

## FOOTWEAR CHARACTERISTICS AND FACTORS INFLUENCING FOOTWEAR CHOICE IN PATIENTS WITH GOUT

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**ABSTRACT**

*Objective.* Gout is associated with foot pain, impairment and disability. The aim of this study was to assess footwear characteristics and key factors influencing footwear choice in patients with gout. We also wished to evaluate the relationship between footwear characteristics and foot disability.

*Methods.* Fifty patients with a history of acute gout were recruited from rheumatology clinics during the summer months. Clinical characteristics, global function, and foot impairment and disability measures were recorded. Footwear characteristics and the factors associated with choice of footwear were identified using validated assessment tools. Suitability of footwear was assessed using pre-determined criteria for assessing adequacy of footwear, based on a previous study of foot pain.

*Results.* The patients had moderate to severe foot pain, impairment and disability. Poor footwear characteristics included poor cushioning, lack of support, lack of stability and motion control. Over 50% of shoes were  $\geq 12$  months old and demonstrated excessive wear patterns. Patients reported comfort (98%), fit (90%), support (79%) and cost (60%) as important factors in choosing their own footwear. No correlation was found between footwear characteristics (length and width) and foot characteristics (foot pain, impairment and disability). Patients with poor footwear reported higher foot-related impairment and disability.

*Conclusion.* Use of poor footwear is common in patients with chronic gout and is associated with foot disability and impairment.

Key words: gout, footwear, foot, pain, disability

### Significance and Innovations

- Poor footwear is a major problem in patients with gout
- Foot pain, impairment and disability may contribute to the problem.
- Patients reported comfort, fit, support and cost as important factors in choosing their own footwear.
- Future research should be focused on assessing the role of competitively priced footwear with adequate cushioning, motion control and sufficient width at the forefoot.

## INTRODUCTION

Gout is the most prevalent inflammatory arthropathy in men, caused by formation of monosodium urate crystals in joints and other tissues (1). Gout typically presents as recurrent self-limiting flares of acute joint inflammation, and in the presence of persistent hyperuricaemia, chronic tophaceous disease may also develop (2). Gout displays a striking predilection to affect the feet, particularly the first metatarsophalangeal joint (1st MTPJ), midfoot and ankle (3-6). We have recently reported that patients with chronic gout have changes in gait parameters focused on the midfoot and the hallux, consistent with a pain avoidance strategy (7). It is likely that these gait changes contribute to altered loading patterns and impaired foot function in chronic gout.

Footwear has been developed and modified to provide protection from the environment, conform to fashion, assist function, accommodate foot deformities, and treat musculoskeletal injury (8). Various footwear characteristics have been linked to the development of musculoskeletal disorders such as osteoarthritis of the foot and knee, low back pain, foot ulceration, hallux valgus and hammer toes (8). Poorly fitting shoes have also been linked to foot pain in rheumatoid arthritis (9, 10). In addition to shoe features, previous studies have reported that the individual fit of a shoe is important; loose-fitting shoes can also cause excessive foot slippage within the shoe during walking, altered contact area between the foot and shoe, impairing foot stability and walking parameters (11-13).

To date, the choice of footwear and factors impacting on the choice of footwear have been not been reported in patients with chronic gout. The aim of this study was to assess footwear characteristics and key factors influencing footwear choice in patients with gout. We also wished to examine the relationships between footwear and foot characteristics (pain, disability and impairment).

## PATIENTS AND METHODS

This was a cross-sectional observational study of fifty adult patients with a history of gout attacks recruited from rheumatology outpatient clinics at Auckland and Counties

Manukau District Health Boards, Auckland, New Zealand. All patients had a physician diagnosis of gout and a history of acute gout according to ACR classification criteria (14). Ethical approval was obtained by Northern X Ethics Committee, Auckland, New Zealand (NTX/10/EXP/231) and local institutional approval was also obtained. Participants were excluded if they were experiencing an acute gout flare at the time of assessment or had lower limb amputation. Patients with diabetes or neurological disease associated with gout were not excluded from the study. A single podiatrist (MF) assessed all patients at a single study visit.

The following data were collected: age, gender, ethnicity, body mass index (BMI), disease duration, current pharmacological management, and history of cardiovascular disease and diabetes. Foot type was assessed using the Foot Posture Index which is a validated method for quantifying standing foot type with scores above +4 suggest a flat-foot type (15).

