Arch Rheumatol 2021;36(2):267-273
doi: 10.46497/ArchRheumatol.2021.8354

ORIGINAL ARTICLE

Assessment of foot posture and related factors in patients with knee osteoarthritis

Mazlum Serdar Akaltun[1], Burhan Fatih Koçyiğit[2]

[1]*Department of Physical Medicine and Rehabilitation, Gaziantep University, Faculty of Medicine, Gaziantep, Turkey*
[2]*Department of Physical Medicine and Rehabilitation, Kahramanmaraş Sütçü Imam University, Faculty of Medicine, Kahramanmaraş, Turkey*

ABSTRACT

Objectives: The aim of this study was to compare foot posture between patient and control groups, and to identify factors associated with foot posture abnormality in knee osteoarthritis (OA).

Patients and methods: This case-control study included a total of 115 patients (26 males, 89 females; mean age: 54.4±9.3 years; range, 29 to 73 years) with OA and 77 healthy controls (20 males, 57 females; mean age: 52.1±8.1 years; range, 32 to 69 years) between May 2019 and July 2019. The participants were evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Visual Analog Scale (VAS), and the Beighton criteria. Radiological assessments were performed using the Kellgren-Lawrence grading, condylar plateau angle, and medial tibiofemoral joint width. The Foot Posture Index-6 (FPI-6) was used for foot posture analysis and three groups were formed as supinated, neutral, and pronated postures.

Results: Foot posture was significantly different between the patient and control groups ($p<0.05$). Of the patients with knee OA, significant differences were found in the VAS, WOMAC-pain, WOMAC-physical function, and WOMAC-total ($p<0.05$) among the foot postures. No significant difference was found among the foot posture groups in terms of the radiological parameters and WOMAC-stiffness ($p>0.05$). Hypermobility and WOMAC-total scores were significantly associated with foot posture abnormality ($p<0.05$).

Conclusion: Joint hypermobility and foot posture are the factors which may influence the clinical characteristics of knee OA. Foot posture and joint hypermobility should be taken into consideration during the examination and management of patients with knee OA.

Keywords: Foot posture, hypermobility, knee osteoarthritis.

Knee osteoarthritis (OA) frequently leads to disability and affects a significant part of the population.[1,2] A multifactorial etiopathogenesis including genetic, biochemical, and biomechanical factors influences the progression of the disease.[3] During walking, the forces transmitted along the knee joint significantly increase on the medial compartment, resulting in medial compartment loading.[4] The adduction moment is described as a moment that forces the knee joint to adduct during walking and it has been demonstrated to play a role in the development of OA.[5] To prevent abnormal loading on the knee, the lower extremity joints, adjacent joints in particular, work in a coordinated manner. Therefore, a disorder in lower limb joints changes the load on the knee and triggers the progression of knee OA. From this perspective, foot/ankle deformities increase the adduction moment and change the loading on the knee joint.[6] Foot/ankle orthoses provide benefit in the treatment of knee OA by decreasing the adduction moment and normalizing load distribution.[7] Therefore, a biomechanical approach should be included in

Received: July 25, 2020 ***Accepted:*** October 12, 2020 ***Published online:*** January 14, 2021

Correspondence: Mazlum Serdar Akaltun, MD. Gaziantep Üniversitesi Tıp Fakültesi Fiziksel Tıp ve Rehabilitasyon Anabilim Dalı, 27310 Şehitkamil, Gaziantep, Türkiye.
Tel: +90 542 - 820 65 63 e-mail: mserdarakaltun@gmail.com

Citation:
Akaltun MS, Koçyiğit BF. Assessment of foot posture and related factors in patients with knee osteoarthritis. Arch Rheumatol 2021;36(2):267-273.

the treatment plan for patients with knee OA to increase patient functionality and possibly reduce disease progression.[8]

Joint hypermobility (JHM) is a clinical condition that can occur alone or in combination with various syndromes and is associated with excessive mobility of the joints.[9] It causes musculoskeletal disorders as a result of connective tissue laxity and increased JHM, thereby, leading to injuries and abnormal joint loading patterns. Through these mechanisms, JHM influences the progression of knee OA.[10,11]

To date, many studies have assessed the link between foot posture and knee OA using parameters such as knee OA frequency and pain level.[12-14] Although the JHM and OA link has been assessed in many studies previously,[10,15] the relationship between JHM and foot posture has not been adequately evaluated in knee OA. The JHM may induce the progression of knee OA by changing foot posture. As there is a limited number of studies in the on this subject, we aimed to identify potential factors affecting foot posture, including JHM, in patients with knee OA. The primary aim of this study was to compare foot posture between patient and control groups, and the secondary aim was to compare radiological and clinical parameters between foot posture groups in patients with knee OA.

