

Community-based survey of podoconiosis in Bedele Zuria woreda, west Ethiopia

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Received 28 September 2012; revised 12 December 2012; accepted 12 December 2012

Background: Podoconiosis is a neglected tropical disease resulting in progressive bilateral swelling of the lower legs in barefoot individuals exposed to red-clay soil derived from volcanic rocks. It is a considerable public health problem in countries across tropical Africa, Central America and northern India. The present study aimed to assess the prevalence and clinical features of podoconiosis, and patients' experience of disease prevention and treatment, in Bedele Zuria woreda (district), west Ethiopia.

Methods: The study was conducted during 2011 and involved a house-to-house survey in all 2285 households of five randomly selected rural *kebeles* (villages).

Results: The prevalence of podoconiosis was 5.6% (379/6710) (95% CI 5.1–6.2%) and was significantly greater among women than men (6.6% vs 4.7%; $p = 0.001$). A total of 311 (16.9%) households had at least one member with podoconiosis, and 128 (33.8%) study participants reported having a blood relative with podoconiosis. Two hundred and forty-three (76.4%) podoconiosis patients were in the economically productive age group of 15–64 years. On average, a patient experienced at least six episodes of adenolymphangitis per year resulting in a loss of 25 working days per year.

Conclusion: This study has revealed a high burden of podoconiosis in west Ethiopia, and suggests that disease prevention and treatment programmes are needed.

Keywords: Podoconiosis, Non-filarial elephantiasis, Lymphoedema, Prevalence, Survey, Ethiopia

Introduction

Podoconiosis is a chronic, progressive, disabling and disfiguring disease exclusively affecting the lower limbs. It is a non-infectious geochemical condition resulting in bilateral swelling of the lower legs in genetically susceptible people that have long-term barefoot exposure to red-clay soil derived from volcanic rocks.^{1–4} The disease is common in more than 10 countries across tropical Africa, Central and South America and northwest India.^{5,6} The WHO has recently included podoconiosis in the list of neglected tropical diseases (NTD) (http://www.who.int/neglected_diseases/diseases/podoconiosis/en/).

Ethiopia is one of the countries with the highest number of podoconiosis patients. It is estimated that in Ethiopia between 500 000 and one million people are affected, and an additional 15 million people (18% of the population) are at risk through exposure to red-clay soil.^{5,7} In endemic areas, podoconiosis causes severe social stigma, physical disability and huge economic burden to patients and affected families.^{8–11}

Podoconiosis is relatively well studied in southern Ethiopia^{7,10,12} but data from other parts of the country are limited or absent. Programmes that focus on prevention and treatment of podoconiosis are also non-existent even in endemic areas. In addition, despite existence of evidence that there is familial clustering of the disease due to genetic and non-genetic risk factors, the burden of the disease at the household level has not been studied. In the present study we aimed to estimate the prevalence of podoconiosis at individual and household levels, document its clinical features in patients, and describe patients' experiences of prevention and treatment in Bedele Zuria woreda, west Ethiopia.

Materials and methods

Study area

The study was conducted during 2011 in Bedele Zuria woreda (a government administrative unit, equivalent to a district), Oromia

region of Ethiopia. The *woreda* has 41 rural *kebeles* (the lowest government administrative unit, equivalent to a village), of which 33 are highland *kebeles* with altitude ranging from 1700 to 2100 m asl. The *woreda's* rural population is 86 275 and most residents are farmers.

Study design and sampling

The present study had a cross-sectional quantitative research design. The names of the 33 highland *kebeles* were written on pieces of paper, rolled and shuffled in a hat, and five *kebeles* (Odo, Ourgesa, Dabena Daru, Dekaye Dabena and Bosoke Dakal) were randomly drawn and included in the study.

Households in the five selected *kebeles* were visited to identify and register podoconiosis patients. The head of the household was asked whether any member of the household had podoconiosis. When a patient was reported in the household, a structured questionnaire was administered to record demographics of patients, features of disease, and past and current experience of foot washing and shoe wearing.

