

# Diabetic foot ulcers and ethnicity in Tanzania: a contrast between African and Asian populations

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## Key Points

- over the past decade, medical personnel at Muhimbili National Hospital (MNH) and Abbas Medical Centre (AMC), both located in Dar es Salaam, Tanzania, have observed increasing numbers of people with diabetes presenting with foot ulcers to the diabetes clinic at both of these institutions and the subsequent admission of a substantial number of these patients to the MNH inpatient service
- it was not until 2002 that the clinical outcome of these hospitalised patients was characterised in a prospective cohort study carried out by Abbas *et al*
- in this study, the researchers found that approximately one-third patients admitted with foot ulcers subsequently underwent minor or major amputations
- patients who underwent limb amputation were significantly more likely to have gangrene or neuropathy although the overall mortality rate among all patients was 29%, the highest inpatient mortality rate (54%) was observed among patients with severe ulcers who did not undergo surgical amputation of the affected limb

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## ABSTRACT

To characterise the role of ethnicity in the occurrence of foot ulcer disease in persons with diabetes, we analysed prospectively collected data for persons attending the diabetes clinic at Muhimbili National Hospital (MNH), Dar es Salaam, Tanzania. A case was defined as any adult presenting to MNH with an ulcer at or below the ankle joint during July 1998–June 2005. We documented clinical and epidemiologic characteristics, progress, interventions and outcome. Seven hundred and eight persons met the case definition – 570 (80%) ethnic Africans and 138 (20%) Asian Indians. Ethnic Africans were more likely to present with gangrene ( $P < 0.01$ ); Indians were more likely to be obese ( $P < 0.001$ ) or have large vessel disease ( $P < 0.001$ ). For Africans, *intrinsic* complications (neuro-ischaemia or macrovascular disease) delayed ulcer healing; for Asian Indians, *mode of intervention* (e.g. sloughectomy or glycaemic control with insulin or oral agents) determined the same outcome. Indigenous ethnic African and Asian Indian populations with diabetes display contrasting foot ulcer epidemiology. Peripheral vascular disease and gangrene are playing a larger role in ulcer pathogenesis and outcomes for both ethnic groups than was previously thought. Preventive efforts and interventions should be tailored to the two ethnic groups to achieve complete ulcer healing.

**Key words:** Ethnicity • Foot ulcers • Outcomes • Peripheral neuropathy • Peripheral vascular disease • Sub-Saharan Africa • Tanzania

## INTRODUCTION

For people with diabetes in many African countries, foot ulcers continue to be responsible for prolonged hospital admissions and substantial morbidity and mortality (1–3). Peripheral neuropathy causes sensory denervation of feet and is the principal underlying risk factor in the pathogenesis of most of these foot ulcers,

which can progress to infection, necrosis, gangrene, loss of the limb or death (2–5). Over the past decade, medical personnel at Muhimbili National Hospital (MNH) and Abbas Medical Centre (AMC), both located in Dar es Salaam, Tanzania, have observed increasing numbers of people with diabetes presenting with foot ulcers to the diabetes clinic at both of these institutions and the subsequent admission of a substantial number of these patients to the MNH inpatient service. However, it was not until 2002 that the clinical outcome of these hospitalised patients was characterised in a prospective cohort study carried out by Abbas *et al*. (6). In this study, the researchers found that approximately one-third patients admitted with foot ulcers subsequently underwent minor or major amputations (6). Of note, patients who

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underwent limb amputation were significantly more likely to have gangrene or neuropathy; although the overall mortality rate among all patients was 29%, the highest inpatient mortality rate (54%) was observed among patients with severe ulcers who did not undergo surgical amputation of the affected limb (6).

Most of the people who attend the MNH diabetes clinic are of African ethnicity. Demographic changes, particularly population growth because of the dynamics of earlier high birth rates and increased movement of people in the at-risk age groups from rural to urban areas, have contributed to the increased numbers of ethnic Africans presenting to the MNH clinic with diabetes and the various complications linked to the condition: in particular, associated limb complications. In parallel, increasing numbers of ethnic African and ethnic Asian Indians have been presenting to the AMC diabetes clinic with diabetic foot complications.