PATIENTS AND METHODS

This case-control study was conducted at Kahramanmaraş Sütçü Imam University, Faculty of Medicine, Department of Physical Medicine and Rehabilitation between May 2019 and July 2019. A total of 115 patients (26 males, 89 females; mean age: 54.4±9.3 years; range, 29 to 73 years) with OA and 77 healthy volunteers (20 males, 57 females; mean age: 52.1±8.1 years; range, 32 to 69 years) were included. The patient group was selected according to the American College of Rheumatology (ACR) clinical classification criteria.[16] Inclusion criteria for the patient group were as follows: age between 18 and 75 years and willingness to participate in the study. Being above a certain level of pain was not used as an inclusion criterion. Regardless of the pain level, all knee OA patients were evaluated. Those with a diagnosis of inflammatory rheumatic disease, lower limb amputation, neurological deficits in the lower extremity with diagnoses of polyneuropathy, peripheral nerve damage causing significant motor and sensory deficits on physical examination, multiple sclerosis, stroke, a history of fracture or surgery in the lower extremity, diabetes mellitus, polio sequelae, or limb length discrepancy were excluded from the study. Blood donors who did not have knee pain, knee OA, or any musculoskeletal complaint which could affect the study results were enrolled in the control group. A questionnaire investigating age, sex, height (m), weight (kg), occupational status, educational status, and symptom duration was developed and the data were recorded. Participation was on a voluntary basis for both groups. A written informed consent was obtained from each participant. The study protocol was approved by the Kahramanmaraş Sütçü Imam University, Faculty of Medicine Ethics Committee (Date: 30.04.2019, No: 11). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Foot posture analysis was performed using the Foot Posture Index-6 (FPI-6).[17] During the evaluation, it was ensured that the patient stood in a relaxed position. Each parameter is scored between -2 and +2 points. Scores of -2 indicate clear supination findings, while +2 points indicate clear pronation findings. The total score ranges from -12 to +12. Total scores between 0 and +5 indicate a neutral foot, +6 and above a pronated foot, and scores below 0 a supinated foot.[14]

The Beighton criteria were used for the assessment of JHM. The patients were scored on a scale of 0-9 points. Passive dorsiflexion of each fifth finger ≥90°; passive apposition of each thumb to forearm; hyperextension of each elbow ≥10°; hyperextension of each knee ≥10°, and resting palms on floor on forward flexion with straight knees are the parameters of the Beighton criteria. A score of ≥4 points indicates hypermobility.[15,18]

The clinical assessment was performed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). It contains 24 items in three sections: pain, stiffness, and physical function. Each item is scored between 0 and 4 points, with higher scores indicating worsening in each section.[19]

An anteroposterior X-ray was taken of each patient in the standing position with the knees in extension. Radiological assessments were performed using *(i)* the Kellgren-Lawrence grading system, *(ii)* the condylar plateau angle, and *(iii)* the medial tibiofemoral joint width.

All evaluations were performed using digitalized radiographs from the hospital database. Grading of knee OA (Grade 1-4) was evaluated using the Kellgren-Lawrence classification on knee radiographs.[20] For the condylar plateau angle measurement, a tangent line to the femoral condyle and a tangent line to the tibial plateau was drawn and the angle between them was calculated.[21] The evaluation of the medial tibiofemoral joint width was performed by measuring the minimum vertical distance between the medial femoral condyle and the medial tibial plateau in mm.[22]

A 10-cm (0 to 10) Visual Analog Scale (VAS) was used to assess the severity of pain (10 points indicate the highest level of pain).