Disease impact was measured using the Leeds Foot Impact Scale (16). This self-administered questionnaire comprises two subscales for impairment/footwear (LFIS<sub>IF</sub>) and activity limitation/participation restriction (LFIS<sub>AP</sub>). The former contains 21 items related to foot pain and joint stiffness as well as footwear related impairments and the latter contains 30 items related to activity limitation and participation restriction. Turner (17) reports that a LFIS<sub>IF</sub> >7 point and LFIS<sub>AP</sub> >10 point as a high to severe level of foot impairment and disability.

Foot pain was assessed using the Foot Function Index domain (17). The FFI is a self-administered questionnaire consisting of 23 items grouped in three domains: foot pain (nine items), disability (nine items) and functional limitation (five items). All items are rated using 100mm visual analogue scales, and higher scores indicate greater pain, disability and limitation of activity and thus poorer foot health (18).

An objective assessment of footwear was conducted by the examiner to ascertain the type, structural components and fit of the participant's footwear at the time of the study visit (8). Patients did not receive any instructions about their footwear prior to the study visit. Six aspects of footwear are evaluated and include: (i) *fit* (length,

width and depth); (ii) *general* (age of shoe, footwear style, weight and length); (iii) *general structure* (heel height, fixation, forefoot height, forefoot sole flexion point, and last); (iv) *motion control properties* (density, fixation, heel counter stiffness, midfoot sole sagittal and frontal stability); (v) *cushioning* (presence lateral, medial and heel sole hardness); (vi) *wear patterns* (upper, midsole, tread and outsole wear pattern).

Based upon previous studies of patients with foot pain and rheumatoid arthritis, we classified current footwear into poor, average and good footwear (10,20). The poor footwear group consisted of footwear that lack support and sound structure, including sandals, flip-flops, slippers, mules and moccasins. The average footwear group included shoes such as hard-or-rubber-soled shoes and work boots. The good footwear group consisted of athletic shoes, walking shoes, therapeutic footwear and Oxford-type shoes. Foot dimensions (foot length and width) were measured using a Brannock measuring device (Liverpool, New York, USA). The device allows the weight-bearing measurement of foot length and width. Each patient was also asked by the examiner to identify the most important feature on a validated check-list that included: comfort, style, fit, sole, costs, weight and colour (21).

All analyses were performed using SPSS V17.0. Gender, ethnicity, clinical characteristics such as current pharmacological management, history of hypertension, cardiovascular disease, diabetes, renal impairment and general footwear scores are described as n (percentages). All other demographic characteristics are described as the mean (SD). The association of changes with foot characteristics (pain, disability and impairment) with footwear characteristics (shoe length and width) were evaluated using Spearman's  $\rho$  correlation coefficients. We examined significant differences between shoe category (good, poor and average) and foot characteristics (pain, disability and impairment) using one-way ANOVA. We undertook secondary analysis using independent t-tests to evaluate significant differences in all footwear characteristics between participants with diabetes and those without diabetes. All tests were two tailed and  $P < 0.05$  was considered significant.

## RESULTS

### *Clinical and foot characteristics*

The clinical and foot characteristics are summarised in Table 1. Patients were predominantly middle-aged males with longstanding disease. Obesity and cardiovascular disease were common comorbidities. The majority of patients ( $n=27$ , 58%) had a low-foot profile (flatfoot). Patients had high to severe ( $\text{LFIS}_{\text{IF}} >7$  points ( $n=27$ , 52%),  $\text{LFIS}_{\text{AP}} >10$  points,  $n=30$ , 60%) levels of foot impairment and disability (Table 1). The Foot Function Index, pain domain illustrated a moderate level of pain.

### *Footwear assessment*

Table 2 summarises the footwear types observed. Overall, 28 (56%) of patients wore good footwear that included walking, athletic and Oxford-type shoes, with 42% of patients wearing shoes that were defined as 'poor'. No participants wore high-heeled shoes.

