

Factors Associated With Knee Pain and Heel Pain in Youth Soccer Players Aged 8 to 12 Years

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Background: Soccer is played by many children younger than 12 years. Despite its health benefits, soccer has also been linked to a high number of sport-related injuries.

Purpose: To investigate the relationship between clinical factors and knee or heel pain in youth soccer players.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: Study participants included 602 soccer players aged 8 to 12 years who were asked whether they had experienced episodes of knee or heel pain. Data were collected on age, body mass index, years of playing soccer, playing position, and training hours per week. Associations of clinical factors with the prevalence of knee or heel pain were examined by univariate and multivariate logistic regression analyses.

Results: Episodes of knee and heel pain were reported by 29.4% and 31.1% of players, respectively. Multivariate analyses revealed that older age and more years of playing soccer were significantly and positively associated with the prevalence of knee pain ($P = .037$ and $P = .015$ for trend, respectively) but did not identify any significant associations for heel pain.

Conclusion: In this study of youth soccer players, knee pain was associated with older age and more years of play, but heel pain was not significantly associated with any factor.

Keywords: epidemiology; soccer; youth players; knee pain; heel pain

Soccer is one of the most popular sports worldwide, and its popularity is continuing to grow, especially among children

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younger than 12 years.² Soccer has potentially beneficial effects on health and can promote a lifelong healthy lifestyle.¹ However, it has been with a high number of sport-related injuries.² These injuries may lead to decreased physical activity³ and may have a considerable impact on athletes' future enjoyment of sport activities.

Froholdt et al⁵ prospectively examined the risk of injuries in 1 season in 1879 soccer players aged 6 to 16 years and reported that their injury risk was lower than that of older adolescents. Furthermore, in their prospective epidemiological studies of injuries in children who played soccer, Faude et al⁴ and Rössler et al¹² reported that the characteristics of these injuries were different from those in older players. Suzue et al¹⁵ investigated the location of pain in 1162 youth soccer players using a questionnaire and found that the most frequent location of pain was the heel, which was documented in about 20% of players, followed by the knee joint in about 16% of players. Leppänen et al⁸ prospectively investigated overuse injuries in 733 soccer players aged 9 to 14 years using a questionnaire and found that the most prevalent injuries were those involving the knee and that boys had a greater likelihood of heel problems.

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Several epidemiological studies of soccer-related injuries in youth soccer players have been reported.^{4-6,8-10,12,13,15} However, little is known about the risk factors for these injuries in children. Clarifying the potential risk of injuries is necessary for the implementation of injury prevention strategies in youth players. The purpose of this study was to investigate the association of clinical factors with knee or heel pain in youth soccer players aged 8 to 12 years.

METHODS

Participants

All 1034 players in the youth soccer teams that participated in a regional summer championship in Japan in August 2017 were asked to answer a questionnaire about their experience of knee or heel pain; 602 (58.2%) agreed to complete the questionnaire and were enrolled in the study. The mean age of the respondents was 10.6 years (range, 8-12 years). All participants were boys. The study protocol was approved by our institutional review board and was performed in accordance with the ethical standards set down by our institutional committee. Informed consent was obtained from the parents and coaches.

Questionnaire

The study questionnaire was circulated to the team coaches and completed by the participants with the assistance of their coaches and/or parents. The participants were asked whether they had experienced knee or heel pain (excluding acute or contact-related pain) in their dominant and/or nondominant leg after starting to play soccer. The questionnaire was also used to gather data on age, height, weight, years of playing soccer, playing position, and training hours per week (see the Appendix). Playing position was divided into fielder and goalkeeper groups. Training hours per week included hours spent at practices and games. All playing surfaces were natural grass. The completed questionnaires were returned by post. The first author (T.I.) then reviewed the questionnaire with each participant to confirm their understanding of the questions and the accuracy of the information provided. Data were collected on the frequency of knee or heel pain and on the following clinical factors that could cause pain at these sites: age, body mass index, years of playing soccer, playing position, and number of training hours per week.