Although the increasing public health importance of diabetes among ethnic African and Asian Indian people in Tanzania was appreciated over a decade ago (7,8), the importance of foot complications as a determinant of patient outcome in Dar es Salaam was only more recently characterised (2–4). Although Abbas *et al.*, working at MNH and AMC, have long recognised a distinct dissimilarity in the epidemiology of foot complications among persons with diabetes in the two ethnic groups, a formal comparative study of foot complications in these two important patient populations had not been carried out. Thus, we conducted this study to characterise the epidemiology and outcome of diabetic foot ulcers in the two major ethnic groups that regularly attend the diabetes clinics in Dar es Salaam.

## METHODS

### Study sites

MNH has more than 2500 beds and is the largest referral hospital in Tanzania. The MNH diabetes clinic serves mainly an ethnic African population; >5000 persons with diabetes are seen in the MNH diabetes clinic each year. AMC is a medical facility in Dar es Salaam that provides general medical and specialist endocrine services. In addition, AMC is the largest referral centre for diabetic foot complications in Tanzania and serves a broad patient population consisting of ethnic African, ethnic Asian Indians and Arabs.

Approximately 4000 persons are registered with the AMC diabetes clinic. In 1998, the investigators of the present study established the Tanzania Diabetic Ulcer Surveillance System (TANDUSS), one of the largest surveillance systems for diabetic hand and foot ulceration in Africa. Adult persons with diabetes voluntarily participate in TANDUSS following informed consent and are prospectively followed up in the MNH and AMC diabetes clinics, where epidemiologic data, clinical progress and outcome (e.g. non resolution, healing or death) are documented in a standardised questionnaire.

### Study population

For this study, a case was defined as any adult person registered in TANDUSS who presented to MNH or AMC with an ulcer at or below the ankle joint during July 1998–June 2005 (study period). Epidemiologic and clinical data that were analysed included demography, area of residence (urban or rural), occupation, education level, type and duration of diabetes, body mass index, family history of diabetes, tobacco and alcohol use and previous history of ulcers. Surgical debridement, antimicrobial therapy, education and counselling were part of the follow-up programme of care that study participants received in the AMC and MNH diabetes clinics. At these visits, details of care, progress of ulcer healing and clinical outcome were recorded for each study participant. One of the principal investigators (ZGA) saw and reviewed all patients during follow-up in the outpatient clinic, instituted appropriate management and therapy and entered the data in a computerised database.

### Physical assessment

Comprehensive histories and physical assessment were carried out for each patient during visits to the MNH or AMC clinics. These assessments have been described previously (4) and included objective evaluation of peripheral neuropathy and peripheral vascular disease as follows:

#### *Peripheral neuropathy*

Patients were asked to assess subjectively their symptoms (pain, numbness or paraesthesia) as absent, mild, moderate or severe. The symptoms score was graded no neuropathy (0–2 points), mild (3–4 points), moderate (5–6 points) or severe (7–9 points). A maximum symptom score of 9 points was possible. The signs of peripheral neuropathy (pain, temperature and

## Key Points

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- we conducted this study to characterise the epidemiology and outcome of diabetic foot ulcers in the two major ethnic groups that regularly attend the diabetes clinics in Dar es Salaam
- the investigators of the present study established the Tanzania Diabetic Ulcer Surveillance System (TANDUSS), one of the largest surveillance systems for diabetic hand and foot ulceration in Africa
- adult persons with diabetes voluntarily participate in TANDUSS following informed consent and are prospectively followed up in the MNH and AMC diabetes clinics, where epidemiologic data, clinical progress and outcome (e.g. non resolution, healing or death) are documented in a standardised questionnaire