Informed verbal consent was obtained from the study participants before conducting the study. When children aged <18 years (the legal age for giving consent for research in Ethiopia) were encountered, consent was obtained from their parents or guardians, and assent was obtained from children aged ≥ 12 years.

Data collection

The data collection team consisted of four nurses, one health officer and health extension workers, and village chairpersons from each *kebele*. The researchers trained the nurses and the health officer on the nature, aetiology, treatment and prevention of podoconiosis. Practical training was also provided on clinical diagnosis and disease staging using a recently developed five-level podoconiosis staging system.¹³ A pre-test done in Bedele town to test the skills of the nurses and health officer ensured

reliability of their diagnostic skills. The health extension workers and village chairpersons guided the interviewers during house-to-house visits. The nurses registered households that included a podoconiosis patient, administered a structured questionnaire to these patients, and conducted a physical examination of the legs and feet of patients. The legs and feet were assessed for clinical stage of disease (using a validated podoconiosis staging system), adenolymphangitis (ALA; painful inflammation of the foot and leg with swollen lymph nodes and fever¹⁴), mossy lesions (fluid filled or papillomatous horny lesions giving the skin a rough appearance¹³) and open wounds (usually the result of minor trauma). The largest circumference of the leg between the levels of the ankle and knee was measured using a tape to a precision level of the nearest centimetre.

Data analysis

Data were entered and analysed using IBM SPSS Statistics 19 (IBM Corp., Armonk, NY, USA). Statistical significance was tested using χ^2 and Student's *t*-tests as appropriate. A *p* value of <0.05 was considered statistically significant.

Results

Burden of podoconiosis at individual, household and family level

House-to-house visits were made to 2285 households. A total of 379 podoconiosis patients were registered giving an overall prevalence of podoconiosis of 5.6% (379/6710; 95% CI 5.1–6.2%). The prevalence was greater among women than men (6.6% [222/3377] vs 4.7% [157/3333]; OR = 1.4, 95% CI 1.2–1.8) (Table 1).

A total of 128 patients (40.8% [64/157] of men and 28.9% [64/222] of women; $\chi^2 = 4.6$; *p* = 0.028) reported having a blood relative with podoconiosis. Of these, 97 (75.8%) reported having one or more affected close relatives (sibling, parent or

Table 1. Prevalence of podoconiosis in Bedele Zuria *woreda*, west Ethiopia

Kebele	Population at risk ^a			Prevalence [n(%); 95% CI] ^b		
	Men	Women	Total	Men	Women	Total
Odo	462	480	942	33 (7.1; 5.1–9.9)	44 (9.2; 6.9–12.1)	77 (8.2; 6.6–10.1)
Dekaye Dabena	636	642	1278	38 (6.0; 4.4–8.1)	54 (8.4; 6.5–10.8)	92 (7.2; 5.9–8.8)
Ourgesa	572	598	1170	25 (4.4; 3.0–6.4)	37 (6.2; 4.5–8.4)	62 (5.3; 4.2–6.7)
Dabena Daru	784	785	1569	40 (5.1; 3.8–6.9)	43 (5.5; 4.1–7.3)	83 (5.3; 4.3–6.5)
Bosoke Dakal	879	872	1751	21 (2.4; 1.6–3.6)	44 (5.0; 3.8–6.7)	65 (3.7; 2.9–4.7)
Total ^c	3333	3377	6710	157 (4.7; 4.0–5.5)	222 (6.6; 5.8–7.5)	379 (5.6; 5.1–6.2)

^aThe population at risk was the number of individuals aged ≥ 10 years (because podoconiosis is rare in those aged <10 years). The population at risk was considered to be 65% of the total population of the *kebeles* based on the 2007 Housing and Census for rural Midakegn *woreda*.

^bThe percentage shows the prevalence of podoconiosis, calculated as the ratio of registered patients divided by the total population at risk in each *kebele*.