Statistical Analysis

Continuous variables are expressed as the mean \pm SD, and categorical variables are expressed as the number (percentage). The *t* test or chi-square test was used to compare the characteristics between participants with and without knee pain or heel pain as appropriate.

The association of the clinical factors with knee or heel pain was analyzed by univariate and multivariate logistic regression, and the results are presented as the odds ratio (OR) and profile likelihood 95% CI. An OR is a measure of the association between an exposure variable and an

TABLE 1
Demographic Characteristics (N = 602)^a

Age, mean \pm SD, y	10.6 \pm 1.0
\leq 9 y	88 (14.6)
10 y	181 (30.1)
11 y	229 (38.0)
12 y	104 (17.3)
Body mass index, mean \pm SD, kg/m ²	16.9 \pm 1.9
Years of play, mean \pm SD	3.5 \pm 1.5
<2 y	99 (16.4)
\geq 2 and <3 y	113 (18.8)
\geq 3 and <4 y	137 (22.8)
\geq 4 and <5 y	120 (19.9)
\geq 5 y	133 (22.1)
Playing position	
Fielder	523 (86.9)
Goalkeeper	79 (13.1)
Training hours per week, mean \pm SD	8.1 \pm 2.6
\leq 6 h/wk	196 (32.5)
>6 and \leq 8 h/wk	151 (25.1)
>8 and \leq 10 h/wk	160 (26.6)
>10 h/wk	95 (15.8)

^aData are shown as n (%) unless otherwise indicated.

outcome. If the OR equals 1.0, there is no association between them. In this study, an OR $>$ 1 indicates that the presence of a certain exposure factor is associated with an increased prevalence of pain. A confidence interval is a range of values, derived from sample statistics, that is likely to contain the value of an unknown population parameter. A 95% CI indicates that if 100 different samples were extracted and a 95% CI was computed for each sample, approximately 95 of the 100 CIs will contain the true (population) mean value. Therefore, when an OR of 1.0, the null value, is not included in the 95% CI, the association is statistically significant at the *P* = .05 level. Tests for trends were performed by assigning the ordinal variables for each category. Statistical tests were based on 2-sided probabilities. All statistical analyses were performed using SAS software (version 9.4; SAS Institute). A *P* value $<$.05 was considered statistically significant.

RESULTS

The demographic characteristics of the study population are shown in Table 1. Of the 602 participants, 177 (29.4%) reported episodes of knee pain, 187 (31.1%) reported episodes of heel pain, and 85 (14.1%) reported both knee and heel pain. The clinical characteristics of the participants with and without knee or heel pain are presented in Tables 2 and 3, respectively. There were significant differences in age, years of playing soccer, and training hours per week between participants with and without knee pain and significant differences in age between those with and without heel pain.

Associations of the clinical factors with the prevalence of knee pain analyzed by logistic regression are summarized in Table 4. Multivariate-adjusted analyses revealed that age 10, 11, or 12 years was associated with significantly

TABLE 2
Clinical Characteristics of Players
With and Without Knee Pain^a

	With Knee Pain (n = 177)	Without Knee Pain (n = 425)	P
Age, mean ± SD, y	10.8 ± 0.9	10.5 ± 1.0	<.0001
Age group			.001
<9 y	13 (7.3)	75 (17.7)	
10 y	48 (27.1)	133 (31.3)	
11 y	75 (42.4)	154 (36.2)	
12 y	41 (23.2)	63 (14.8)	
Body mass index, mean ± SD, kg/m ²	16.9 ± 2.1	16.8 ± 1.8	.41
Years of play			.0001
<2 y	19 (10.7)	80 (18.8)	
≥2 and <3 y	28 (15.8)	85 (20.0)	
≥3 and <4 y	36 (20.4)	101 (23.8)	
≥4 and <5 y	34 (19.2)	86 (20.2)	
≥5 y	60 (33.9)	73 (17.2)	
Playing position			.75
Fielder	155 (87.6)	368 (86.6)	
Goalkeeper	22 (12.4)	57 (13.4)	
Training hours per week			.014
≤6 h/wk	45 (25.4)	151 (35.5)	
>6 and ≤8 h/wk	48 (27.1)	103 (24.2)	
>8 and ≤10 h/wk	45 (25.4)	115 (27.1)	
>10 h/wk	39 (22.1)	56 (13.2)	

^aData are shown as n (%) unless otherwise indicated.