### Key Points

- a total of 708 persons met the case definition during the study period. Of these, 570 persons (80%) were ethnic Africans, 138 (20%) ethnic Asian Indians
- ethnic Africans were significantly more likely than Asian Indians to present with a first-time ulcer (82% versus 70%) or to have gangrene of the lower limb at the time of presentation, resulting in major amputation of the affected limb and subsequent longer hospital stay
- Asian Indians were significantly more likely than ethnic Africans to have a family history of diabetes, large vessel disease, previous foot ulcers, history of tobacco use or higher body mass index

vibration) were scored separately for each leg as follows: 1 point if impaired or absent, 1 point if ankle reflex if present with reinforcement and 2 points if absent. The signs score was graded as no neuropathy (0–2 points), mild (3–5 points), moderate (6–8 points) or severe (9–10 points); a maximum sign score of 10 points was possible. Sensation modalities were tested as follows: touch (monofilaments and cotton balls), pain (disposable clean toothpicks), vibration (128 Hz turning fork) and temperature (hot and cold testing). In addition, the threshold of appreciation of vibration in subjects was measured with a biothesiometer, while the thermal perception threshold among persons with neuropathy was tested with a sensitometer.

#### *Peripheral vascular disease*

Peripheral vascular disease is defined as an ankle/brachial index ratio <0.9.

Study participants were deemed to have neuro-ischaemia if they had both peripheral neuropathy and peripheral vascular disease. Large vessel disease (macrovascular disease) was defined as the presence of one or more of the following: cerebrovascular disease, ischaemic heart disease or peripheral vascular disease. Microvascular was deemed to be present if the individual had one or both of documented retinopathy or nephropathy. Amputations or disarticulation performed at or below midtarsal level were classified as minor; amputations performed above the midtarsal level were classified as major (6). To characterise patient outcomes, we looked at time taken for ulcer to completely heal and rates of amputation at the time of hospital discharge.

#### **Statistical analysis**

We carried out univariate and multivariate analyses of the data using SAS statistical software package, version 6.12 (SAS Institute, Cary, NC). We compared proportions (prevalence estimates) using  $\chi^2$  or Fisher's exact test, where appropriate; the Wilcoxon rank sum test was used to compare medians. *P* values  $\leq 0.05$  were used to infer significance of difference. Multivariate analysis was carried out using logistic regression; adjusted odds ratio and 95% confidence interval were calculated for independent variables.

### **RESULTS**

A total of 708 persons met the case definition during the study period. Of these, 570 persons

(80%) were ethnic Africans, 138 (20%) ethnic Asian Indians, 386 (55%) were female, 663 (94%) had type 2 diabetes, 600 (85%) had peripheral neuropathy, 145 (21%) had peripheral vascular disease, 132 (19%) had neuro-ischaemia, 331 (47%) had microvascular disease, 177 (25%) had macrovascular disease, 133 (19%) underwent some form of amputation and 129 (18%) had ulcers that had progressed to gangrene (Wagner score  $\geq 4$ ) at the time of presentation. The overall mortality rate attributable to the foot ulcer was 6% (42/708). Characteristics of the study population are outlined in Table 1.

Ethnic African and Asian Indian people were similar for the following: median age, occurrence of microvascular disease or peripheral neuropathy, alcohol intake, hypertension, occurrence of cataracts, duration of diabetes, fasting blood glucose, delay in seeking medical attention or mortality (Table 1). However, ethnic Africans were significantly more likely than Asian Indians to present with a first-time ulcer (82% versus 70%) or to have gangrene of the lower limb at the time of presentation, resulting in major amputation of the affected limb and subsequent longer hospital stay (Table 1). Although ethnic Africans were over twice as likely as Asian Indians to have type 1 diabetes (7% versus 3%), the difference was not significant to the 0.05 level. In contrast, Asian Indians were significantly more likely than ethnic Africans to have a family history of diabetes, large vessel disease, previous foot ulcers, history of tobacco use or higher body mass index (Table 1).

On multivariate analysis, independent factors associated with failure of ulcers to heal in the ethnic African population were diabetes of duration <36 months at the time presentation, presence of neuro-ischaemia or macrovascular on initial physical assessment or a body mass index <22 (Table 2). In addition, independent correlates for amputation in the ethnic African population were large vessel disease or ulcers with Wagner score  $\geq 3$  at the time of presentation (Table 2).

