

# Footwear used by older people and a history of hyperkeratotic lesions on the foot

## A prospective observational study

Patricia Palomo-López, PhD, MsC, DP<sup>a</sup>, Ricardo Becerro-de-Bengoa-Vallejo, RN, BSc, MLIS, DPM, DHL, PhD, FFPM RCPS<sup>b</sup>, Marta Elena Losa-Iglesias, RN, PhD, MSc, DP<sup>c</sup>, David Rodríguez-Sanz, PhD, MsC, PT, DP<sup>d</sup>, César Calvo-Lobo, PhD, Msc, PT<sup>e</sup>, Daniel López-López, PhD, MSc, DP<sup>f,\*</sup>

### Abstract

Inadequate footwear, painful and hyperkeratotic lesions (HL) are an extremely common problems amongst older people. Such problems increase the risk of falls, hamper mobility, reduction of quality of life, dignity, and ability to remain independent. The etiology of painful and feet conditions is poorly understood.

To discover footwear preferences of older people, pain tolerance may favor presence of HL for the use of inadequate footwear in old age.

A sample of 100 participants with a mean age of  $74.90 \pm 7.01$  years attended an outpatient clinic where self-reported demographic data, frequency with which they checked their feet were recorded and measurements were taken of foot sensitivity. Additionally, all participants' shoes were allocated into optimal, adequate, and dangerous categories based on design, structural and safety features, and materials.

Only 12% of the sample population checked their feet every day, 37% revealed symptoms of neuropathy, 14% used optimal shoes, and 61% presented HL. In a bivariate analysis, no significant differences were observed.

HL are associated with inadequate footwear, loss of sensitivity, and low frequency of foot health checks.

**Abbreviations:** BMI = body mass index, HL = hyperkeratosis lesions, SD = standard deviation.

**Keywords:** aging, foot, foot deformities, foot disease, shoes

## 1. Introduction

Hyperkeratosis lesions (HL), also known as corns and calluses is one of the most common foot problems.<sup>[1]</sup> Approximately, 90% of older people exhibit some form of HL,<sup>[2]</sup> which do not receive early attention, leading to considerable dysfunction<sup>[3]</sup> related with pain and deformity,<sup>[4]</sup> foot ulcerate,<sup>[5]</sup> gait abnormalities,<sup>[6]</sup> high-risk to falls,<sup>[7]</sup> overall reduced health-related quality of

life.<sup>[8]</sup> The frequency of impact of HL on the podiatric services is 75%<sup>[9]</sup> and 84% of people will visit a podiatrist for treatment these problems on the foot.<sup>[10]</sup>

Also, HL is the result of abnormal mechanical stresses on the skin which stimulate overactivity of the keratinisation process related<sup>[11]</sup> are numerous etiologies related by mechanical stresses from faulty footwear,<sup>[12]</sup> changes of the foot morphology,<sup>[8]</sup> and high levels of activity.<sup>[13]</sup>

Editor: Eric Bush.

*Ethics Approval and Consent to Participate:* Research and Ethics Committee of the University of A Coruña (Spain), file number CE 10/2015. All those who volunteered to take part in the study gave their informed written consent.

*Consent for Publication:* The authors declare that they consent for publication.

*Availability of data and supporting materials section:* The dataset supporting the conclusions of this article is available in the daniellopez@udc.gal in the Research, Health and Podiatry Unit, Department of Health Sciences, Faculty of Nursing and Podiatry, Universidade da Coruña, Spain.

*Funding:* The authors did not receive any sponsor's role in the design, methods, subject recruitment, data collections, analysis and preparation of paper.

*Author Contributions:* All authors: concept, design, analyses, interpretation of data, drafting of manuscript, or revising it critically for important intellectual content.

*Trial registration:* Not applicable are because we did not apply any intervention in our study. Our study is an observational study.

*Conflict of Interest:* The authors did not receive any financial assistance from or have any personal relationships with other people or organisations that could inappropriately influence (bias) their work.

<sup>a</sup> University Center of Plasencia, Universidad de Extremadura, <sup>b</sup> School of Nursing, Physiotherapy and Podiatry, Universidad Complutense de Madrid, <sup>c</sup> Faculty of Health Sciences, Universidad Rey Juan Carlos, <sup>d</sup> Physical Therapy & Health Sciences Research Group Department, Faculty of Health, Exercise and Sport, European University of Madrid, Villaviciosa de Odón, Madrid, <sup>e</sup> Nursing and Physical Therapy Department, Institute of Biomedicine (IBIOMED), Faculty of Health Sciences, University of León, Ponferrada, León, <sup>f</sup> Research, Health and Podiatry Unit, Department of Health Sciences, Faculty of Nursing and Podiatry, Universidade da Coruña, Spain.