^cPrevalence was significantly higher among women than men (OR = 1.4, 95% CI 1.2–1.8; *p* = 0.001).

grandparent). There was at least one member with podoconiosis in 311 households (16.9%) and 70 of these households (22.5%) had two or more podoconiosis-affected members. Of the households reporting two or more affected members, 32 (45.7%) included an affected couple.

Characteristics of patients and clinical features of podoconiosis

A total of 318 patients underwent further interview about the clinical features of podoconiosis and a physical examination of their legs. Two hundred and forty-three (76.4%) patients were in the economically active age group of 15–64 years, 242 (76.1%) could not read or write and 294 (92.5%) were subsistence farmers (Table 2).

The average age of onset of podoconiosis was 32.2 years and the average duration of illness between time of onset and time of interview was 17 years. Physical examination of patients' legs showed that 216 (68%) had stage I or II disease, 237 (74.5%) had mossy lesions, 23 (7.2%) had open wounds and 37 (11.6%) had ALA. Two hundred and forty-six (77.4%) patients said that they experienced at least one episode of ALA during the year prior to the interview in the study (Table 3). On average a patient experienced six episodes of ALA per year. Two hundred and forty (75.5%) patients said they stayed in bed for an average of 4.3 days per each

episode, resulting in a loss of 25.4 days of activity per year. More women than men experienced ALA (81.3% [152/187] vs 73.4% [94/128]; OR = 1.9, 95% CI 1.1–3.2; $p=0.028$), and women experienced more episodes of ALA per year (6.1 vs 5.6), more bed days per episode (4.8 vs 3.6 days), and hence more days of activity lost per year due to morbidity (29.3 vs 20.2) than men, but the differences in these last three comparisons were not statistically significant. More men than women said that they sought treatment at a modern health care facility (80.8% [76/94] vs 66.4% [101/152]; OR = 2.2, 95% CI 1.3–3.7; $p=0.006$). Most patients associated severity and frequency of ALA with the rainy season (45% [130/289]) and *chagino* (the local term for the season when they see the new moon) (25.3% [73/289]).

Shoe wearing and foot washing experience

The average age of patients when they had their first shoes was 31 years. At the time of interview, 104 patients were barefoot (41.8% [77/184] of women vs 20.7% [27/130] of men; $\chi^2=22.5$, $p<0.001$); these patients said they did not wear shoes on non-cemented home floors, while farming fields or in other places that contain red-clay soil. Patients estimated the average distance to the nearest water source to be a 12 min walk (range 1–60). Sixty-four of 317 patients (20.2%) said they had inadequate access to water because of seasonal water shortages and 115 of 317 patients (36.3%) did not use soap for washing their feet. The use of soap for washing feet was associated with absence of open wounds ($\chi^2=4.3$; $p=0.042$) (Table 4).

Discussion

This study found a high prevalence of podoconiosis in Bedele Zuria *woreda*, west Ethiopia of 5.6% which was higher than that recently reported for disease-endemic areas in northern, western and southern Ethiopia,^{7,11,15} and less than that of Mid-akegn district, central Ethiopia.¹⁶ This prevalence is lower than that reported in 1992 among long-term residents in Illubabor zone (of which Bedele Zuria *woreda* is one of the subdistricts);¹⁷ however the difference was not statistically significant. This observed slight decline in prevalence may be because of the general gradual increase in the use of footwear in rural areas. In addition, the current estimate may be an underestimate because examination of the legs for case detection was undertaken only when patients were reported by household heads. This is likely because in rural areas such as Bedele Zuria *woreda* where there are no podoconiosis prevention and treatment programmes, patients may avoid being seen in public as a coping strategy against deep-seated social stigma.^{8,18,19} In Bedele Zuria *woreda* and other podoconiosis-endemic areas, the prevalence of podoconiosis is greater than that of HIV/AIDS, TB and malaria.¹¹ A fraction of local and global resources for these diseases would cover prevention and treatment of podoconiosis, thereby improving the quality of life for patients and reversing the economic burden of the disease.