Independent correlates for ulcer healing or amputation were essentially different for Asian Indians: gangrene at presentation was the single independent risk factor for undergoing limb amputation; sloughectomy or control of diabetes with oral agents or insulin (i.e. surgical intervention and therapeutics rather than intrinsic risk factors) was independently associated

**Table 1** Patient characteristics by ethnicity (univariate analysis)

	Ethnic African (n = 570)	Asian Indian (n = 138)	P value
Selected characteristics			
Sex (female)	310 (54%)	76 (55%)	NS
Type 2 diabetes	530 (93%)	134 (97%)	NS
Alcohol	244 (43%)	51 (37%)	NS
Peripheral neuropathy	485 (85%)	115 (83%)	NS
Microvascular disease*	265 (46%)	66 (48%)	NS
Cataract	36 (6.3%)	4 (3%)	NS
Hypertension	218 (38%)	65 (47%)	NS
Family history of diabetes	239 (42%)	93 (67%)	<0.001
Macrovascular disease†	117 (20%)	60 (44%)	<0.001
Wagner score $\geq 3$	200 (35%)	18 (13%)	<0.001
Tobacco use	54 (9%)	25 (18%)	<0.01
Peripheral vascular disease	103 (18%)	42 (30%)	<0.01
Neuro-ischaemia‡	93 (16%)	39 (28%)	<0.01
First-time ulcer	470 (82%)	97 (70%)	<0.01
History of previous foot ulcers	85 (15%)	36 (26%)	<0.01
Gangrene of the lower limb	117 (21%)	12 (9%)	<0.01
Major amputation of the lower limb	42 (7.4%)	2 (1.4%)	<0.05
Type 1 diabetes	40 (7%)	4 (3%)	0.07
Surgical intervention§	418 (73%)	77 (56%)	<0.001
Mortality attributable to foot ulcer	36 (6.3%)	6 (4.3%)	NS
Continuous variables (median)			
Body mass index (kg/m <sup>2</sup> )	24.4	27.7	<0.0001
Duration of hospital stay (days)	85	38	<0.01
Age (years)	53	54	NS
Duration of diabetes (years)	7	7	NS
Delay in seeking medical attention (days)	9	9.5	NS
Fasting blood glucose (mmols/l)	12.8	11.8	NS

\*Microvascular disease: retinopathy, nephropathy or both.

†Macrovascular disease: presence of one or more of ischaemic heart disease, cerebrovascular disease or peripheral vascular disease.

‡Neuro-ischaemia: presence of both peripheral vascular disease and neuropathy.

§Surgical intervention: sloughectomy, amputation or both.

NS, not significant

with complete healing (Table 2). Overall, ethnic African patients were more likely than Asian Indians to undergo a surgical intervention (73% versus 56%,  $P < 0.001$ ) (Table 1). Of note, a body mass index  $>22$  kg/m<sup>2</sup> was independently associated with complete healing for both ethnic populations (Table 2); however, obesity (i.e. body mass index  $\geq 28$  kg/m<sup>2</sup>) was not found to be a risk factor for poor outcomes in and of itself.

## DISCUSSION

Our findings confirm that foot ulceration is associated with substantial morbidity and mortality among persons with diabetes in Tanzania. Moreover, we highlighted differences in the epidemiology of foot ulcers among persons of African and Asian Indian ethnicity: the former were more likely to have type 1 diabetes, to present with foot ulcers for the first

time, to have ulcers with a relatively high severity score or gangrene at presentation or to subsequently undergo major amputation following admission to the MNH inpatient service. Asian Indians were more likely to have a family history of diabetes, to be tobacco smokers, to have a history of previous foot ulcers or to have peripheral neuropathy and complications generally associated with large vessel disease or neuro-ischaemia. With regard to patient outcome, we found that the main independent determinants of ulcer healing among ethnic Africans was the presence or absence of intrinsic complications of diabetes at the time of presentation (Table 2); in contrast, ulcer healing among the Asian Indians was largely dependent on surgical intervention or control of diabetes with insulin or oral agents (Table 2). These findings have implications for the management and prevention of foot complications