\* Correspondence: Daniel López-López, Universidade da Coruña, Unidade de Investigación Saúde e Podoloxía, Facultade de Enfermaría e Podoloxía, Departamento de Ciencias da Saúde, Campus Universitario de Esteiro s/n, 15403 Ferrol, Spain (e-mail: daniellopez@udc.es).

Copyright © 2017 the Author(s). Published by Wolters Kluwer Health, Inc.

This is an open access article distributed under the Creative Commons Attribution-NoDerivatives License 4.0, which allows for redistribution, commercial and non-commercial, as long as it is passed along unchanged and in whole, with credit to the author.

Medicine (2017) 96:15(e6623)

Received: 15 November 2016 / Received in final form: 20 March 2017 / Accepted: 26 March 2017

<http://dx.doi.org/10.1097/MD.0000000000006623>

These problems occur more frequently in women and than in men, a wide range of lesion distribution patterns, most can be classified into medial, central, or lateral groups<sup>[14]</sup> that often become both permanent and painful.<sup>[15,16]</sup>

The study of López López et al,<sup>[17]</sup> with an older people showed that the use of differently sized shoes for each foot may be necessary to prevent the onset of foot conditions and deformities. Based on previous reports of this age group, the aim to study is to discover footwear preferences of older people, pain tolerance may favor presence of HL for the use of inadequate footwear in old age.

## 2. Methods

### 2.1. Design and sample

A total of 100 older people participated in the research. This descriptive observational study was carried out in a Clinic of Podiatric Medicine and Surgery that provides treatment of diseases and disorders of the foot at University of Extremadura in the city of Plasencia (Spain) between January and December 2015. A nonrandomized and consecutive sampling method was used to select the 117 participants in the age 65 or over were asked to participate. Two men and 15 women refused arguing personal decision making. Hundred participants gave consent and were recruited. Exclusion criteria: under 65 years of age, autoimmune diseases, previous foot trauma or foot surgery, have a neurodegenerative disorder (for example, Parkinson's disease), be unable to make daily living activities and unable to understand instructions relating to the study and/or carry them out.

### 2.2. Procedure

At enrollment, patients were interviewed about general health, demographic characteristics (age and sex), and frequency with which they checked their feet. A single trained examiner performed a standardized clinical examination on all participants who first measured height, weight with the subject barefoot and wearing light clothing, and the body mass index (BMI) was calculated from the height (m) and weight (kg<sup>2</sup>), applying Quetelet equation follow  $BMI = \text{weight}/\text{height}^2$ .<sup>[18]</sup>

In the second place, to determine the examination foot sensitivity using a Semmes–Weinstein 5.07 monofilament nylon wire of 10 g. This test is a reliable and specific for identifying loss of protective sensation in older people ( $\kappa = 0.74$ ;  $r_s = 0.89-0.93$ ).<sup>[19]</sup>

The instrument was pressed against perpendicular to the foot and with a smooth, steady motion, touched the skin until the monofilament bends the following areas of both feet, dorsal surface of the foot, between the base of the first and second toe, the plantar surface, on the ball of the foot (distal phalanges) of the first, third, and fifth toes, the first, third, and fifth metatarsal heads, the lateral and mid points of the internal and external

longitudinal arches, and the heel.<sup>[20,21]</sup> The positive monofilament score result (insensitivity) was defined if the participant gave a negative response for a minimum of 4 out the 10 pressure points assessed on each foot.<sup>[22,23]</sup>

Lastly, to determine the severity of shoes using the Tovey criteria, life-size versions of the photographs in the original publication were printed and laminated.<sup>[24]</sup>

This scale describes a noninvasive method of assessing the severity of shoes as optimal adequate, or dangerous. Optimal footwear was defined lace-up, forgiving materials with at least 3 to 4 eyes on each side, extra width across the metatarsal heads, extra depth in the toe box, low heels, and a padded tangle to firmly hold the foot. Adequate shoes were determined as a cushioned shock-absorbing outsole, flexible uppers, a reasonable toe box, laces, and accommodative features. Dangerous shoes were those with a shallow or narrow toe box, no laces, open toes or heels, and a heel height placing extra pressure on the ball of the foot.<sup>[25]</sup>

### 2.3. Ethical considerations

This research was approved by the Research Ethics Committee at the University of A Coruña (Spain), case number CE 10/2015. All participants gave informed written consent before being included, and the ethical standards in human experimentation contained in the World Medical Association Declaration of Helsinki, the Council of Europe Convention on Human Rights and Biomedicine, the UNESCO Universal Declaration on the Human Genome and Human Rights, and those of the relevant national bodies and institutions were observed at all times.