Table 3 describes footwear characteristics. Footwear characteristics demonstrated that shoes were frequently either too long or too short. A similar finding was also found for shoe width, although shoe depth was deemed good in over 62% of patients. We found that 23% ( $n=12$ ) of shoes had no fixation. Over 60% ( $n=30$ ) of shoes demonstrated no cushioning and only 36% ( $n=18$ ) of shoes with heel/forefoot cushioning. Minimal motion control properties was found in the current study with only 26% ( $n=13$ ) wore shoes that had adequate heel counter stiffness, 50% ( $n=25$ ) of shoes with midfoot sole sagittal stability and a further 42% ( $n=21$ ) with midfoot sole frontal stability. We observed that 64% ( $n=32$ ) of patients wore shoes with a heel height ranging between 2.6-5.0cm; of those 13 (41%) wore athletic shoes, 9 (28%) wore Oxford-type shoes, 7 (22%) wore open shoes, 2 (6%) wore bespoke footwear and 1 (3%) wore boots. Forefoot sole flexion point demonstrated 54% ( $n=27$ ) of shoes before the level of the 1<sup>st</sup> MPTJ. Over half of patients wore shoes that were aged over 12 months old.

Table 4 describes the factors patients perceived as important; most commonly identified factors were comfort (98%), fit (90%), support (79%), cost (60%) and

weight (63%). Patients reported style (36%) and colour (33%) as being less important.

#### *Factors influencing changes in foot characteristics and footwear*

Shoe width and depth did not correlate with foot pain, impairment and disability (data not shown). However, patients with poor footwear reported higher foot-related impairment and activities, particularly in the scores of the LSIS<sub>AP</sub> ( $p = 0.01$ ) and the Foot Function Index, impairment domain ( $p = 0.02$ ) (Table 5). Secondary analysis demonstrated no significant differences in any of the footwear characteristics between participants with diabetes ( $n=7$ ) and those without diabetes ( $n=43$ ) ( $p > 0.05$ ).

## **DISCUSSION**

The aim of this study was to identify current footwear styles, footwear characteristics, and factors that influence footwear choice experienced by patients with chronic gout. Overall, we found severe impairment and limited activity scores, consistent with significant foot disability and impairment associated with gout. A previous study has reported similar findings of foot pain, impairment and disability relating to chronic gout (7).

Over 40% of patients in the current study wore sandals, moccasins and flip-flops. A previous study (22) reported that gait changes were observed in an asymptomatic population with wearing flip-flops and suggested that the shoe construction may contribute to lower limb leg pain and are counter-productive to alleviating pain. The wearing of open-type footwear should be interpreted with caution in the current study. It is important to understand that open-type footwear, such as flip-flops and sandals are commonly worn in New Zealand. However, wearing open-type footwear may reflect the issue of finding appropriate footwear, in particular relating to finding footwear that has adequate foot width and length.



Analysis of patient footwear illustrated signs of detrimental changes. Minimal motion control was found in the current study and since the midfoot is required to form a rigid lever during propulsion, footwear instability may contribute to foot problems in patients with chronic gout. The current study found over 50% of shoes with a flexion point distal to the level of the first metatarsophalangeal joint (1st MPJ). This may limit gait efficiency due to altered kinematics which results from inhibition of normal 1st MPJ function (8). We can postulate that a flexion point proximal may jeopardise the shoe's stability and may exacerbate the problem of efficient toe-off observed in patients with chronic gout (7).

Heel height greater than 2.5cm has been associated with hallux valgus, plantar callus, postural instability in older adults [8]. In our study over 40% of those with high heel height wore athletic shoes. Athletic shoes vary significantly with midsole construction that may use elements of gel, foamed polyurethane, or air chambers that serve to aid cushioning [20]. The elevated heel height of athletic shoes may go some way to explain the high heel height observed in this study.

The lack of cushioning found in shoes demonstrates the inadequate amount of structural support for the foot and lower limb. Wear patterns on the footwear provided some indication that they were partially worn and there were considerable amount of medial compression signs. The poor midfoot sole stability and poor heel counter stiffness found suggests that the current footwear does not stabilise the foot during walking. The definition of poor shoes (sandals, slippers and flip-flops) used in this study implies a shoe design with poor fit, poor foot posture, and a lack of shock absorption characteristics. The lack of shock attenuation has the potential to increase loads on plantar tissues, potentially leading to foot pain. Combined with the presence of a flatfoot type, patients with gout wear footwear that gives no support or cushioning and is prone to be unstable. Hence, footwear that has inadequate stability, poor cushioning and limited stability may exacerbate foot pain in patients with gout.