The overall prevalence of podoconiosis in the current study area was significantly higher among women than among men, consistent with studies in Gulliso, Wolaita, Pawe and Ocholo.^{11,14,20,21} The predominance of podoconiosis among

Table 2. Characteristics of podoconiosis patients in Bedele Zuria *woreda*, west Ethiopia

Characteristic	Men (n = 131)	Women (n = 187)	Overall (n = 318)
Average age (years)	49.2 ± 19.8	49.0 ± 17.8	49.1 ± 18.5
Age group (years)			
<15	3 (2.3)	2 (1.1)	5 (1.6)
15–64	97 (74.0)	146 (78.1)	243 (76.4)
>64	31 (23.7)	39 (20.9)	70 (22.0)
Able to read and write			
Yes	51 (38.9)	25 (13.4)	76 (23.9)
No	80 (61.1)	162 (86.6)	242 (76.1)
Level of education ^a			
Grades 1–4	32 (24.4)	13 (7.0)	45 (14.2)
Grades 5–8	11 (8.4)	9 (4.8)	20 (6.3)
Grades 9–10	7 (5.3)	2 (1.1)	9 (2.8)
College	1 (0.8)	1 (0.5)	2 (0.6)
Occupation			
Farmer	120 (91.6)	174 (93.0)	294 (92.5)
Other ^b	11 (8.4)	13 (7.0)	24 (7.5)

Data are number (%) or mean ± SD.

^aLevel of education completed for patients able to read and write.

^bOther includes retired (n = 13), student (n = 9), housewife (n = 1) and government employee (n = 1).

Table 3. Clinical features of podoconiosis and acute lymphadenitis (ALA) in patients in Bedele Zuria *woreda*, west Ethiopia

Feature	Men	Women	Total
Clinical stage (n = 318)			
I	9 (6.9)	23 (12.3)	32 (10.1)
II	78 (59.5)	106 (56.7)	184 (57.9)
III	44 (33.6)	57 (30.5)	101 (31.8)
IV	0	1 (0.5)	1 (0.3)
Leg circumference in cm (n = 265)	26 ± 3.3	25.4 ± 3.3	25.7 ± 3.4
Mossy lesion present (n = 318)	103 (78.6)	134 (71.7)	237 (74.5)
Open wound present (n = 318)	13 (9.9)	10 (5.4)	23 (7.2)
Had ALA during the previous 12 months (n = 315) ^a			
Previous week	18 (14.1)	42 (22.5)	60 (19.0)
Previous 1 month	61 (47.7)	115 (61.5)	176 (55.9)
Previous 6 months	75 (58.6)	131 (70.1)	206 (65.4)
Previous 12 months	94 (73.4)	152 (81.3)	246 (78.1)
No. of ALA episodes in previous 12 months (n = 239)	5.6 ± 5.4	6.1 ± 5.9	5.9 ± 5.6
Facility where treatment for ALA was sought (n = 246) ^b			
Clinic	57 (60.6)	73 (48.0)	130 (52.8)
Pharmacy	19 (20.2)	28 (18.4)	47 (19.1)
Traditional	7 (7.4)	16 (10.5)	23 (9.3)
None	11 (11.7)	35 (23.0)	46 (18.7)
No. of days in bed during an ALA episode (n = 240)	3.6 ± 4.9	4.8 ± 5.1	4.3 ± 5.1
Season or activity when symptoms of ALA get worse (n = 289)			
Rainy season	66 (52.0)	64 (35.2)	130 (45.0)
<i>Chagino</i> (new moon)	23 (18.1)	50 (27.5)	73 (25.3)
Dry season	19 (15.0)	20 (22.0)	39 (13.5)
No specific season	11 (8.7)	16 (8.8)	27 (9.3)
During farming or walking long distance	8 (6.3)	12 (6.6)	20 (6.9)

Data are number (%) or mean ± SD.