In patients with bilateral knee OA, all evaluations were performed on the clinically more symptomatic side.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 20.0 software (IBM Corp, Armonk, NY, USA). The normality of data distribution was evaluated using the Shapiro-Wilk test. Data were expressed in mean ± standard deviation (SD) for normally distributed quantitative data and in median (min-max) values for non-normally distributed quantitative data. Categorical variables were expressed in number and percentage. Group comparisons were performed using the Yates continuity correction test and the Chi-square test for categorical variables. For continuous variables, comparisons of two groups were made using the independent samples t-test or the Mann-Whitney U test according to the distribution of the data. Multiple comparisons were performed using the Kruskal-Wallis test. The Mann-Whitney U test was used to evaluate the significance of pairwise differences with the Bonferroni correction (post-hoc test) to adjust for multiple comparisons. For post-hoc tests, the level of statistical significance was accepted as 0.017 (0.05/3). Binary logistic regression analysis was applied to identify the

Table 1. Baseline demographic and clinical characteristics of study population

	Patient group (n=115)					Control group (n=77)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
Age (year)			54.4±9.3					52.1±8.1			0.073*
Sex											0.592†
Female	89	77.4				57	74				
Male	26	22.6				20	26				
Body mass index (kg/m²)				26.89	19.34-42.22				26.36	21.20-32.45	0.186‡
Symptom duration (months)				12	1-120						
Grade (Kellgren-Lawrence)											
Grade 1	13	11.4									
Grade 2	56	49.1									
Grade 3	31	27.2									
Grade 4	14	12.3									
Employment status											0.143¶
Worker	38	33				36	46.8				
Non-worker	65	56.5				36	46.8				
Retired	12	10.5				5	6.4				
Educational status											0.088¶
Literate	45	39.1				16	20.8				
Primary school	24	20.9				21	27.2				
Secondary school	15	13				17	22.1				
High school	22	19.1				16	20.8				
University or higher	9	7.8				7	9.1				

SD: Standard deviation; Min: Minimum; Max: Maximum; * Independent sample t-test; † Yates continuity correction test; ‡ Mann-Whitney U test; ¶ Chi-square test.

Table 2. Radiological and clinical parameters according to foot postures in knee osteoarthritis patients

	Supinated		Neutral		Pronated		
	Median	Min-Max	Median	Min-Max	Median	Min-Max	*p*
Medial tibiofemoral joint width (mm)	2.8	0.8-6.3	3.8	0.6-8.4	3.2	0.7-6.8	0.154
Condylar plateau angle (°)	3.1	1.8-6.4	3.4	1.1-7.2	3.9	1.8-4.9	0.932
Visual Analog Scale	8*	5-10	6	2-9	6	5-9	<0.001
WOMAC-pain	15†	8-17	11	2-18	13	5-18	0.002
WOMAC-stiffness	6	3-8	5	0-8	6	4-8	0.301
WOMAC-physical function	51†	26-66	35	9-68	37.5	24-58	0.004
WOMAC-total	73†	38-87	52	12-88	54	36-83	0.002

Min: Minimum; Max: Maximum; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; * p<0.001 by Mann-Whitney U test to evaluate the significance of pairwise differences using Bonferroni correction to adjust multiple comparisons; † p=0.002 by Mann-Whitney U test to evaluate the significance of pairwise differences using Bonferroni correction to adjust multiple comparisons.

relationship of the foot posture with JHM and other related variables. The foot posture groups were re-coded as neutral and abnormal (supinated and pronated) foot posture. Variables which may affect the foot posture were added to this model with reference to the literature data. Collinearity was investigated and the enter method was performed in the analysis. A *p* value of <0.05 was considered statistically significant.

RESULTS

In patients with bilateral knee OA, the side with the higher pain level (symptomatic side) was assessed. The mean age was 54.4±9.3 years in the knee OA group and 52.1±8.1 years in the healthy control group. No significant difference was found between the groups in terms of age, sex, body mass index (BMI), and employment and educational status (p>0.05) (Table 1).