In the current study the participants reported that fit and comfort were important factors in choosing footwear, suggesting that patients with gout may prioritise these factors due to their condition. More than half of patients reported cost as a factor contributing to their footwear choice. The wearing of poor shoes may be due to financial restrictions when purchasing footwear. Furthermore, gout is a painful and distressing condition that can have a major impact on economically active adults, who may be forced to give up work either temporarily or permanently due to their condition (23,24). These data highlight the barriers related to costs that patients with gout may encounter when purchasing footwear.

We found no relationship between foot length and width with foot pain, disability and impairment. Previous studies have found similar findings in older adults with arthritis (20) and rheumatoid arthritis (10). However, we found significant differences between shoe fit category and foot characteristics with higher scores associated with foot impairment and disability in the poor shoe category. Poor footwear may exacerbate the problem. Lindsay (25) reported that patients with gout may impede the patients' lower limb function, particularly with recreational activities.

In the current study we found high mean BMIs indicative of obesity. The findings in the patients with gout are consistent with a previous gout study (7). The sustained repetition of such loading in these activities make significant demands on the feet in normal-weight individuals, and these demands are likely to be magnified in those with gout, obesity and poor footwear. It is possible that the increased demand related to obesity, coupled with the structural changes associated with chronic gout and poor cushioning and control contributes to foot disability in patients with gout.

This study has several limitations. The study was conducted in the summer and in an urban environment, and the results may not be generalisable to other seasons or geographic locations. The footwear questionnaire contains both objective and

subjective data and not all footwear meet the criteria [8]. For example, open-type footwear such as mules, flip-flops and sandals are difficult to assess and do not have all the footwear features to evaluate. Furthermore, the category for the subjective measure of heel height is based on an arbitrary range (i.e. 0-2.5cm; 2.6-5.0cm and  $\geq 5.0$ cm). Therefore, future research is needed to develop a more objective measure to evaluate of heel height. The current study was cross-sectional and future work using prospective studies is needed to evaluate causative relationships before any definitive conclusions can be made regarding the role of poor footwear in contributing to foot pain, impairment and disability in patients with chronic gout. We did not exclude patients with diabetes from this study. Diabetes is frequently associated with gout [26] and this combination may contribute to more severe foot problems. These patients were not excluded as we wished to ensure that patients with a wide spectrum of disease severity and co-morbidities were included, consistent with gout that is managed in clinical practice. Importantly, sub-analysis of patients with and without diabetes did not show major changes between the groups. Not all patients in this study had microscopically proven gout. The rates of microscopically proven gout are consistent with our previous studies of patients with chronic gout [27,28]. Although it is possible that misclassification may have occurred, all patients included in the study had a physician diagnosis of gout and also fulfilled the ACR diagnostic classification for acute gout.

In summary, patients with chronic gout suffer from foot pain, disability and impairment. This study has demonstrated that fit, comfort and costs were perceived by patients to be important factors in choosing footwear although patients current footwear were objectively poor. Overall, the current footwear demonstrated a lack of cushioning, control and stability as well as excessive wear. The majority of shoes worn by patients were also over 12-months old. For patients with gout, this might explain the problems of purchasing adequate footwear due to foot pain, impairment and disability. Based upon the current findings we suggest that footwear should be considered in the management plan of patients with gout. Future research should be focused on assessing the role of competitively priced footwear with adequate cushioning, motion control and sufficient width at the forefoot.

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**Table 1: Clinical and foot characteristics**

Age, years, mean (SD)	63.1 (13.2)
Male sex, n (%)	42 (84%)
Ethnicity, n (%)	Caucasian, 26 (52%)
	Pacific Island, 13 (26%)
	Maori, 8 (16%)
	Asian, 1 (2%)
	Indian, 2 (4%)
Disease duration, years, mean (SD)	17.9 (14.4)
Cardiovascular disease, n (%)	20 (40%)
Diabetes, n (%)	7 (14%)
Diuretic use, n (%)	10 (20%)
Allopurinol use, n (%)	28 (56%)
Body mass index, kg/m <sup>2</sup> , mean (SD)	31.9 (7.8)
Tophi present, n (%)	8 (16%)
Serum urate, mmol/L, mean (SD)	0.43 (0.14)
<u>Crystal-confirmed diagnosis, n (%)</u>	<u>18 (36%)</u>
Foot Posture Index, mean (SD)	4.1 (2.9)
Leeds Foot Impact Scale (impairment), mean (SD)	8.3 (5.3)
Leeds Foot Impact Scale (activities), mean (SD)	13.3 (10.7)
Foot Function Index (pain), mean (SD)	34.0 (28.3)
Foot Function Index (disability), mean (SD)	33.4 (29.1)
Foot Function Index (activities), mean (SD)	18.1 (24.7)