## Key Points

- With regard to patient outcome, we found that the main independent determinants of ulcer healing among ethnic Africans was the presence or absence of intrinsic complications of diabetes at the time of presentation; in contrast, ulcer healing among the Asian Indians was largely dependent on surgical intervention or control of diabetes with insulin or oral agents
- these findings have implications for the management and prevention of foot complications among all persons with diabetes who are followed up in this region of Africa

**Table 2** Independent correlates of amputation and total ulcer healing among persons with diabetes, Dar es Salaam, Tanzania (by ethnic group) – multivariate analyses

Outcome	Correlate	Adjusted odds ratio (95% CI)	
Ethnic African patients	Amputation	Gangrene (Wagner score $\geq 3$ ) at presentation	47 (21.8–117)
		Macrovascular disease*	2.8 (1.3–6.1)
	Complete healing	Diabetes of duration >36 months	2.5 (1.4–4.5)
		Absence of neuro-ischaemia†	2.8 (1.4–6.0)
		Absence of macrovascular disease	2.8 (1.4–5.6)
	Body mass index >22 kg/m <sup>2</sup>	2.9 (1.6–5.2)	
Ethnic Asian Indian patients	Amputation	Gangrene (Wagner score $\geq 3$ ) at presentation	61.8 (12.1–484)
	Complete healing	Sloughectomy	22.5 (2.0–832)
		Body mass index >22 kg/m <sup>2</sup>	4.9 (1.2–24)
		Control of diabetes with tablets and/insulin	10.1 (2.4–57)

\*Macrovascular disease: presence of one or more of ischaemic heart disease, cerebrovascular disease or peripheral vascular disease.  
†Neuro-ischaemia: presence of both peripheral vascular disease and peripheral neuropathy.

among all persons with diabetes who are followed up in this region of Africa.

A previous study at MNH found that 15% of persons with diabetes admitted to the medical inpatient service had foot ulcers at presentation; 80% of these were first-time occurrences (6). Data from that study also highlighted the association of ulcer severity at presentation and subsequent mortality among the ethnic African population admitted to the hospital inpatient services (6). As far back as 1990, clinical researchers in Nigeria and Tanzania recognised that foot complications in ethnic African people with diabetes frequently progressed to gangrene and resulted in prolonged hospital stays and significant mortality (5,9). Unfortunately, this reality remained unchanged in the ensuing 18 years, and all current data suggest that diabetic foot problems are getting worse across the African continent (1–3).

There are various reasons why ethnic Africans are more likely to have gangrenous foot ulceration at presentation. First, it has long been observed that ethnic African persons with diabetes who are admitted to MNH with foot ulcers frequently end up undergoing some form of amputation of the affected foot; the underlying reasons are complex but involve cultural issues (6): in a culture where the stigma associated with limb loss is often considered worse than loss of life, there is a natural reluctance to seek medical attention until the foot has deteriorated to a point where amputation is inevitable. Even after admission to the hospital inpatient service and a decision to operate has been made by a surgeon, the patient might still

choose to defer surgery, increasing the risk of disseminated infection occurrence and death (6,10). Second, the problem is compounded by the relative poverty in the ethnic African population, especially among those persons from rural areas. For example, barefoot walking is a common practice among people living in rural Africa and is generally related to low income, although to some degree it might be cultural as well. Living at or below the poverty level often precludes the purchase of basic footwear and essential medications or the ability to underwrite the cost of travel for acute medical attention or routine 6-monthly follow-up at the nearest diabetes clinic – a reality often encountered in the MNH and AMC diabetes clinics. The issue of poverty has been highlighted in a recent report by Abbas *et al.* in which rodents were identified as a cause of severe foot ulceration and sepsis – poverty and unhygienic conditions were identified as the main underlying risk factors (11).