### 2.4. Statistical analysis

Qualitative variables are shown as absolute values and percentages, while the quantitative variables described are the mean and standard deviation (SD) and maximum and minimum values. The fisher exact test was used to compare categorical variables. Independent *t* test was used to compare differences between groups. In all of the analyses, statistical significance was established with a *P* value < .05 with a 95% confidence interval. Statistical analyses were performed using IBM SPSS statistical software (Version 19.0; IBM Corp. Armonk, NY) for Windows.

## 3. Results

### 3.1. Sample characteristics

A total of 100 older people completed all stages of the research process (50 men [50%] and 50 women [50%]). The mean age was  $74.90 \pm 7.01$  years (range 65–89).

Table 1 shows the clinical and sociodemographic characteristics of the informants. As can be seen, most informants are overweight ( $BMI = 27.86 \text{ kg/m}^2$ ).

**Table 1**  
Socio-demographic and clinical characteristics of the sample population.

	Total group Mean $\pm$ SD Range N = 100	Male Mean $\pm$ SD Range n = 50	Female Mean $\pm$ SD Range n = 50	<i>P</i> value male vs. female
Age, y	74.90 $\pm$ 7.01 (65–89)	75.54 $\pm$ 6.38 (65–89)	74.26 $\pm$ 7.60 (65–89)	.181
Weight, kg	73.40 $\pm$ 10.44 (45–100)	77.94 $\pm$ 9.91 (50–100)	68.86 $\pm$ 8.95 (45–97)	.001
Height, cm	162.28 $\pm$ 9.38 (145–181)	169.66 $\pm$ 5.84 (153–181)	154.9 $\pm$ 5.71 (145–171)	.001
BMI, kg/m <sup>2</sup>	27.86 $\pm$ 3.18 (19.48–37.10)	27.01 $\pm$ 2.60 (20.55–33.13)	28.72 $\pm$ 3.50 (19.48–37.10)	.003

BMI = body mass index, SD = standard deviation. Independent *t* test was performed and for all the analyses, *P* < .05 with a 95% confidence interval was considered statistically significant.

**Table 2**  
**Foot health check frequency.**

Frequency with which patients carry out foot health checks	Total N=100 (%)	With neuropathy n=37 (%)	Without neuropathy n=63 (%)	P
Daily	12 (12)	6 (16.22)	6 (9.52)	.001
1–3 times per week	2 (2)	0 (0)	2 (3.18)	
Bi-monthly	6 (6)	6 (16.22)	0 (0)	
Once a month	34 (34)	16 (43.24)	18 (28.57)	
Every 3 months	26 (26)	5 (13.51)	21 (33.33)	
Never	20 (20)	4 (10.81)	16 (25.40)	
Total	100 (100)	37 (100)	63 (100)	

The fisher exact test was performed and for all the analyses, *P* < .05 with a 95% confidence interval was considered statistically significant.

A majority of the participants responses to the self-reporting questionnaire revealed that the frequency with which participants carried out foot health checks was relatively low, with only 12% (n = 12) checking their feet every day, versus 34% (n = 34) who check them once a month and 20% (n = 20) who do not typically check their feet. Older people suffering from neuropathy were more willing to perform a once a month foot health check than those who do not have this condition (see Table 2).

Also, older people suffered HL on the feet and a subsequent physical examination revealed that 12% (n = 12) had deformed toes, 61% (n = 61) had HL, and 19% (n = 19) had bunions.

Types of severity of shoes, measured with a Tovey criteria, revealed that 67% of patients were using inadequate footwear. Only 43 participants (43%) used optimal shoes for your feet (Table 3).

**4. Discussion**

The purpose of this study was to discover footwear preferences of those older people, pain tolerance may favor presence of HL for the use of inadequate footwear in old age.

Footwear is essential for the elderly in managing HL,<sup>[26]</sup> for the maintenance of foot health and mobility and it has long been recognized that suboptimal footwear can be detrimental.<sup>[27,28]</sup> Although several studies have been undertaken to assess the effectiveness of optimal footwear interventions in elderly, patients with rheumatoid arthritis, individuals with diabetes, foot pain, and other degenerative foot disorder,<sup>[17,29–34]</sup> none have focused on the relationships footwear preferences and HL.