Table 2: Footwear Type

Footwear suitability	Total	Footwear type	n (%)
Good	28 (56%)	Oxford Shoe	9 (18%)
		Walking Shoe	4 (8%)
		Athletic Shoe	13 (26%)
		Therapeutic Footwear	2 (4%)
Average	1 (2%)	Boot	1 (2%)
Poor	21 (42%)	Sandal	6 (12%)
		Flip-flop	7 (14%)
		Slipper	4 (8%)
		Backless Slipper	3 (6%)
		Moccasin	1 (2%)



**Table 3: Footwear Construction Characteristics**

<b>Footwear Variable</b>	<b>n (%)</b>
<b>Fit of Shoe</b>	
<b>Length</b>	
Good	21 (42%)
Too short	12 (24%)
Too long	17 (34%)
<b>Width</b>	
Good	20 (40%)
Too narrow	27 (54%)
Too wide	3 (6%)
<b>Depth</b>	
Good	31 (62%)
Too shallow	19 (38%)
<b>Heel Height</b>	
0-2.5cm	15 (30%)
2.6-5.0cm	32 (64%)
>5.0cm	3 (6%)
<b>Forefoot Height</b>	
0-0.9cm	11 (22%)
1.0-2.0cm	33 (66%)
>2.0cm	6 (12%)
<b>Age</b>	
< 6 months	17 (34%)
6-12 months	7 (14%)
>12 months	26 (52%)
<b>Width, mm, mean (SD)</b>	23.7 (2.44)
<b>Length, mm, mean (SD)</b>	271.6 (18.9)
<b>Motion Control Properties</b>	
<b>1. Midfoot Sole Sagittal Stability</b>	

Minimal	25 (50%)
Moderate	16 (32%)
Rigid	9 (18%)
<b>2. Midfoot Sole Frontal Stability</b>	
Minimal	21 (42%)
Moderate	17 (34%)
Rigid	12 (24%)
<b>3. Heel Counter Stiffness</b>	
Not Available	13 (26%)
Minimal	21 (42%)
Moderate	3 (6%)
Rigid	13 (26%)
<b>4. Density</b>	
Single	48 (96%)
Dual	2 (4%)
<b>5. Fixation</b>	
None	12 (23%)
Laces	21 (44%)
Straps/Buckles	17 (33%)
<b>Presence of Cushioning</b>	
None	30 (60%)
Heel	2 (4%)
Heel/forefoot	18 (36%)
<b>Forefoot Sole Flexion Point</b>	
At level of 1 <sup>st</sup> MPJT	23 (46%)
Before 1 <sup>st</sup> MPJT	27 (54%)
<b>Wear Patterns</b>	
<b>Upper Wear</b>	
Medial tilt	21 (42%)
Neutral	27 (54%)
Lateral tilt	2 (4%)
<b>Midsole Wear</b>	

Medial compression signs	10 (20%)
Neutral	37 (74%)
Lateral compression signs	3 (6%)
<b>Tread Pattern</b>	
Not worn	14 (28%)
Partly worn	34 (68%)
Fully worn	2 (4%)
<b>Outer wear pattern</b>	
None	14 (28%)
Normal	23 (46%)
Lateral	4 (8%)
Medial	9 (18%)

**Table 4: Factors relating to footwear choice (more than one response was possible using questionnaire)**

<b>Factors</b>	<b>n (%)</b>
Comfort	47 (98%)
Fit	43 (90%)
Support	43 (90%)
Weight	30 (63%)
Cost	29 (60%)
Sole	22 (46%)
Style	17 (36%)
Colour	16 (33%)

**Table 5: Differences between shoe fit category and foot characteristics.**

	Poor Shoe Category  mean (SD)	Good Shoe Category  mean (SD)	p value
Leeds Foot Impact Scale (impairment)	9.9 (6.5)	6.5 (4.5)	0.05
Leeds Foot Impact Scale (activities)	17.2 (11.3)	8.2 (8.7)	0.01
Foot Function Index (pain)	43.5 (33.7)	27.4 (22.4)	0.07
Foot Function Index (impairment)	45.9 (29.2)	24.2 (26.4)	0.02
Foot Function Index (limitation)	24.3 (25.3)	24.1 (26.4)	0.20