscle soreness develops 24-48 hours after strenuous exercise biased toward eccentric muscle actions or strenuous endurance events like a marathon and despite the common occurrence of pain associated with exercise, the exact cause of these pains remains a mystery.[24] Close et al demonstrated that 30 min of downhill running at a sub-maximal intensity results in muscle damage and a significant increase in reactive oxygen species production and subsequent lipid peroxidation in the days following the exercise. However, it is still unclear if this production of reactive oxygen species in the days following lengthening muscle contractions is a pathological process that amplifies the sensations of delayed onset muscle soreness.[25] Although it is stated in the literature that eccentric muscle actions can cause delayed muscle soreness, assistant referees are running with concentric contractions. However their running is strenuous endurance event stated as Miles and Clarkson.[23]

Additionally, environmental and individual factors come to mind when considering the occurrence of pain in calf muscles. Poor quality football pitches in the regional league and inappropriate footwear could be some of these reasons. Overuse of the calf muscles during side running may be another reason. Contrary to what may be thought, as the speed increases in lateral running, the positive work done by the hip abductor muscles increases for a while but starts to decrease after 1.8 m / s., whereas the increase in plantar flexors continues to increase.[24] As the speed increases in side running, it increases the negative work – defined as absorption[23] in the direction of eversion / inversion in the ankle.[26] The use of footwear with better absorption properties will help to reduce the load on the muscles. Although there was no statistical difference between the two groups in the FPI-6 score, it was determined that 60% of the assistant referees step on the ground in a pronated position with both the right and left foot. Only one assistant referee was determined to step on the ground in a highly supinated position.

Evidence-based research conducted with Cochrane Library, Medline, Ovid, PEDRO, Pubmed, EMBASE and SumSearch (until 15 March 2018) showed that there was no study investigating foot pressure distribution, foot postures and physical activity levels and their relation to calf pain. Therefore, the current study can be considered of value as the first investigation of these parameters.

Limitations

There are some limitations of the present study. The performance of the assistant referees was not evaluated throughout a whole season with follow-up assessments. Factors like acids, ions, proteins, and hormones might be related with pain could not be assessed in this study. Only one week of physical activity level was evaluated with a questionnaire. In future studies, the evaluation of individuals with higher physical activity levels with more objective methods such as physical activity assessment tools will provide more valuable results. Another limitation was that any movement analysis and lower extremity muscle electromyography (EMG) evaluations were not made. Although the sample comprised assistant referees in the regional league, the results could be indicative for top class referees.

Conclusion

The present study showed that side running performed by assistant referees did not alter the foot posture. It was determined that calf pain, which could not be affected due to a physical cause, was not associated with foot posture. It can be suggested that future studies should examine sports field, the sports equipment and other factors related pain to determine the cause of pain.

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