The study outlined in this protocol is, therefore, novel in that it targets a footwear used by those older people and a history of hyperkeratotic lesions on the foot. In our study, 57% of the participants wearing incorrectly fitting shoes, and 61% presence HL in their feet. Our results are in line with a previous report of Schwarzkopf et al,<sup>[32]</sup> indicating that proper footwear sizing is lacking among a large proportion of patients and this may be related to a higher number of foot injuries.<sup>[33–35]</sup>

Also, the majority of elderly who took part in the survey pay little attention to their feet, only 12% (12 of 100) of the total of our participants performed foot health checks daily. Only 16.22% (6 of 37) from the group with neuropathy which suffer HL performed foot health checks daily, and the HL, as a risk factor for foot ulcer, might have been preventable.<sup>[17,36]</sup> We think that population do not give adequate importance to maintain the foot health by using proper footwear to avoid keratosis lesions as a risk factor to develop further pathology.

One important finding is that very few any people without HL 15.38% (6 of 39) are using the category of dangerous footwear,

**Table 3**  
**Types of shoes and history HL.**

Frequency with which patients have HL	Total N=100 (%)	With HL n=61 (%)	Without HL n=39 (%)	P
Optimal	14 (14)	5 (8.2)	9 (23.08)	.0001
Adequate	43 (43)	19 (31.15)	24 (61.54)	
Dangerous	43 (43)	37 (60.65)	6 (15.38)	
Total	100 (100)	61 (100)	39 (100)	

HL = hyperkeratotic lesions. The fisher exact test was performed and for all the analyses, *P* < .05 with a 95% confidence interval was considered statistically significant.

while 60.65% (37 of 61) are using dangerous footwear category. We think that the presence of HL at toes or any other site of foot should be considered as a risk factor to develop further lesion in a short time for people at risk due to presence of neuropathy or at medium or large time for older people. The presence of HL should advise the people to avoid the use of this kind of shoes and clinicians should be aware patients with HL are using dangerous footwear and it could be promoted some actions, as change the footwear to improve healthy foot health in elderly population.

Also, in light of the results obtained in this study, we have identified that the presence of inadequate footwear is associated with HL equally in both men and women.

There are several limitations to the study that should be acknowledged. First this research excluded people who required custom shoes or custom inserts. Second, a larger and more diverse (individuals from various countries) sample size would be beneficial to improve the strength of the study. Third, expanding data collection to other countries may help to identify if there is a culture where this association does not exist and identify the mechanisms involved.

This highlights the need for further research on the presence and severity of shoes and how it influences on the presence foot disorders in order to improve patient’s health, quality of life, and autonomy of senior citizens.

**5. Conclusions**

This study offers another proof that older people with HL are associated with inadequate footwear, loss of sensitivity, and low frequency of foot health checks. Therefore, proper care and control of the foot are extremely important to ensure healthy feet in order to prevent the appearance or development of lesions, pain, infections, or deformities along the process of controlling its functionality.

**Acknowledgments**

To all patients who had participate in the research.

**References**

- Anderson J, White KG, Kelechi TJ. Managing common foot problems in older adults. *J Gerontol Nurs* 2010;36:9–14.
- Helfand AE, Halter JB, Ouslander JG, Tinetti ME, Studenski S, High KP, Asthana S, et al. Primary considerations in managing the older patient with foot problems. *Hazzard’s Geriatric Medicine and Gerontology* 6th ed. McGraw-Hill, New York:2009;1479–89.
- Pattillo MM. Therapeutic and healing foot care: a healthy feet clinic for older adults. *J Gerontol Nurs* 2004;30:25–32.
- Helfand AE. Assessing hyperkeratotic lesions in the older patient. *Clin Podiatr Med Surg* 2003;20:443–52.