^aExperience of ALA over the previous 12 months was significantly higher among women than men (OR = 1.9, 95% CI 1.1–3.2; p = 0.028)

^bTreatment seeking at a modern health care facility was significantly higher among men than women (OR = 2.2, 95% CI 1.3–3.7; p = 0.006)

women when compared with men is consistent with the observation that women are less likely to have shoes in many rural areas. Similar to the finding in Gulliso,¹¹ early forms of podoconiosis (stages I and II) were more common among women, while the advanced forms (stages III and IV) were more common among men. This may be because women seek help earlier to control disease progress, motivated by physical appearance, or because they have better access to rinsing water because of their primary involvement in household chores such as washing clothes and fetching water.

Over three-quarters of the podoconiosis patients were in the economically productive age group, suggesting that the economic effect of the disease in the study area is high. Previous studies have also shown high prevalence of podoconiosis in this age group^{5,7,11} and huge economic costs resulting from loss of productivity including a loss of 45% of productive days per year in patients.¹⁰ Household level impoverishment may be aggravated by the fact that clustering of affected individuals was observed in several households in the present study, possibly because of genetic susceptibility.^{2–4} We acknowledge that reported family history of the disease, though high, may still be

an underestimate²² and is lower than that in northern Ethiopia.²² Underestimation may have occurred because podoconiosis is believed to run in families in endemic areas, resulting in stigmatization of family members manifested as exclusion from social events and loss of marriage prospects for women. As a consequence, affected people tend to keep any family history of disease confidential.^{8,9,18,19} This is likely in the present study area because disease prevention and treatment programmes, which have helped reduce social stigma in southern Ethiopia,⁹ had not been instituted in Bedele Zuria *woreda* at the time of the study. We also found that fewer women than men reported having a relative affected by podoconiosis. This suggests more pronounced under-reporting by female patients whose marriage prospects are diminished by the stigma associated with the disease,¹¹ and is in agreement with our previous study in Gulliso *woreda*. The presence of affected couples in many households reflects previous observations that non-affected individuals in the community are not willing to marry podoconiosis patients^{8,9} and may be a coping strategy that patients have adopted to mitigate social stigma by limiting marriage to other podoconiosis patients only.¹⁹ Previous studies have shown that

Table 4 Factors related to washing feet and wearing shoes in patients in Bedele Zuria *woreda*, west Ethiopia

Factor	Men	Women	Total
Access to water for washing feet (n = 317)			
Said they did not have access to enough water	28 (20.4)	36 (19.4)	64 (20.2)
Of those that did not have access to enough water, water source was reported to be too far	11 (39.3)	12 (33.3)	23 (35.9)
Of those that did not have access to enough water, those that reported seasonal water shortage	12 (42.9)	19 (52.8)	31 (48.4)
Minutes' walk to access water for washing	11.5 ± 10.0	12.6 ± 11.8	12 ± 11.1
Foot washing habit (n = 317)			
Washed feet at least once per day	124 (96.6)	181 (97.3)	305 (96.2)
Did not use soap when washing feet	51 (38.9)	64 (34.6)	115 (36.3)
Shoe wearing history (n = 317)			
Age shoes first worn (years)	28.7 ± 18.2	32.1 ± 18.5	30.5 ± 18.4
Pairs of shoes owned	1.7 ± 0.7	1.6 ± 0.8	1.6 ± 0.8
Pairs of shoes needed per year	2.8 ± 1.3	3.0 ± 1.4	2.9 ± 1.3
Type of footwear at time of interview (n = 314)			
Hard plastic	73 (56.2)	73 (39.7)	146 (46.5)
Ethylene-vinyl acetate rubber shoes	20 (15.4)	23 (12.5)	43 (13.7)
Canvas	3 (2.3)	6 (3.3)	9 (2.9)
Leather	7 (5.4)	5 (2.7)	12 (3.8)
No footwear (barefoot) ^a	27 (20.7)	77 (41.8)	104 (33.1)
Situations when shoes are not usually worn (n = 232)			
During farming/work	23 (20.7)	20 (15.2)	43 (17.1)
While at home	0	13 (5.2)	13 (12.8)
Never wears shoes	4 (3.6)	14 (10.6)	18 (7.2)
Never walks barefoot	84 (75.7)	74 (56.1)	158 (62.9)

Data are number (%) or mean ± SD.