The majority of ethnic African patients who attend the MNH and AMC diabetes clinics reside up-country in far-flung villages; relatively fewer of the MNH ethnic African attendees reside locally in the areas around Dar es Salaam (unpublished observations). Reflected in this observation are our findings that 82% of the ethnic Africans in our study were presenting to the clinics for the first time, 35% with ulcers with a Wagner severity score index of 3 or more at initial assessment (versus 13% for ethnic Asian Indians) and 21% with gangrene (9% for Asian Indians). This disparity in ulcer severity between ethnic Africans and Asian Indians at the time of

presentation is almost certainly the reason why the former patient population was more likely to undergo surgery with minor and major amputation of the affected limb during hospitalisation. In addition, because the majority of ethnic Africans live in remote areas, routine postoperative follow-up to monitor progress of wound healing or other clinical progress would not have been realistic. Thus, ethnic African patients who underwent surgery generally would have been managed in the MNH inpatient setting during the postoperative period until a satisfactory degree of wound healing and diabetes control were achieved. For these two reasons (i.e. undergoing surgery and prolonged, inpatient postoperative care), median duration of hospital stay for ethnic Africans (85 days) was significantly higher than the median inpatient stay for Asian Indians (38 days).

Typically, for ethnic African persons from rural areas, presentation to the MNH or AMC clinic would occur following a series of sequential referrals after unsuccessful home therapy (e.g. soaking in hot water): first, visits to local 'herbal doctors' for application of unproven remedies or visits to faith healers, followed by visits to primary care centres, district hospitals and regional hospitals, where health care providers might not be familiar with management of the diabetic foot, which oftentimes become septic because of the resulting delays. By the time the patient is finally referred for specialist care at MNH or AMC, the ulcer has often progressed to gangrene and systemic infection, leading inevitably to poorer outcomes. Although ethnic Asian Indians generally live in urban areas in and around Dar es Salaam, they, too, frequently (70%) presented with first-time ulcers with a median delay in seeking medical attention no different from ethnic Africans (Table 1). Thus, although they do not have the disadvantage of having to travel long distances from up-country villages, Asian Indians still tend to present late to AMC because they would often seek medical attention at other urban medical centres not specialised in diabetic foot management and, by and large, are referred to AMC only when there is failure to heal or deterioration of the foot to osteomyelitis, gangrene or systemic infection. Thus, the common thread linking poor outcomes in both ethnic groups is not racial inequity but rather lack of education on prevention issues (i.e. appreciation of the negative outcomes associated with

delays in presentation, basic foot care, glycaemic control and the importance of follow-up care) among both health care providers and patients alike, unfamiliarity or inexperience with up-to-date management of the diabetic foot among the providers or lack of facilities and skilled medical personnel and ancillary staff trained in diabetic foot management.

Whatever the underlying reasons for not attending a specialist diabetes clinic for follow-up care and education, the consequences are critical. For example, we found that diabetes diagnosed <36 months before the time of presentation for ethnic Africans was independently associated with failure of the ulcer to heal (Table 2). This finding is explained by the fact that ethnic Africans persons with more recently diagnosed diabetes are less likely to be familiar with or grounded in the basic tenets of foot ulcer prevention and glycaemic control compared with those with diabetes of longer duration, who had been attending the MNH and AMC clinics regularly or even periodically and for whom these tenets were familiar. These data underscore the importance of education for the prevention of diabetic foot ulcers in Tanzania. Thus, although we describe two patient populations with lifestyles that are distinctly dichotomous – a population of ethnic Africans typical of rural Tanzania and of lower socio-economic means versus an Asian Indian population living in urban areas, eating a completely different diet and accustomed to a relatively affluent lifestyle not dissimilar to industrialised countries – lack of education and knowledge of diabetes and its various complications among health care providers and the patients themselves result in poor outcomes, regardless of ethnicity or social standing.