Three foot-posture groups (pronated, neutral, and supinated) were formed according to the FPI-6 results. A supinated foot was found in 16.5% (n=19) of the patient group, a neutral foot in 73% (n=84), and a pronated foot in 10.5% (n=12). In the control group, 6.5% (n=5) had a supinated foot, 89.6% (n=69) had a neutral foot, and 3.9% (n=3) had a pronated foot. A significant difference was found between the knee OA and control groups in terms of the foot posture (p<0.05). The rate of neutral foot posture was lower, while the rate of supinated and pronated foot postures was higher in the patients with knee OA.

Comparisons of the radiological and clinical parameters were performed between the supinated, neutral, and pronated foot postures in the patients with knee OA. Significant differences were found in the VAS, WOMAC-pain, WOMAC-physical function, and WOMAC-total scores among the groups (p<0.05). However,

Table 3. Factors affecting foot posture in knee osteoarthritis patients

			95% CI for Exp (B)		
Factors	B	Exp (B)	Lower	Upper	Significance
Age	-0.003	0.997	0.936	1.062	0.929
Sex	0.596	1.816	0.466	7.081	0.390
Body mass index	-0.30	0.971	0.864	1.090	0.616
Joint hypermobility	1.876	6.529	2.023	21.070	0.002
WOMAC-total	0.055	1.057	1.020	1.096	0.003

CI: Confidence interval; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.

no significant difference was found in terms of the condylar plateau angle, medial tibiofemoral joint width, and WOMAC-stiffness ($p>0.05$) (Table 2).

Binary logistic regression analysis was applied to assess the factors which affected foot posture in patients with knee OA. Age, sex, BMI, JHM, and WOMAC-total scores were added to the model. The JHM and WOMAC-total score were found to be significantly associated with an abnormal foot posture ($p<0.05$). Patients with JHM had a 6.529-fold higher probability of abnormal foot posture (95% confidence interval [CI], 2.023–21.070) (Table 3).

DISCUSSION

The opinion that abnormalities in the foot posture (i.e., supinated or pronated foot) only affect the ankle joint complex results in incomplete physical examinations. Abnormalities in the foot posture lead to changes in force distribution throughout the entire lower extremity, including the knee joint. The results of this study demonstrated that the rate of neutral foot posture was lower, whereas the rate of supinated and pronated foot postures was higher in patients with knee OA. Although not found in radiological parameters, significant differences were detected in clinical parameters between the supinated, neutral, and pronated foot postures in the patients with knee OA. Moreover, the JHM and WOMAC-total scores were found to be influenced by foot posture in patients with knee OA.

According to the current study results, the rate of supinated and pronated foot postures increased in patients with knee OA. Consistent with these results, Levinger et al.,[12] Abourazzak et al.,[13] and Reilly et al.[22] found abnormalities in foot posture in patients with knee OA, compared to healthy volunteers. Although all these studies have suggested that there may be a relationship between knee OA and foot posture, it may not be accurate to reach this conclusion with the designs of the aforementioned studies. Foot posture abnormalities in knee OA can be considered a "chicken and egg" issue. It is difficult to discriminate the foot posture changes which contribute to knee OA from the compensatory changes due to knee OA itself. Abnormalities in foot posture may induce the development of knee OA; however, advanced knee OA may lead to changes in the foot posture as a compensatory mechanism. All of the aforementioned studies were cross-sectional, and longitudinal, prospective studies are required to confirm this relationship.

In our study, we observed significant differences among the foot posture groups in terms of the clinical severity parameters, including VAS, WOMAC sections, and WOMAC-total. In addition, the highest clinical parameter scores were found in the supinated foot posture group. However, there was no significant difference in radiological parameters among the groups. Similar to these results, Al-Bayati et al.[14] reported differences in clinical parameters among the foot posture groups, and the highest scores were determined with supinated foot posture in that study. Contrary to the current study results, differences were also found in radiological parameters. Knee adduction moment is accepted as an important factor that affects the loading on the knee joint. Abnormalities in this moment adversely affect the load on the knee joint, thereby leading to the development of medial tibiofemoral knee OA.[23] The ground reaction force can significantly influence the adduction moment, particularly during the gait stance phase. A supinated foot posture leads to a change in the ground reaction force line, allowing it to pass through the more medial part of the knee joint, leading to an increase in knee adduction moment.[24] The foot posture influences static and dynamic postural control, which may contribute to the clinical symptoms of knee OA.[25] These mechanisms may explain how changes in foot posture, particularly supinated foot posture, affect clinical parameters in knee OA. In addition, there may be various reasons for the lack of differences in radiological parameters. Variations in parameters such as sample size, genetics, symptom duration, and physical activity status in the current study group may have affected the results. Changes in radiological parameters may develop in later periods in these patients. Knee radiographs taken in an incorrect or unsuitable position may also have affected the measurements.