^aThe proportion of barefoot women at time of interview was significantly higher than that of men ($\chi^2 = 22.5$; $p < 0.001$).

podoconiosis has a strong genetic component with heritability of 63% (i.e. 63% of the variation in development of podoconiosis is accounted for by genetic factors), and sibling recurrence risk ratio of 5.07 (i.e. the sibling of an affected person is at five times increased risk of developing podoconiosis when compared with a person in the general population).^{2,3} Recently, a genome-wide association study has identified genetic variants in the HLA class II loci, particularly *HLA-DQA1*, *HLA-DRB1* and *HLA-DQB1* genes that confer susceptibility to podoconiosis.⁴ Using family history of podoconiosis to target disease prevention resources to affected families²³ has been found to be useful in southern Ethiopia, and might be adopted in the present study area.

The majority of patients had the early clinical stage of podoconiosis (stages I or II) and mossy lesions. Empirical evidence from southern Ethiopia showed a reduction in leg circumference and an improvement in clinical stage following the use of a simple lymphoedema management method including regular use of footwear, washing of feet with soap, water and an antiseptic, and compression bandage or elevation of legs at night.¹² Provision of health education about podoconiosis and supplying affordable shoes in the study area might help

reverse the progress of disease in the majority of patients in the present study area. The other common clinical feature among the study patients was ALA. ALA episodes occurred frequently, and resulted in considerable absence from productive work, similar to that demonstrated in Gulliso *woreda*,¹¹ and higher than that reported for lymphatic filariasis.^{24–26} We also found that women were twice as likely to experience ALA and had more prolonged morbidity during each episode of ALA than men. Despite the higher burden of ALA among women, treatment seeking for ALA was less common among women than men. This may be because of economic and social dominance of men in rural areas, and the fact that women are less likely to access scarce resources.

The primary component of podoconiosis prevention is wearing shoes consistently from childhood.^{5,17} However, we found that on average, patients started wearing shoes during the fourth decade of life, around the time they reported onset of podoconiosis. Previous studies have also recorded that podoconiosis patients start wearing shoes after the third decade of life,^{5,27} suggesting that starting to wear shoes may be one response to early signs of disease. More women than men were

observed to be barefoot at the time of data collection, reflecting the gender-related socioeconomic disparities in rural areas of Ethiopia.

The second basic component of podoconiosis prevention and treatment is washing feet with soap and water.¹² This study showed that open wounds (resulting from minor trauma to feet and damage to the skin barrier following the inflammatory process) were less common among study patients who washed their feet with soap and water. Feet that are kept clean by washing with soap and water tend to have intact skin that provides a stronger barrier against external insults, and are less prone to microbial infection that would otherwise undermine the healing process. On average, patients in the present study were within the WHO criterion on 'reasonable' access to drinking water (i.e. availability of at least 20 L of water per person per day within a round trip walking distance of 30 min).²⁸ However, 36.4% (115) of the study patients had never used soap for washing their feet and 48.4% (31) of those that did not have access to enough water also reported seasonal lack of access to adequate water.

In conclusion, this study reported a high prevalence of podoconiosis at individual and household levels in west Ethiopia, and documented morbidities such as ALA and mossy lesions that result in severe physical, social and economic loss. Therefore, public health programmes that include prevention, treatment and control of podoconiosis should be instituted in west Ethiopia.

Authors' contributions: All authors conceived and designed the study, developed the study instruments and interpreted the data; FTA and CA analysed the data and wrote the manuscript; CA coordinated the fieldwork. All authors revised the manuscript for substantial intellectual content and read and approved the final version. FTA is guarantor of the paper.

Acknowledgements: The authors thank the study participants and staff of Bedele Zuria *Woreda* Health Office, Ethiopia.

Funding: This work was supported by a donation through International Orthodox Christian Charities (IOCC) Podoconiosis Research for undertaking baseline surveys, capacity building, and training in North Ethiopia.

Competing interests: None declared.

Ethical approval: This study was approved by the Ethical Review Committee of the Oromia Regional Health Bureau, Ethiopia.

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