TABLE 3
Clinical Characteristics of Players
With and Without Heel Pain^a

	With Heel Pain (n = 187)	Without Heel Pain (n = 415)	P
Age, mean ± SD, y	10.7 ± 0.9	10.5 ± 1.0	.014
Age group			.011
≤9 y	15 (8.0)	73 (17.6)	
10 y	55 (29.4)	126 (30.3)	
11 y	83 (44.4)	146 (35.2)	
12 y	34 (18.2)	70 (16.9)	
Body mass index, mean ± SD, kg/m ²	16.7 ± 1.7	16.9 ± 2.0	.298
Years of play			.09
<2 y	24 (12.8)	75 (18.1)	
≥2 and <3 y	30 (16.1)	83 (20.0)	
≥3 and <4 y	42 (22.5)	95 (22.9)	
≥4 and <5 y	38 (20.3)	82 (19.7)	
≥5 y	53 (28.3)	80 (19.3)	
Playing position			.236
Fielder	167 (89.3)	356 (85.8)	
Goalkeeper	20 (10.7)	59 (14.2)	
Training hours per week			.051
≤6 h/wk	54 (28.9)	142 (34.2)	
>6 and ≤8 h/wk	39 (20.9)	112 (27.0)	
>8 and ≤10 h/wk	56 (29.9)	104 (25.1)	
>10 h/wk	38 (20.3)	57 (13.7)	

^aData are shown as n (%) unless otherwise indicated.

higher ORs for knee pain compared with age ≤9 years. Additionally, ≥5 years of soccer experience and training for >10 hours per week were associated with higher ORs for knee pain compared with the corresponding reference groups. Older age and more years of soccer experience were significantly and positively associated with knee pain ($P = .037$ and $P = .015$, respectively, for trend in a multivariate-adjusted model); however, there was no significant relationship between knee pain and training hours per week ($P = .065$ for trend in a multivariate-adjusted model). Body mass index and playing position were not associated with knee pain.

Associations of the clinical factors with prevalence of heel pain are summarized in Table 5. Multivariate-adjusted analyses revealed that age 10, 11, or 12 years was associated with significantly higher ORs for heel pain compared with age ≤9 years. However, no significant association was observed between older age and heel pain ($P = .067$ for trend in a multivariate-adjusted model). Participants with ≥5 years of soccer experience and those who spent >10 hours training per week were at a significantly higher risk of heel pain than their respective reference groups in univariate analyses but not in the multivariate-adjusted model. No other factor was significantly associated with heel pain.

DISCUSSION

This epidemiological study reported on knee and heel pain in youth soccer players aged 8 to 12 years. Knee pain was reported by 29.4% of players and heel pain by 31.1%. There were some differences in the factors associated with pain at each site, suggesting different causes.

In this study, there was a significant association between older age and knee pain. The relationship between age and the risk of growth-related soccer injuries in children aged 7 to 12 years was investigated in a study by Rössler et al.¹² In that study, players aged 11 to 12 years had the highest percentage and incidence of growth-related injuries. In a subsequent study, the same research group found that when players were adjusted for height, taller players were at a greater risk of injuries.¹³ In a report by Leppänen et al,⁸ the likelihood of reporting an overuse problem increased with age in a study population of 733 youth soccer players. Our results suggest a strong correlation of increasing age with knee pain in youth soccer players.