The fact that ethnic Asian Indian people were more likely to have a family history of diabetes is not new. In 1990, MNH researchers conducted clinical and epidemiologic studies that showed diabetes and impaired glucose tolerance were common among Asian Indian people with a family history of diabetes and that type 2 diabetes had already become a substantial public health problem among Asian Indians living in Tanzania at that time (8). Despite the recognition of the underlying risks of diabetes for the indigenous Asian Indian population in Tanzania (as it is for Asian Indians across the globe), the secular trend of diabetes rates in the Tanzanian Asian Indian population over the ensuing 18 years has remained incremental, suggesting

### Key Points

- the common thread linking poor outcomes in both ethnic groups is not racial inequity but rather lack of education on prevention issues (i.e. appreciation of the negative outcomes associated with delays in presentation, basic foot care, glycaemic control and the importance of follow-up care) among both health care providers and patients alike, unfamiliarity or inexperience with up-to-date management of the diabetic foot among the providers or lack of facilities and skilled medical personnel and ancillary staff trained in diabetic foot management
- whatever the underlying reasons for not attending a specialist diabetes clinic for follow up care and education, the consequences are critical

### Key Points

- in our analyses, we found that body mass index  $>22 \text{ kg/m}^2$  was an independent correlate for complete ulcer healing in both ethnic Africans and Asian Indians
- the most plausible explanation for this finding is the importance of good nutrition in promoting healing
- furthermore, our findings suggest that obesity did not deter ulcer healing in both ethnic groups
- in conclusion, our findings show contrasting foot ulcer epidemiology for indigenous ethnic African and Asian Indian populations with diabetes
- in addition, it appears that peripheral vascular disease might be playing a more significant role in the pathogenesis of foot ulcers in both ethnic groups than was previously thought but particularly in the indigenous Asian Indian population
- preventive efforts and interventions should be tailored to the two ethnic groups to achieve complete ulcer healing: an ethnic African population for whom intrinsic factors (neuro-ischaemia or macrovascular disease) determined complete ulcer healing versus an Asian Indian population for whom the modes of intervention (e.g. sloughectomy or glycaemic control with insulin or oral agents) determined the same outcome
- finally, the basic principles of prevention must remain the same for both populations and should include educational programmes, simple and repetitive, targeted at both health care workers and patients alike, focusing on the importance of foot care and of consulting a doctor during the early stages of foot-related symptoms and before the onset of gangrene or infection once an ulcer has developed

that prevention and control of diabetes in this ethnic group have not been successful and that higher socio-economic standing does not necessarily imply a critical understanding about diabetes and its complications.

Reasons for increased body mass index in the Indian study population include diet, cultural and behavioural factors, sedentary lifestyle, especially among women, and a relatively affluent lifestyle compared with ethnic Africans. In a 1993 report of global estimates for prevalence of diabetes and impaired glucose tolerance in adults carried out by the World Health Organisation (WHO), the highest estimates for the prevalence of impaired glucose tolerance were seen in female Muslim Asian Indians living in Tanzania (12). Our documentation of higher rates of tobacco use, stroke, ischaemic heart disease, peripheral vascular disease and neuro-ischaemia in the Tanzanian Asian Indian risk profile is not dissimilar to those of persons with diabetes in industrialised countries and is worrying when the above WHO findings for women are taken into consideration. Our findings also parallel those of a previous, comparative, population-based survey carried out among Asian Indian communities living in Tanzania and the UK (7). Although the investigators of that study found no differences in the prevalence rates of known diabetes or body mass index measurements when subjects in the two countries were compared, newly diagnosed diabetes, hypercholesterolaemia and tobacco use were significantly higher in the Tanzanian study population versus a comparable group in the UK (7). In our analyses, we found that body mass index  $>22 \text{ kg/m}^2$  was an independent correlate for complete ulcer healing in both ethnic Africans and Asian Indians (Table 2). The most plausible explanation for this finding is the importance of good nutrition in promoting healing. Furthermore, our findings suggest that obesity did not deter ulcer healing in both ethnic groups.