The current study results revealed that JHM and WOMAC-total score had the potential to affect the foot posture (supinated and pronated) in knee OA. The relationship between JHM and knee OA has been previously reported in the literature.[10,15,26] This relationship has been attributed to an abnormal increase in range of motion, recurrent injuries, and changes in load on the knee joint.[14] It can be also considered that possible changes in the foot posture due to JHM and the subsequent effects on knee OA development and symptoms are underestimated. In line with the results of the current study, FPI was previously shown to be associated with hypermobility scores in asymptomatic children.[27] Joint laxity in patients with hypermobility leads to inversion or eversion in the frontal plane and changes foot posture. Therefore, knee OA examinations should include hypermobility assessment and foot posture should be evaluated, particularly in patients with hypermobility. The association between WOMAC-total score and abnormal foot posture can be attributed to the adverse effects of foot posture abnormalities on the clinical condition of patients.

Nonetheless, this study has some limitations. The sample size is relatively small and, therefore, the number of patients with knee OA with supinated or pronated feet is low. Also, the cross-sectional design of the study precludes the full interpretation of the causality between foot posture and knee OA. In addition, the foot posture of the participants was assessed using the FPI-6 only and no kinematic analysis was applied. Furthermore, the physical activity level of the participants was unable to be evaluated. Thus, there is a need for further, longitudinal, prospective studies using kinematic analyses in larger samples to support the causality between foot posture and knee OA.

In conclusion, patients with knee OA are more prone to supinated and pronated feet. In this study, clinical parameters were found to be significantly different among the foot posture groups of patients with knee OA, and the highest scores were found in the supinated feet. The JHM can influence foot posture in knee OA. Foot posture should be clinically evaluated with simple tools such as the FPI-6, and assessment of hypermobility should be a part of the examination of patients with knee OA. These results can provide treatment options for the management of knee OA, as footwear interventions and orthoses may be beneficial with the effect of ameliorating foot posture in appropriate patients. However, further longitudinal studies are required to gain a better understanding of the contribution of orthoses and footwear interventions in the treatment of knee OA.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Bush PG, Huntley JS, Brenkel IJ, Hall AC. The shape of things to come: chondrocytes and osteoarthritis. Clin Invest Med 2003;26:249-51.
2. Peat G, McCarney R, Croft P. Knee pain and osteoarthritis in older adults: a review of community burden and current use of primary health care. Ann Rheum Dis 2001;60:91-7.
3. Felson DT, Lawrence RC, Dieppe PA, Hirsch R, Helmick CG, Jordan JM, et al. Osteoarthritis: new insights. Part 1: the disease and its risk factors. Ann Intern Med 2000;133:635-46.
4. Mündermann A, Dyrby CO, Andriacchi TP. Secondary gait changes in patients with medial compartment knee osteoarthritis: increased load at the ankle, knee, and hip during walking. Arthritis Rheum 2005;52:2835-44.
5. Schipplein OD, Andriacchi TP. Interaction between active and passive knee stabilizers during level walking. J Orthop Res 1991;9:113-9.
6. Shelburne KB, Torry MR, Steadman JR, Pandy MG. Effects of foot orthoses and valgus bracing on the knee adduction moment and medial joint load during gait. Clin Biomech (Bristol, Avon) 2008;23:814-21.
7. Shakoor N, Lidtke RH, Sengupta M, Fogg LF, Block JA. Effects of specialized footwear on joint loads in osteoarthritis of the knee. Arthritis Rheum 2008;59:1214-20.
8. Krohn K. Footwear alterations and bracing as treatments for knee osteoarthritis. Curr Opin Rheumatol 2005;17:653-6.
9. Murray KJ, Woo P. Benign joint hypermobility in childhood. Rheumatology (Oxford) 2001;40:489-91.
10. Sharma L, Lou C, Felson DT, Dunlop DD, Kirwan-Mellis G, Hayes KW, et al. Laxity in healthy and osteoarthritic knees. Arthritis Rheum 1999;42:861-70.
11. Smith TO, Jerman E, Easton V, Bacon H, Armon K, Poland F, et al. Do people with benign joint hypermobility syndrome (BJHS) have reduced joint

proprioception? A systematic review and meta-analysis. Rheumatol Int 2013;33:2709-16.