More years of playing soccer appeared to be an important risk factor for knee pain but not heel pain in the present study. The risk of injuries in relation to years of playing soccer has not been well documented in children. Players with more years of soccer experience are more skilled and likely to be given the opportunity to participate in more games. This observation, combined with our findings, suggests that the knee may be more susceptible to stress than the heel in players who have more experience.

Our results showed that participants with >10 training hours per week had a significantly increased risk of developing knee pain compared with the respective reference; however, the P value for trend (.065) did not indicate a

TABLE 4
Univariate and Multivariate-Adjusted Associations of Clinical Factors With Knee Pain^a

	Nonadjusted		Multivariate Adjusted	
	OR (95% CI)	P	OR (95% CI)	P
Age group				
≤9 y	1.00		1.00	
10 y	2.08 (1.09-4.23)	.027	2.00 (1.03-4.12)	.041
11 y	2.81 (1.51-5.59)	.001	2.11 (1.09-4.35)	.027
12 y	3.75 (1.89-7.86)	.0001	2.49 (1.18-5.52)	.017
P for trend	<.0001		.037	
Body mass index, kg/m ²	1.04 (0.95-1.14)	.416	1.01 (0.91-1.11)	.897
Years of play				
<2 y	1.00		1.00	
≥2 and <3 y	1.39 (0.72-2.71)	.327	1.21 (0.62-2.39)	.576
≥3 and <4 y	1.50 (0.81-2.86)	.201	1.28 (0.68-2.49)	.449
≥4 and <5 y	1.67 (0.89-3.20)	.114	1.33 (0.69-2.60)	.399
≥5 y	3.46 (1.92-6.47)	<.0001	2.37 (1.21-4.79)	.012
P for trend	<.0001		.015	
Playing position				
Fielder	1.00		1.00	
Goalkeeper	0.92 (0.53-1.53)	.745	0.92 (0.52-1.59)	.765
Training hours per week				
≤6 h/wk	1.00		1.00	
>6 and ≤8 h/wk	1.56 (0.97-2.53)	.066	1.47 (0.90-2.41)	.124
>8 and ≤10 h/wk	1.31 (0.81-2.12)	.265	1.20 (0.73-1.96)	.473
>10 h/wk	2.34 (1.38-3.97)	.002	1.89 (1.09-3.29)	.025
P for trend	.007		.065	

^aAll independent variables included in the multivariate-adjusted models are listed in the table. OR, odds ratio.

TABLE 5
Univariate and Multivariate-Adjusted Associations of Clinical Factors With Heel Pain^a

	Nonadjusted		Multivariate Adjusted	
	OR (95% CI)	P	OR (95% CI)	P
Age group				
≤9 y	1.00		1.00	
10 y	2.12 (1.14-4.14)	.016	2.27 (1.20-4.48)	.011
11 y	2.77 (1.53-5.29)	.001	2.64 (1.40-5.23)	.002
12 y	2.36 (1.20-4.82)	.012	2.12 (1.01-4.58)	.047
P for trend	.009		.067	
Body mass index, kg/m ²	0.95 (0.86-1.04)	.293	0.93 (0.84-1.03)	.169
Years of play				
<2 y	1.00		1.00	
≥2 and <3 y	1.13 (0.61-2.11)	.700	0.98 (0.52-1.87)	.957
≥3 and <4 y	1.38 (0.77-2.51)	.276	1.21 (0.66-2.25)	.539
≥4 and <5 y	1.45 (0.80-2.66)	.223	1.21 (0.65-2.27)	.558
≥5 y	2.07 (1.17-3.73)	.012	1.54 (0.80-3.02)	.200
P for trend	.006		.146	
Playing position				
Fielder	1.00		1.00	
Goalkeeper	0.72 (0.41-1.22)	.229	0.75 (0.42-1.29)	.302
Training hours per week				
≤6 h/wk	1.00		1.00	
>6 and ≤8 h/wk	0.92 (0.56-1.48)	.719	0.82 (0.50-1.34)	.426
>8 and ≤10 h/wk	1.42 (0.90-2.23)	.131	1.29 (0.81-2.06)	.276
>10 h/wk	1.75 (1.04-2.94)	.034	1.52 (0.89-2.61)	.128
P for trend	.014		.061	

^aAll independent variables included in the multivariate-adjusted models are listed in the table. OR, odds ratio.

significant association. Many soccer-related injuries are believed to be a result of cumulative microtrauma from repetitive dynamic motion. However, the associations between training hours and these injuries are not well-established. Our results indicate that a high number of training hours may lead to knee pain.