There were several limitations to our study. First, we did not document glycaemic control among study participants because glycosylated haemoglobin level testing was either too expensive or not routinely available. Thus, we were not able to carry out a comparative study of glycaemic control in the two populations or ascertain the effect of high body mass index on diabetes control in the respective populations. Second, available laboratory resources did not allow us to ascertain the role of infection in the

pathogenesis of foot ulceration or as a factor contributing to attributable morbidity and mortality in the study population. Such testing would have required deep tissue biopsies of ulcers and culture of these biopsies for aerobic and anaerobic organisms, fungi and mycobacteria. Third, although our population sample size was overall substantial, it was not sufficient for stratification by region; thus, we were not able to characterise regional variation in the occurrence of foot ulcers in persons with diabetes who attend the MNH and AMC clinics. Fourth, we were not able to characterise the deaths that were non-ulcer related. And finally, we were not able to delineate the *treatment intensity* for individual patients: that is, the degree to which indicated therapies, such as off-loading, wound debridement or treatment of infection with antimicrobials and optimal health education were carried out by MNH and AMC personnel and adhered to by patients.

In conclusion, our findings show contrasting foot ulcer epidemiology for indigenous ethnic African and Asian Indian populations with diabetes. In addition, it appears that peripheral vascular disease might be playing a more significant role in the pathogenesis of foot ulcers in both ethnic groups than was previously thought but particularly in the indigenous Asian Indian population. Preventive efforts and interventions should be tailored to the two ethnic groups to achieve complete ulcer healing: an ethnic African population for whom *intrinsic* risk factors (neuro-ischaemia or macrovascular disease) determined complete ulcer healing versus an Asian Indian population for whom the *modes of intervention* (e.g. sloughectomy or glycaemic control with insulin or oral agents) determined the same outcome. Finally, the basic principles of prevention must remain the same for both populations and should include educational programmes, simple and repetitive, targeted at both health care workers and patients alike, focusing on the importance of foot care and of consulting a doctor during the early stages of foot-related symptoms and before the onset of gangrene or infection once an ulcer has developed.

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## REFERENCES

- 1 Amos AF, McCarty DJ, Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. *Diabet Med* 1997;14:S1–8.
- 2 Abbas ZG, Archibald LK. Epidemiology of the diabetic foot in Africa. *Med Sci Monit* 2005;11:RA262–70.
- 3 Abbas ZG, Gill GV, Archibald LK. The epidemiology of diabetic limb sepsis: an African perspective. *Diabet Med* 2002;19:895–9.
- 4 Abbas ZG, Archibald LK. Foot complications in diabetes patients with symptomatic peripheral neuropathy in Dar es Salaam, Tanzania. *Diabet Int* 2000;10:52–6.
- 5 McLarty DG, Pollitt C, Swai ABM. Diabetes in Africa. *Diabet Med* 1990;7:670–84.
- 6 Abbas ZG, Lutale JK, Morbach S, Archibald LK. Clinical outcome of diabetes patients hospitalised with foot ulcers, Dar es Salaam, Tanzania. *Diabet Med* 2002;19:575–9.
- 7 Ramaiya KL, Denver E, Yudkin JS. Diabetes, impaired glucose tolerance and cardiovascular disease risk factors in the Asian Indian Bhatia community living in Tanzania and the United Kingdom. *Diabet Med* 1995;12:904–10.
- 8 Swai AB, McLarty DG, Sherrif F, Chuwa LM, Maro E, Lukmanji Z, Kermali W, Makene W, Alberti KG. Diabetes and impaired glucose tolerance in an Asian community in Tanzania. *Diabetes Res Clin Pract* 1990;8:227–34.
- 9 Akanji AO, Adetuyidi A. The pattern of presentation of foot lesions in Nigerian diabetic patients. *West Afr J Med* 1990;9:1–5.
- 10 Akanji AO, Famuyiwa OO, Adetuyibi A. Factors influencing the outcome of treatment of foot lesions in Nigerian patients with diabetes mellitus. *Q J Med* 1989;73:1005–14.
- 11 Abbas ZG, Lutale J, Archibald LK. Rodent bites in the feet of diabetes patients in Tanzania. *Diabet Med* 2005;22:631–3.
- 12 King H, Rewers M. Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults. WHO Ad Hoc Diabetes Reporting Group. *Diabetes Care* 1993;16:157–77.