- [5] Reiber G, Ylleykyte L, Boyko E, et al. Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. *Diabetes Care* 1999;22:157–62.
- [6] Gijon-Nogueron G, Garcia-Paya I, Ortega-Avila AB, et al. Changes in the parameters of gait after a mechanical debridement of a plantar callosities. *J Tissue Viability* 2015;24:12–6.
- [7] Tinetti ME. Clinical practice. Preventing falls in elderly persons. *N Engl J Med* 2003;348:42–9.
- [8] George DH. Management of hyperkeratotic lesions in the elderly patient. *Clin Podiatr Med Surg* 1993;10:69–77.
- [9] Potter J, Potter MJ. Effect of callus removal on peak plantar pressures. *The Foot* 2000;10:23–6.
- [10] Greenberg L, Davis H. Foot problems in the US. The 1990 National Health interview survey. *J Am Podiatr Med Assoc* 1993;83:475–83.
- [11] Murray HJ, Young MJ, Hollis S, et al. The association between callus formation, high pressure and neuropathy in diabetic foot ulceration. *Diabet Med* 1996;13:979–82.
- [12] Freeman DB. Corns and calluses resulting from mechanical hyperkeratosis. *Am Fam Physician* 2002;65:2277–80.
- [13] Grouios G. Corns and calluses in athletes' feet: a cause for concern. *The Foot* 2004;14:175–84.
- [14] Spink MJ, Menz HB, Lord SR. Distribution and correlates of plantar hyperkeratotic lesions in older people. *J Foot Ankle Res* 2009;30:8.
- [15] Menz HB, Stephen RL. Foot pain impairs balance and functional ability in community-dwelling older people. *J Am Podiatr Med Assoc* 2001;91:222–9.
- [16] Tencer AF, Koepsell TD, Lobo ME, et al. Biomechanical properties of shoes and risk of falls in older adults. *J Am Geriatr Soc* 2004;52:1840–6.
- [17] López López D, Losa Iglesias ME, Becerro de Bengoa Vallejo R, et al. Optimal choice of footwear in the elderly population. *Geriatr Nurs* 2015;36:458–61.
- [18] Garrow JS, Webster J. Quetelet's index (W/H<sup>2</sup>) as a measure of fatness. *Int J Obes* 1985;9:147–53.
- [19] Shaffer S, Harrison A, Brown K, et al. Reliability and validity of Semmes-Weinstein Monofilament testing in older community-dwelling adults. *J Geriatr Phys Ther* 2005;28:112–3.
- [20] Modawal A, Fley J, Shukla R, et al. Use of monofilament in the detection of foot lesions in older adults. *J Foot Ankle Surg* 2006;45:76–81.
- [21] Jeng C, Michelson J, Mizel M. Sensory thresholds of normal human feet. *Foot Ankle Int* 2000;21:501–14.
- [22] Friends J, Augustine E, Danoff J. A comparison of different assessment techniques for measuring foot and ankle volume in healthy adults. *J Am Podiatr Med Assoc* 2008;98:85–94.
- [23] McInnes AD, Hashmi F, Farndon LJ, et al. Comparison of shoe-length fit between people with and without diabetic peripheral neuropathy: a case-control study. *J Foot Ankle Res* 2012;16:5–9.
- [24] Tovey FI. The manufacture of diabetic footwear. *Diabet Med* 1984;1:69–71.
- [25] Reiber GE, Smith DG, Wallace CM, et al. Footwear used by individuals with diabetes and a history of foot ulcer. *J Rehabil Res Dev* 2002;39:615–22.
- [26] Singh D, Bentley G, Trevino SG. Callosities, corns, and calluses. *BMJ* 1996;312:1403–6.
- [27] Menz HB, Lord SR. Footwear and postural stability in older people. *J Am Podiatr Med Assoc* 1999;89:346–57.
- [28] Finlay OE, Pickles B. Foot problems and footwear prescription. *Physiotherapy with Older People Saunders, London*:1995;382–98.
- [29] Harrison SJ, Cochrane L, Abboud RJ, et al. Do patients with diabetes wear shoes of the correct size? *Int J Clin Pract* 2007;61:1900–4.
- [30] Paiva A, Rebelatto JR, Aurichio TR. The relationship between foot pain, anthropometric variables and footwear among older people. *Appl Ergon* 2010;41:93–7.
- [31] Menz HB, Frescos N, Munteanu S. Effectiveness of off-the-shelf footwear in reducing foot pain in Australian Department of Veterans' affairs recipients not eligible for medical grade footwear: study protocol for a randomized controlled trial. *Trials* 2013;14:106.
- [32] Schwarzkopf R, Perretta DJ, Russell TA, et al. Foot and shoe size mismatch in three different New York City populations. *J Foot Ankle Surg* 2011;50:391–4.
- [33] Dahmen R, Buijsmann S, Siemonsma PC, et al. Use and effects of custom-made therapeutic footwear on lower-extremity-related pain and activity limitations in patients with rheumatoid arthritis: A prospective observational study of a cohort. *J Rehabil Med* 2014;46:561–7.
- [34] MacFarlane RM, Jeffcoate WJ. Factors contributing to the presentation of diabetic foot ulcers. *Diabet Med* 1997;14:867–70.
- [35] Burns SL, Leese GP, McMurdo ME. Older people and ill fitting shoes. *Postgrad Med J* 2002;78:344–6.
- [36] Yaar M, Gilchrist BA, Wolff K, Goldsmith LA, Katz SI, Gilchrist B, Paller AS, Leffell DJ. *Aging of skin. Fitzpatrick's Dermatology in General Medicine* 7th ed. New York: McGraw-Hill; 2007.