In this study, there was no association of body mass index or playing position with knee or heel pain. Rössler et al¹³ similarly reported no significant association of body mass index or playing position with overuse injuries in their study of potential risk factors for soccer injuries in children aged 7 to 12 years.

Our study focused on knee and heel overuse injuries in youth soccer players. The factors associated with knee pain in this study are similar to those for Osgood-Schlatter disease, Sinding-Larsen-Johansson syndrome, and bipartite patellas, and those associated with heel pain are representative of those in children with Sever disease. Jespersen et al⁶ prospectively investigated 1259 schoolchildren aged 6 to 12 years over a period of 2.5 years and found that by far the most common injuries were those involving overuse in the lower extremities; they also noted a high number of apophyseal injuries at the heel and knee that were similar to the lesions found in Sever disease, Sinding-Larsen-Johansson syndrome, and Osgood-Schlatter disease. If these injuries are not recognized and treated, they can cause functional impairment, become chronic, and even impair activities of daily living.⁷ Such injuries may be diagnosed late because of their gradual progression; therefore, it is important to know the risk factors for these injuries to be able to prevent them. As we found that older age was strongly associated with the likelihood of experiencing knee or heel pain in youth soccer players, the implementation of age-specific exercise programs for the prevention of soccer-related injuries in children should be considered. Several studies have reported the effectiveness of an injury prevention program called FIFA 11+Kids for the prevention of these injuries in soccer players aged 7 to 13 years.^{11,14} Further investigations of the risk factors for such injuries in youth soccer players are needed, and an effective injury prevention program should be developed.

The current study has several limitations that must be acknowledged. The major limitation is that only 58.2% of players responded to the study questionnaire. First, our results are based on self-reporting by children who were assisted by their coaches and/or parents, which might have introduced a degree of recall bias when the players were asked about their history of knee and/or heel pain. Additionally, some players might have been reluctant to report pain for fear of being dropped from their teams. Therefore, the true injury incidence rate, that is, injuries per 1000 hours of soccer exposure, could not be calculated in this study. Second, no detailed information was sought from respondents who reported experiencing heel or knee pain, such as the duration of pain, whether the pain was recurrent, and which leg was involved (ie, dominant or nondominant leg). Third, our study assessed only 5 variables: age and years of playing soccer, which are nonmodifiable, and body mass index, training hours per week, and playing position, which are modifiable. Other modifiable factors,

such as type of footwear or use of supports, were not assessed. Fourth, all players were from the same geographic region in Japan, and it is unclear whether the risk factors identified are generalizable to other regions or countries. Fifth, the cross-sectional design of the study meant that causal relationships could not be addressed. However, the study was designed to identify the relationship between clinical factors and knee or heel pain in youth soccer players. A longitudinal study is now needed to confirm the associations identified in this study.

CONCLUSION

Episodes of knee and heel pain were reported by 29.4% and 31.1%, respectively, of 602 soccer players aged 8 to 12 years. We identified some differences in associations with pain at each location, in that knee pain was associated with increasing age and more years of playing soccer while heel pain was not significantly associated with any factor.

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APPENDIX

Survey Questionnaire for Youth Soccer Players

1. Name:
2. Team:
3. Age:
4. Number of years played:
5. Dominant leg: Right or Left
6. Training hours per week (including games):
7. Position played most: Fielder or Goalkeeper
8. Have you ever sustained knee pain (not including acute or contact type)? Yes or No
9. Have you ever sustained heel pain (not including acute or contact type)? Yes or No