12. Levinger P, Menz HB, Fotoohabadi MR, Feller JA, Bartlett JR, Bergman NR. Foot posture in people with medial compartment knee osteoarthritis. J Foot Ankle Res 2010;3:29.
13. Abourazzak FE, Kadi N, Azzouzi H, Lazrak F, Najdi A, Nejjari C, et al. A positive association between foot posture index and medial compartment knee osteoarthritis in moroccan people. Open Rheumatol J 2014;8:96-9.
14. Al-Bayati Z, Coskun Benlidayi I, Gokcen N. Posture of the foot: Don't keep it out of sight, out of mind in knee osteoarthritis. Gait Posture 2018;66:130-4.
15. Gürer G, Bozbas GT, Tuncer T, Unubol AI, Ucar UG, Memetoglu OI. Frequency of joint hypermobility in Turkish patients with knee osteoarthritis: a cross sectional multicenter study. Int J Rheum Dis 2018;21:1787-92.
16. Altman R, Asch E, Bloch D, Bole G, Borenstein D, Brandt K, et al. Development of criteria for the classification and reporting of osteoarthritis. Classification of osteoarthritis of the knee. Diagnostic and Therapeutic Criteria Committee of the American Rheumatism Association. Arthritis Rheum 1986;29:1039-49.
17. Redmond AC, Crosbie J, Ouvrier RA. Development and validation of a novel rating system for scoring standing foot posture: the Foot Posture Index. Clin Biomech (Bristol, Avon) 2006;21:89-98.
18. Naal FD, Hatzung G, Müller A, Impellizzeri F, Leunig M. Validation of a self-reported Beighton score to assess hypermobility in patients with femoroacetabular impingement. Int Orthop 2014;38:2245-50.
19. Tüzün EH, Eker L, Aytar A, Daşkapan A, Bayramoğlu M. Acceptability, reliability, validity and responsiveness of the Turkish version of WOMAC osteoarthritis index. Osteoarthritis Cartilage 2005;13:28-33.
20. Kellgren JH, Lawrence JS. Radiological assessment of osteo-arthrosis. Ann Rheum Dis 1957;16:494-502.
21. Harvey WF, Niu J, Zhang Y, McCree PI, Felson DT, Nevitt M, et al. Knee alignment differences between Chinese and Caucasian subjects without osteoarthritis. Ann Rheum Dis 2008;67:1524-8.
22. Reilly K, Barker K, Shamley D, Newman M, Oskrochi GR, Sandall S. The role of foot and ankle assessment of patients with lower limb osteoarthritis. Physiotherapy 2009;95:164-9.
23. Sharma L, Hurwitz DE, Thonar EJ, Sum JA, Lenz ME, Dunlop DD, et al. Knee adduction moment, serum hyaluronan level, and disease severity in medial tibiofemoral osteoarthritis. Arthritis Rheum 1998;41:1233-40.
24. Beaudreuil J, Bendaya S, Faucher M, Coudeyre E, Ribinik P, Revel M, et al. Clinical practice guidelines for rest orthosis, knee sleeves, and unloading knee braces in knee osteoarthritis. Joint Bone Spine 2009;76:629-36.
25. Hogan KK, Powden CJ, Hoch MC. The influence of foot posture on dorsiflexion range of motion and postural control in those with chronic ankle instability. Clin Biomech (Bristol, Avon) 2016;38:63-7.
26. Grahame R. Joint hypermobility and the performing musician. N Engl J Med 1993;329:1120-1.
27. Hawke F, Rome K, Evans AM. The relationship between foot posture, body mass, age and ankle, lower-limb and whole-body flexibility in healthy children aged 7 to 15 years. J Foot Ankle Res 2016;9:14.